Ossipee Lake Watershed Management Plan
Phase I

A Watershed Plan for
Danforth Ponds and the Lower Bays of Ossipee Lake

Carroll County, New Hampshire

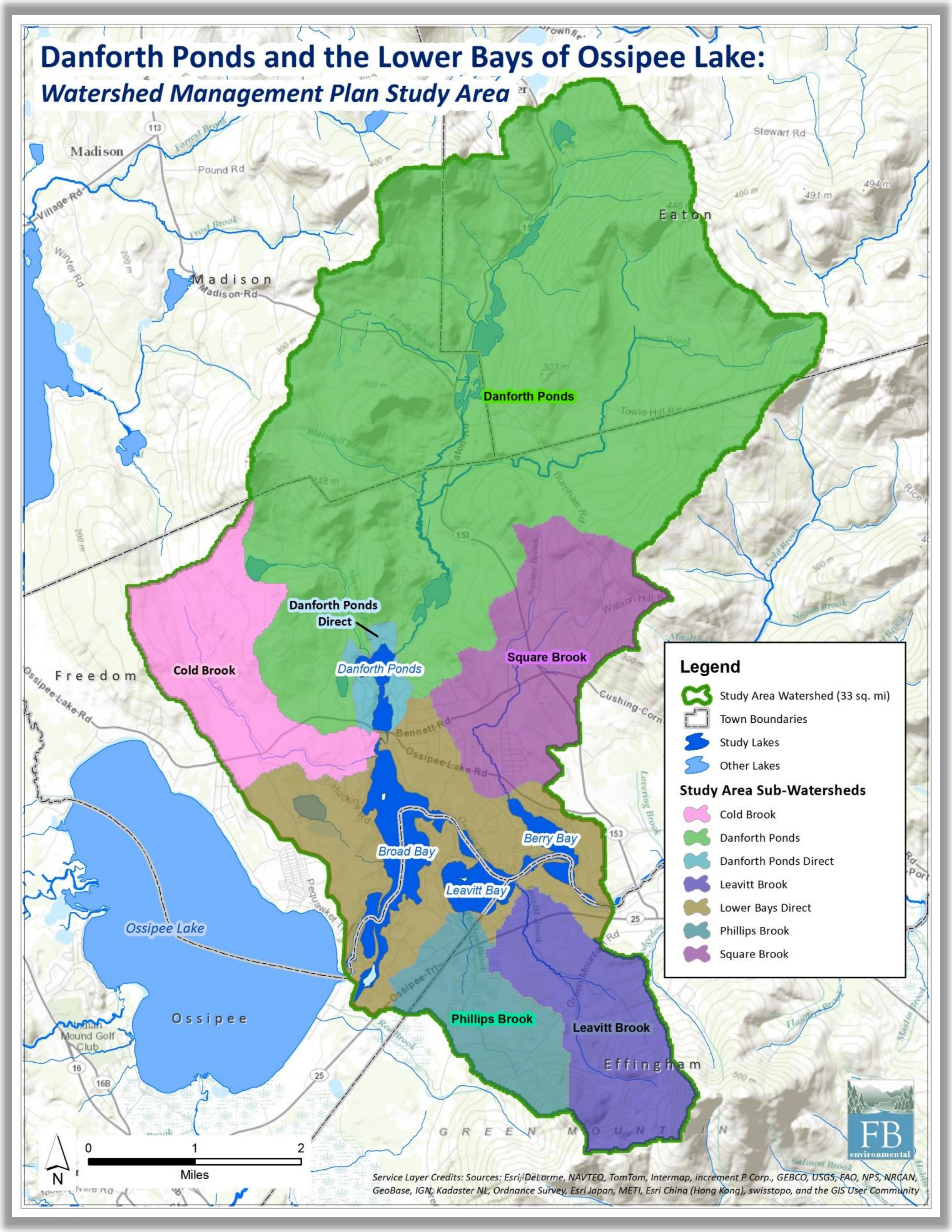
In Partnership with:

Green Mountain Conservation Group

FB environmental

New Hampshire Department of Environmental Services

March 2015


Danforth Ponds and the Lower Bays of Ossipee Lake:
Watershed Management Plan Study Area
Danforth Ponds
Danforth Ponds Direct
Cold Brook
Square Brook
Broad Bay
Berry Bay
Leavitt Bay
Ossipee Lake
Phillips Brook
Leavitt Brook
Madison
Eaton
Freedom
Ossipee
Effingham
Legend
Study Area Watershed (33 sq. mi)
Town Boundaries
Study Lakes
Other Lakes
Study Area Sub-Watersheds
Cold Brook
Danforth Ponds
Danforth Ponds Direct
Leavitt Brook
Lower Bays Direct
Phillips Brook
Square Brook
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1
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Miles
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FB environmental
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Ossipee Lake Watershed Management Plan Phase I:

A Watershed Plan for Danforth Ponds and the Lower Bays of Ossipee Lake

Prepared by FB Environmental Associates, Inc
in cooperation with Green Mountain Conservation Group, Town of Freedom, and the New Hampshire Department of Environmental Services

March 2015

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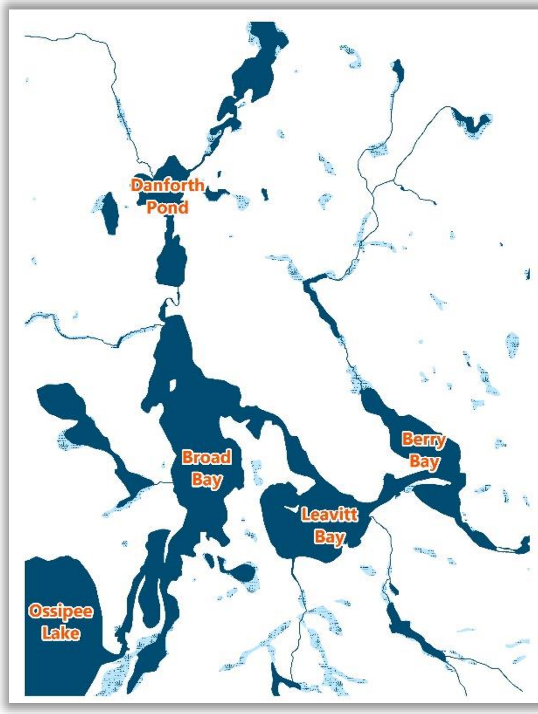
Cover photos: Views of Danforth Ponds and the lower bays (Photo: GMCG, FBE)

EXECUTIVE SUMMARY

Project Overview



Located in the Towns of Freedom, Effingham, and Ossipee in Carroll County, New Hampshire, Danforth Ponds and the lower bays of Ossipee Lake (Leavitt Bay, Broad Bay, and Berry Bay) serve as attractive summer getaways for tourists who come to enjoy the scenic beauty and excellent water clarity of the lakes. Threats to the water quality of Danforth Ponds and the lower bays of Ossipee Lake include inputs of excess sediment and nutrients from existing and future development, aging septic systems, and roads throughout the watershed.

This watershed management plan for Danforth Ponds and the lower bays of Ossipee Lake is the culmination of a major effort by many individuals who not only care about the long-term protection of water quality in these lakes, but also recognize that high water quality is directly connected to the economic well-being of the area. Green Mountain Conservation Group (GMCG) is the region's leader in protecting and managing water resources and hosted an initial meeting to generate interest in the plan with many stakeholders representing a diverse range of interests in attendance. From senior members of municipal planning boards and conservation commissions (e.g. Freedom, Eaton), to local residents and business owners, to technical experts from the University of New Hampshire (UNH) and the New Hampshire Department of Environmental Services (NHDES), to stakeholders from the Ossipee Watershed Coalition (OWC) – GMCG guided the creation of a Steering Committee to ensure that a strong watershed management plan was developed for these important New Hampshire lakes.

> The Ossipee Lake Watershed Management Plan Phase I is a scientifically-based plan that provides decision makers and local residents the tools needed to protect the water quality of these lakes for future generations.

This plan was partially funded by a Watershed Assistance Grant for High Quality Waters from the NHDES using Clean Water Act Section 319 funds from the USEPA, with additional financial and in-kind services provided by GMCG and its members, the Town of Freedom, the Davis Conservation Foundation, and the Royal Little Family Foundation. This comprehensive watershed plan will provide guidance for the next phase of actions needed to preserve the water quality of these picturesque lakes. The water quality of these lakes represents a core asset for the local economy as a premier tourist destination.

The Watershed of Danforth Pond and the Lower Bays of Ossipee Lake

Within the Lakes Region of east central New Hampshire, the watershed of Danforth Ponds and the lower bays of Ossipee Lake (Leavitt Bay, Broad Bay, and Berry Bay) covers a total area of 33 square miles in the Towns of Effingham, Freedom, Eaton, Ossipee, and Madison in Carroll County. These lakes, which exist in the summertime between 407 ft (lower bays) and 410 ft (Danforth Ponds) above sea level, are encompassed by mountainous woodlands in all directions.

Danforth Ponds and the lower bays of Ossipee Lake provide a plethora of critical water resources for the surrounding landscape, including 603 acres of wetlands, 1,229 acres of open water, and 47 miles of streams.

The watershed is characterized by non-developed land, including mixed forest, regenerating land, and wetlands. The large extent of wetlands and other riparian habitat in the watershed of Danforth Ponds and the lower bays of the Ossipee Lake is home to a diverse community of fish, birds, mammals, and plants that are dependent on clean water for survival. Based on available data from UNH GRANIT, conservation land in the watershed of Danforth Ponds and the lower bays of Ossipee Lake covers 6.79 square miles (4,346 acres) or approximately 21% of the watershed.

The most significant tributary to the lower bays of Ossipee Lake is the Ossipee River, which enters Broad Bay downstream from the outlet to Ossipee Lake. The Ossipee River accounts for nearly all the water to the lower bays (89%). Other major inlets to the lower bays include Cold, Phillips, Leavitt, and Square Brooks and an unnamed stream that flows south from Danforth Ponds to Broad Bay. Danforth Ponds are fed by a wetland located in the Town of Eaton. These tributaries and the contributing land cover of their watersheds are important to the water quality of Danforth Ponds and the lower bays of Ossipee Lake.

Why Develop a Watershed Management Plan?

Low levels of oxygen (anoxia) at depths greater than 20 feet (6 meters) have been consistently observed at Danforth Ponds; and two of the three bays (Leavitt and Broad Bays) are listed as impaired for aquatic life use based on low percent dissolved oxygen (DO) saturation and presence of non-native aquatic plants. Phosphorus is the likely culprit for this DO impairment. Phosphorus is generally the limiting nutrient in freshwater systems, driving algal and plant growth, including non-native aquatic plants. Excess phosphorus can stimulate productivity (e.g. algal blooms and excessive plant growth). The algae and plants die and accumulate on the lake bottom where they are decomposed. Decomposition is a process that consumes oxygen, causing anoxia in bottom waters, particularly during stratification when oxygen-rich surface waters are thermally-separated from nutrient-rich bottom waters. Anoxia can release sediment-bound phosphorus back into the water column where it can re-stimulate algal blooms and plant growth, creating a positive feedback to eutrophication. Anoxia can also be lethal to fish and other aquatic organisms.

Phosphorus was used to set water quality goals for Danforth Ponds and the lower bays of Ossipee Lake to improve current water quality conditions at these lakes. Although Danforth Ponds and the lower bays of Ossipee Lake are currently within acceptable in-lake median phosphorus capacity levels for their respective trophic class, Broad Bay and Berry Bay are exceeding their reserve capacity and are at risk for water quality degradation, particularly with rising development pressures. When comparing pre-2003 data to averaged data collected from 2003-2013 obtained from the Volunteer Lake Assessment Program (VLAP) and NHDES Trophic Survey Reports, there has been a slight increase in median total phosphorus (TP) in Danforth Ponds and the lower bays of Ossipee Lake; however, Mann-Kendall tests show no significant statistical trend in TP over the collection period.

The over-arching goal for the watershed is to improve water quality conditions at Danforth Ponds and the lower bays of Ossipee Lake and to protect the lakes from future, unaccounted-for inputs of phosphorus as a result of new development in the watershed over the next ten to twenty years. The Steering Committee has chosen an interim goal of lowering current phosphorus loading and in-lake phosphorus concentrations to at least 10% lower than NHDES thresholds for oligotrophic conditions at 7.2 ppb, which places more stringent controls on phosphorus loading to Danforth Ponds, a mesotrophic lake. This water quality goal translates more specifically to reducing current median in-lake total phosphorus by 1.4% (from 7.3 to 7.2 pbb) in Broad Bay, 1.4% (from 7.3 to 7.2 ppb) in Berry Bay, and 20% (from 9.0 to 7.2 ppb) in Danforth Ponds. This would require a reduction in phosphorus loading to these waterbodies, assuming the average annual water loading remains the same: 119 kg P/yr reduction for Danforth Ponds and 57 kg P/yr for the lower bays. Management actions should focus on improving upstream waterbodies (i.e. Ossipee Lake and Danforth Ponds), since these waterbodies feed directly into the lower bays. These are interim recommendations pending the completion of the Ossipee Lake LLRM results in 2015. Achieving these goals will help reduce current in-lake phosphorus and DO impairments over time and help safeguard against increased phosphorus loading from the landscape as a result of development (e.g. septic systems, paved surfaces, sediment, etc.).

This plan provides a roadmap for improving the water quality of Danforth Ponds and the lower bays of Ossipee Lake, and provides a mechanism for procuring funding to secure action needed to achieve water quality goals. In addition, this plan sets the stage for ongoing dialogue among key stakeholders in many facets of the community, and promotes coordinated municipal land use changes to address stormwater runoff. The success of this plan is dependent on the concerted effort of volunteers, and a strong and diverse Steering Committee that meets regularly to review progress and make any necessary adjustments to the plan.

The Ossipee Lake Watershed Management Plan Phase I is dedicated to future generations that will continue to enjoy these lakes in the same way we enjoy them today.

As part of the development of this plan, a build-out analysis, water quality and assimilative capacity analysis, and volunteer stormwater survey were conducted. Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the current and projected amount of phosphorus being delivered to the lakes from the watershed. An Action Plan (Section 5.2) with associated timeframes, responsible parties, and estimated costs was developed based on feedback from the twenty-four community members that attended the community forum in July 2014. Attendees represented a diverse subset of the community, including GMCG, the Towns of Freedom and Madison, Broad Bay/Leavitt Bay Watershed Association, Long Sands Association, community businesses, students, and watershed citizens. The forum was designed to provide local stakeholders with background information about the watersheds and water quality of Danforth Ponds and the lower bays of Ossipee Lake, to solicit stakeholder concerns, and to discuss the timing and elements of the watershed management plan. The Steering Committee helped further refine these inputs into relevant action items.

The target reduction in phosphorus can be achieved through the following objectives:

1) Implement recommended BMPs throughout the watershed to reduce sediment, phosphorus, and road salt runoff from existing development;
2) Educate landowners through the NHDES Soak up the Rain program, BMP demonstration sites, workshops, and other communication strategies, targeting high priority septic systems (>20 years old, within 50 feet of a water resource, or rarely pumped out);
3) Institute greater controls on new and re-development, require low-impact development (LID) in site plans, and encourage regular septic system maintenance;
4) Focus on education outreach regarding conservation easements;
5) Continue and/or expand the water quality monitoring and aquatic invasive plant control programs.

Plan Components

The Ossipee Lake Watershed Management Plan Phase I for Danforth Ponds and the lower bays of Ossipee Lake includes nine key planning elements to address nonpoint source (NPS) pollution (Section 1.3). These guidelines, set forth by the USEPA, highlight important steps in protecting water quality for waterbodies impacted by human activities, including specific recommendations for guiding future development, and strategies for reducing the cumulative impacts of NPS pollution on lake water quality. Below is a summary of information presented by Section:

SECTION 1- INTRODUCTION

Section 1 introduces the plan by describing the problem, the goals and objectives, the community-based planning process, and applicable federal regulations. Section 1 also provides background information, including watershed survey results and current watershed efforts in phosphorus reduction and awareness.

SECTION 2- WATERSHED CHARACTERIZATION

Section 2 describes the watershed, providing detailed information about climate, population and demographics, land cover, topography, soils and geology, wetlands and riparian habitat, lake morphology and morphometry, and drainage areas or tributaries.

SECTION 3- ASSESSMENT OF WATER QUALITY

Section 3 describes water quality standards, highlights the estimated sources of phosphorus in Danforth Ponds and the lower bays of Ossipee Lake, and provides a summary of current classification based on the water chemistry assessment and water quality goals. Estimates of future phosphorus loading and identification of nonpoint source pollution are also included in this section.

SECTION 4- MANAGEMENT STRATEGIES

Section 4 outlines the necessary management strategies (both structural and non-structural best management practices (BMPs)) to reduce phosphorus inputs to Danforth Ponds and the lower bays of Ossipee Lake. Current and future sources of phosphorus are discussed and an adaptive management strategy is presented.

SECTION 5- PLAN IMPLEMENTATION

Section 5 describes who will be carrying out this plan and how the action items will be tracked to ensure that necessary steps are being taken to improve the water quality of Danforth Ponds and the lower bays of Ossipee Lake over the next ten years. This section also provides estimated costs and technical assistance needed to successfully implement the plan and a description of the evaluation plan to assess the effectiveness of restoration and monitoring activities.

Funding the Plan

Reducing phosphorus inputs from existing development in the watershed of Danforth Ponds and the lower bays of Ossipee Lake will require significant financial and technical resources on the order of $718,000 over the next ten years, including the financial support of private, town, state, and federal partners. Section 5.4 lists the costs associated with successfully implementing this ten-year watershed plan, including both structural and non-structural management measures. 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).

Administering the Plan

Through the efforts of GMCG, the recommendations of this plan should be orchestrated and carried out by a committee similar to the Steering Committee assembled for development of this plan. Local participation is an integral part of the success of this plan, and should include the leadership of local municipalities with land in the watershed (Effingham, Freedom, Eaton, Ossipee, and Madison). This task will also require the support of other stakeholders, including NHDES, schools and community groups, local businesses, and individual landowners. The primary stakeholder group will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce NPS pollution in the watershed of Danforth Ponds and the lower bays of Ossipee Lake. Periodic updates to the plan will need to be made to maintain the action items and keep the plan relevant to current watershed activities. Measurable milestones (number of BMP sites, volunteers, funding received, etc.) should be tracked by the Steering Committee and reported to NHDES on an annual basis.

Next Steps

The success of the plan can be measured in many ways, as outlined in Section 5.3, *Indicators to Measure Progress*. Much of this progress weighs heavily on the cooperation of local municipalities and key stakeholders to support the plan, and the ability of the Steering Committee to develop a sustainable funding strategy.

ACKNOWLEDGMENTS

Ossipee Lake Watershed Management Plan Phase I Steering Committee

Blair Folts, Executive Director, Green Mountain Conservation Group

Corey Lane, Program Manager, Green Mountain Conservation Group

Tom Schevenell, Research Committee Member, Green Mountain Conservation Group

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Bob Craycraft, Center for Freshwater Biology, University of New Hampshire

Jean Marshall, Ossipee Lake Association

John Shipman, Chairman, Ossipee Watershed Coalition

Sheila Jones, Broad/Leavitt Bay Association

Anne Cunningham, Planning Board, Town of Freedom

Scott Brooks, Road Agent, Town of Freedom

Barry Keith, Forester, Town of Freedom

Craig Niiler, Zoning Board Chairman, Town of Freedom

Pat Jones, Planning Board & Conservation Commission, Town of Ossipee

Peter Klose, Conservation Commission, Town of Eaton

Noreen Downs, Planning Board, Town of Madison

Courtney Croteau, Planning Board & Conservation Commission, Town of Madison

Susan Slack, Selectboard Chairman, Town of Effingham

Jody Skelton, Director, Camp Huckins

Dianne Battles, Danforth Bay Camping Resort

Jim McElroy, Watershed Resident

Paul Wheeler, Watershed Resident

John Wacker, Regional Resident

Community Forum Attendees

Rob Hatch, Conservation Commission, Town of Freedom
Noreen Downs, Planning Board, Town of Madison
Judy and Jim Blake, Watershed Residents
Barre Hellquist, Green Mountain Conservation Group
Eric Hellquist, Watershed Resident
Richard Klausner, Green Mountain Conservation Group
Jim McElroy, Watershed Resident
Sheila Jones, Broad/Leavitt Bay Association
Tim Otterbach, Green Mountain Conservation Group
Chuck Depew, Watershed Resident
Anne Cunningham, Planning Board, Town of Freedom
John Shipman, Ossipee Watershed Coalition
Ned Hatfield, Watershed Resident
Jay Buckley, Watershed Resident
BB Wright, Long Sands Association
Frank Virnelli, Green Mountain Conservation Group
Ashley Grevelink, Student
Chuck Brooks, Watershed Resident
Kathy Covino, Totem Pole Park
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Sam Wilson, Acton Wakefield Watershed Alliance
Lisa Loosigian, NHDES Soak Up the Rain New Hampshire
Sara Steiner, NHDES Volunteer Lake Assessment Program

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1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

Located in the Towns of Effingham, Freedom, Eaton, Ossipee, and Madison in Carroll County, New Hampshire, Danforth Ponds and the lower bays of Ossipee Lake serve as an attractive summer getaway for tourists who come to enjoy the scenic beauty and excellent water clarity of the lakes. Lakes are highly valued natural resources that provide critical habitat for a diverse abundance of plants, wildlife, and aquatic life, and opportunities for recreation, scenic enjoyment, and drinking water. Because the water quality of lakes and streams can decline rapidly as a result of stormwater runoff from watershed development, taking proactive steps to properly manage and treat stormwater runoff to protect these important water resources is essential for continued ecosystem health, including resources valued by humans.

Seasonal and year-round residents and tourists alike enjoy the excellent water quality and clarity in Danforth and the lowers bays of Ossipee Lake. (Photo: FB Environmental)

The Ossipee Lake Watershed Management Plan Phase I for the Danforth Ponds and lower bays of Ossipee Lake is the culmination of a major effort by many individuals who not only care about the long-term protection of water quality in these lakes, but also recognize that high water quality is directly connected to the economic well-being of the area. Green Mountain Conservation Group (GMCG) is the region's leader in protecting and managing water resources and hosted an initial meeting to generate interest in the plan with many stakeholders representing a diverse range of interests in attendance. From senior members of municipal planning boards and conservation commissions (e.g. Freedom, Eaton), to local residents and business owners, to technical experts from the University of New Hampshire (UNH) and the New Hampshire Department of Environmental Services (NHDES), to stakeholders from the Ossipee Watershed Coalition (OWC) – GMCG guided the creation of a Steering Committee to ensure that a strong watershed management plan was developed for these important New Hampshire lakes.

This plan was partially funded by a Watershed Assistance Grant for High Quality Waters from the NHDES using Clean Water Act Section 319 funds from the USEPA, with additional financial and in-kind services provided by GMCG and its members, the Town of Freedom, the Davis Conservation Foundation, and the Royal Little Family Foundation. This comprehensive watershed plan will provide guidance for the next phase of actions needed to preserve the water quality of these picturesque lakes. The water quality of these lakes represents a core asset for the local economy as a premier tourist destination. In addition, Danforth Ponds and the lower bays of Ossipee Lake feed into the Ossipee River from which over 300,000 people take their drinking water from in Maine.

This plan provides a roadmap for improving the water quality of Danforth Ponds and the lower bays of Ossipee Lake, and provides a mechanism for procuring funding to secure action needed to achieve water quality goals. In addition, this plan sets the stage for ongoing dialogue among key stakeholders in many facets of the community, and promotes coordinated municipal land use changes to address stormwater runoff. The success of this plan is dependent on the concerted effort of volunteers, and a strong and diverse Steering Committee 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 stormwater survey were conducted. Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the current and projected amount of phosphorus being delivered to the lakes from the watershed.

The Ossipee Lake Watershed Management Plan Phase I for Danforth Ponds and the lower bays of Ossipee Lake includes nine key planning elements to address **nonpoint source (NPS) pollution** in impaired waters. These guidelines, set forth by the USEPA, highlight important steps in protecting water quality for waterbodies impacted by human activities, including specific recommendations for guiding future development, and strategies for reducing the cumulative impacts of NPS pollution on lake water quality.

1.2 STATEMENT OF GOAL

Low levels of oxygen (anoxia) at depths greater than 20 feet (6 meters) have been consistently observed at Danforth Ponds; and two of the three bays (Leavitt and Broad Bays) are listed as impaired for aquatic life use based on low percent dissolved oxygen (DO) saturation and presence of non-native aquatic plants. Phosphorus is the likely culprit for this DO impairment. Phosphorus is generally the limiting nutrient in freshwater systems, driving algal and plant growth, including non-native aquatic plants. Excess phosphorus can stimulate productivity (e.g. algal

Nonpoint Source (NPS) Pollution (a.k.a. stormwater runoff) cannot be traced back to a specific source, but comes from a number of diffuse sources throughout a watershed. One of the major constituents of NPS pollution is sediment, which contains a mixture of nutrients and inorganic and organic material that stimulate algal growth.

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.

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.

blooms and excessive plant growth). The algae and plants die and accumulate on the lake bottom where they are decomposed. Decomposition is a process that consumes oxygen, causing anoxia in bottom waters, particularly during stratification when oxygen-rich surface waters are thermally-separated from nutrient-rich bottom waters. Anoxia can release sediment-bound phosphorus back into the water column where it can re-stimulate algal blooms and plant growth, creating a positive feedback to eutrophication. Anoxia can also be lethal to fish and other aquatic organisms.

Phosphorus was used to set water quality goals for Danforth Ponds and the lower bays of Ossipee Lake to improve current water quality conditions at these lakes. Although Danforth Ponds and the lower bays of Ossipee Lake are currently within acceptable in-lake median phosphorus capacity levels for their respective trophic class, Broad and Berry Bays are exceeding their reserve capacity and are at risk for water quality degradation, particularly with rising development pressures. When comparing pre-2003 data to averaged data collected from 2003-2013 obtained from the Volunteer Lake Assessment Program (VLAP) and NHDES Trophic Survey Reports, there has been a slight increase in median total phosphorus (TP) in Danforth Ponds and the lower bays of Ossipee Lake; however, Mann-Kendall tests show no significant statistical trend in TP over the collection period. NHDES VLAP reports over the entire collection period (1990-2013) also show stable trends in TP with moderate variability in Danforth Ponds and the lower bays of Ossipee Lake with the exception of Broad Bay, which shows degrading (increasing) TP from 1990-2013.

This plan provides short and long-term goals for improving the water quality of Danforth Ponds and the lower bays of Ossipee Lake over the next ten years (2015-2025). The Steering Committee has set interim water quality goals that would reduce current median in-lake total phosphorus by 20% (119 kg/year) to 7.2 ppb in Danforth Ponds and 1.4% (57 kg/yr) to 7.2 ppb in the lower bays. These are interim recommendations pending the completion of the Ossipee Lake LLRM results in 2015. Achieving these goals will help reduce current in-lake phosphorus and DO impairments over time and help safeguard against increased phosphorus loading from the landscape as a result of development (e.g. septic systems, paved surfaces, sediment, etc.).

This target reduction in TP can be achieved through the following structural (engineered treatment options) and non-structural objectives:

- Implement **best management practices (BMPs)** throughout the watershed to reduce sediment, phosphorus, and road salt runoff from existing development (Sections 3.4 and 4.2).
- Educate landowners through the NHDES Soak Up the Rain program, BMP demonstration sites, workshops, and other communication strategies, targeting high priority septic systems (>20 years old, within 50 feet of a waterbody, and rarely pumped out).
- Institute greater controls on new and redevelopment, require **low-impact development (LID)** in site plans, and encourage regular septic system maintenance.
- Focus on education outreach regarding conservation easements (Section 2.2.3).
- Continue and/or expand the water quality monitoring and aquatic invasive plant control programs (Section 5.2.5).

These objectives and more are discussed in greater detail in the Action Plan (Section 5.2).

1.3 INCORPORATING EPA'S NINE ELEMENTS

USEPA Guidance lists nine components that are required within a watershed-based management plan to restore waters impaired or likely to be impaired by NPS pollution. These guidelines highlight important steps in 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: Sections 1.5.1 and 3.4** highlight known sources of NPS pollution in the watershed of Danforth Ponds and the lower bays of Ossipee Lake and describe the results of the watershed surveys conducted in 2013. 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 Planned Management Measures** described under (C) below: **Section 4.3** describes how reductions in annual phosphorus loading to Danforth Ponds and the lower bays of Ossipee Lake may be realized over a ten-year period, and describes the methods used to estimate phosphorus reductions. These reductions apply primarily to structural BMPs (e.g. installing vegetated buffers or rain gardens, mitigating runoff from roofs and driveways, improving and maintaining roads, and managing fertilizer) for existing development, but they will not be possible without the use of non-structural BMPs. Examples of non-structural practices include, but are not limited to, reviewing and improving zoning ordinances, promoting the use of LID designs for future development, and educating watershed citizens about activities to reduce phosphorus at home.

C. **Description of Management Measures: Section 5.2** identifies ways to achieve the estimated phosphorus load reduction and reach water quality targets. The Action Plan focuses on five major topic areas that address NPS pollution, including: septic systems, shoreline residential 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 5.2 and 5.4** includes 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 and lake associations), private donations, and landowner contributions for BMP implementation on private property. GMCG and its core stakeholders, led by a steering committee, should oversee the planning effort by meeting regularly and efficiently coordinating resources to achieve the goals 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 implemented to enhance public understanding of the project as a result of leadership from GMCG.

F. **Schedule for Addressing Phosphorus Reductions: Section 5.2** provides a list of strategies to reduce stormwater and phosphorus runoff to Danforth Ponds and the lower bays of Ossipee Lake. Each strategy, or "Action Item," has a set schedule that defines when the action should begin. The schedule should be adjusted by the Steering Committee on an annual basis (see Section 4.4 on Adaptive Management).

G. **Description of Interim Measureable Milestones: Sections 5.3 and 5.6** outline 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 broken down 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 the steering committee or number of new lake monitoring volunteers.

H. **Set of criteria: Section 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** describes the long-term water quality monitoring strategy for Danforth Ponds and the lower bays of 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 ultimate objective of this plan is to achieve a stable or decreasing trophic state. This means halting any current trends of declining water clarity, and reducing the probability of algal blooms and associated depletion of dissolved oxygen concentration in the deeper sections of Danforth Ponds. 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

On June 3, 2013, FB Environmental Associates presented information to the Steering Committee about the development of the Ossipee Lake Watershed Management Plan Phase I for Danforth Ponds and the lower bays of Ossipee Lake at the Town of Freedom library. The presentation provided an overview of the process of developing a watershed management plan and the role of the Steering Committee in that process.

A public meeting to kick-off the watershed management plan took place on July 24, 2013 at the Freedom Town Hall to give interested stakeholders an introduction to the main purpose of the plan and to explain how the watershed towns and residents can utilize this information to protect Danforth Ponds and the lower bays of Ossipee Lake.

On May 15, 2014, FBE presented preliminary results of the Lakes Loading Response Model (LLRM) for Danforth Ponds and the lower bays of Ossipee Lake to the Steering Committee. The objective of the meeting was to familiarize the Steering Committee with the model results and help guide the Steering Committee toward establishing a water quality goal for the watershed.

The 2014 community forum for Danforth Pond and the lower bays of Ossipee Lake had 24 watershed stakeholders in attendance. (Photo: FB Environmental)

On July 12, 2014, GMCG and FBE sponsored a community forum at Totem Pole Park in Freedom, New Hampshire. The forum was designed to provide local stakeholders with background information about the watersheds and water quality of Danforth Ponds and the lower bays of Ossipee Lake, to solicit stakeholder concerns, identify threats to water quality, and prioritize actions to mitigate identified threats.

Twenty-four people attended the community forum and provided valuable input for this plan. Attendees represented a diverse stakeholder set, including GMCG members, other organizational representatives, municipal staff, community business members, volunteers, and landowners. Attendees were broken out into four focus groups of 4-6 people based on areas of concern (roads and septic systems, shorefront residential, planning and land conservation, and water quality monitoring).

A total of 36 threats were identified, including over-occupancy of homes, lack of enforcement, and inadequate education on property maintenance and local regulations. From this and additional actions provided by FB Environmental, a total of 49 action items were identified and prioritized, including ordinance development or refinement, public educational program development, and water quality monitoring improvement. Of the four categories at the forum, shorefront residential and planning and land conservation had the most threats and the greatest number of action items identified. Recommendations from the forum are listed in the Action Plan (Section 5.2).

This plan was developed through the collaborative efforts of numerous Steering Committee meetings and conference calls between FB Environmental and outside technical staff, including GMCG, UNH, and NHDES (see Acknowledgments). Subcommittees of the Watershed Management Plan Steering Committee for the Danforth Ponds and the lower bays of Ossipee Lake served to review data and goals regarding water quality and priority BMP identification.

1.5 CURRENT WATERSHED EFFORTS

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 the 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 the 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.

Camp Calumet collecting data at the mouth of the Bearcamp River. (Photo: GMCG)

- 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) has also worked with GMCG since 2004 to host several workshops related to cooperative natural resource-based planning. The OWC is a partnership of municipal officials, community and business leaders, and interested residents who want to protect the natural resources of the Ossipee Lake watershed through natural resource-based planning. This cooperative planning ensures natural resource protection and sustainability in light of development and population growth. The OWC and GMCG have 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. Of recent, the OWC has partnered with the Lakes Region Planning Commission (LRPC) to help four towns update or develop their aquifer protection ordinances.

1.5.1 Shoreline/Watershed Surveys

A shoreline/watershed survey is designed to locate potential sources of NPS pollution in an area that drains to a waterbody. Shoreline/watershed 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.

Lack of vegetative buffer, as shown in this photo from the 2013 survey, results in delivery of nutrients and sediments in the lakes. (Photo: FB Environmental)

A shoreline survey for Danforth Ponds and the lower bays of Ossipee Lake was conducted on September 28, 2013 by FB Environmental staff and GMCG volunteers. Teams identified areas of erosion and stormwater runoff along the shoreline of each lake by tax parcel. A total of 490 shoreline parcels were evaluated. Each site was rated for buffer condition (1-5), bare soil extent (1-4), shoreline erosion extent (1-3), building setback distance (1-3), and slope (1-3). Lower scores equate to better shoreline condition, while higher scores correspond to inadequate shoreline condition with extensive erosion. The score for each category was summed for each site as a total "shoreline disturbance score" used to help with BMP prioritization and highlighting areas along shorelines where mitigation efforts should be focused. Average disturbance scores for Danforth Ponds (10.3), Berry Bay (10.4), Broad Bay (11.2), and Leavitt Bay (12.1) were fairly similar and exhibited high scores for inadequate buffers and exposed or bare soil along shorelines.

A watershed survey was also conducted by Forrest Bell from FB Environmental and Corey Lane from GMCG on November 20, 2013. The team documented erosion on the roads, properties, driveways, and municipal areas using cameras and standardized forms. The survey focused on examining sites on public lands around Danforth Ponds and the lower bays of Ossipee Lake where stormwater runoff was a significant issue. Areas with eroding soil were especially noted because soil contains phosphorus, the limiting nutrient of greatest concern for freshwater lakes. Ten sites were identified and rated for impact level based on location, slope, amount of soil eroded, and proximity to water. Six of the ten sites were found on roads, two of which were rated as high impact. The other two high impact sites were associated with a driveway and a commercial property.

The results from the shoreline and watershed surveys were compiled and prioritized. High priority sites and recommendations were listed in the Action Plan (Sections 3.4, 4.2.1, and 5.2).

2. WATERSHED CHARACTERIZATION

2.1 LOCATION & CLIMATE

Located in the Lakes Region of east central New Hampshire, just south of the White Mountains, Danforth Ponds and the lower bays of Ossipee Lake (Leavitt Bay, Broad Bay, and Berry Bay) have been long treasured as a recreational haven for summer vacationers and year-round residents. The 33 square-mile watershed of Danforth Ponds and the lower bays of Ossipee Lake 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. The watershed of the study lakes are spread across five towns, with 47% of the watershed in Freedom, 24% in Eaton, 13% in Effingham, 12% in Madison, and 5% in Ossipee.

Danforth Ponds and the lower bays of Ossipee Lake 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, 2014). 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, 2014).

2.2 POPULATION, GROWTH TRENDS, AND LAND COVER

2.2.1 Population and Growth Trends

Most lakeshore residents in the watershed of Danforth Ponds and the lower bays of Ossipee Lake 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 lake shore, including private camps, private rental camps, group rental cottages, family resorts, children's camps, and overnight cabins.

Development in the watershed changes the natural land cover that protects lake water quality. All new development should be managed carefully to mimic natural conditions by infiltrating stormwater runoff during storm events. (Photo: FB Environmental)

Understanding population growth and demographics, and ultimately development patterns, provides critical insight into 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). There is limited public transportation in the area, and most people use personal vehicles in their daily commute. Residents are attracted to the watershed of Danforth Ponds and the lower bays of Ossipee Lake for its small town character and easy commute by vacationers in northern and southern New England.

From 2000 to 2010, the populations of Effingham, Freedom, Eaton, Ossipee, and Madison increased by 14%, 14%, 1%, 4%, and 21%, respectively (NHOEP, 2011). Based on census data, the Town of Eaton experienced the lowest percentage change in population among the towns in the watershed, while the Town of Madison experienced the greatest change. The majority of watershed towns have experienced annual growth rates greater than the annual growth rate of Carroll County (Table 2.1).

Table 2.1: Population growth rates for watershed communities of Danforth Ponds and the lower bays of Ossipee Lake.

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	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%
Eaton	151	221	256	362	375	393	3.21%	0.43%	0.48%
Ossipee	1,409	1,647	2,465	3,309	4,211	4,345	4.17%	1.57%	0.32%
Madison	429	572	1,051	1,704	1,984	2,502	9.66%	2.34%	2.61%

The majority 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 (30-52%) and renter occupied (6-12%) 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 Danforth Ponds and the lower bays of Ossipee Lake.

Table 2.2: 2010 population demographics for watershed communities of Danforth Ponds and the lower bays of Ossipee Lake.

State/County/Town	Total Pop	Aged 0-19	Aged 20-64	Aged 65+	Total Houses	Total Occ Houses	Owner Occ Houses	Seasonal Houses	Renter Occ Houses
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%
Eaton	393	53	255	85	291	67%	55%	30%	12%
Ossipee	4,345	924	2,578	843	3,057	60%	48%	34%	12%
Madison	2,502	545	1,535	422	1,877	57%	48%	39%	9%

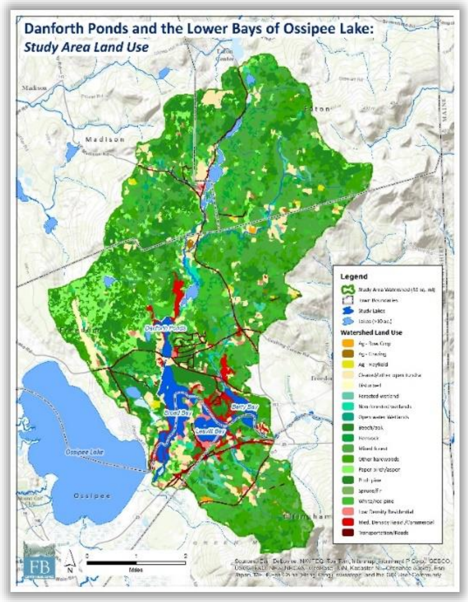
The desirability of Danforth Ponds and the lower bays of Ossipee Lake as a recreational destination will likely stimulate continued population growth in the future. Growth figures and estimates suggest that communities within the watershed should consider the effects of current municipal land-use regulations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

2.2.2 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.

Today, development accounts for 11% of the watershed, while forested areas dominate at 79% (Figure 2.1). Wetlands and open water (aside from the surface areas of Danforth Ponds and the lower bays of Ossipee Lake) represent 3% and 6% of the watershed, respectively. Agriculture represents only 1%, and includes row crops, grazing pastures, and hayfields. These trends coupled with the recent water quality analysis (Section 3) may suggest that new development of residential, commercial, and agricultural land may be affecting the water quality of wetlands, lakes, and ponds in the watershed.

Developed areas within the watershed of Danforth Ponds and the lower bays of Ossipee Lake 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. Studies have shown a link between the amount of impervious area in a watershed and water quality conditions (CWP, 2003). In one study, researchers correlated the amount of pathogens in a waterbody to the percentage of land with impervious cover in a watershed (Mallin *et al.*, 2000).



Land cover within the watershed of Danforth Pond and the lower bays of Ossipee Lake is dominated by forest (see Appendix B for larger map).

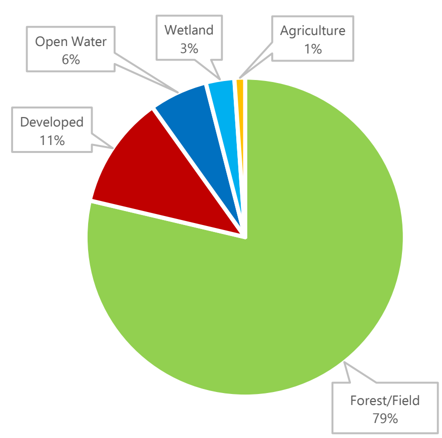
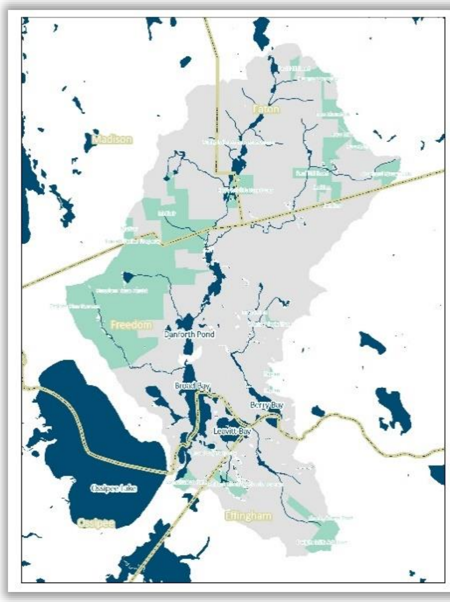


Figure 2.1: Land cover in the watershed of Danforth Pond and the lower bays of Ossipee Lake.

The total impervious cover is relatively low at 6% in the watershed of Danforth Ponds and the lower bays of Ossipee Lake, and is limited primarily to areas along major routes along the lakes and through the watershed. The build-out analysis conducted for the watershed, coupled with projected population growth trends, indicates that the percentage of impervious cover 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.

2.2.3 Protected and Public Lands

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 in the watershed of Danforth Ponds and the lower bays of Ossipee Lake 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 of Danforth Ponds and the lower bays of Ossipee Lake covers 6.79 square miles (4,346 acres) or approximately 21% of the watershed.



Conservation land (green) covers 21% of the watershed of Danforth Pond and the lower bays of the Ossipee Lake (gray).

2.3 PHYSICAL FEATURES

2.3.1 Topography

Danforth Ponds and the lower bays of Ossipee Lake exist at 410 feet above sea level (fasl) and are encompassed by mountainous woodlands in all directions. The highest peaks in the watershed are located to the north on Manson Hill at 1,467 fasl and to the southeast on Green Mountain at 2,188 fasl. Green Mountain drains to Phillips and Leavitt Brooks.

2.3.2 Soils and Geology

The composition of soils surrounding Danforth Ponds and the lower bays of Ossipee Lake reflects the dynamic geological processes that have shaped the landscape over millions of years. Over 380 million years ago, the region was under a shallow sea from a sinking continent; layers of mineral deposition compressed to form sedimentary layers of shale, sandstone, and limestone known as the Littleton Formation (Goldthwait, 1968). The Earth's crust folded under high heat and pressure to form metamorphic rock comprising the parent material – schist, quartzite, and gneiss. This parent material has since been modified by bursts of igneous rock intrusions known as the New Hampshire Plutonic Series (300 million years ago) and the White Mountain Plutonic Series (120 million years ago) (Goldthwait, 1968).

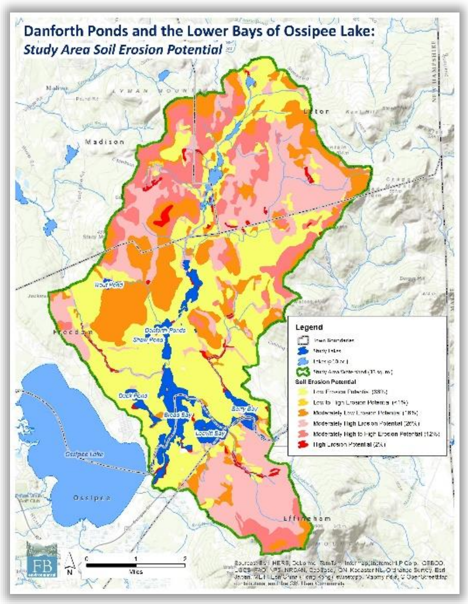
The current landscape formed 12,000 years ago at the end of the Great Ice Age as the mile-thick glacier over half of North America melted and retreated, scouring bed rock and depositing glacial till to create the deeply scoured basin of lakes. The retreating action also eroded nearby mountains composed of granite, quartz, gneiss, and schist, leaving behind remnants of drumlins and eskers from ancient stream deposits. The glacier deposited more than three feet of glacial till (mix of coarse sand, silt, and clay), laying the foundation for invading vegetation and meandering streams as the depression basins throughout the region began to fill with water (Goldthwait, 1968).

The watershed of Danforth Ponds and the lower bays of Ossipee Lake are characterized by multiple soil series. Over 3,130 acres (16%) of the watershed is underlain by the Monadnock and Berkshire soil series; 2,815 acres (14%) is underlain by Colton gravelly loamy fine sand soil series; 2,244 acres (11%) is underlain by Lyman-Berkshire fine sandy loams soil series; 2,023 acres (10%) is underlain by Lyman-Berkshire-Rock outcrop complex soil series; and 1,168 acres (6%) is underlain by Becket fine sandy loam soil series (Table 2.3).

Table 2.3: Dominant soil series found in the watershed of Danforth Ponds and the lower bays of Ossipee Lake. Source: USDA, 1977.

Soil Series Name	Soil Erosion Potential	Parent Material	Water Holding Capacity	Permeability
Monadnock/Berkshire	Low	Sandy glacial till on upland hills and plains	Moderate	Moderate
Colton	Low	Glacial outwash near streams or lakes	Low	Rapid
Lyman-Berkshire	Moderately Low	Glacial till in hilly uplands and mountains	Low	Moderate
Becket	Moderately High	Sandy glacial till on oval hills and mountainsides	Moderate	Moderate

Other soil series present in the watershed include Berkshire fine sandy loam (980 acres), Skerry fine sandy loam (898 acres), Henniker fine sandy loam (864 acres), Naumburg loamy sand (552 acres), Pillsbury fine sandy loam (540 acres), Adams loamy sand (519 acres), Peru fine sandy loam (454 acres), Champlain loamy sand (427 acres), Waumbek fine sandy loam (407 acres), Woodstock-Bice fine sandy loam (337 acres), Boscawen gravelly loamy sand (300 acres), Chocorua mucky peat (253 acres), Croghan loamy fine sand (216 acres), Limerick silt loam (211 acres), Metacomet fine sandy loam (189 acrs), Leicester-Moosilauke fine sandy loam (188 acres), Paxton fine sandy loam (153 acres), Marlow fine sandy loam (141), Ossipee mucky peat (122 acres), Duane fine sandy loam (113 acres), Woodstock-Bice-Rock outcrop complex (95 acres), Rock outcrop (48 acres), Bucksport mucky peat (32 acres), Sunday loamy fine sand (29 acres), Podunk fine sandy loam (22 acres), Pits (13 acres), Henniker-Gloucester fine sandy loam (10 acres), Acton fine sandy loam (7 acres), Salmon very fine sandy loam (6 acres), Whitman loam (5 acres), and Nicholville silt loam (3 acres).



Moderately high to high soil erosion potential areas cover 40% of the watershed (Appendix B).

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 development within a watershed. Soils with negligible soil erosion potential are primarily low lying wetland areas near abutting streams. The soil erosion potential for Danforth Ponds and the lower bays of Ossipee Lake watershed was determined from each soil class hydrologic group (or runoff potential) as classified by the Natural Resources Conservation Service (NRCS) in the Hydrology National Engineering Handbook, May 2007, Part 630 (210-VI-NEH).

Moderately high and high soil erosion potential areas, which account for 40% of the watershed, are concentrated in the higher elevation areas in the northern and southern headwaters of the watershed. Low to moderately low erosion potential areas, which account for 54% of the watershed, are found primarily in the flatter, intact forests throughout the watershed. 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.

2.3.3 Wetlands, Streams, Open Water, and Riparian Habitat

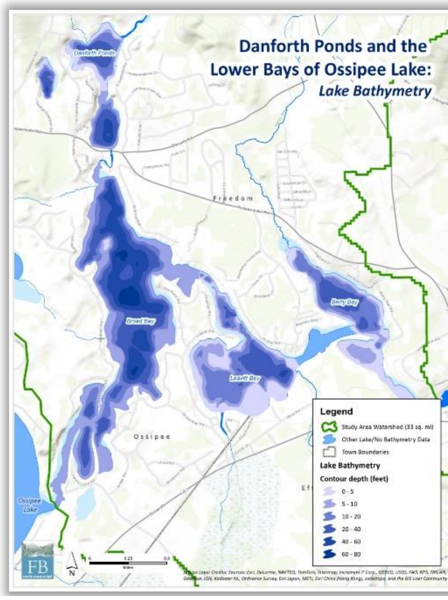
Danforth Ponds and the lower bays of Ossipee Lake provide a plethora of critical water resources for the surrounding landscape, including 603 acres of wetlands, 1,229 acres of open water, and 47 miles of major streams. The **riparian habitat** of these waterbodies is home to a diverse community of fish, birds, mammals, and plants that are dependent on clean water quality to flourish. Wetlands can maintain this necessary water quality by acting as a filter of nutrients and sediments from incoming stormwater runoff. Any decrease in the extent of wetlands as a consequence of development will limit this natural filtration and cause detrimental long-term effects on water quality and diversity of inhabiting species.

New Hampshire Fish & Game ranks habitat based on value to the state, biological region, and supporting landscape. According to this schema, the majority (88%) of the watershed of Danforth Ponds and the lower bays of Ossipee Lake is considered Tier 1 for highest ranked habitat in the State of New Hampshire. This area includes the major ponds, bays, and tributaries in the watershed, along with their contributing matrix forests. A smaller portion (10%) of the watershed, particularly hillslopes and wetlands, is considered Tier 2 for highest ranked habitat in the biological region. Other land in the southern portion of the watershed is considered Tier 3 for the supporting landscape. A map detailing priority habitats for conservation based on the NH Wildlife Action Plan can be found in Appendix B.

Riparian Habitat refers to the type of wildlife habitat found along the banks of a lake, river or stream and associated waterbodies. Not only are these areas ecologically diverse, but they also help protect water quality by preventing erosion and filtering polluted stormwater runoff by trapping nutrients and sediments.

The watershed of Danforth Ponds and the lower bays of Ossipee Lake is characterized primarily by mixed forest that includes both conifers (white pine, hemlock, larch, spruce, and juniper), and deciduous tree species (maple, birch, beech, ash, red oak, alder, and poplar). 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. Warmwater fish species present in Danforth Ponds include largemouth bass, smallmouth bass, yellow perch, sunfish, pickerel, and brown bullhead.



Bathymetry of Danforth Pond and the lower bays of Ossipee Lake (UNH GRANIT; Appendix B).

2.3.4 Lake Morphology and Morphometry

The morphology (shape) and morphometry (measurement of shape) 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.

> **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.

The surface area of Danforth Ponds and the lower bays of Ossipee Lake is 1.37 square miles (877 acres) with mean depths of 23.3 ft (7.1 m) and 50.5 ft (15.4 m), respectively) and maximum depth of 73 feet (22.3 m) in Broad Bay. There are 14.0 miles of shoreline and 21,698,000 cubic meters of water volume in Danforth Ponds and the lower bays of Ossipee Lake[1]. The **areal water load** is 1,076 m/yr, and the water in Danforth Ponds and the lower bays flushes on average 135 times each year (~31 times for Danforth Ponds, ~34 times for Broad Bay, ~221 times for Leavitt Bay, and ~254 times for Berry Bay). In comparison, Ossipee Lake flushes 4.6 times each year.

2.3.5 Direct and Indirect Drainage Areas

The most significant tributary to the lower bays of Ossipee Lake is the Ossipee River, which enters Broad Bay downstream from the outlet to Ossipee Lake. The Ossipee River accounts for nearly all the water in the lower bays (89%). Other major inlets to the lower bays include Cold, Phillips, Leavitt, and Square Brooks and an unnamed stream that flows south from Danforth Ponds to Broad Bay. Danforth Ponds are

[1] *Lake volume was calculated for the lakes based on the most recent bathymetry data provided by NHDES. Using the hydrologic budget determined by the land use model, new flushing rates were calculated for the lakes.*

fed by a wetland located in the Town of Eaton. These tributaries and the contributing land cover of their watersheds are important to the water quality of Danforth Ponds and the lower bays of Ossipee Lake.

Watershed load (runoff and tributary flow) accounts for 99% of the water entering Danforth Ponds and the lower bays of Ossipee Lake, which makes the condition of tributaries and their associated land covers critical to water quality. Additional inputs to Danforth Ponds and the lower bays of Ossipee Lake are from rainfall (1%). The large volume of water entering these lakes directly or indirectly via tributary streams makes phosphorus loading from these subwatersheds of major importance for lake management. High phosphorus inputs can result in nuisance algal blooms that damage the ecology and aesthetics of a lake. As a result, reducing phosphorus inputs to Danforth Ponds and the lower bays of Ossipee Lake from tributaries should be a high management priority. A detailed summary of the nutrient loading analysis for Danforth Ponds and the lower bays of Ossipee Lake is provided in Section 3.2.3.

2.4 INVASIVE PLANTS

Variable milfoil is an invasive plant species that has infiltrated Danforth Pond and the lower bays of Ossipee Lake (with the exception of Berry Bay).

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 control 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.

In summer 2014, multiple herbicide treatments and hand-pullings of milfoil, totaling an area of 2.7 acres, were conducted at Danforth Ponds. A survey was also completed by the NHDES on August 20, 2014 to document all infestation sites at Danforth Ponds, which showed less milfoil in 2014 than in previous years likely due to a combination of eradication efforts and the preceding cold winter (pers.comm., John Shipman, OWC). A new milfoil infestation site was discovered by Susan Marks in the channel connecting Leavitt Bay and Berry Bay, which puts Berry Bay at risk for milfoil infestation.

3. ASSESSMENT OF WATER QUALITY

This section provides an overview of the water quality standards that apply to Danforth Ponds and the lower bays of Ossipee Lake, the methodology used to assess water quality, and recommendations for managing these lakes to prevent future decline in water quality. Leavitt and Broad Bays are both on the 2012 303(d) list of New Hampshire impaired waters[2]. The impairment listing is for aquatic life based on observed low dissolved oxygen (DO) and presence of non-native aquatic plants in the lakes. The outlet stream from Danforth Ponds to Broad Bay is listed as impaired for aquatic life because of low pH. Low levels of oxygen (anoxia) at depths greater than 20 feet (6 meters) have also been consistently observed at Danforth Ponds. This plan focuses on total phosphorus (TP) as a driver of overall lake health and the likely culprit for the DO impairment. Lakes with excess nutrients, particularly phosphorus, which is considered the limiting nutrient in freshwater systems, are overproductive and may experience symptoms of water quality decline, including algal blooms, fish kills, decreased water clarity, loss of aesthetic values, and beach closures. Decomposition of accumulated organic matter from dead algal blooms and plants, such as milfoil, can result in anoxia in bottom waters, which can release phosphorus back into the water column as food for algae and plants and can also be lethal to fish and other aquatic organisms.

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 standards and 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 water. 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.

> The **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.

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 for surface waters include aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife. Lakes can have multiple designated uses.

[2] http://des.nh.gov/organization/divisions/water/wmb/swqa/2012/index.htm

In New Hampshire, all surface waters are legislatively classified as Class A or Class B; most of which are Class B. A brief description is provided in Table 3.1 (NHDES, 2012); however, a more detailed discussion of these classifications can be found in the State statute RSA 485-A:8. Further review and interpretation of the regulations (Env-Wq 1700) reveals that the general rules can be expanded and refined to include the seven specific designated criteria (Table 3.2). Danforth Ponds and the lower bays of Ossipee Lake are Class B waters in the State of New Hampshire.

Table 3.1: New Hampshire surface water classifications (adapted from NHDES, 2012).

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.

Table 3.2: Designated uses for New Hampshire surface waters (adapted from NHDES, 2012).

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.

3.1.2 Antidegradation

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.

3.1.3 Lake Nutrient Criteria

New Hampshire incorporates criteria in its water quality regulations to help determine whether nutrients are affecting lake water quality. For aquatic life uses (ALU), the State has a narrative nutrient criteria with a numeric translator or threshold, consisting of a "nutrient indicator" or **total phosphorus (TP)** 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). Sampling results from both the nutrient and response indicator are used to assess ALU in New Hampshire lakes (Table 3.3). For primary contact recreation (PCR), New Hampshire has a narrative criteria with a numeric translator or threshold for Chl-a. The nutrient indicator and response indicator are intricately linked since increased TP loading frequently results in increased phytoplankton levels, which can be estimated by measuring Chl-a levels in the lake. Increased phytoplankton may lead to decreased **dissolved oxygen (DO)** at the bottom of the lake, decreased water quality, and possibly changes in aquatic species composition.

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 (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.

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

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

Table 3.3: Aquatic life nutrient criteria ranges by trophic class in New Hampshire.

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

Trophic State is the degree of eutrophication of a lake as assessed by the transparency, Chl-a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion.

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

Primary Contact Recreation

The narrative criteria for PCR can be found in Env-Wq 1703.03, 'General Water Quality Criteria' and reads, "*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 Chl-a and cyanobacteria scums are used as secondary indicators for PCR assessments. These indicators can provide reasonable evidence to classify the designated use as "not supporting," but cannot result in a "fully supporting" designation. *E. coli* is the primary indicator for "fully supporting" designations. Elevated Chl-a levels or the presence of cyanobacteria scums interfere with the aesthetic enjoyment of swimming or may pose a health hazard. Chl-a levels greater than or equal to 15 ppb or presence of cyanobacteria scums are considered "not supporting" for this designated use.

Aquatic Life Use

Measurements for ALU ensures that waters provide suitable habitat for the survival and reproduction of desirable fish, shellfish, and other aquatic organisms. For ALU assessment, the combination of TP and Chl-a indicators is used to make support determinations. The ALU nutrient criteria vary by lake trophic class, since each trophic state has a certain phytoplankton biomass (Chl-a) that represents a balanced, integrated, and adaptive community. Exceedances of the Chl-a criterion suggests that the phytoplankton community is out of balance. Since phosphorus is the primary limiting growth nutrient for Chl-a, it is included in this evaluation process. For ALU assessment determinations, TP and Chl-a results are combined according to the decision matrix presented in Table 3.4. The Chl-a concentration will dictate the assessment if both Chl-a and TP data are available and the assessments differ.

Table 3.4: Decision matrix for aquatic life use assessment determinations in New Hampshire.

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

From 1974 through 2010, NHDES conducted trophic surveys on lakes to determine **trophic state**. The trophic surveys evaluate physical lake features and chemical and biological indicators. Trophic state may be designated as: oligotrophic, mesotrophic, or eutrophic. These are broad categories used to describe how productive a lake is. Generally, oligotrophic lakes are less productive or have less nutrients, while eutrophic lakes have more nutrients and are therefore more productive and exhibit algal blooms more frequently than oligotrophic lakes. Oligotrophic lakes typically have low productivity, low levels of phosphorus and Chl-a, few rooted aquatic plants and algae, deep **Secchi disk transparency (SDT)** readings (8.0 m or greater), and high DO levels throughout the water column. Danforth Ponds is designated as mesotrophic, and the lower bays (Broad, Leavitt, and Berry Bays) are designated as oligotrophic by the NHDES.

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).

3.2 ASSIMILATIVE CAPACITY ANALYSIS

A lake receives natural inputs of phosphorus in the form of runoff from its watershed. This phosphorus will 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** is based on factors such as lake volume, watershed area, and precipitation runoff coefficient. If a lake is receiving more phosphorus from the watershed than it can assimilate, then its water quality will decline over time as algal blooms become more frequent.

3.2.1 Study Design and Data Acquisition

Historical water quality monitoring data was analyzed by FB Environmental to determine the median phosphorus value and the assimilative capacity for Danforth Ponds and the lower bays of Ossipee Lake. GMCG, the New Hampshire Lake Survey Program and Volunteer Lake Assessment Program (VLAP), and the New Hampshire Lakes Lay Monitoring Program (LLMP) are the primary groups collecting water quality data from lakes and streams in the Ossipee Lake watershed. The LLMP is administered jointly by the UNH Center for Freshwater Biology (CFB) and UNH Cooperative Extension (UNHCE). All NHDES and UNH data is available through the NHDES Environmental Monitoring Database (EMD). GMCG tributary data collected since 2001 was analyzed and presented in the GMCG 10-Year Water Quality Monitoring Report.

Data acquisition and analysis for Danforth Ponds and the lower bays of Ossipee Lake followed protocols set forth in the Site Specific Project Plan (SSPP) in Appendix A. Historical water quality monitoring data was used for determining the median phosphorus values and the assimilative capacity of both lakes and for determining the phosphorus water quality goal for each lake. The analysis includes a comparison of historical (2003 and earlier) and recent (2003-2014) seasonal TP monitoring results (samples collected between May 15 and September 30), as well as a summary of available TP data and sources for these waterbodies (Table 3.5).

Table 3.5: Available water quality data for Danforth Ponds and the lower bays of Ossipee Lake.

Data Source	Agency/Org	Danforth Ponds		Lower Bays	
		Years Sampled	# Years Sampled	Years Sampled	# Years Sampled
Trophic Reports & Surveys	NHDES	1983, 2001	2	1976, 1978, 1980, 1987-88, 2003	6
VLAP	NHDES	2003-2014	12	1990-2014	25

Water quality data from multiple sources were combined into a common spreadsheet for each waterbody and then sorted by date and station for Quality Assurance/Quality Control (QA/QC) to avoid duplicating data sets. All duplicates were removed. An initial analysis was conducted to determine median TP based on all samples regardless of whether they were **grab or epilimnetic core (EC) samples.** Minimum, maximum, and median TP values were determined for each station on the lakes, and were sorted by depth of sample (EC samples vs. grab samples from the epilimnion, metalimnion, and hypolimnion). Data were further refined using only EC data to calculate the median TP concentration. The seasonal (May 15- Sept 30) median EC value represents the 'Existing Median Water Quality' applied to the NHDES Assimilative Capacity Analysis for determining if a waterbody is Impaired, Tier 1, or Tier 2. See Figure 3-1 in the 2012 Consolidated Assessment and Listing Methodology for a conceptual diagram of Tier 1 and Tier 2 waters (NHDES, 2012).

Grab Samples are water samples taken just below the surface, or with a depth sampler collected at a specified depth or location in the water column.

Epilimnetic Core (EC) samples represent a vertical sample of the water column obtained within the lake's epilimnion using flexible plastic tubing, usually ½ inch in diameter. The tubing is lowered to a desired depth, clamped at the water's surface, raised, and decanted into a collection jug. This integrated sample is tested for multiple water quality parameters.

TSI Index (Stratified Lakes)

TSI > 6 may support algal blooms

TSI > 12 indicates extreme productivity & annual algal blooms

Water quality monitoring data for Danforth Ponds and the lower bays of Ossipee Lake has been collected since 1976, and in Danforth Ponds since 1983. This includes SDT readings, DO profiles, and data on phosphorus and Chl-a concentrations. Water quality data has been consistently collected at the deep spots of each lake.

NHDES calculates **Trophic State Index (TSI)** from summer bottom DO, summer SDT, aquatic vascular plant abundance, and summer epilimnetic Chl-a. This trophic classification system also accounts for lake stratification. Stratified lakes with TSI values greater than 6 may support algal blooms (for unstratified lakes this value is 4), while TSI values over 12 indicate extreme productivity and annual algal blooms (for unstratified lakes this value is 9).

NHDES's most recent (2003) TSI determination numerically scored the trophic state of all three lower bays (Broad, Leavitt, and Berry Bays) as oligotrophic. NHDES considers the water quality of the lower bays to be high based on measures of SDT, aquatic plant abundance, and Chl-a. The potential for nuisance algal blooms in the lower bays is therefore low. NHDES has listed Danforth Ponds as mesotrophic, which means that the lake may be more susceptible to aquatic plant growth and algal blooms.

Leavitt and Broad Bay are both on the 2012 303(d) list of New Hampshire impaired waters (NHDES, 2012). The impairment listing is for aquatic life based on observed low DO in the lakes. The outlet stream from Danforth Ponds to Broad Bay is listed as impaired for aquatic life based on low pH.

3.2.2 Water Chemistry Assessment

Existing and future development pose a major threat to water quality as stormwater runoff exports excess sediment and nutrients to streams and lakes in the watershed. A water quality assessment is a key component to assessing the health of a lake and determining impacts from watershed activities. The water quality analysis for Danforth Ponds and the lower bays of Ossipee Lake examined trends over time (increasing, decreasing, or unchanged) for TP.

Mann-Kendall trend tests[3] were completed for the previous twelve years (2003 - 2014) of TP data for Ossipee Lake, Broad Bay, Leavitt Bay, Berry Bay, and Danforth Ponds (Table 3.6). No significant trend for TP was found in any of these lakes. Generally speaking, the results indicate a stable water quality trend for TP over the past ten years with moderate variability. Figure 3.1 shows the trend graphs for each of the lakes from 2003-2014, with corresponding water quality thresholds and historical averages. Year-to-year variability is expected in data from lakes with low sample sizes per year (n = 1 to 5 in most cases) and as a result of climate variation. NHDES VLAP reports over the entire collection period (1990-2013) also show stable trends in TP with moderate variability in Danforth Ponds and the lower bays of Ossipee Lake with the exception of Broad Bay, which shows degrading (increasing) TP from 1990-2013.

Mean TP concentrations have increased slightly over the ten-year time period, but all lakes are below or near their respective New Hampshire water quality threshold for TP: 8.0 ppb for oligotrophic lakes (Ossipee Lake and Broad, Leavitt, and Berry Bays) or 12.0 ppb for mesotrophic lakes (Danforth Ponds) (Table 3.7). The seemingly large increase in median in-lake TP for Danforth Ponds is likely a factor of low sample size prior to 2003.

The 2003-2014 median TP for Ossipee Lake (7.2 ppb), Broad Bay (7.3 ppb), and Berry Bay (7.3 ppb) are slightly greater than or equal to 7.2 ppb, which is 10% of the water quality threshold "reserve" for phosphorus (8.0 ppb – 10% = 7.2 ppb); this is what NHDES refers to as the "Reserve Assimilative Capacity" (Table 3.7). Since some of these lakes are within this "reserve," steps should be taken to

[3] A non-parametric statistical test that determines if the central value (median) of a dataset has changed over time.

identify sources of phosphorus that are entering the lakes and work towards reducing those loads before the lakes surpass the threshold of 8.0 ppb. The efforts of GMCG to develop a watershed-based management plan for the area is the first step in controlling phosphorus loading in the watershed.

Table 3.6: Summary of Mann-Kendall tests using 12 years of median annual total phosphorus (TP) for the lakes. The null hypothesis (no trend) cannot be rejected if the p-value is greater than 0.05. Ossipee Lake is included here for reference.

Waterbody	Observations	Min Median Annual TP (ppb)	Max Median Annual TP (ppb)	Mean Median Annual TP (ppb)	Std. Dev. Median Annual TP (ppb)	p-value	Sig. (α = 0.05)
Broad Bay	12	5.9	12.0	7.8	2.1	0.837	No trend
Leavitt Bay	12	5.5	9.0	7.1	1.1	0.890	No trend
Berry Bay	12	6.0	9.0	7.4	1.2	0.127	No trend
Danforth Ponds	12	5.8	12.5	9.2	2.5	0.114	No trend
Ossipee Lake	12	5.0	13.7	7.7	2.3	0.536	No trend

Table 3.7: Median total phosphorus (TP) values for the five lakes analyzed, both pre-2003 and from 2003-2014, and their NHDES water quality thresholds for TP. Ossipee Lake is included here for reference.

Lake	Pre-2003 Median TP (ppb)	2003-2014 Median TP (ppb)	Change (ppb)	NH DES Trophic Designation	NH Water Trophic Threshold for TP (ppb)
Broad Bay	7.0	7.3	+0.3	Oligotrophic	8.0
Leavitt Bay	6.0	6.8	+0.8	Oligotrophic	8.0
Berry Bay	7.0	7.3	+0.3	Oligotrophic	8.0
Danforth Ponds*	6.5	9.0	+2.5	Mesotrophic	12.0
Ossipee Lake	6.0	7.2	+1.2	Oligotrophic	8.0

**The seemingly large increase in TP for Danforth Ponds is likely a factor of low sample size prior to 2003.*

Of special concern is phosphorus concentration in the deep waters of Danforth Ponds. This is likely linked to oxygen depletion at these lower depths, which can be related to bacterial respiration during decomposition of organic matter (such as dead plants and algae). Oxygen depletion at the sediment/water interface can cause a chemical reaction that releases phosphorus from sediment into the water column. An oxygen study at Danforth Ponds will help to understand the extent and duration of oxygen depletion in the lake, and how it may relate to phosphorus release.

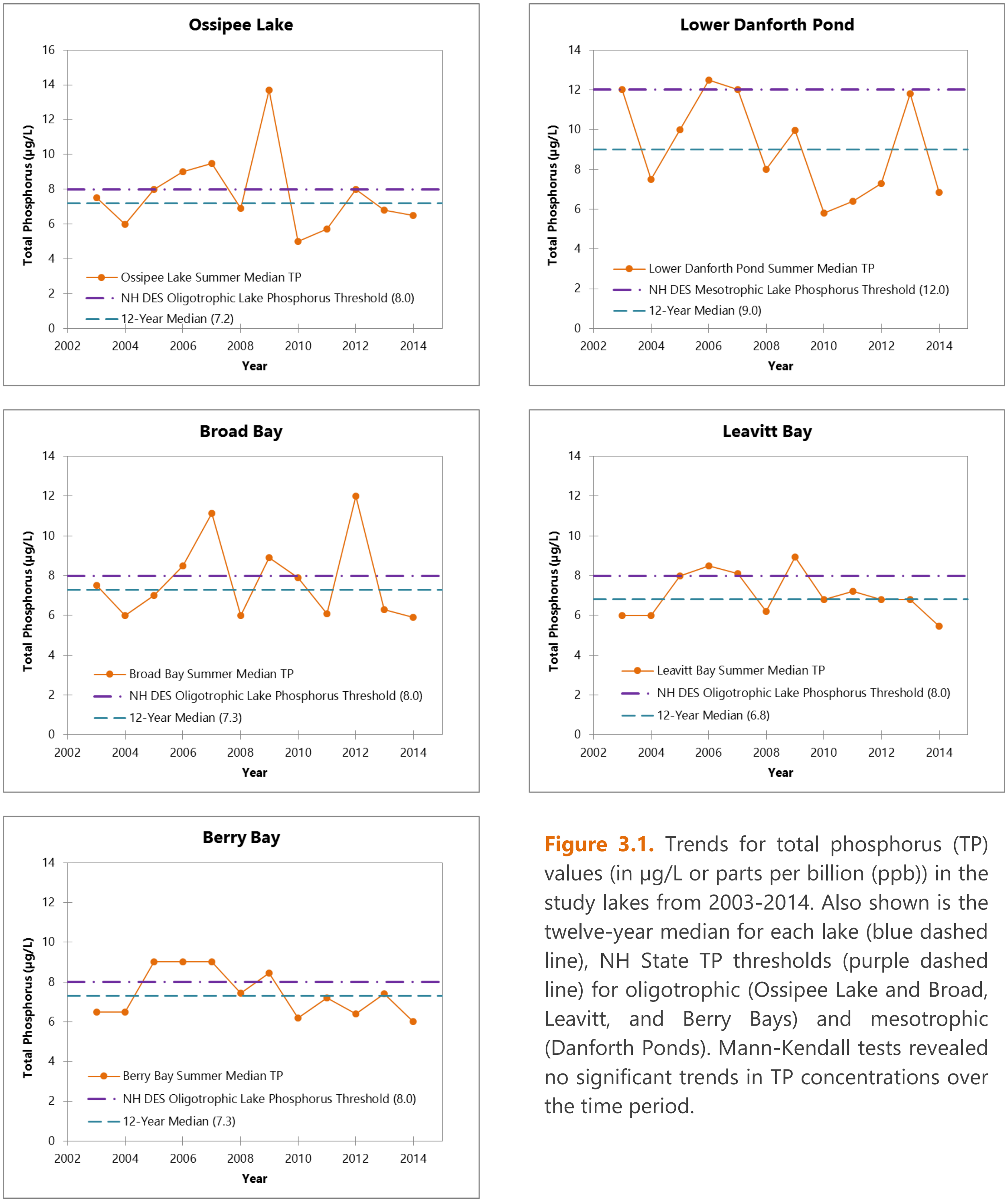


Figure 3.1. Trends for total phosphorus (TP) values (in µg/L or parts per billion (ppb)) in the study lakes from 2003-2014. Also shown is the twelve-year median for each lake (blue dashed line), NH State TP thresholds (purple dashed line) for oligotrophic (Ossipee Lake and Broad, Leavitt, and Berry Bays) and mesotrophic (Danforth Ponds). Mann-Kendall tests revealed no significant trends in TP concentrations over the time period.

3.2.3 Assimilative Capacity Analysis and Lakes Loading Response Modeling

As stated previously, the assimilative capacity of a lake is its ability to resist the effects of landscape disturbance without water quality impairment. For purposes of this plan, phosphorus was determined to have the greatest direct impact on water quality in Danforth Ponds and the lower bays of Ossipee Lake and the likely culprit for observed DO impairments. The median TP concentration from each lake (by station) was used to calculate the total, reserve, and remaining assimilative capacity for each lake using procedures described in the Standard Operating Procedures for Assimilative Capacity Analysis for New Hampshire Waters (Table 3.8; NHDES, 2008). Tier 2 waters, or high quality waterbodies, have one or more water quality parameters that exceed the water quality standard and that also exhibit a reserve capacity of at least 10% of the waterbodies' total assimilative capacity. Tier 2 waters have some assimilative capacity remaining, whereas Tier 1 and Impaired Waters do not.

Table 3.8: Assimilative capacity analysis results for Danforth Ponds and the lower bays of Ossipee Lake. All data are based on samples taken from the deep hole in each lake.

Lake	Existing Median TP (ppb)	NHDES TP Water Quality Threshold (ppb)	Assimilative Capacity Reserve Threshold (ppb)	Remaining Assimilative Capacity	Assimilative Capacity Category	Allowable TP Increase?
Broad Bay	7.3	8.0	7.2	-0.1	Tier 1	No
Leavitt Bay	6.8	8.0	7.2	0.4	Tier 2	Yes
Berry Bay	7.3	8.0	7.2	-0.1	Tier 1	No
Danforth Ponds	9.0	12.0	10.8	1.8	Tier 2	Yes[4]

Assimilative Capacity Analysis Categories:
Tier 2 = Better than Standard + Reserve Capacity
Tier 1 = Better than the Standard but w/in the Reserve Capacity (no remaining capacity)
Impaired= Worse than Standard (no remaining capacity-not w/in the Reserve)

[4] It should be noted that these thresholds used to calculate the assimilative capacity are based on analyses of all New Hampshire lakes and ponds and should only serve as guidelines for determining the most appropriate water quality targets for a particular waterbody. Each waterbody is unique; for instance, the assimilative capacity for Danforth Ponds revealed a large reserve capacity, meaning the waterbody can supposedly have an allowable increase of 1.8 ppb before exceeding its trophic class threshold. However, aquatic plant growth is already a significant problem for the lake with recurring low oxygen concentrations in bottom waters. This is why the Steering Committee decided to treat Danforth Ponds as oligotrophic, so that the water quality goal would be to reduce in-lake phosphorus to 7.2 ppb (the assimilative capacity reserve threshold for oligotrophic waterbodies).

This Assimilative Capacity Analysis demonstrates that Danforth Ponds and Leavitt Bay are **Tier 2**, because the existing median water quality value for TP is below the threshold that is 10% less than the cutoff for the trophic class of these lakes (Table 3.8). These results are based on water quality analyses for the deepest location in each lake. The Assimilative Capacity Analysis for Broad and Berry Bays classifies these waterbodies as **Tier 1**, since the remaining assimilative capacity falls within the reserve capacity. Lakes with no remaining assimilative capacity (with TP values that surpass the value set for their lake type) are designated as **impaired**.

Tier 2 or High Quality Waters exhibit water quality that is better than the standard + reserve capacity.

Tier 1 waters exhibit water quality that is better than the standard but is within the reserve capacity.

Impaired waters exhibit water quality that is worse than the standard, has no remaining assimilative capacity, and is not within the reserve.

A second analysis was used to link watershed loading conditions with in-lake TP concentrations to predict the effect of existing watershed development on future water quality in Danforth Ponds and the lower bays of 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 lakes and their tributaries. The model makes predictions about Chl-a concentrations and SDT readings. 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 an estimate of internal lake loading, combined with many coefficients and equations from scientific literature on lakes and nutrient cycles.

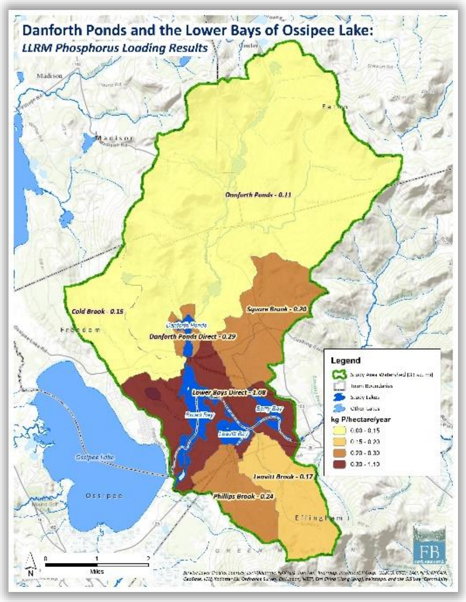
As shown in Table 3.9, the results of this model indicate that the greatest phosphorus load comes from watershed runoff, which accounts for 88% of the total loading for Danforth Ponds and 96% of the total loading for the lower bays. Atmospheric deposition accounts for about 2% and 1% percent of the TP loading to Danforth Ponds and the lower bays, respectively. Septic systems account for 1% and 4%, and waterfowl are assigned just 0% and 1% of the TP entering Danforth Ponds and the lower bays, respectively. Internal loading was calculated to contribute about 6% of the TP load to Danforth Ponds. This is higher than in the lower bays because of the low oxygen conditions observed in the deep waters of Danforth Ponds.

Table 3.9: Total phosphorus (TP) and water loading summary for Danforth Ponds and the lower bays of Ossipee Lake.

Loads to Danforth Ponds	TP *(kg/year)*	TP *(%)*	Water *(m^3/year)*	Water *(%)*
Atmospheric Deposition	7.0	1%	252,473	1%
Internal Loading	33.5	6%	0	0%
Waterfowl	3.0	1%	0	0%
Septic Systems	26.6	4%	19,080	<1%
Watershed Runoff	525.9	88%	31,384,958	99%
Total Load To Danforth Ponds	**596.0**	**100%**	**31,656,510**	**100%**

Loads to Lower Bays	TP *(kg/year)*	TP *(%)*	Water *(m^3/year)*	Water *(%)*
Atmospheric Deposition	62.6	2%	2,257,826	1%
Internal Loading	12.3	<1%	0	0%
Waterfowl	17.4	<1%	0	0%
Septic Systems	56.6	1%	40,684	<1%
Watershed Runoff – includes Ossipee Lake	3,918	96%	404,606,597	99%
Total Load To Lower Bays	**4,067**	**100%**	**406,905,107**	**100%**

The model estimates that 97.6% of the watershed load to the lower bays of Ossipee Lake comes from Ossipee Lake itself, with the remainder originating from tributaries and overland runoff. Despite the large proportion of water coming into the lower bays from Ossipee Lake, examining the phosphorus concentration and attenuation factors for each contributing tributary to the lower bays is important for nutrient management. Based on high phosphorus concentrations and low attenuation, the model determined that the direct drainage area of the lower bays contributed the most phosphorus per hectare per year of any of the other tributaries.



The direct drainage area of the lower bays contribute the most phosphorus per ha per year compared to the other tributaries (Appendix B).

The large watershed of Danforth Ponds is mainly forested (88%). Subsequently, the phosphorus load to Danforth Ponds is much lower than that of the lower bays. Forested headwaters support good water quality and healthy aquatic ecosystems.

A more detailed discussion of watershed modeling results with a breakdown of loading by subwatershed can be found in Appendix C.

3.2.4 Establishment of Water Quality Goals

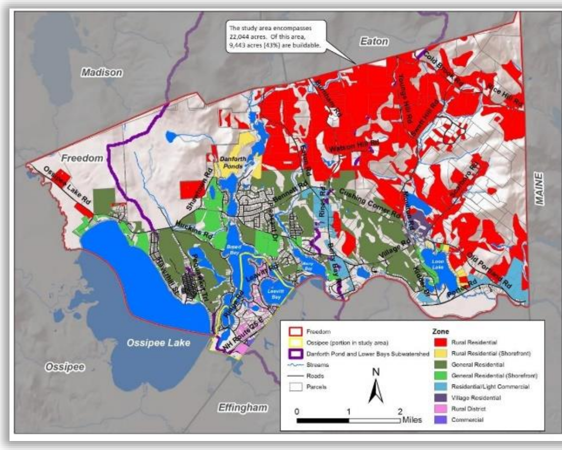
The purpose of setting a water quality goal in a phosphorus-focused watershed management plan is to quantify the amount of reductions in phosphorus loading to achieve the desired water quality conditions. The process of establishing water quality goals for Danforth Ponds and the lower bays of Ossipee Lake was guided by the water quality and assimilative capacity analysis and watershed modeling conducted by FB Environmental.

The over-arching goal for the watershed is to improve water quality conditions at Danforth Ponds and the lower bays of Ossipee Lake and to protect the lakes from future, unaccounted-for inputs of phosphorus as a result of new development in the watershed over the next ten to twenty years. The Steering Committee has chosen an interim goal of lowering current phosphorus loading and in-lake phosphorus concentrations to at least 10% lower than NHDES thresholds for oligotrophic conditions at 7.2 ppb, which places more stringent controls on phosphorus loading to Danforth Ponds, a mesotrophic lake. This water quality goal translates more specifically to reducing current median in-lake TP by 1.4% (from 7.3 to 7.2 pbb) in Broad Bay, 1.4% (from 7.3 to 7.2 ppb) in Berry Bay, and 20% (from 9.0 to 7.2 ppb) in Danforth Ponds. This would require a reduction in phosphorus loading to these waterbodies, assuming the average annual water loading remains the same: 119 kg P/yr reduction for Danforth Ponds and 57 kg P/yr for the lower bays (refer to Table 3.9). It should be noted that Danforth Ponds watershed contributes 6.9% and 13.2% of the water and phosphorus loading to the lower bays. Achieving a 20% reduction in the phosphorus load to Danforth Ponds will result in 2.6% reduction in phosphorus load to the lower bays. In addition, any reductions in phosphorus coming from Ossipee Lake will also reduce in-lake phosphorus concentrations in the lower bays. Management actions should focus on improving upstream waterbodies (i.e. Ossipee Lake and Danforth Ponds), since these waterbodies feed directly into the lower bays. These are interim recommendations pending the completion of the Ossipee Lake LLRM results in 2015.

The projected increase in phosphorus from the build-out analysis indicates that new development in the watershed of Danforth Ponds and the lower bays of Ossipee Lake needs to be carefully managed to reach this goal. The watershed towns should focus efforts on implementing LID techniques for future development as well as installing BMPs that address existing sources of phosphorus throughout the watershed. These goals will be discussed further in Section 5.2.

3.3 FUTURE LAND COVER PROJECTIONS: BUILD-OUT ANALYSIS

With support from the Town of Freedom, a build-out analysis was conducted by FB Environmental for the entire Town of Freedom and a portion of the Town of Ossipee within the watershed of Danforth Ponds and the lower bays of Ossipee Lake. The analysis combined 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. The analysis determined that 43% of the study area within the watershed (9,443 acres) in the Towns of Freedom and Ossipee is buildable and can house up to 2,164 more buildings (a 90% increase from current conditions); most of the new development would be contained in the rural residential and residential/light commercial zones (Table 3.2).



Map of buildable area in Freedom (see Appendix B for larger map).

> Within the next 27-50 years, in-lake concentrations of phosphorus could be as high as 10.1 ppb in the lower bays of Ossipee Lake based on 2014 zoning standards.

At the rate of population growth that the Towns of Freedom and Ossipee experienced from 2000-2010 (1.34%), 1990-2010 (2.35%), and 1980-2010 (2.45%), full build-out could occur as early as 2064, 2043, or 2041, respectively. 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. It is recommended that town officials recognize this population pressure in future watershed management planning.

Results of this analysis reinforce the concept of comprehensive planning at the watershed level to address future development and its effect on the water quality of the region. A phosphorus load analysis was conducted for the full build-out scenario for the lower bays of Ossipee Lake. Danforth Ponds could not be modeled without a complete build-out analysis of the entire watershed. At full build-out, it's estimated that there would be a 39% (to 1,695 kg P/yr) increase in phosphorus loading to the lower bays of Ossipee Lake with loading from septic systems increasing 99% (to 113 kg P/yr). The LLRM estimates that at full build-out in-lake concentrations of phosphorus could be as high as 10.1 ppb in the lower bays of Ossipee Lake. However, this is merely a placeholder until a properly completed build-out scenario that encompasses all Ossipee Lake watershed towns is conducted. These increases will place the lower bays into a more productive trophic state class.

Table 3.2: Summary of build-out analysis results for phosphorus loading by source category for the lower bays of Ossipee Lake. Danforth Ponds could not be modeled without a complete build-out analysis.

	Current Conditions *kg/year*	From Danforth Ponds & Lower Bays Build-out Analysis *kg/year*	Build-out Analysis, plus 40% Increase in Ossipee Lake P Load *kg/year*
Direct Loads			
Atmospheric	63	63	63
Internal	12	12	12
Waterfowl	17	17	17
Septic Systems	57	113	113
Watershed Loads			
Lower Bays Watershed – includes Danforth Pond	1,222	1,695	1,695
Upstream Watersheds via Ossipee Lake	2,696	Not Modeled	3,774*
Lower Bays Phosphorus Load (kg/year)	4,067	Not Modeled	5,674*
Lower Bays In-Lake Phosphorus Concentration (ppb)	7.1	Not Modeled	10.1*

** The entire watershed of Danforth Ponds and the lower bays of Ossipee Lake was not modeled for build-out conditions, therefore the 40% increase in phosphorus load coming from Ossipee Lake presented here is merely a provisional placeholder for estimating phosphorus load increase to the lower bays. No estimates could be made for Danforth Ponds without a complete build-out analysis. A proper build-out may show a much higher or lower future phosphorus loading estimate for Danforth Ponds and the lower bays.*

3.4 WATERSHED STORMWATER SURVEY ASSESSMENT

During large precipitation events in forested areas, it is natural for approximately 10% of rain or snowmelt to flow as runoff. In developed areas, however, runoff volumes increase five-fold due to impervious surfaces, including packed dirt or paved roads, parking lots, and rooftops. Stormwater pollutants can have negative consequences for fish and wildlife, native vegetation, public drinking water sites, and public recreational water usage. Landowners, municipal officials, and developers should consider alternatives such as LID for mitigating impacts from any new development. Stormwater retrofits (BMPs) can be utilized for existing development where stormwater issues are prevalent.

The 2014 shoreline stormwater survey identified 108 sites where stormwater improvements are needed within 250 ft. of the shoreline. (Photo: FB Environmental)

As described in Section 1.5.1, a stormwater survey of the watershed of Danforth Ponds and the lower bays of Ossipee Lake was conducted on November 20, 2013 by Forrest Bell, Principal of FB Environmental, and Corey Lane, Project Manager for GMCG. Staff documented erosion on the roads, properties, driveways, and municipal areas using cameras and standardized forms. This survey focused on examining sites on public lands around Danforth Ponds and the lower bays of Ossipee Lake and looking for potential sources of nutrients and bacteria from stormwater runoff. Problems were identified and documented, solutions were recommended, and the costs of improvements were estimated. Ten sites were documented during the stormwater survey. Impact levels were assigned to each site based on location, area, slope, amount of soil eroded, and proximity to water. The survey aims to document sources of pollution from roadside runoff into tributaries, direct runoff to lakes, runoff from development, use of fertilizers, erosion from poorly buffered properties, and artificially-created beaches. More specifically, it identified the type of land use activity, the nature of the stormwater problem, the size of exposed or eroded area, on-site recommendations, impact on water quality, and cost of implementation.

Three of the identified sites were found on private roads and accounted for the majority of documented sites (Figure 3.2). These sites were largely defined by lack of buffer and moderate erosion. Two of the documented sites were found on town roads, and were defined by moderate ditch erosion and severe surface erosion. One site was documented for each of the following: agriculture, state road, driveway, beach/boat access, and commercial land use type. Four of the ten sites were identified as high impact, while one site was identified as low impact (Table 3.10). The slight majority (five sites) were of medium impact.

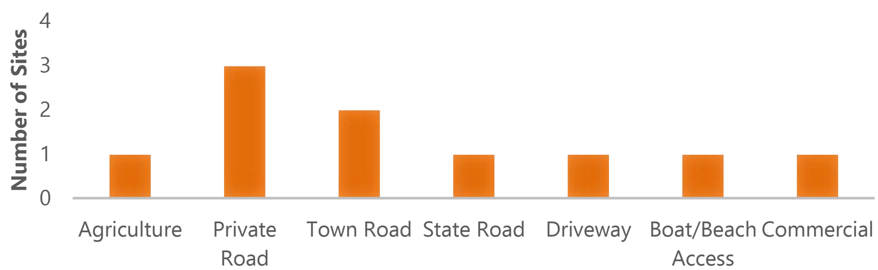


Figure 3.2: Frequency and percentage of polluted runoff problems by type.

Table 3.10: Impact rating for each identified polluted runoff problem by type.

LAND USE	HIGH IMPACT	MEDIUM IMPACT	LOW IMPACT	TOTAL
STATE ROAD	0	1	0	1
DRIVEWAY	1	0	0	1
TOWN ROAD	1	1	0	2
PRIVATE ROAD	1	1	1	3
COMMERICAL	1	0	0	1
BOAT/BEACH ACCESS	0	1	0	1
AGRICULTURE	0	1	0	1
TOTAL	4	5	1	10

Recommendations were made for fixing each site, and the associated cost of labor and materials was estimated. Cost is an important factor in planning for restoration and the cost effectiveness of BMP application. Recommendations at 1 site were determined as "low" cost (< $500), 8 were "medium" cost ($500 - $2,500), and 1 was "high" cost (> $2,500). Implementing erosion control and stormwater runoff control improvements at these sites to limit phosphorus loading to Danforth Ponds and the lower bays of Ossipee Lake will require efforts by individual property owners, road associations, and municipal officials. The four high impact sites are described below.

Site ID #1: a driveway and boat access ramp were identified as having moderate surface and road shoulder erosion that runs off directly into the lake. It is recommended that new surface material (e.g. recycled asphalt) be added, the road crown reshaped, and an open top culvert installed.

Site ID #2: a commercial property was identified as having moderate surface and roof runoff erosion and lack of streambank vegetation that allows stormwater to enter the stream. It is recommended that an infiltration trench at the roof dripline be installed, and a buffer planted along the stream.

Site ID #4: a town road was identified as having severe surface erosion with several large gullies that flow directly into the lake. It is recommended that runoff diverters are installed, a foot path is stabilized, and a buffer is planted with erosion control mulch.

Site ID #6: a private road was identified as having moderate surface erosion, lack of adequate shoreline vegetation, and significant shoreline erosion that was depositing stormwater runoff into a stream. It is recommended that a buffer be planted along the stream for stabilization.

This analysis complements the detailed shoreline survey work completed in September of 2013 by FB Environmental staff and GMCG volunteers. The shoreline survey consisted of visual observation of shoreline condition along the entire lengths of Danforth Ponds and the lower bays of Ossipee Lake, using the scoring criteria presented in Table 3.11.

Table 3.11: Scoring criteria for the shoreline survey.

Category	Scoring Criteria
Buffer	1 = Excellent Buffer (all natural vegetation - trees of mixed sizes and shrubs) 2 = Good (some trees and shrubs, some bare areas) 3= Moderate (a few small trees/shrubs, some lawn) 4= Minimal (mostly lawn, some shrubs) 5= No Buffer (all lawn/bare)
Bare Soil	1=No exposed Soil 2= minimal exposed Soil 3= Fair amount of exposed soil 4=Large amounts of exposed soil
Shoreline Erosion	1=No Erosion Visible 2=Some Erosion Visible 3=Moderate to Severe shoreline erosion
Setback Distance	1 = homes more than 150' from shore 2 = home between 75 - 150' from shore 3 = house/camp less than 75' from shore
Slope	1=Little to no slope (3 - 8%) 2=Moderate Slope (8 - 20%) 3=Steeply sloped (>20%)

Results were broken out by waterbody (Table 3.12) and town (Table 3.13). Danforth Ponds received the lowest (or best) average disturbance score by having good buffer, minimal exposed soil, little to no shoreline erosion, adequate setbacks, and moderate slopes. Berry Bay showed moderate buffer, minimal exposed soil, some shoreline erosion, adequate setbacks, and moderate slopes. Broad Bay showed minimal buffer, minimal exposed soil, some shoreline erosion, inadequate setbacks, and moderate slopes. Leavitt Bay received the highest (or worst) average disturbance score by having minimal buffer, a fair amount of exposed soil, some shoreline erosion, inadequate setbacks, and moderate slopes. Of the three towns that contain Danforth Ponds and the lower bays of Ossipee Lake, the Town of Ossipee had the highest (or worst) average shoreline disturbance score as a result of only minimal buffer, a fair amount of exposed soil, and inadequate setbacks.

Table 3.12: Average shoreline disturbance score values for each lake.

Lake	Number of parcels with structures evaluated	Buffer	Bare Soil	Shoreline Erosion	Setback Distance	Slope	*Average Shoreline Disturbance Score*
Danforth	63	2.6	2.3	1.0	2.3	2.1	10.3
Berry	50	3.0	2.2	1.6	2.4	1.8	10.4
Broad	274	3.5	2.4	1.4	2.6	1.7	11.2
Leavitt	103	4.0	3.0	1.9	2.5	1.6	12.1

Table 3.13: Average shoreline disturbance score values for each town.

Lake	Number of parcels with structures evaluated	Buffer	Bare Soil	Shoreline Erosion	Setback Distance	Slope	*Average Shoreline Disturbance Score*
Effingham	2	3.5	2.5	1.5	2.0	1.0	5.3
Freedom	254	3.1	2.3	1.5	2.4	1.9	10.9
Ossipee	234	3.7	2.7	1.5	2.6	1.5	11.7

The shoreline survey data and the maps generated (refer to Appendix D) highlight areas contributing NPS pollution to the lakes, help determine actions needed to reduce NPS pollution and maintain the water quality goal for the lakes, and help prioritize areas for shoreline restoration using stormwater BMPs. The Action Plan (Section 5.2) prioritizes structural BMP implementation for the ten sites identified by the stormwater survey and addresses the need to target high impact areas identified by the shoreline survey. Of the shoreline parcels surveyed for each waterbody, 31 (11%) for Broad Bay, 29 (28%) for Leavitt Bay, 9 (18%) for Berry Bay, and 0 (0%) for Danforth Ponds had disturbance scores greater than 15, indicating high impact sites. In total, 14% of the 490 parcels surveyed were considered high impact sites. Because Danforth Ponds received no disturbance scores above 14, ten parcels with moderately high scores (13-14) were included in the recommendations.

4. MANAGEMENT STRATEGIES

4.1 GOALS FOR LONG-TERM PROTECTION

The ultimate vision of the Ossipee Lake Watershed Management Plan Phase I for Danforth Ponds and the lower bays of Ossipee Lake is to protect critical watershed characteristics for the maintenance and/or improvement of current water quality status. This ambitious effort is supported by the idea that existing and new development can be conducted in a manner that sustains environmental values, and that citizens, businesses, government, and other stakeholder groups can be responsible stewards of the watershed of Danforth Ponds and the lower bays of Ossipee Lake. The long-term goal is to protect the watershed and water quality of Danforth Ponds and the lower bays of Ossipee Lake through a 20% (119 kg P/yr) and 1.4% (57 kg P/yr) reduction in median in-lake TP in Danforth Ponds and the lower bays, respectively. This target reduction in TP can be achieved through the following **structural and non-structural** BMP objectives:

Structural BMPs, or engineered Best Management Practices (BMPs) are often on the forefront of most watershed restoration projects. However, **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 such as street sweeping and road sand/salt management, and targeted education and training.

- Implement BMPs throughout the watershed to reduce sediment and phosphorus runoff from existing development (Sections 3.4 and 4.2).
- Educate landowners through the NHDES Soak Up the Rain program, BMP demonstration sites, workshops, and other communication strategies, targeting high priority septic systems (>20 years old, within 50 feet of a waterbody, and rarely pumped out) (Section 5.2.1).
- Institute greater controls on new and re-development, require LID in site plans, and encourage regular septic system maintenance (Section 5.2.4).
- Focus on education outreach regarding conservation easements (Sections 2.2.3 and 5.2.4).
- Continue and/or expand the water quality monitoring and aquatic invasive plant control programs (Sections 2.4, 3.2, and 5.2.5).

These objectives and more are discussed in greater detail in the Action Plan (Section 5.2). Achieving the goals and objectives for future implementation work in the watershed of Danforth Ponds and the lower bays of Ossipee Lake will require a comprehensive and integrated set of activities as identified below.

4.2 ADDRESSING NONPOINT SOURCE (NPS) POLLUTION

4.2.1 Structural NPS Restoration

FB Environmental and GMCG documented ten sites that directly impact water quality through the delivery of phosphorus-laden sediment. Consequently, structural BMPs are a necessary and important component for the improvement and protection of water quality in Danforth Ponds and the lower bays of Ossipee Lake. The best methods for treating these sites are to:

Lack of a protective buffer results in excess sediment and nutrient load to Danforth Pond and the lower bays of Ossipee Lake. (Photo: FB Environmental)

1) Address high priority sites with an emphasis on cost-efficient fixes that have the lowest cost per kg of phosphorus treated.

2) 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.

3) Work with experienced professionals on sites that require a high level of technical knowledge (engineering) to install, and ensure proper functioning of the BMP.

4) Measure the pollutant load reduction for each BMP installed (see below).

These basic criteria will help guide the proper installation of BMPs in the watershed. Refer to the Action Plan in Section 5.2 and conservation practice fact sheets provided by the Cumberland County Soil & Water District for a continued discussion of BMP implementation strategies (CCSWD, 2014).

In total, the ten sites identified in the watershed survey will reduce 18.42 kg TP/yr and cost $46,545 to implement on land near or directly adjacent to Danforth Ponds and the lower bays of Ossipee Lake (Table 4.1; refer to Section 5.4 and Appendix E). These estimates are based on the Region 5 model for estimating pollutant load reductions.

Using a simple scoring method, the shoreline survey served as an excellent tool for highlighting shoreline properties around each lake that exhibited significant erosion (refer to Section 3.4). This method of shoreline survey is a rapid technique to assess the overall condition of properties within the shoreland zone; but it does not allow for making specific recommendations for BMP implementation. Therefore, high priority properties (69 parcels), plus moderately-high priority properties at Danforth Ponds (10 parcels), should be resurveyed in person for specific BMP recommendations and more accurate estimated phosphorus reductions and implementation costs by site. However, given some broad assumptions (100 ft shoreline contributing 4.5 kg P/yr), the 69 high priority properties at the lower bays, plus 10 moderately-high priority properties at Danforth Ponds, would each cost about $3,000 to revegetate and mulch with volunteer labor (Table 4.2; refer to Appendix D). In total, this would cost $237,000 to implement and reduce phosphorus by 356 kg TP/yr.

Table 4.1: Summary of estimated cost and total phosphorus (TP) loading removal rates for recommended BMP sites. Estimates are based on CCSWD estimates and UNHSWC (2012). The 10-year cost is the sum of the estimated BMP cost plus 10 times the estimated annual cost to maintain the BMP.

Site ID	Direct flow to:	TP (kg/yr)*	BMP Cost Estimate**	Annual Cost	10-yr Cost	10-yr Cost per TP removed ($/kg)
1	Leavitt Bay	2.04	$8,040	$500	$13,040	$6,388.51
2	Leavitt Brook	1.54	$980	$250	$3,480	$2,256.50
4	Danforth Ponds	5.08	$1,650	$250	$4,150	$816.89
6	Shawtown Brook, Danforth Ponds	2.45	$4,000	$100	$5,000	$2,041.32
5	Danforth Ponds	1.00	$2,075	$500	$7,075	$7,089.87
3	Square Brook, Berry Bay	2.04	$2,725	$250	$5,225	$2,559.81
7	Ferrin Brook, Danforth Ponds	1.41	$1,050	$250	$3,550	$2,524.65
8	Purity Lake, Danforth Ponds	2.04	$1,375	$150	$2,875	$1,408.51
10	Stony Brook, Danforth Ponds	TBD	TBD	TBD	TBD	TBD
9	Stream downstream of Long Pond, Danforth Ponds	0.82	$1,150	$100	$2,150	$2,633.30
	TOTAL	18.42	$23,045	$2,350	$46,545	--

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

Table 4.2: Summary of properties with high disturbance scores (15-18) for each waterbody, plus moderately-high disturbance scores (13-14) for Danforth Ponds since the waterbody had no disturbance scores greater than 14. Refer to Appendix D for full results.

Waterbody	# Parcels	Average Buffer Score (1-5)	Average Bare Soil Score (1-4)	Average Shoreline Erosion Score (1-3)	Average Setback Distance Score (1-3)	Average Slope Score (1-3)	Average Total Disturbance Score
Broad Bay	31	5	4	2	3	2	16
Leavitt Bay	29	5	4	2	3	2	16
Berry Bay	9	4	3	2	3	3	15
Danforth Ponds*	10	4	4	1	3	2	14

**moderately-high disturbance scores (13-14)*

All together, these BMPs would reduce 58 kg TP/yr and 145 kg TP/yr in Danforth Ponds and the lower bays, respectively (Table 4.3). Only 119 kg TP/yr and 57 kg TP/yr are needed to meet the water quality goals of 20% and 1.4% reduction in phosphorus loads for Danforth Ponds and the lower bays, respectively. The phosphorus load reduction for the lower bays may be even greater if BMPs are implemented at Danforth Ponds since this waterbody feeds into the lower bays from the north. Implementing these BMPs would cost about $170,000. These BMP priorities only address slightly under half (49%) of the 20% needed in phosphorus load reduction for Danforth Ponds. To meet this goal, an additional 61 kg TP/yr would need to be reduced at Danforth Ponds, equating to about 14 more properties around the shoreline being revegetated or similar, depending on BMP recommendations made during future site-specific surveys. However, other non-structural BMPs implemented throughout the watershed will help to further reduce the phosphorus loading to Danforth Ponds and the lower bays.

Table 4.3: Summary of total phosphorus (TP) reductions and estimated costs of high or moderately-high priority BMP implementations at Danforth Ponds and lower bays.

Waterbody	Watershed Survey		Shoreline Survey		Total	
	TP reduction (kg/yr)	Estimated Cost	TP reduction (kg/yr)	Estimated Cost	TP reduction (kg/yr)	Estimated Cost
Danforth Ponds	12.8	$24,800	45.0	$30,000	57.8	$54,800
Lower Bays	5.6	$21,745	139.5*	$93,000	145.1	$114,745

**Based values on restoring the 31 sites along Broad Bay only, assuming the water quality improvement will have positive effects downstream at Leavitt and Berry Bays.*

4.2.2 Non-Structural NPS Restoration

Non-structural watershed restoration practices prevent or reduce stormwater related runoff problems by reducing the exposure and generation of pollutants and providing a regulatory framework that minimizes impervious surfaces. Non-structural approaches to watershed restoration can be the most cost-effective and holistic practices within a watershed management framework. The non-structural approaches recommended in this plan can not only improve water quality, but can also enhance watershed aesthetics (e.g. through shade tree planting, landscaping, and trash reduction), streamline the permitting process (e.g. by removing conflicting design or stormwater codes), and reduce development costs (e.g. by minimizing impervious area development).

There are two primary components of non-structural BMPs:

1) Planning, design, and construction that minimizes or eliminates adverse stormwater impacts; and
2) Good housekeeping measures and education/training to promote awareness.

In watersheds with future development potential, it is critical for municipalities to develop and enforce stormwater management criteria to prevent any increase in pollutant loadings that may offset reduced loads as a result of plan implementation. Zoning in the watershed of Danforth Ponds and the lower bays of Ossipee Lake presents considerable opportunity for continued development (see the build-out analysis in Section 3.3) and, by extension, increased threats to aquatic habitat and recreational use of the lakes. In watersheds with significant development potential, the Center for Watershed Protection identifies BMP/LID implementation requirements for development projects as the best mechanism for enhanced long-term stormwater management. It can be argued that local land use planning and zoning ordinances are the most critical components of watershed protection despite federal Clean Water Act requirements. The guidelines for local water policy innovation are as follows:

1) Review current zoning ordinances for regulatory barriers and improvements.
2) Set performance-based standards.

3) Take additional measures to reduce impervious surfaces.
4) Promote the use of specific LID designs.
5) Use overlay districts to add new requirements to existing zoning districts.
6) Establish standards or incentives to improve stormwater management in developed areas.
7) Address storage/use of pollutants that contact stormwater.
8) Consider approving a septic system ordinance that requires regular maintenance and inspections.

Fortunately, the long-standing dedication of the Ossipee Watershed Coalition (OWC) has helped watershed towns improve local ordinances to protect water quality. This cooperative planning ensures natural resource protection and sustainability in light of development and population growth. The OWC and GMCG have 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. Of recent, the OWC has partnered with the Lakes Region Planning Commission (LRPC) to help four towns update or develop their aquifer protection ordinances.

4.3 CURRENT AND FUTURE POLLUTANT SOURCES

GMCG has taken great measures in educating residents about the potential adverse effects of phosphorus-based detergents. In 2009, New Hampshire revised its Prohibited Products Statutes to prohibit the distribution, sale or offering for sale, any household cleansing products containing phosphorus (485-A:56). In 2010, sixteen other states followed suit and enacted a phosphate ban for dishwasher detergent, while many other states have banned the use of high-phosphate laundry detergents.

Example of an unstable shoreline leading directly to Danforth Pond. (Photo: FB Environmental)

The 2013 watershed stormwater survey and shoreline survey indicate that a significant amount of phosphorus is delivered to the lakes as a result of soil erosion. By combining the land-use modeling results with estimated future loading increases from the build-out analysis, we can estimate the phosphorus load at full build-out. Currently, 4,066 kg of phosphorus enters the lower bays of Ossipee Lake annually, 1,222 kg/yr of which comes from the direct lower bays watershed, excluding the upstream watersheds to Ossipee Lake that then feeds into the lower bays. According to the build-out analysis, the lower bays of Ossipee Lake will experience a 39% increase (to 1,695 kg/yr) in phosphorus loading at full build-out. Septic systems contributed the greatest increase in phosphorus loading. Assuming a 40% increase in phosphorus loading from Ossipee Lake, in-lake phosphorus concentration could be as high as 10.1 ppb in the lower bays. However, this is merely a placeholder, and a proper build-out for the Ossipee Lake watershed may show a higher or lower future phosphorus loading estimate for Ossipee Lake, and thus, the lower bays (refer to Section 3.3 for more details).

Ideally, if all ten non-point source (NPS) pollution sites identified in the 2013 watershed survey were treated with BMPs, and all new development contained proper phosphorus controls, these annual phosphorus loadings would be greatly reduced. The ten BMP sites identified would remove approximately 18.42 kg of phosphorus per year from entering Danforth Ponds and the lower bays of Ossipee Lake. It will cost an estimated $1,505 per kg of phosphorus removed.

It is important to note that, while the focus of this plan is on phosphorus (through the direct treatment of sediment), the treatment of stormwater will result in the reduction of many other kinds of harmful pollutants that could have a negative impact on these waters. These pollutants would likely include:

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

Without a monitoring program in place to determine these pollutant levels, it will be difficult to track successful reduction efforts. 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 input to the LLRM model developed for this project to estimate the response of the lakes to the reductions.

4.4 ADAPTIVE MANAGEMENT APPROACH

An adaptive management approach, to be employed by the steering committee, is highly recommended for protecting watersheds. Adaptive management enables stakeholders to conduct restoration activities in an iterative manner. This provides opportunities for utilizing available resources efficiently through BMP performance testing and watershed monitoring activities. Stakeholders can 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 activities. The adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame. Instead, adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration activities. Implementation of this approach would ensure that restoration actions are implemented and that surface waters are monitored to document restoration over an extended time period. The adaptive management components for future implementation efforts should include:

> The **Adaptive Management Approach** recognizes that the entire watershed cannot be restored with a single restoration action or within a short time frame.

- **Maintaining an Organizational Structure for Implementation.** Since the watershed spans multiple municipalities, a cooperating group representing all towns and associations should be established for the implementation of future efforts in the watershed and to help coordinate the implementation of restoration activities. Fortunately, GMCG has already stepped up to take on this role, but other prominent groups, including OLA, Broad-Leavitt Bay Association, and Berry Bay Association, should also become more involved. These groups should also try to involve the various business interests in the watershed to allow for a full consideration of all issues relevant to an effective, efficient, and cost-effective restoration program.

- **Establishing a Funding Mechanism.** A long-term funding mechanism should be established to provide financial resources for restoration actions, and should be guided by an advisory or steering committee that would include representatives from watershed towns, lake residents, GMCG, businesses, associations, land trusts, and more. In addition to construction and organizational management costs, consideration should also be given to the type and extent of technical assistance needed to design, inspect, and maintain stormwater BMPs. Technical assistance costs for the annual field monitoring program should also be considered. Funding is a critical element of sustaining the restoration process, and, once it is established, the management plan can be fully vetted and restoration activities can move forward.

- **Synthesizing Restoration Actions.** This watershed management plan provides prioritized recommendations to support restoration (e.g., structural/nonstructural recommendations for priority areas). These recommendations, or action items, need to be revisited and synthesized to create a unified watershed restoration strategy. Once a funding mechanism is established, the lake watershed restoration program should begin in earnest by developing detailed designs for priority restoration activities on a project-area basis and scheduling their implementation accordingly.

- **Continuing the Community Participation Process.** The development of the plan has greatly benefited from the active involvement of an engaged group of watershed stakeholders with a diversity of skills and interests. Plan implementation will require their continued and ongoing participation as well as additional community outreach efforts to involve even more stakeholders throughout the watershed. A sustained public awareness and outreach campaign is essential to secure the long-term community support that will be necessary to successfully implement this project.

- **Developing a Long-Term Monitoring Program.** Although current monitoring efforts are strong, a detailed monitoring program (including ongoing monitoring of watershed tributaries) is necessary to track the health of the lakes. Indeed, the overall goal of the watershed management planning process is the protection of the long-term health of these lakes (refer to Section 5.2.5).

- **Establishing Measurable Milestones.** A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critically important to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure the progress of the plan. These indicators are listed in Section 5.3, and are intricately tied to the action items identified in the Action Plan in Section 5.2.

Shoreline of Danforth Pond in Freedom, NH. (Photo: FB Environmental)

5. PLAN IMPLEMENTATION

5.1 PLAN OVERSIGHT

Through the efforts of GMCG, this watershed management plan should be carried out by a steering committee similar to the one established during the development of this plan. Local participation is an integral part of the success of this plan, and should include the leadership of local municipalities, such as the Towns of Effingham, Freedom, Eaton, Ossipee, and Madison. This task will also require the support of other stakeholders, including NHDES, schools and community groups, local businesses, and individual landowners. The primary stakeholder group will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce NPS pollution in the watershed of Danforth Ponds and the lower bays of Ossipee Lake.

The formation of subcommittees would result in more efficient implementation of the Action Plan. Suggested action committees include:

1) **Funding:** form a new subcommittee to focus on obtaining funding for the other subcommittees.
2) **Education and Outreach:** form a new subcommittee to focus on education-related action items that incorporates elements already being implemented by GMCG, and targets communities within the watershed of Danforth Ponds and the lower bays of Ossipee Lake.
3) **Septic Systems/Roads:** form a new subcommittee to focus on improving roads and septic system maintenance.
4) **Planning and Land Conservation:** form a new subcommittee to focus on improving municipal ordinances (work with OWC) and increase amount of conserved land.
5) **BMP Implementation:** redirect existing subcommittee to focus on BMP action items.
6) **Water Quality Monitoring and Assessment:** continue existing subcommittee to focus on monitoring action items, including development of a long-term monitoring program.

These subcommittees will be charged with implementing projects and actions within the Action Plan with the support and assistance of state and local natural resource agencies and groups. It is important to note that these subcommittees are merely recommendations under ideal circumstances where membership numbers allow for proper staffing of each subcommittee. It may not be practical to have subcommittees if committee membership is low. GMCG should work to encourage more participation, if this is the case.

5.2 ACTION PLAN

The Action Plan was developed through the combined efforts of GMCG, FB Environmental, and the Steering Committee, as well as the public by way of feedback provided during the community forum held at the Totem Pole Park in Freedom, NH on July 12, 2014. The Action Plan is a critical component of the plan because it provides a list of specific strategies for improving water quality and the means to make the water quality goals a reality (Section 1.2). The Action Plan consists of action items to help address threats identified within five major categories: (1) Septic Systems; (2) Shoreline Residential BMPs; (3) Roads; (4) Planning and Land Conservation; and (5) Water Quality Monitoring.

The Steering Committee should work toward implementing the Action Plan and identifying improvements as needed. The formation of subcommittees would result in more efficient implementation of the Action Plan (Section 5.1). The Action Plan outlines responsible parties, potential funding sources, approximate costs, and an implementation schedule for each task within each category. Current cost estimates for each action item will need to be adjusted based on further research and site design considerations.

5.2.1 Septic Systems

Septic systems were identified as a significant threat to the water quality of Danforth Ponds and the lowers bays of Ossipee Lake. This includes septic systems built in saturated areas, used beyond design capacity, or maintained improperly. Septic system effluent typically stores a thousand times the concentration of phosphorus in lake waters, which means that a small amount of effluent could have a major impact on the lakes. An old or improperly maintained septic system can also result in the delivery of disease-causing bacteria or viruses that can result in gastro-intestinal illness in swimmers. Untreated septic waste may contain chemical and hormones used in pharmaceutical and personal care products, which can reach lake water if a system is not working properly. Inundation of systems by groundwater greatly enhances the transport of phosphorus and pathogens to the lake. Therefore, it is critical to ensure adequate setbacks and good vertical separation from the seasonally-high groundwater table.

Based on the watershed modelling that has been completed, wastewater systems, including septic systems, outhouses, and cesspools, are the third largest source of phosphorus to the watershed. The contribution of septic systems was estimated to provide 4% (27.0 kg) and 1% (56.6 kg) of the phosphorus load to Danforth Ponds and the lower bays, respectively. A wastewater inspection and maintenance program will reduce phosphorus and bacteria loading to Danforth Ponds and the lower bays of Ossipee Lake. Meaningful reductions in phosphorus loading to the lakes will be achieved if landowners take responsibility to check their systems, and make necessary upgrades, especially to old systems, cesspools, and outhouses.

Septic Systems

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Enhance awareness of proper septic system maintenance	1) Distribute educational pamphlets on septic system function and maintenance in tax bills.	GMCG, Lake Associations	2015-2016	$1,000
	2) Host multiple "septic socials" in key neighborhoods near the lakes to address link between septic system maintenance and water quality.	GMCG, Lake Associations	2015-2025	$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.	GMCG, Lake Associations, Consultant	2015-2017	$5,000
	2) Target educational campaign in areas with minimally-maintained or aging septic systems.	GMCG, Lake Associations	2015-2025	$1,000
	3) Conduct voluntary dye testing of high impact septic systems. Goal: 20 systems.	GMCG, Lake Associations, Towns	2015-2017	$100/system

Septic Systems

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Inventory status of septic systems in watershed (continued)	4) Offer free landowner assistance (technical, permitting, and grants) for septic system maintenance and upgrades. Cost estimate based on resources to apply for grant.	GMCG, Towns	2015-2025	$1,500
	5) Develop and maintain a septic system database for the watershed. Conservation Commissions to maintain. Cost estimate based on initial setup by GMCG only.	GMCG, Conservation Commissions	2015-2025	$2,000
Enforce occupancy loads	1) Communicate with town departments to enforce occupancy loads and have septic system inventories in Master Plans.	Towns, Conservation Commissions	2015-2025	TBD
Enforce town codes for conversion development or property transfers	1) Inspect all home conversions from seasonal to permanent residences and property transfers for proper septic system size and design. Goal: 20 systems.	Towns, Landowners	2015-2025	$250/system
Garner funding or discounts that support and encourage septic system maintenance	1) Coordinate group septic system pumping discounts. Assumes volunteer labor.	Towns, Lake Associations, Landowners	2015-2025	N/A
	2) Investigate grants and low-interest loans to provide cost-share opportunities for septic system upgrades.	GMCG	2015-2017	$1,500
	3) Designate a portion of conservation dollars for the watershed that can be used for septic system upgrades.	Lake Associations, Conservation Commissions	2015-2025	N/A

5.2.2 Shoreline Residential Best Management Practices (BMPs)

Shorefront residential property was also identified as a significant threat to the water quality of Danforth Ponds and the lower bays of Ossipee Lake. Residents voiced concerns for erosion from dam management and along beaches, boating in the no wake zone, overuse of rental homes during the summer, grandfathered lots, invasive plants, and inadequate communication between the State and towns.

Direct shoreline areas are typically among the highest for pollutant loading given their proximity to lakes and desirability for development. The Steering Committee conducted a comprehensive shoreline survey in September of 2013 for Danforth Ponds, Broad Bay, Leavitt Bay, and Berry Bay, and found that 14% of the shorelines received high disturbance scores that greatly impact the water quality of the lakes. It was also estimated by the LLRM that the direct drainage areas (within 250 feet of the waters' edge) to Danforth Ponds and the lower bays of Ossipee Lake provide the greatest phosphorus load per unit area among the other subwatersheds. As such, the shoreline deserves special attention in any lake protection plan, and Danforth Ponds and the lower bays of Ossipee Lake are no exception.

The BMPs recommended in this plan are restoration tools that property owners can use to minimize impacts from stormwater runoff and restore degraded shoreline areas. 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 lakes. Coordination with landowners is 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.

Shorefront Residential BMPs

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Address all priority BMPs identified in the surveys	1) Implement BMPs at the 10 sites identified in the watershed survey.	GMCG, Lake Associations, Towns	2015-2025	$46,545
	2) Implement BMPs at the 79 high impact sites identified in the shoreline survey. Assumed 100 ft shoreline contributes roughly 4.5 kg TP/yr and costs $3,000 to revegetate and mulch with volunteer labor.	GMCG, Lake Associations, Towns, Residents	2015-2025	$237,000
	3) Develop a method of tracking and monitoring BMP implementation progress.	GMCG	2015-2025	$500/yr
	4) Help homeowners with state and town regulatory processes to raise the compliance level.	Conservation Commissions	2015-2025	N/A
Maintain and/or improve current invasives management program	1) Support State legislation that increases funds for aquatic invasive plant (e.g. milfoil) eradication.	Towns, Lake Associations	2015-2025	N/A
	2) Increase the number of volunteer inspectors for the Lake Host program.	Conservation Commissions, Lake Associations	2015-2025	N/A
Enhance communication between the dam authority board and residents	1) Work with the dam authority board to bridge the communication gap between them and local residents.	Lake Associations	2015-2025	$500
Garner more funding for action items	1) Develop a subcommittee that determines how funding is spent.	Lake Associations, GMCG	2015-2017	N/A
	2) Establish a capital reserve fund for watershed towns to spend on lake protection initiatives.	Towns	2015-2025	$1,000/yr
	3) Solicit residents for individual donations.	Lake Associations	2015-2025	N/A
Develop new lake protection measures	1) Control and monitor maximum occupancy levels for shorefront residential homes.	Towns	2015-2025	$5,000
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.	Lake Associations	2017	$5,000
	2) Contact local representatives to voice concerns and stay informed.	Residents	2015-2025	N/A
	3) Attend selectman meetings to voice concerns and stay informed.	Residents	2015-2025	N/A
	4) Create flyers/brochures for shorefront homes regarding BMPs, septic systems, no wake zone rules, and fire pit use.	Conservation Commissions, Lake Associations	2015-2025	$1,000

Shorefront Residential BMPs

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Enhance awareness of water quality issues in the watershed (continued)	5) Contribute interesting articles about water quality and watershed protection efforts to various media sources.	GMCG, Lake Associations	2015-2025	$500/yr
	6) Establish multiple sites as BMP demonstration sites and conduct tours for interested residents. Cost estimate does not include actual BMP implementation.	GMCG, Lake Associations	2015-2025	$1,000/yr
Reduce fire impact to watershed	1) Support neighborhood vigilance of proper outdoor fire pit use.	Lake Associations, Towns	2015-2025	N/A
	2) Require metal ID plates for homes so that local Fire Departments can easily find and access homes during an emergency.	Lake Associations, Towns	2015-2025	N/A

5.2.3 Roads

Threats to water quality as a result of roads include undersized culverts, excess road salt and sand, lack of stormwater control, lack of resources to improve and maintain road infrastructure, and erosion from gravel or logging roads in the watershed. The 2013 watershed survey of Danforth Ponds and the lower bays of Ossipee Lake, conducted by GMCG and FB Environmental, identified ten sites that are resulting in the delivery of nutrients and other pollutants to the lake. Of these, six are associated with state, town or private roads. Several of these road sites are a significant threat to water quality due to their proximity to the lakes and their tributaries and ability to deposit sand and gravel directly into the water.

ROADS

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Create and manage drainage easements on roads	1) 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.	Towns, Lake Associations	2015-2025	TBD
Improve municipal permitting process	1) 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.	Towns	2015-2025	$5,000
Require training of road agents	1) Require training for road agents on proper salt, sand, and equipment use.	Towns	2015-2025	$5,000
Host road maintenance workshops	1) Hold workshops on proper road management.	Lake Associations	2015-2025	$500/yr
Consider private road associations	1) Consider forming 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.	Lake Associations	2015-2025	$5,000

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. Action items were based on threats identified at the community forum, including lack of enforcement rules related to forestry practices and new development, lack of education of ZBA regarding development impact to water quality, lack of targeted land conservation, lack of awareness of key development or other permitting restrictions, and lack of education of right-of-ways and easements.

Planning & Land Conservation

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Adopt plan recommendations	1) Incorporate watershed plan recommendations into Town master plans.	Towns	2015-2025	N/A
Host workshops for watershed resident education of local land ordinances	1) Hold informational workshops for new landowners, towns, and developers on local ordinances and watershed goals. Goal: 2-4.	GMCG, Lake Associations, OWC, Towns	2015-2025	$10,000
	2) Hold educational workshops on conservation easements in the region. Goal: 2.	GMCG, Lake Associations, OWC, Towns	2015-2025	$5,000
Host training of code enforcement officers and ZBAs	1) Host training for code enforcement officers and ZBAs in watershed towns, where applicable.	Towns	2015-2025	$5,000
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 Freedom.	Towns, Conservation Commissions	2015-2025	$20,000
Enhance enforcement of proper land management practices	1) Create better enforcement of forestry rules and regulations.	Towns	2015-2025	$2,000/yr
	2) Encourage easement holders to be notified and present at closings.	Landowners	2015-2025	N/A
Improve land permitting process with BMP list	1) Create list of BMP descriptions for Town Selectman, ZBA, Planning Boards, and landowners.	GMCG	2015-2017	$1,500
Improve municipal ordinances	1) Develop new or improve existing ordinances to address setbacks, buffers, lot coverage, LID, and open space. Goal: 3 towns.	OWC, Towns	2015-2025	$5,000/town

5.2.5 Water Quality Monitoring

Monitoring programs are crucial to evaluating the effectiveness of watershed planning activities, and to determine if water quality goals are being achieved over the long-term. This Action Plan includes recommendations for enhancing current water quality monitoring efforts, including sample collection from various tributaries, and continuation of the invasive species monitoring program. Since volunteers typically conduct many different monitoring activities, it will be critical to continue building on the success of GMCG's outstanding and ongoing education, outreach, and volunteer monitoring programs. Refer to Appendix B for a map showing current monitoring sites in the watershed.

Tributary Monitoring – It is recommended that GMCG continues their tributary monitoring program at consistent locations. Alterations to the monitoring plan may include:

- ***Capturing water samples during storm events*** to examine peak discharges and measure inputs of sediment and nutrients during heavy rains. These samples may be collected either by manual or automated grab sampling during storm events; these automated sampling devices are deployed at collection sites and triggered to fill when water rises to a pre-determined level (e.g., the samplers may be positioned so that they fill when the water rises 6 inches).

- ***Deploying data loggers to capture continuous water quality information***. Data sondes and loggers may be deployed at strategic locations in rivers, streams, and lakes to capture continuous (e.g., every 30 minutes) data on a number of parameters, including water temperature, dissolved oxygen, specific conductivity, turbidity, and chlorophyll-a or algae abundance. Data such as this could be valuable for understanding water quality processes in the watershed.

- ***Using water level loggers***. A specific type of logger that measures continuous water level in a river, stream, or lake. In flowing waters, water level can be converted to stream discharge, which is used to measure flow during storm events as well as baseflow conditions. Coupled with water chemistry data, loading rates of nutrients may also be calculated with continuous flow data.

Lake Monitoring – The data from Ossipee Lake, Danforth Ponds, and Broad, Leavitt, and Berry Bays indicate that phosphorus concentrations have been mostly stable for the past ten years. However, this analysis is based on a limited dataset of 1-3 readings per year, which may not be a large enough sample size to make strong assertions about trends in lake condition. Recent testing in 2013 and 2014 has increased to 4-5 readings per year with plans to expand this monitoring further. The median phosphorous values for all lakes have increased slightly in the past ten years compared to phosphorus values reported prior to the year 2003. All lakes are below their NHDES water quality threshold for their trophic class.

It is recommended that monitoring continue at all existing lake sampling locations. Alterations to the monitoring plan may include:

- ***Sampling more times per year*** to examine how nutrients are distributed in the water column and processed throughout and outside of the growing season. Recent monitoring in 2013 and 2014 has increased to about 5 times per season, which should be sustained as resource availability permits.

- ***Sampling at pre-determined times of year to maintain a consistent dataset***. Such times could be spring turnover, peak of summer algal growth, and fall turnover. Monitoring since 2013 has sampled at regular intervals from ice out to fall turnover.

- ***Promoting advanced research collaborations with other groups*** active in the lake system (such as Plymouth State) to collect data with more frequency and additional parameters. In addition to TP, consider collecting samples for total nitrogen, chlorophyll-a, chloride, and turbidity. Continue to collect temperature and dissolved oxygen profiles through the season.

- ***Conducting a dissolved oxygen study at Danforth Ponds***. Danforth Ponds has issues with DO depletion in the deeper waters through the summer. Collecting temperature and DO profiles with greater frequency (and year-round) could help determine the extent of DO depletion and how it relates to sediment phosphorus release.

Water Quality Monitoring

ACTION ITEM	DESCRIPTION	RESPONSIBLE PARTY	SCHEDULE	ESTIMATED COST
Expand lake monitoring program	1) Add more volunteers and equipment to ongoing lake monitoring program (e.g. increase monitoring at Bear Camp, add pH probe to profile sampling procedure) and increase sampling frequency. See description in Section 5.2.5.	GMCG, Lake Associations	2015-2025	$15,000/yr
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.	GMCG, Towns, Lake Associations, Partner with PSU	2015-2025	$6,100/yr
Expand tributary monitoring program	1) Add more sites (e.g. mouth of Bear Camp and Mill/Ferrin Brook) and increase sampling frequency at 3 sites. See description in Section 5.2.5.	GMCG	2015-2025	$5,000/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.	PSU	2015-2017	N/A
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.	GMCG	2015-2025	$1,500/yr

5.3 INDICATORS TO MEASURE PROGRESS

Establishing indicators and numeric targets (benchmarks) to quantitatively measure the progress of this plan will provide both short-term and long-term input about how successful the plan has been in meeting the established goals and objectives for the watershed.

Indicators are derived directly from tasks identified in the Action Plan. While the Action Plan provides a description of tasks, responsible party, a schedule, and estimated annual costs associated with each task, the indicators are developed to reflect how well implementation activities are working, and provides a means by which to track progress toward established goals and objectives.

The following environmental, programmatic, and social indicators and associated benchmarks will help measure the progress of this plan. These benchmarks represent short-term (2017), mid-term (2020), and long-term (2025) targets for improving water quality in these waterbodies. Setting benchmarks allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. The 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. 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 indirectly result in reductions in median in-lake TP concentrations, the duration and extent of anoxic conditions at deep holes, and the frequency of peak flows to tributaries from unbuffered impervious or bare soil surfaces that carry phosphorus-laden sediment.

Environmental Indicators

Indicators	Benchmarks		
	2017	2020	2025
Reduce median in-lake TP for Danforth Ponds and the lower bays	10% of goal	50% of goal	75% of goal
Improve DO conditions in deep waters of all lakes by reducing the duration and increasing the depth of low DO occurrence	5%	10%	50%
Reduce magnitude of peak flows during storm events using BMP/LID techniques	2%	5%	10%

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

Programmatic Indicators

Indicators	Benchmarks		
	2017	2020	2025
Amount of funding secured for plan implementation (include contributions from fundraisers, donations, and grants)	$125,000	$250,000	$600,000
Number of high priority sites remediated (89 identified)	5	25	40
Number of residential BMP demonstration projects completed	1	3	5
Linear feet of buffers installed in the shoreland zone	250	500	1,000
Linear feet of roadway addressed by BMPs (300 feet identified)	50	100	300
Number of voluntary septic system inspections and dye testing	10	25	100
Number of septic system upgrades	1	5	10
Number of "septic socials" held	1	3	5
Number of parcels with conservation easements	5	10	20
Number of copies of watershed-based educational materials distributed	250	500	1,000
Number of new road associations (if determined as feasible)	1	3	5
Number of lake associations or organizations actively working together under an umbrella association	2	4	6

Social Indicators measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement.

Social Indicators

Indicators	Benchmarks		
	2017	2020	2025
Number of new GMCG, OLA, OWC or other local association members	25	45-75	75-125
Number of volunteers participating in educational campaigns	10	20	30
Number of people participating in workshops or demonstrations	20	50	75
Number of new lake hosts (partner with conservation commissions)	2	5	10
Number of newly trained VLAP volunteers (partner with conservation commissions)	1	3	5
Number of active weed watchers (partner with conservation commissions)	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%

5.4 ESTIMATED COSTS AND TECHNICAL ASSISTANCE NEEDED

The cost of successfully implementing this watershed plan for Danforth Ponds and the lower bays of Ossipee Lake is estimated at $718,000 over the next ten years (Table 5.1). **However, many costs are still unknown and should be incorporated into the Action Plan as information becomes available.** These costs will come from a variety of stakeholders, grants, or other funding sources identified in the Action Plan. This includes both structural BMPs, such as fixing eroding roads and planting shoreline buffers, and non-structural BMPs, such as improving ordinances. 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 5.1: Estimated annual and 10-year costs for watershed restoration.

Category	Estimated Annual Costs	10-year Total
Septic Systems*	$2,500	$20,500
Shorefront Residential BMPs	$32,504.5	$325,045
Roads	$2,000	$20,000
Planning & Conservation	$7,650	$76,500
WQ Monitoring	$27,600	$276,000
Total Cost	**$71,804.5**	**$718,045**

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

A diverse source of funding and a funding strategy will be needed to match these implementation activities. 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 lake associations. Funding to improve septic systems, roads, and shoreland zone buffers could be expected from property owners most affected by the improvements. As the plan evolves into the future, the steering committee will be a key part of how funds are raised, tracked, and spent to implement and support the plan.

5.5 EDUCATIONAL COMPONENT

As detailed in Section 1.5, much effort is already being done by various groups (e.g. GMCG, OWC, etc.) 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).

5.6 EVALUATION PLAN

Annual steering committee meetings should be organized to review the status of goals and objectives presented in this watershed management plan. It is recommended that an adaptive management approach be used to assess annual progress, determine key projects for the following year, and provide a venue for sharing information with watershed stakeholders. Adaptive management is the process by which new information about the health of the watershed is incorporated into the plan. This process allows stakeholders the opportunity to evaluate the effectiveness of restoration and monitoring activities before implementing future actions. Tasks listed in the Action Plan should be tracked and recorded as they occur, and new tasks should be added to the plan as determined through the adaptive management process. All achievements, such as press releases, outreach activities, number of sites repaired, number of volunteers, amount of funding received, number of sites documented, should be tracked. Stakeholders can then use the established indicators (Section 5.3) to determine the effectiveness of the plan.

5.7 CONCLUSION

Watershed residents, landowners, business owners, and recreationalists alike should have a vested interest in protecting the long-term water quality of Danforth Ponds and the lower bays of Ossipee Lake for future generations. With a goal of reducing in-lake phosphorus concentrations by 20% and 1.4% in Danforth Ponds and the lower bays, respectively, water quality trends in phosphorus will likely be maintained or slowed over time. At this stage, implementation of the plan over the next ten years is projected to cost $718,000, and will require the dedication and hard work of municipalities, conservation groups, and volunteers to ensure that the actions identified in this plan are carried out accordingly. The Action Plan will need to be updated as the plan is implemented and new action items are added, in accordance with the adaptive management approach detailed in Section 4.4.

ADDITIONAL RESOURCES

A Shoreland Homeowner's Guide to Stormwater Management. New Hampshire Department of Environmental Services. NHDES-WD-10-8. Online: http://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: http://extension.unh.edu/CommDev/Buffers.pdf

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