SALMON FALLS HEADWATER LAKES

Watershed Management Plan

Acton Wakefield Watersheds Alliance
PO Box 235, 254 Main Street
Union, NH 03887

FB Environmental Associates, Inc.
97A Exchange Street, Suite 305
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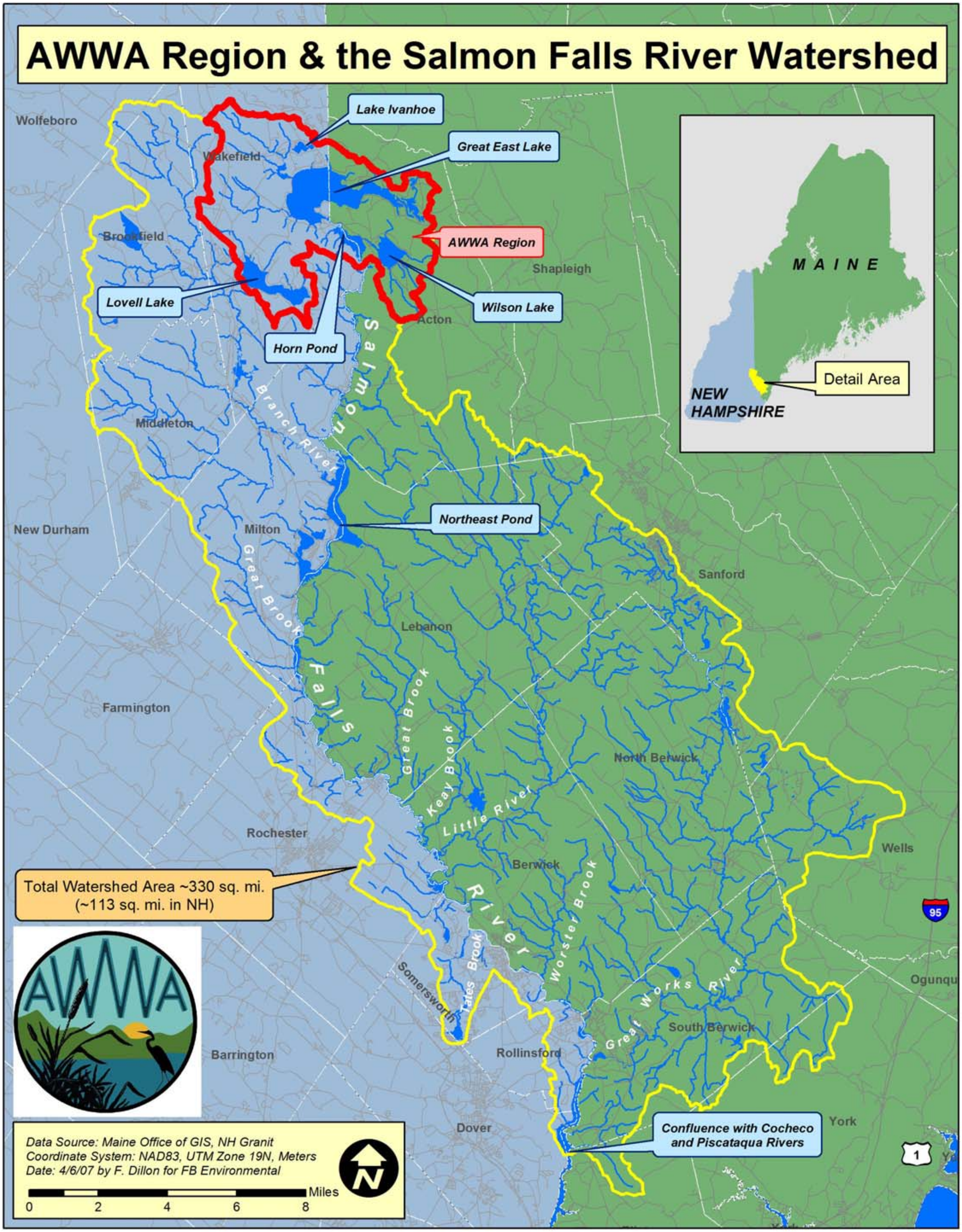
~ *March 2010* ~



AWWA Region & the Salmon Falls River Watershed
Lake Ivanhoe
Great East Lake
AWWA Region
Lovell Lake
Horn Pond
Wilson Lake
Northeast Pond
Wolfeboro
Wakefield
Brookfield
Shapleigh
Acton
Middleton
New Durham
Milton
Sanford
Lebanon
Farmington
North Berwick
Rochester
Berwick
Wells
Somersworth
Rollinsford
South Berwick
Barrington
Dover
York
Ogunquit
Salmon Falls River
Branch River
Great Brook
Keay Brook
Little River
Worster Brook
Tates Brook
Great Works River
MAINE
NEW HAMPSHIRE
Detail Area
Total Watershed Area ~330 sq. mi. (~113 sq. mi. in NH)
Confluence with Cocheco and Piscataqua Rivers
AWWA
Data Source: Maine Office of GIS, NH Granit
Coordinate System: NAD83, UTM Zone 19N, Meters
Date: 4/6/07 by F. Dillon for FB Environmental
0 2 4 6 8 Miles
N
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Watershed Management Plan

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March 2010

Cover photo: Aerial view of the Salmon Falls headwater lakes, with Great East Lake (top center), Horn Pond and Wilson Lake (courtesy of John Wilson).

Acknowledgements

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Carol Lafond, President
Dick DesRoches, Vice President
Pat Theisen, Secretary
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Marcia Hodsdon, Director
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Horn Pond Association
Lovell Lake Association
Round Pond Association
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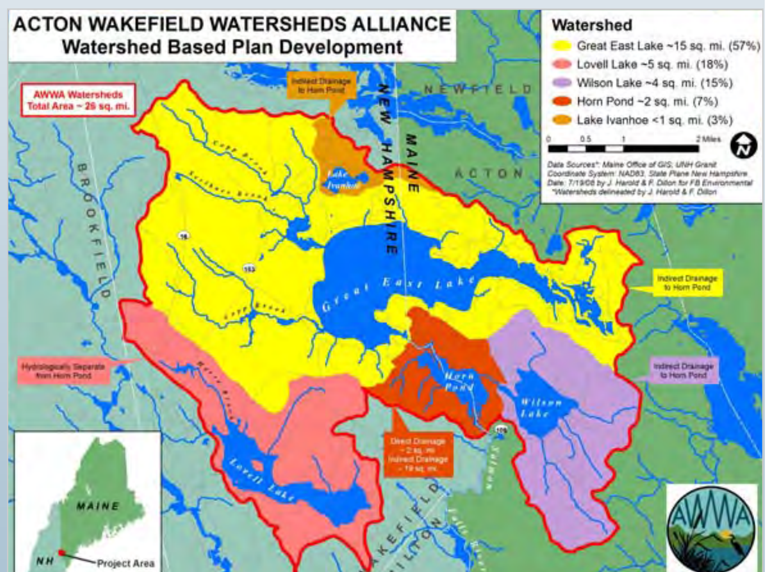
EXECUTIVE SUMMARY

Project Overview

The Salmon Falls Headwater Lakes Watershed Management Plan (WMP) is a reflection of the interests and ideas put forth by a dedicated group of individuals to protect and restore the water quality of the lakes that form the headwaters of the Salmon Falls River including Great East Lake, Horn Pond, Lake Ivanhoe, Lovell Lake and Wilson Lake. This group of local landowners, community decision-makers, municipal officials, lake associations, and natural resource professionals agree that these waterbodies are of significant value to the communities of Acton, Maine and Wakefield, New Hampshire, and that action is needed to preserve their high quality status. The Acton Wakefield Watersheds Alliance (AWWA) obtained a grant from the US Environmental Protection Agency (EPA) and the New Hampshire Department of Environmental Services (NHDES) to develop this community-based plan in cooperation with the towns, lake associations and other local stakeholders.

A Watershed Steering Committee, led by AWWA, came together as part of this plan representing a number of stakeholders including the Wakefield and Acton planning boards, town officials, representatives of the lake associations, local land trusts and interested community members.

The Salmon Falls Headwater Lakes Watersheds



This WMP focuses on five of the Salmon Falls headwater lake watersheds: Great East Lake, Horn Pond, Lake Ivanhoe, and Wilson Lake, which form the headwaters of the Salmon Falls River; and Lovell Lake, which feeds the Branch River. Branch River flows into Milton Three Ponds, where it joins the Salmon Falls River. The Salmon Falls River defines the border between Maine and New Hampshire from Great East Lake to its confluence with the Cocheco River. When the Salmon Falls River joins the Cocheco River they form the Piscataqua River, defining the state border to the Gulf of Maine. These five watersheds cover approximately 26 square miles within Acton, ME and Wakefield, NH.

Development in the Acton-Wakefield region is considered rural with nearly 89% of land area undeveloped. The approximately 11% developed land is largely residential, primarily occurring along major roadways and lake shores. The lakes and their associated wetlands are home to a diverse community of fish, birds, mammals and plants that are dependent on clean water for survival.

The Problem

Phosphorus, known as a limiting nutrient in lakes, is so minute that it is measured in parts per billion (ppb). Phosphorus is present in soils, both naturally, and as a result of human activity such as improperly functioning septic systems, fertilizers and construction activity. Small increases in phosphorus can have devastating effects on water quality leading to decreased clarity and frequent algal blooms. Rain and snowmelt result in stormwater runoff which carries pollutants, including phosphorus, from the land into the waterbodies.

A series of analyses were used to determine current in-lake phosphorus levels for all five lakes, and to determine the phosphorus threshold, (the amount of phosphorus that each lake can accept before the water quality will decline). These detailed analyses of the water quality data for the SF headwater lakes indicate that Lake Ivanhoe, Lovell Lake and Horn Pond may not meet the NHDES criteria for High Quality Waters (HQW) and that all five need phosphorus control measures to maintain or achieve HQW status.

With increased development, phosphorus runoff generally increases if development is not properly managed. The build-out analysis conducted for the project estimated that (given current growth rates) 4,239 new buildings and 9,000 new people may become part of this watershed within the next 44 years. This could result in several hundred more pounds of phosphorus entering the lakes each year which would have a devastating effect on the lake water quality if proper controls are not put in place.

Why Develop a Management Plan?

Lakes are arguably one of our most valuable natural resources. We use them for recreation, relaxation, drinking water, and to build our homes near. Lakes and their surrounding lands also provide habitat for plants, wildlife and aquatic life. While clean water is essential for all life, pollution and irresponsible water use plague our waterbodies, making proactive protection of water resources essential. The Acton-Wakefield region in Western Maine and Eastern New Hampshire has an economy that depends greatly on the local waterbodies, including those that form the Salmon Falls Headwaters.

Photo credit—Jim Theisen

It is estimated in Maine that the State's lakes generate 13 million annual recreation user days and New Hampshire's lakes generate nearly 15 million recreation user days per year. This generates more than 1.1 billion dollars in total sales (for boating, fishing, and swimming) in each state. Additionally, lakefront property owners in these states contribute nearly $600 million per year in property taxes. The value of lakes (including property values) declines when water quality declines. Therefore it is essential to find the balance between environmental quality and economic growth that benefits these valuable waterbodies.

This WMP provides a roadmap for protecting and improving the water quality of the five headwater lakes and provides a mechanism and rationale for acquiring grant and other funding to help pay for the efforts needed to address the recommended actions. In addition, it sets the stage for ongoing dialogue among key stakeholders in many facets of the communities, and promotes coordinated municipal land use ordinance changes to address stormwater runoff. For this plan to succeed, it will need a concerted effort of volunteers, and a strong and diverse steering committee that will meet at least annually to review progress made, and to make adjustments to the plan as needed.

What the Plan Includes

Over the two year project period AWWA, NHDES and FB Environmental Associates (FBE) partnered to assess the five lakes' watersheds. Several models were utilized to help stakeholders understand the state of the current water quality in the lakes, and to assist with quantifying necessary efforts to improve and protect them in the future. In order to estimate pollution flowing off of the land during storm events the project team analyzed current land uses and phosphorus inputs to the watershed. A separate model and ordinance review were used to estimate future water quality levels based on new development. In order to measure current inputs, the AWWA conducted watershed surveys with the help of over 100 local citizens to identify sites contributing excess phosphorus, the main pollutant of concern, to the project lakes and tributaries. Finally, the project team worked together with Maine and New Hampshire environmental agencies to organize, summarize, and analyze all of the lake water quality data gathered by volunteers and professionals for more than three decades for the project lakes. These data enabled the project scientists to determine the current in-lake status and set phosphorus goals for each of the five lakes. This plan describes the challenges of overcoming the differences in water quality standards in Maine and New Hampshire, and outlines recommendations that aim to harmonize these standards so they can be used on a regional, watershed-wide basis (*see below*).

In January 2009, 32 stakeholders gathered to provide valuable input for this plan. The ideas were refined into an Action Plan by the Steering Committee in March and May of 2009. With the assistance of FBE these actions were further defined, and time-frames and associated costs were set.

MAJOR GOALS FOR 2010-2020:
MAINTAIN OR IMPROVE EXISTING WATER QUALITY

Maintain existing water quality at current phosphorus levels.

- **Great East Lake at 6.4 ppb**
- **Wilson Lake at 6.5 ppb**
- **Horn Pond at 8.0 ppb**

Improve existing water quality. Reduce in-lake phosphorus to 7.2 ppb.

- **Lake Ivanhoe—reduce by 0.8 ppb**
- **Lovell Lake—reduce by 0.3 ppb**

5 KEY ACTION CATEGORIES
FOR THE SALMON FALLS HEADWATER LAKES

⇒ **Private and Public Roadway Best Management Practices (BMP)** - Reducing sediment loads to the lakes and tributary streams is a priority and can be accomplished through the stabilization and reinforcement of road crossings and roadsides to trap pollutants before entering the watercourses.

⇒ **Community Planning & Development** - local ordinances must be strengthened to protect water quality and both local and state regulations must be routinely and fairly enforced.

⇒ **Residential BMPs - Riparian Buffers, Low Impact Development and Septic Systems** – coordinate with local landowners to encourage vegetated buffers at the shoreline and low impact development techniques, and implement a septic system inspection and pumping recommendation program.

⇒ **Education and Outreach** – work with seasonal and full-time residents to enhance the understanding of land use/water quality connections through school programs, lake associations, and community groups.

⇒ **Land Conservation** – coordinate among municipalities, land trusts, regional planning commissions, and lake associations to protect upland areas of the SF headwater lakes' watersheds to ensure that some land remains in an undisturbed state which will help reduce total phosphorus runoff.

Funding the Plan

Reducing phosphorus inputs from existing development and preventing phosphorus inputs from future development in the SF headwater lakes watersheds will require significant financial and technical resources on the order of at least $600,000 per year including the financial support of private, town, state and federal partners. Section 5.4 lists the costs associated with successfully implementing the 10-year plan, including both structural and non-structural measures. Success requires that a sustainable funding plan be developed to ensure that the major planning objectives can be achieved over the long-term. This funding strategy will outline the financial responsibilities at all levels of the community (landowners, towns, community groups, and state and federal government). The funding plan should be incorporated into this WMP within the first year, and revisited on an annual basis.

Administering the Plan

AWWA will work with the municipalities and stakeholder groups to administer the Salmon Falls Headwater Lakes Watershed Management Plan. AWWA will work toward implementing the Action Plan which outlines responsible parties, potential funding sources, approximate costs, and an implementation schedule for each task within the five categories.

AWWA will convene the Steering Committee at least annually to provide periodic updates to the plan, track and record any progress made, maintain and sustain the action items, and make the plan relevant on an ongoing basis by adding new tasks as they develop. The Steering Committee will use established indicators within the WMP to determine the effectiveness of the Plan. All achievements, such as press coverage, outreach activities, number of sites repaired, number of volunteers, amount of funding received, and number of sites documented, will be tracked by AWWA.

Next Steps

The success of this WMP will weigh heavily on the cooperation of the local municipalities and key stakeholders to support the plan, and the Steering Committee to engage enthusiastic support, to develop a sustainable funding plan and acquire the necessary funds to implement it. AWWA has been approved for a NHDES Watershed Assistance grant for 2010-2011 to begin implementing some of the action items recommended in the Plan. The goal is to engage all facets of the communities in the protection of the region's most valuable assets – **our lakes**.

Photo credit—Jeanne Achille

KEY CHAPTERS IN THE PLAN

<u>Chapter 1</u> of the Plan introduces the plan, describing the problem, defining the goals and objectives, the community-based planning process, and outlines the federal requirements of the Plan. Chapter 1 also provides background information of the AWWA's activities related to the plan development and watershed protection.

<u>Chapter 2</u> describes the watershed, providing detailed information about climate, population, land use and growth trends, physical features and the threat of invasive plants. Chapter 2 also explains the process of estimating the pollutant load sources using the STEPL model.

<u>Chapter 3</u> provides an overview of the water quality standards, the methodology used to assess the water quality, and the recommendations for managing these lakes to prevent water quality decline in the future. Further, this Chapter will describe why several of the Salmon Falls (SF) headwater lakes may not be considered High Quality Waters and the evidence that shows that they are experiencing a decline in water quality. Chapter 3 also includes the results of the Master Plan and Ordinance Review, the Build Out Analysis and the Shoreline Survey Assessment.

<u>Chapter 4</u> offers the Management Plan rationale and approach and details the goals and techniques that may be used to achieve them. This Chapter explains non-structural and structural restoration approaches to phosphorus reduction and describes the current and projected pollution sources. An explanation of how to use an adaptive management approach is also included here.

<u>Chapter 5</u> gets to the core of the Plan, outlining necessary management strategies to reduce phosphorus to the SF headwater lakes. The Action Strategy is included detailing the action items, schedule and estimated costs.

<u>Chapter 6</u> provides recommendations for how the action items in the plan will be tracked in order to ensure that necessary steps are being taken to protect or improve the water quality of the SF headwater lakes over the next 10 years. Specific water quality monitoring recommendations are made for each lake.

<u>Chapter 7</u> describes who will be carrying out the plan and suggests methods for securing sustainable funding.

1. Introduction

1.1 Purpose and Background


The Salmon Falls headwater lakes region includes Great East Lake, Horn Pond, and Wilson Lake (shown in photo) as well as Lake Ivanhoe and Lovell Lake.

Lakes are arguably one of our most valuable natural resources. We use them for recreation, relaxation, drinking water, and to build our homes near. Lakes and their surrounding lands also provide habitat for plants, wildlife and aquatic life. While clean water is essential for all life, pollution and irresponsible water use plague our waterbodies, making proactive protection of water resources essential. The Acton-Wakefield region in Western Maine and Eastern New Hampshire has an economy that depends greatly on the local waterbodies, including those that form the Salmon Falls Headwaters. The Salmon Falls watershed headwaters region (see map, inside cover) includes Great East Lake, Horn Pond, Lake Ivanhoe (also known as Round Pond, and Little Round Pond), Lovell Lake, Wilson Lake and their associated tributaries. These lakes are considered high quality waters as defined by the NH Department of Environmental Services (NHDES) Watershed Assistance Section. These waters eventually flow to the Piscataqua River after flowing to the Salmon Falls River, which forms the southern border between Maine and New Hampshire.

> **Phosphorus -**
> *A nutrient needed for plant growth. It is generally present in small amounts, and limits plant growth in lakes. As the amount of phosphorus increases in the lake, the amount of algae also increases.*

The region's lakes are particularly threatened by ***phosphorus.*** A small increase in phosphorus inputs can have devastating effects on lakes. With increased development, phosphorus runoff generally increases if development is not properly managed. Growth projections in the Acton-Wakefield region indicate strong development pressure in the years to come. The purpose of this Watershed Management Plan (WMP) is to provide recommendations for the local decision-makers as they plan for future development and to offer other stakeholders strategies for minimizing the potential negative effects of our collective impact on water quality. The plan provides the necessary assessments and recommendations for the communities of Acton and Wakefield and its partners including the Acton Wakefield Watersheds Alliance (AWWA) and the individual lake associations to maintain high quality water status in each of the five waterbodies and their associated tributaries over the next ten to fifteen years. These efforts will help protect the tax bases in Wakefield and Acton, including lakefront property values. For reference, conservation efforts in the Mousam Lake watershed provide a strong example of successful efforts to restore and protect a valuable local waterbody. This lake was recently removed from the State of Maine impaired waters (303d) list due to the consistent and outstanding efforts of the local communities, conservation groups, state and federal agencies, and the citizens of the watershed.

1.2 Plan Development and Community Participation Process

This plan was developed using a watershed approach. Using a watershed approach to protect high quality waters is beneficial because it is a holistic process in which local stakeholders are actively involved in selecting management strategies that will be implemented to solve problems in the watershed. The AWWA WMP for the Salmon Falls (SF) headwater lakes worked within this framework by using a series of cooperative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement selected options. The outcomes of this process are documented within this plan. A community participation process was developed with the assistance of FB Environmental Associates (FBE), a consulting firm hired to help with the Plan. FBE, AWWA, and NHDES representatives lead a series of three well attended workshops to solicit public input and design future efforts for watershed protection.

The first workshop was designed to describe the watershed planning process to local stakeholders. The second workshop served as a public forum in which participants provided input on priority issues and action items for the plan. The third workshop involved the prioritization of action items and helping to set schedules and specific tasks for completing action items. A complete description of these action items appear in Chapter 5 of this plan. The results of these workshops ensure that the Plan is community driven and supported and will allow stakeholders to have a living, working action plan to guide their future efforts. The AWWA is the ideal organization to lead these efforts given their current mission and recent lake protection successes in this region.

Three public workshops were held during the development of this plan.

1.3 Current Efforts of the Acton Wakefield Watersheds Alliance

The Acton Wakefield Watersheds Alliance (AWWA) is a non-profit organization working to protect and restore water quality by affecting land use policies and practices, through education and remediation of ***nonpoint source (NPS) pollution*** in the border region of Acton, Maine and Wakefield, NH. The Alliance is registered with the State of New Hampshire and holds 501(c)3 status. AWWA has active staff and directors who bring a wide range of expertise and affiliations to the group. The mission of the Acton Wakefield Watersheds Alliance is to protect and restore water quality, by affecting land use policies and practices through education and remediation in the border region of Acton, Maine and Wakefield, NH.

Nonpoint source (NPS) pollution *comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into waterbodies.*

In 2006, AWWA received a two-year Watershed Assistance grant from the NH Department of Environmental Services to initiate a Youth Conservation Corps (YCC) program. In 2008 the NH State Conservation Committee awarded AWWA a Moose Plate grant to continue its YCC work. In addition to the YCC program, the AWWA board members have been actively promoting water resource awareness in the communities. They have presented shorefront landscaping workshops, taught in the local schools, worked with the town boards, presented at local lake association meetings and staffed informational displays and activities at community events. AWWA encourages regular press coverage for its activities and has been featured in the local newspapers on several occasions. AWWA board members have been invited to share their YCC model with presentations at the NH Lakes Congress, the Green Mountain Conservation Group Watershed Weekend, the Maine Lakes Conservancy Institute Lake Science Academy, 2009 Chicago Lakes Conference, Maine Congress of Lake Associations Conference, and the NH Watersheds Conference.

As the initial YCC project period was completed the AWWA Board recognized the need to focus its efforts to reduce the effects of stormwater runoff and applied for and was awarded a NHDES Watershed Assistance grant to develop this WMP for the headwaters of the Salmon Falls River including Great East Lake, Horn Pond, Lake Ivanhoe, Lovell Lake and Wilson Lake. The WMP will allow AWWA to focus its outreach and remediation efforts on areas with significant problems (adapted from www.awwatersheds.org).

1.3.1 Watershed Surveys

As part of its watershed planning and assessment efforts, more than 75 volunteers completed watershed surveys on Great East Lake, Horn Pond, Lake Ivanhoe and Lovell Lake and assisted with the Wilson Lake watershed survey. The purpose of these surveys was to determine critical areas contributing polluted runoff to these lakes. Volunteers were trained by environmental professionals and spent several days looking at roads, residential areas, commercial areas, and any other land uses that could be contributing polluted runoff to these valuable lakes. In particular, sites with eroding soil were noted. Soil contains phosphorus (P), the pollutant that local stakeholders are most concerned about. The following table (Table 1.1) summarizes the results of these watershed surveys and indicates that sites were found to contribute more than 240 tons of sediment (that's 12 dump trucks full of sediment), and an associated 204 pounds of phosphorus, to the lakes and their tributaries each year.

Table 1.1: Watershed survey results-sediment and phosphorus loads.

Lake	# Sites	Sediment (tons)	Phosphorus (lbs.)
Great East Lake	67 NH, 112 ME	105.21	88.82
Horn Pond	21 NH, 37 ME	10.7	9.2
Lake Ivanhoe	26 NH	42.07	35.95
Lovell Lake	157 NH	57.2	48.8
Wilson Lake	71 ME	24.87	21.14
TOTALS	**491**	**240.05**	**203.91**

Field measurements collected during the watershed surveys were used to estimate the sediment and phosphorus load for each lake. Final estimates were calculated using the US EPA Region 5 model (MDEQ, 1999) which provides a gross estimate of sediment and nutrient load reductions from implementation of various Best Management Practices.

1.3.2 Youth Conservation Corps

The AWWA YCC, following the model of many Maine YCCs, includes a Technical Director, Crew Leader and 4-6 youth crew members. The Technical Director solicits projects, meets with the landowners and creates the site specific design using Maine DEP approved Conservation Practices. From those technical assistance designs, the Technical Director meets with the YCC Committee to select project sites based on the severity of the problems and the suitability for the YCC crew to correct it. The projects require hand tools only and all required permits are secured prior to any work beginning. The Crew Leader oversees the onsite work and the youth crew do the heavy lifting.

Sine AWWA's YCC program was formed in 2005, 61 projects have been completed, including 202 BMP installations. In total, these projects have prevented approximately 62 tons of sediment and over 52 lbs of phosphorus from entering the AWWA lakes and ponds each year. Annually, the crew showcases their projects to the communities with a tour. In 2009, the tour was captured on video and presented by the youth crew at the AWWA annual meeting and is available on the AWWA website: www.AWwatersheds.org.

The YCC Program is an important tool for engaging the community in the quest for healthy waters. Since the AWWA YCC began there has been a noticeable increase in requests for assistance and calls for how-to information on lake protection. The AWWA region towns have consistently given financial support to AWWA and encourage AWWA members to participate in the local decision-making process.

The Acton-Wakefield region has very few employment opportunities for its youth. For most members of the YCC crew this is a first job and an opportunity to learn the basics of successful employment. The AWWA crew members eagerly share their pride in their work and have become knowledgeable spokespeople for water resource protection.

1.3.3 Public Outreach

AWWA's outreach efforts are aimed at local and seasonal residents, school children, summer visitors and community decision-makers. Through presentations, hands-on workshops, interactive classroom sessions, and print and electronic media AWWA's message has been widely broadcast. AWWA's outreach is focused on the concept that a personal connection to one's environment breeds a sense of place and desire to protect it. Much of the recent outreach provided by AWWA has revolved around the completion of and recommendations listed in this Plan. In addition to community workshops, AWWA has sponsored two presentations by FBE to the Planning Boards of the two watershed communities, Acton and Wakefield. These presentations were effective in delivering the message that development will likely increase and that protection of these waters will need local support from the municipalities and their citizens.

1.4 Incorporating EPA's 9 Elements

EPA Guidance lists nine components that are required to be included in Watershed Management Plans to restore waters impaired by nonpoint source pollution. The following describes the nine required elements and where they are found in this plan:

A. **Identify Causes and Sources** or groups of similar sources that need to be controlled to achieve the load reductions estimated in this WMP (and to achieve any other watershed goals identified in the WMP), as discussed in item (B) immediately below: **Section 1.31 and Appendix C** describe the results of the watershed surveys conducted for the five lakes included in this project and highlights known sources of NPS pollution in these watersheds.

B. **Estimate Phosphorus Load Reductions Expected from Planned Management Measures** described under (C) below: **Section 4.4** describes how reductions in annual phosphorus loading to SF headwater lakes may be realized over a 10-20 year period, and describes the methods used to estimate phosphorus reductions by applying a relational P reduction method developed by Maine DEP to the different land use categories identified. These reductions apply primarily to structural BMPs applied to existing development, (but will not be possible without non-structural BMPs). Examples of structural practices include (but are not limited to) installing vegetated buffers, infiltration practices for roof and driveway runoff, improving and maintaining roads, and fertilizer management.

C. **Description of Management Measures** that will need to be implemented to achieve the estimated phosphorus load reductions and identification of the critical areas in which those measures will be needed to implement this plan: **Section 5.4** describes management measures needed to reach reduction targets described in B above. (Management measures to address future development in the watershed are also described in the AWWA watershed surveys.) The Action Plan focuses on five major topic areas to address NPS pollution including: Private and Public Roadway BMPs; Community Planning & Development; Residential BMPs- Riparian Buffers; Low Impact Development and Septic Systems; and Education and Outreach, and Land Conservation. The management options in the action plan focus more on the non-structural BMPs that are integral to making implementation of the structural BMPs possible.

D. **Estimate of Technical and Financial Assistance** needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan: **Sections 5.4 and 7.2** describe the cost of successfully implementing this 10-year management plan. The estimated cost to address NPS pollution and reduce phosphorus loading to SF headwater lakes is estimated at $601,000 per year. Sources of funding need to be diverse, and should include state and federal granting agencies such as the USEPA, NH DES and Maine DEP, local groups such as the towns and lake associations, as well as private donations, and landowner contributions for BMP implementation on private property. AWWA and its core stakeholders shall lead the planning effort while meeting regularly, and efficiently coordinating resources to achieve the goals set forth in this plan.

E. **Information & Education & Outreach** are key components of the plan that will be used to enhance public understanding of the project: **Section 5.3.2** describes how the Education & Outreach component of the plan will be implemented. This includes leadership from AWWA to help promote lake/watershed stewardship. BMP demonstration sites, buffer tours, LakeSmart or similar lake stewardship program, and outreach to Road Associations are a few of the actions within the plan, as outlined in **Section 5.4**.

F. **Schedule for Addressing Phosphorus Reductions**: **Section 5.4** provides a list of all the strategies that have been developed to help reduce stormwater runoff and phosphorus runoff to SF headwater lakes. 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.

G. **Description of Interim, Measureable Milestones** for determining whether NPS management measures are being implemented: **Section 6.1** outlines indicators that should be tracked annually in order to see how successful the plan is at meeting established goals and objectives for the watershed. Using indicators to measure progress of the plan makes the plan relevant, and helps maintain and sustain the action items. This section is broken down into three different types of indicators including: Programmatic, Social and Environmental Indicators. Programmatic indicators are indirect measures of restoration activities in the watershed and include measures of how much funding has been secured or how many BMPs have been installed. Social indicators measure change in social behavior over time. These include indicators such as number of new stakeholders on the steering committee or number of new lake monitoring volunteers. Environmental indicators are a direct measure of environmental conditions, and include indicators such as improvement in water clarity or reduced P concentration in the lake. All told, 27 indicators have been identified for tracking the progress of this plan.

H. **A set of criteria** that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards water quality standards, and if not, the criteria for determining whether this WMP needs to be revised: The indicators identified in G above and in **Section 6.2** will be used as the criteria.

I. **A monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria in (H) above: The ultimate objective of this watershed-based management 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 any near-future late summer/early fall algal blooms. Success of this plan will not be recognized without ongoing monitoring and assessment. **Section 6.3** describes how AWWA and its core stakeholders will take the lead in overseeing the long-term water quality monitoring strategy for the project lakes. Careful tracking of load reductions following successful BMP implementation projects will be essential for tracking how much P has been reduced as a result of this plan.

2. Watersheds Characterization

2.1 Climate

The climate in the Acton-Wakefield region is relatively consistent over the long-term, exhibiting a mean maximum July temperature of 70° F, a mean minimum January temperature of 19.7° F, and an overall average temperature of 45.5° F annually. The average annual precipitation is 37.15 inches including rainfall and snow equivalent. The frost-free season usually ranges from 93 to 108 days. In the winter 2007-2008 Acton accumulated 132.5 inches of snow, while over the past 10 years snowfall has averaged 101.75 inches per winter in Acton. The Acton-Wakefield region is well-known for its high quality lakes and picturesque towns which serve as the backdrop for all-season activities. People are drawn by the moderate climate to participate in activities such as water sports, hiking, ice fishing, snowmobiling, and leaf peeping.

2.2 Population, Land Use and Growth Trends

2.2.1 Population and Growth Trends

Development in the Acton-Wakefield region is considered rural with nearly 89% of land area undeveloped. The approximately 11% developed land is largely residential, primarily occurring along major roadways and lake shores (Figure 2.1). Population and demographics are important factors in watershed planning because large increases in unplanned population growth, and consequently development, could negatively affect lake water quality.

The Acton-Wakefield region has experienced considerable population growth over the last several decades (though increases in dwelling units have been more modest). From 1990-2005, Wakefield experienced the largest average annual and overall population growth rates – 3.4% and 56.5%, respectively – of all the communities in Carroll County (NHOEP, 2008). While Acton's population increase from 1990-2000 was more modest compared to other York County communities (it had the 9th highest growth rate of the 29 towns in the county), its average annual and overall growth rates were 2.2% and 24.2%, respectively (SMRPC, 2004). In 2007, the NH Office of Energy and Planning projected a 36% population growth in Wakefield between 2005 and 2025. A report prepared by the NH Society for the Protection of NH Forests "New Hampshire's Changing Landscape" projected a decrease in over 1,000 acres or 5.4% of forest land.

Given the Acton-Wakefield's region's unique character and desirability as a residential and recreational destination, it is likely significant growth will continue to occur in Wakefield and Acton well into the future. Consequently, both communities should carefully 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.

Table 2.1: 2000 Population demographics for Acton and Wakefield.

Town	Population	Population Aged 0-17	Population Aged 18-64	Population Aged 65 and Over	Median Household Income
Wakefield, NH	4,252	455	3,160	637	$42,500
Acton, ME	2,145	209	1,067	335	$39,036

Median household income among towns in the Acton-Wakefield region ranges from a high of $46,500 in Wakefield to a low of $39,036 in Acton (Table 2.1). Most people living in these towns are married and have families. In both Wakefield and Acton 24.4% of residents have received college degrees and higher, and over 80% have received high school diplomas.

A buildout analysis was conducted for the SF headwater lakes watersheds in Wakefield and Acton (Appendix E). The analysis combined projected population estimates, current zoning restrictions, and a host of additional development constraints (conservation lands, steep slopes, wetlands, existing buildings, soils with low development suitability, unbuildable parcels) in order to determine the extent of buildable area in the watershed. Projected development follows closely with population estimates in that Wakefield not only holds the majority of land in the SF headwater lakes watersheds but also has the most buildable area (Table 2.2).

Table 2.2: Buildable land in the Acton-Wakefield region.

Town	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
Acton	5,882	2,407	41%
Wakefield	16,770	5,648	52%

2.2.2 Land Uses

A watershed land use inventory is a useful tool that shows where potential sources of nonpoint source pollution may be stemming from on a larger scale than a watershed survey. A watershed with high levels of development and little remaining undisturbed forests is a likely candidate for high levels of NPS pollution, and consequently, polluted waterbodies. On the other hand, a watershed with carefully managed development, and large areas of undisturbed forests, especially along headwater streams, will be less likely to show the characteristic effects of NPS pollution in the downstream waterbody.

A land use inventory can also provide information about how land uses have changed over time. The SF headwater lakes watershed land use inventory conducted in 2009 determined that the majority of these watersheds consist of non-developed land including mixed forest land (69%), surface water (19%) and wetlands (1%) (Figure 2.1; Map 1, Appendix B). Other managed land uses in the watershed include agricultural land (7%) and beaches and gravel pits (<1%). Agricultural uses in the watershed include cropland, pasture, and hayland.

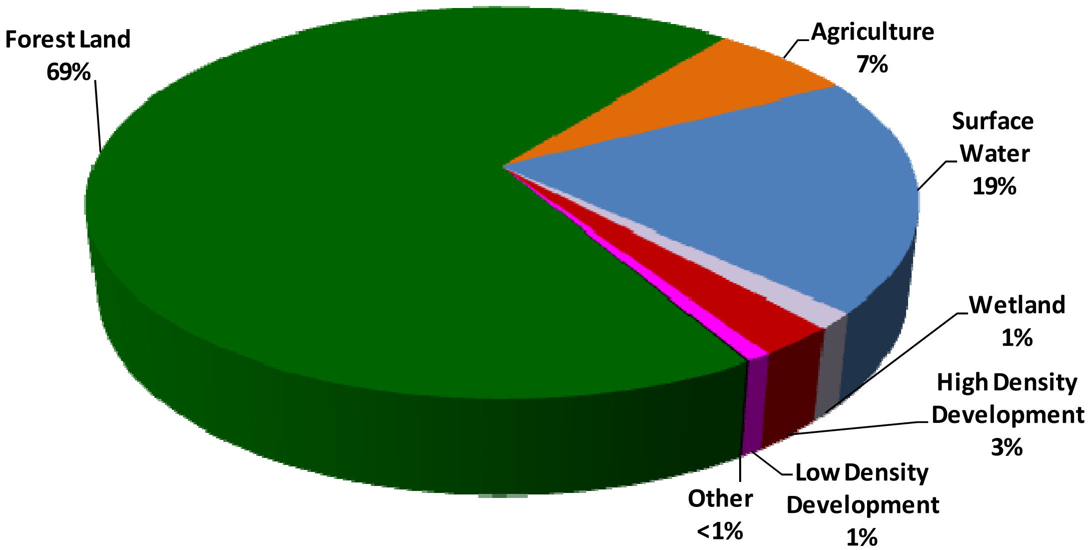


Figure 2.1: Land uses in the Salmon Falls headwater lakes watersheds.

Developed land covers approximately 11% of the SF headwater lakes watershed area. This includes high and low density residential and commercial development and some commercial development encompassing approximately 656 acres (~ 4%) of Impervious Cover (IC), as shown in Figure 2.2 below.

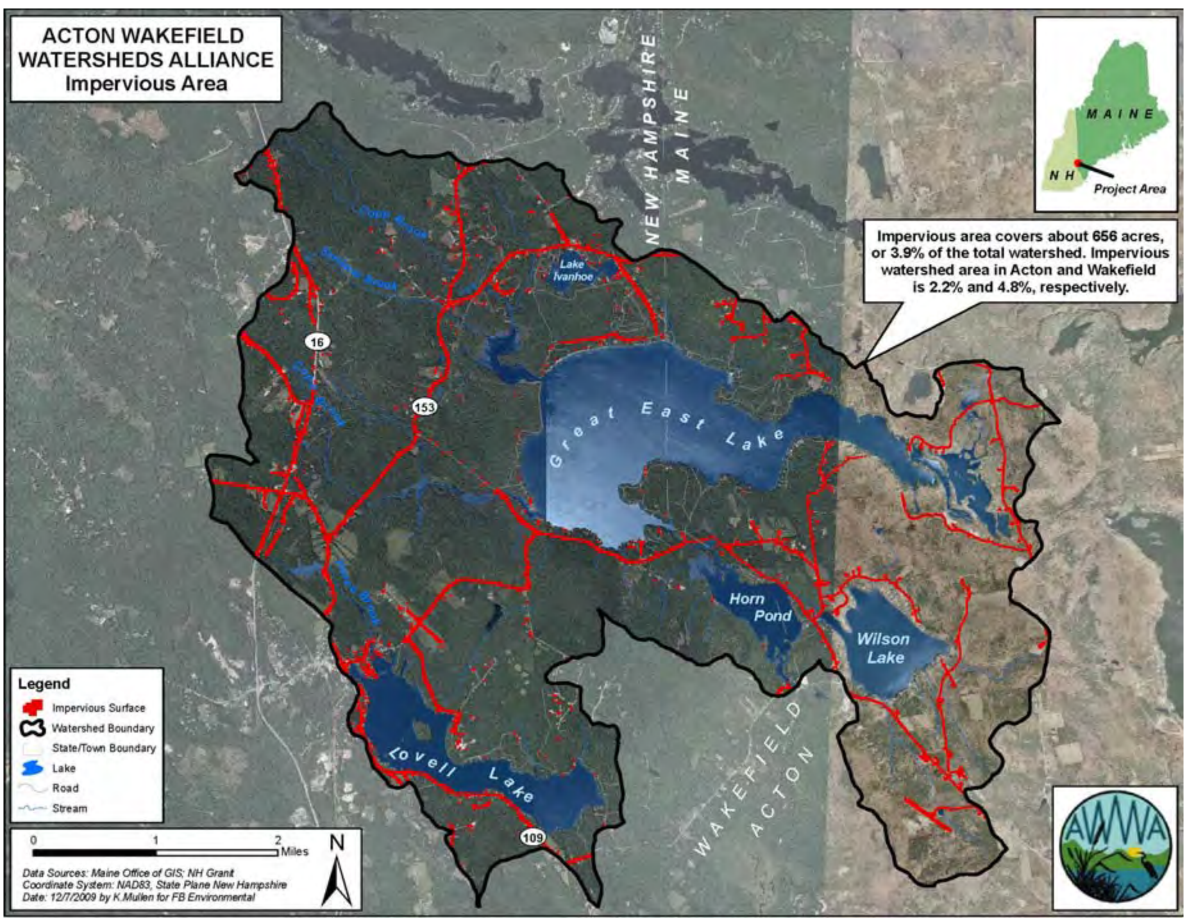


Figure 2.2: Impervious cover (IC) in the AWWA region (*see Appendix B for larger map*).

IC refers to any man made surface (e.g. asphalt, concrete, and rooftops), along with compacted soil, that water cannot penetrate.

Rain and snow that would otherwise soak into the ground turns into stormwater runoff when it comes into contact with impervious surfaces. Stormwater runoff carries numerous pollutants, such as sediments, nutrients, pathogens, pesticides, hydrocarbons, metals and deicers, into our surface waters. Studies have shown that streams with greater than 10% IC in the watersheds have documented biological impairments in Maine and throughout the country. These impacts are attributed to changes in the aquatic environment due to the increased flow volume associated with stormwater runoff.

Although the SF headwater lakes watersheds have relatively low IC under current conditions, the buildout analysis conducted for the area (Appendix E) along with projected population growth trends indicate that % IC will continue to increase. Consequently, both communities should consider ways to minimize the effects of future development, such as incorporating low impact development (LID) techniques into new development projects. More information on long-term strategies for addressing the effects of public and private roadways, and strategies to implement residential BMPs and low impact development techniques, can be found in the Action Plan in Section 5.4.

2.2.3 Protected Lands

There are many reasons to conserve land in the SF headwater lakes watersheds - protection of water resources, creating and enhancing outdoor recreation opportunities, protecting the region's economic vitality and protecting wildlife habitat among them. These reasons are critical in preserving and enhancing the quality of life in the Acton-Wakefield region.

Currently, based on available data, the amount of conservation lands in the these watersheds is minimal, covering 335 acres, or about 4% of the total watershed area (Figure 2.3; Map 4, Appendix B). Existing conserved lands in the watershed include:

- ***Moose Mountains Regional Greenway:*** (52.16 acres) Located on the western boundary of the watershed near Copp Brook. This land is part of a larger project to protect New Hampshire's natural resources.
- ***Herberich Property:*** (62 acres) Located north of Lovell Lake along Witchtrot Road. This land is owned by the Society for the Protection of New Hampshire Forests. (An adjacent 117-acre Remick property on Witchtrot Road is owned by the Strafford Rivers Conservancy (not shown on Figure 2.3).)
- ***Siemon Property:*** 27.47 acres on the backside of Oak Hill at the eastern end of Lovell Lake, and 7.71 acres on the southern edge of eastern Lovell Lake. The Siemon family donated this land to the Society for the Protection of New Hampshire Forests.

With about 89% of the SF headwater lakes watershed area currently undeveloped, there are numerous opportunities for continued land conservation in the region. Protection of the "upland" areas of the AWWA watersheds would help ensure that some land remains in an undisturbed state, which will help reduce total phosphorus runoff to the SF headwater lakes. Additionally, the New Hampshire wildlife action plan has identified areas in the Acton-Wakefield region that are of critical importance for maintaining habitats and populations of the state's species of conservation and management concern (Appendix B). These areas, including high priority marshes, conservation focus areas, and supporting natural landscapes, cover nearly 2,690 acres, or 16% of the total watershed area.

Information on strategies to coordinate conservation efforts among the local land trust, AWWA, and the municipalities is included in the Action Plan in Section 5.4.

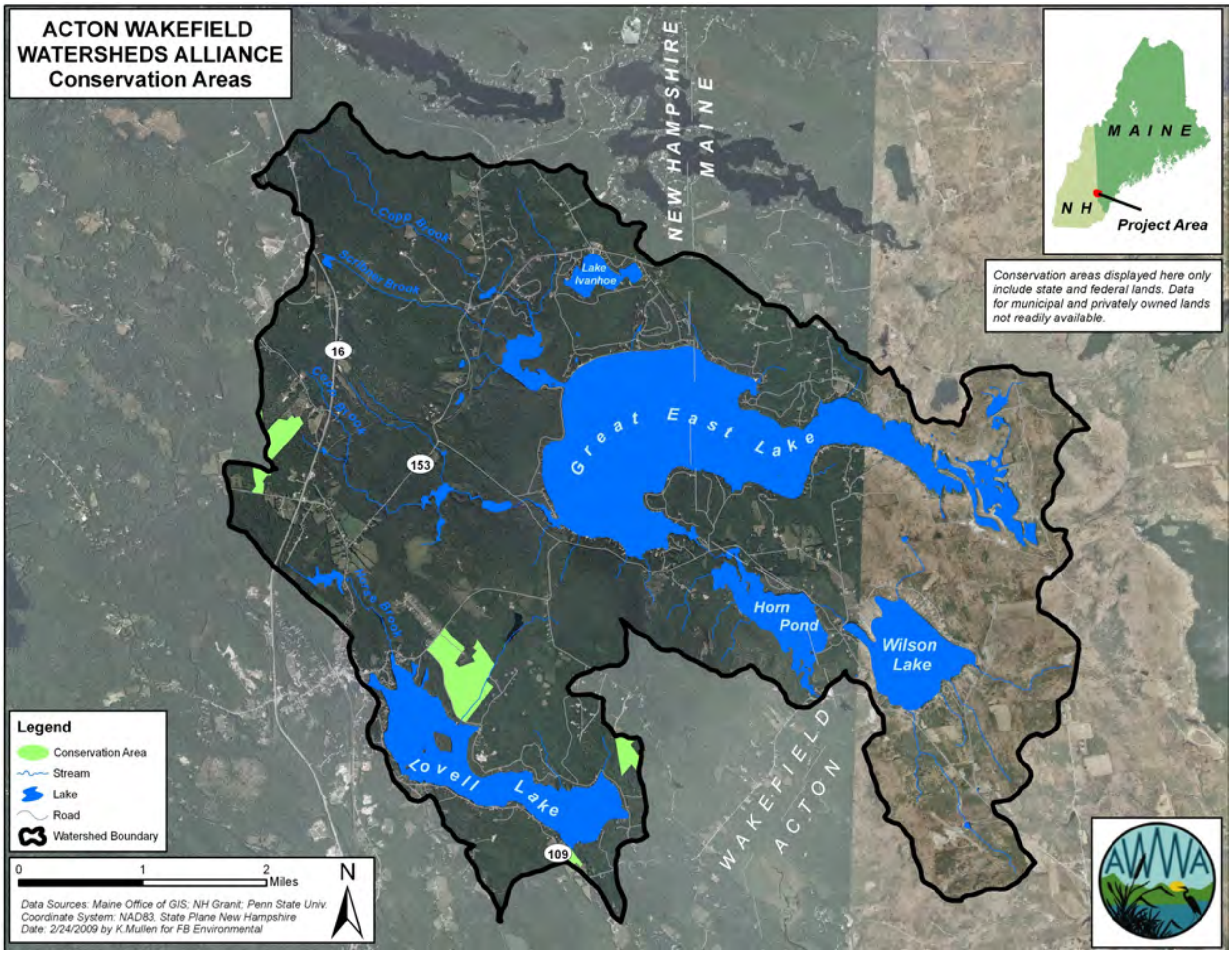


Figure 2.3: Conservation lands in the AWWA region (*see Appendix B for larger map*).

2.3 Physical Features

2.3.1 Topography

Elevations in the SF headwater lakes watersheds range from a low elevation of 560 to 580 feet at Horn Pond and Great East Lake, to a high elevation of 1,080 feet on Oak Hill and Davis Hill, south of Great East Lake and west of Horn Pond (Map 6, Appendix B). The mean elevation across the SF headwater lakes watersheds is 726 feet. Additional peaks in the region include Cooks Hill and Long Mountain, both 1,060 feet and located along the northwest watershed boundary. Perkins Hill (780 feet) sits along the northern watershed boundary and Gerrish Mountain (940 feet) sits along the southern boundary, south of Wilson Lake.

The steepest slopes in the SF headwater lakes watersheds are found on the northern faces of Oak Hill and Davis Hill, along the northeastern edge of Lovell Lake, and southeast of Wilson Lake.

2.3.2 Soils and Geology

Much like the topography of the region, the different types of soils and their location in the landscape can be attributed to the movement of the glacier that covered Maine and New Hampshire more than 12,500 years ago. Maine and New Hampshire soils are therefore a conglomerate of rock-fragments and soil material called glacial-till, and water-sorted sediment deposited in glacial streams, rivers, and lakes. Fine blue marine sediment known as the Presumpscot Formation was deposited hundreds of miles inland as a result of the mass of ice from the glacier depressing the landscape and then rebounding as the ice melted.

Soil associations are groups of soils with similar characteristics. The SF headwater lakes watersheds within Acton are characterized by the Hermon-Brayton-Dixfield general soil association which consists of sandy, loamy soils formed in glacial till, and the Skerry-Hermon-Monadnock-Colonel general soil association which also consists of loamy and sandy soils formed in glacial till (Ferwerda et al. 1997). Soils on the Wakefield side of the SF headwater lakes watersheds are similar, with the most common soil being Woodstock-Bice fine sandy loam, which is found on hillslopes and formed in glacial till. Paxton fine sandy loam is also common in the Wakefield watershed area. Like the Woodstock-Bice soils, this soil type is found on hillslopes and formed in glacial till. Aside from wetland areas, soils in these watersheds are generally well to excessively well drained.

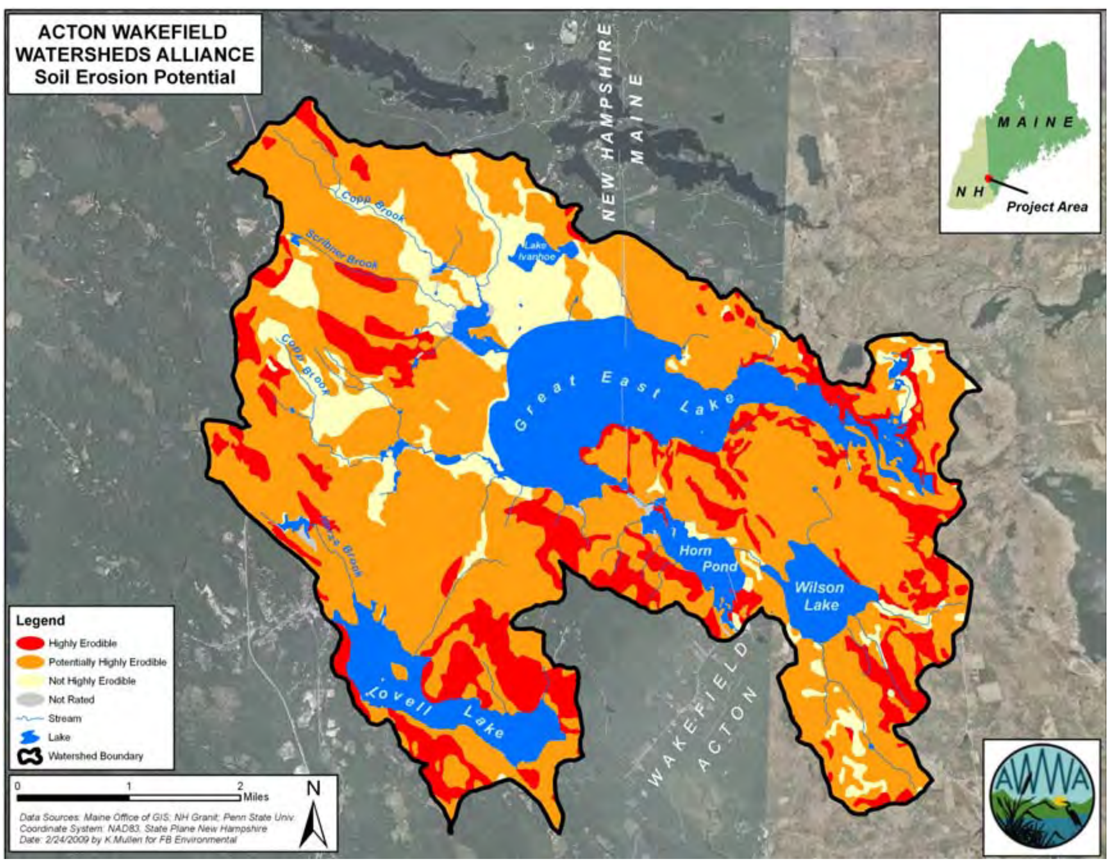


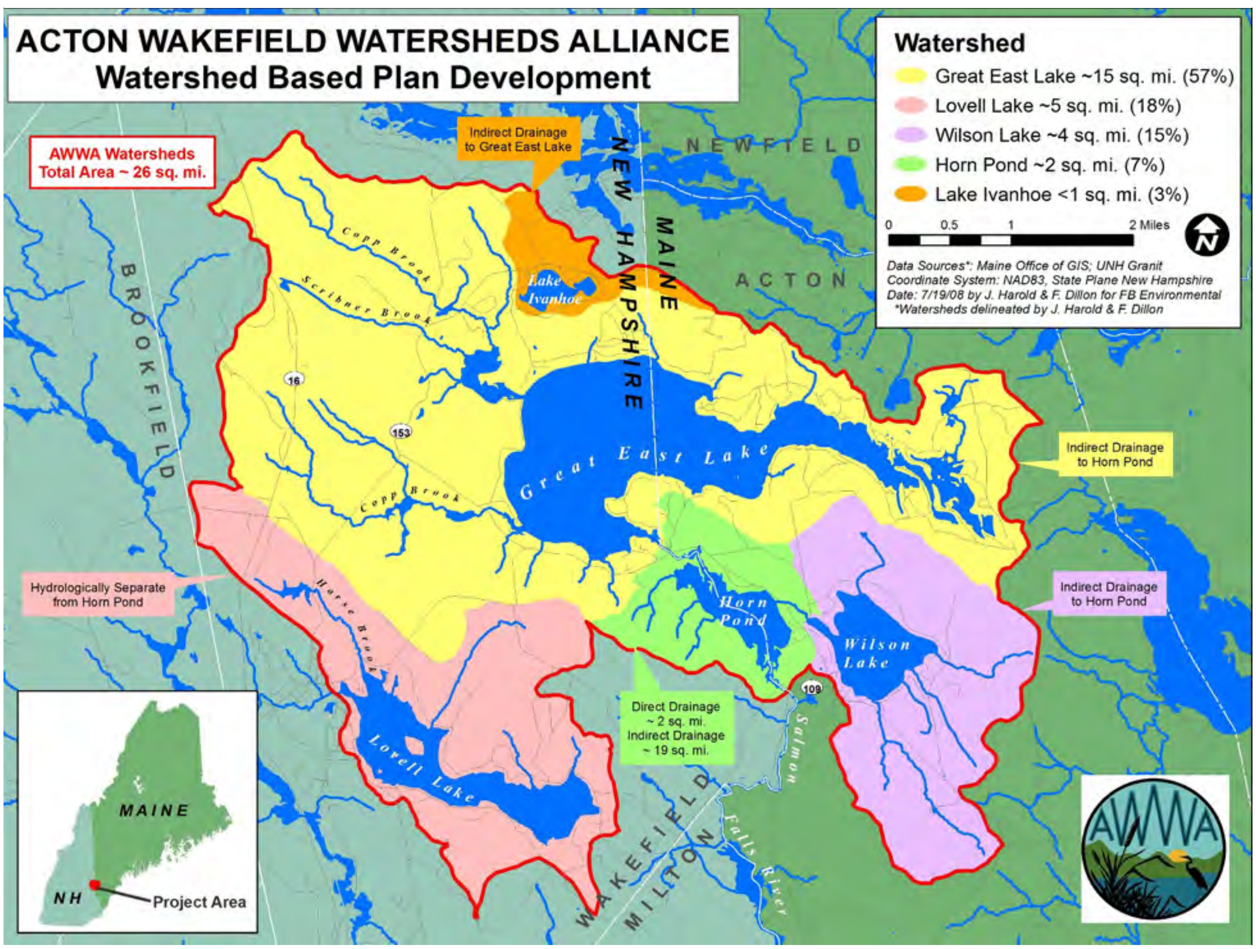
Figure 2.4: Soil erosion potential in the Salmon Falls headwater lakes region (*see Appendix B*).

Soil erosion potential should be a major factor when determining where development should and should not occur in a watershed. Areas with highly erodible soils should be avoided for future development because they inherently have a potential to erode at a rate far greater than what is considered tolerable soil loss. The potential erodibility of soil is dependent on a combination of factors including land contours, climate conditions, as well as physical and chemical soil properties such as soil texture, composition, permeability, and structure (O'Geen et al. 2006). A highly erodible soil has a higher potential to negatively affect water quality, and therefore requires a greater investment to maintain its stability and function in the landscape.

In these watersheds, 18.4% of the land area is considered highly erodible (Figure 2.4). This land is generally located along the southern shore of Great East Lake, around Lovell Lake and west of Horn Pond, in addition to other areas scattered throughout the watersheds. Potentially erodible land encompasses the majority of the watershed area (68.3%). This means that the soils are at risk of erosion if they are not managed properly. Not highly erodible soils (12.6%) are generally located in low lying wetland areas near abutting streams.

2.3.3 Drainage Areas

Figure 2.5: The Salmon Falls headwater lake watersheds.



The watersheds of Lake Ivanhoe, Great East Lake, and Wilson Lake are all hydrologically connected to the Horn Pond watershed, which flows directly to the Salmon Falls River. Lovell Lake, though not hydrologically connected to Horn Pond, flows to the Salmon Falls River via Branch River and Milton Three Ponds.

The greater Acton-Wakefield region includes the watersheds of Province Lake, Belleau Lake, Balch Lake, Pine River Pond, Sandy Pond, Woodman Lake, Lake Ivanhoe, Great East Lake, Horn Pond, Wilson Lake, Lovell Lake and their tributaries. This WMP focuses on five of the SF headwater lakes watersheds: Great East Lake, Horn Pond, Lake Ivanhoe, and Wilson Lake, which form the headwaters of the Salmon Falls River; and Lovell Lake, which feeds the Branch River. Branch River flows into Milton Three Ponds, where it joins the Salmon Falls River. The Salmon Falls River defines the border between Maine and New Hampshire from Great East Lake to its confluence with the Cocheco River. When the Salmon Falls River joins the Cocheco River they form the Piscataqua River, defining the state border to the Gulf of Maine. These five watersheds cover approximately 26 square miles within Acton, ME and Wakefield, NH (Figure 2.5).

As mentioned earlier, both a land use analysis (Section 2.2.2) and a buildout analysis (Appendix F) were conducted for the AWWA watersheds. Table 2.3 shows the percentage of developed land – including residential, commercial, and agricultural lands – in each watershed, derived from the land use analysis, and the percentage of available buildable area for each watershed, derived from the buildout analysis. Great East Lake, the largest of the watersheds, has the second lowest percentage of developed land, and the second highest percentage of buildable area. Lake Ivanhoe has the smallest watershed, but the highest percentage of both developed land and buildable area. As such, Lake Ivanhoe is likely influenced by this higher level of development, and future development in the watershed should be carefully planned and monitored.

Table 2.3: Percent developed and buildable area in the SF headwater lakes watersheds.

Watershed	Watershed Area (acres)	Percent Developed Area	Percent Buildable Area
Great East Lake	9,620	9%	52%
Horn Pond	1,139	6%	34%
Lake Ivanhoe	455	17%	59%
Lovell Lake	3,075	14%	37%
Wilson Lake	2,480	8%	49%

Table 2.4: Salmon Falls headwater lakes characteristics and morphology.

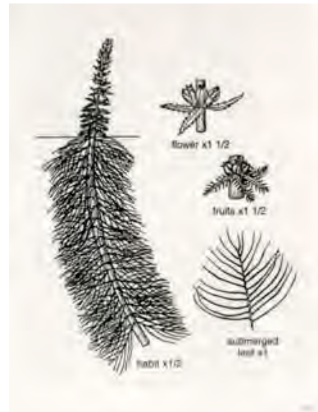
Watershed	Surface Area (acres)	Volume (m^3)	Mean Depth (feet)	Max. Depth (feet)	Flushing Rate (flushes/yr)
Great East Lake	1,707	75,589,500	35	102	0.3
Horn Pond	227	3,155,000	13	31	8.2
Lake Ivanhoe	68	992,000	12	20	0.9
Lovell Lake	538	8,623,000	13	41	0.7
Wilson Lake	308	6,756,766	17	44	0.85

2.3.4 General Lake Characteristics and Morphology

The morphology (shape) and morphometry (measurement of shape) of lakes have been shown to be good predictors of water clarity and lake ecology, where large, deep lakes are typically clearer than small shallow lakes. Differences in factors such as lake area, number and volume of upstream lakes, and flushing rate affect the way lakes function. This proves somewhat true for the SF headwater waterbodies (Table 2.4). For example, Great East Lake has the largest surface area, volume, and depth of the five lakes, and is the only lake with "outstanding" water quality. Lake Ivanhoe, on the other hand, has the smallest surface area, volume, and depth of all five lakes, and is the only lake for which current water quality data indicate that the lake may be "impaired" under NH water quality standards.

2.4 Invasive Plants

The introduction of non-indigenous invasive aquatic plant species to Maine and New Hampshire's waterbodies has been increasing. The impacts of the spread of invasive aquatic plants are well known: habitat disruption, loss of native plant and animal communities, reduced property values, impaired fishing and degraded recreational experiences, and enormous and ongoing control costs.



Variable milfoil is the aquatic invasive most commonly found in Maine and New Hampshire's lakes.

It is crucial that aquatic invasives are detected as early as possible, before they have had an opportunity to cause significant damage or to spread to other waterbodies. Early detection provides the best hope of eradication. Once established, invasive species are difficult and sometimes costly to remove, making early detection of critical importance.

An effective early detection system includes consistent screening by trained monitors. Lakes should be visited and revisited on a frequent and ongoing basis. Invasive species that have been found in lakes throughout Maine and/or New Hampshire include Variable milfoil (ME & NH), Eurasian milfoil (NH), Fanwort (NH), Brazilian elodea (NH) Curly leaf pondweed (ME & NH), Hydrilla (ME), and Brazilian elodes (NH)

While none of the target lakes in the AWWA watersheds have any documented infestations, some nearby lakes have. Additionally, in 2006, a monitor found Variable milfoil growing near the public boat launch on Great East Lake. Although Variable milfoil is an aggressive reproducer that can spread quickly, subsequent monitoring has revealed no sign of regrowth of the original plant or new plants.

Great East Lake has an inspection program that is run by the New Hampshire Lake Host program, and supported with funds from the Courtesy Boat Inspector program in Maine, as the boat launch is located in both states. Lovell Lake participates in the NH Lake Host program as well. Both lakes have staff at the launches on weekends and holidays and occasional other busy days during the summer. The staff is mostly paid but volunteers help to fill in the gaps and extend the inspection hours. Both Great East Lake and Lovell also have weed watcher programs, similar to the Invasive Plant Patrollers program in Maine, in which trained volunteers survey the lakes regularly. Wilson Lake, Horn Pond and Lake Ivanhoe do not yet have inspection or weed watcher programs in place.

2.5 Estimating Watershed Pollutant Sources

Watershed-scale pollutant load modeling is a useful tool for estimating and comparing the potential impacts from various physical processes occurring throughout the landscape. A range of well established approaches exist, varying in level of detail and budget requirements. Most can provide a relative basis for comparison between pollutant loads from various land uses and thereby assist water resource managers in selecting appropriate Best Management Practices (BMPs). Since all models have their strengths and weaknesses, model selection should be based on the project goals and objectives. The primary goals and objectives for estimating pollutant loads in the Acton-Wakefield region are to identify current and future sediment and nutrient sources by land use type and subwatershed. After consulting with NHDES, the modeling method selected for the Salmon Falls Headwater Lakes WMP was EPA's Spreadsheet Tool for Estimating Pollutant Loads (STEPL), which is described in the next section.

2.5.1 STEPL Methodology

STEPL employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various BMPs. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The sediment and pollutant load reductions that result from the implementation of BMPs are calculated using the known BMP efficiencies.

Determining Pollutant Loads from Land Use-Based Sources

STEPL allows users to determine pollutant load sources for single watersheds or for multiple watersheds. Since the Acton-Wakefield region for which this Plan has been developed consists of five watersheds (Great East Lake, Lovell Lake, Wilson Lake, Horn Pond and Lake Ivanhoe), all of these were collectively included as inputs for the STEPL model. Initial data inputs for each watershed were for land use types and areal extents. Land uses originated from a data set developed by the New England Interstate Water Pollution Control Commission (NEIWPCC) for the entire northeast region of the U.S. as part of another nonpoint source pollutant load modeling methodology. This Geographic Information System-based (GIS) land use data, referred to as Northeast AVGWLF, consisted of considerably more categories than the five pre-defined categories included with STEPL, which consist of urban, cropland, pastureland, forest, and user defined. (Feedlots are also included with STEPL, but none were identified by the AVGWLF land use data). Therefore, the Northeast AVGWLF land use categories were combined to fit the pre-defined STEPL land use categories (Table 2.5).

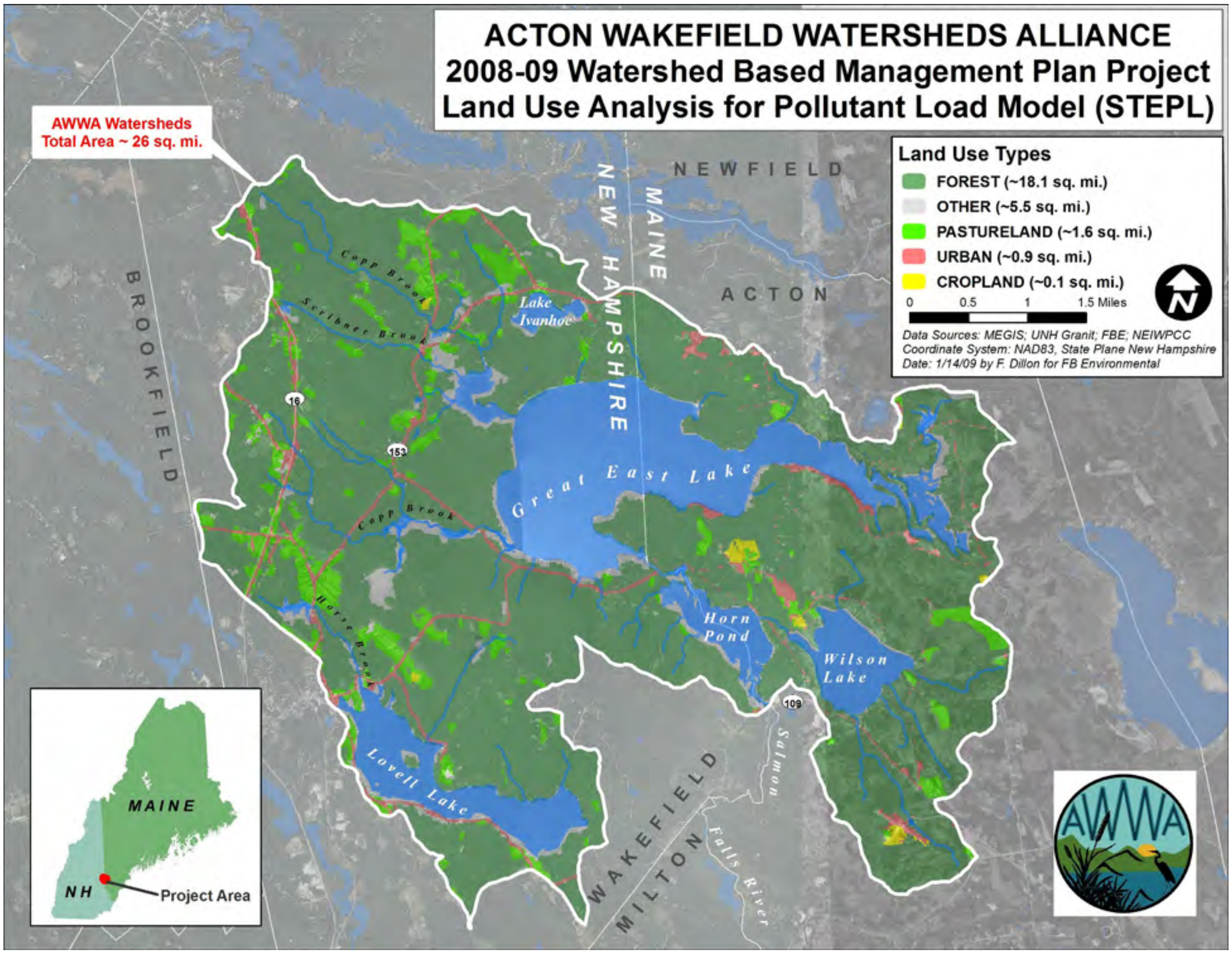
Table 2.5: AVGWLF land use categories combined to fit STEPL land use categories.

Combined AVGWLF and STEPL LU Types	Great East (acres)	Horn (acres)	Ivanhoe (acres)	Lovell (acres)	Wilson (acres)	AWWA Total (Acres)	AWWA % Total
URBAN							
High-density development Total	235.7	21.5	24.7	116.8	39.3	438.0	2.6%
Low-density development Total	86.0	7.4	3.0	7.8	24.2	128.4	0.8%
Subtotals:	*321.7*	*28.9*	*27.7*	*124.6*	*63.5*	*566.4*	*3.4%*
CROPLAND							
Row crops Total	27.8	6.5	-	3.2	19.0	56.4	0.3%
PASTURELAND							
Hay/pasture Total	538.9	37.1	47.7	316.0	122.1	1061.9	6.3%
FOREST							
Mixed forest Total	3489.8	323.1	88.5	1043.1	1137.7	6082.2	36.3%
Coniferous forest Total	935.2	31.0	83.9	191.6	199.8	1441.5	8.6%
Deciduous forest Total	2131.0	441.5	118.0	733.4	628.2	4052.0	24.2%
Subtotals:	*6556.0*	*795.5*	*290.4*	*1968.1*	*1965.8*	*11575.6*	*69.0%*
OTHER							
Emergent wetland Total	91.4	2.6	-	22.9	6.4	123.2	0.7%
Woody wetland Total	90.0	-	6.8	3.6	-	100.3	0.6%
Quarries Total	9.7	-	-	4.8	-	14.5	0.1%
Beaches Total	1.9	-	-	-	0.2	2.1	0.0%
Water Total	1983.1	269.2	82.6	632.7	302.7	3270.3	19.5%
Subtotals:	*2176.0*	*271.8*	*89.4*	*663.9*	*309.3*	*3510.4*	*20.9%*
Overall Total Acres:	**9620.3**	**1139.7**	**455.2**	**3075.8**	**2479.6**	**16770.6**	**100%**
Overall Total Square Miles:	**15.03**	**1.78**	**0.71**	**4.81**	**3.87**	**26.20**	

STEPL also allows for further distinction of the urban land uses. For the SF headwater lakes region these consist of high density development (primarily roads) and low density residential. Creating custom user defined land use categories was beyond the project scope. As a result, the five remaining general land use types used for the STEPL model inputs were urban, cropland, pastureland, forest and other. This last category is a catchall for land uses that did not fit any of STEPL's other general land use types and was therefore not included in the pollutant load estimation. (Note: other nonpoint source pollutant load models also generally exclude these land uses since they are presumed to contribute negligible amounts of pollutants to nearby surface waters). Overall, the general land use types occupying the SF headwater lakes region from largest to smallest are forest at approximately 11,575 acres (~18 square miles); pastureland at approximately 1,062 acres (~1.7 square miles); urban land at approximately 566 acres; and cropland at approximately 56 acres. The resulting STEPL land use map is shown in Figure 2.6.

STEPL calculated annual pollutant loads for each land use type using researched concentration values for nutrients (phosphorus and nitrogen) and biochemical oxygen demand (a measure of decomposable organic matter) along with runoff volume based on rainfall data from a weather station nearby (Durham, NH). STEPL also adjusts pollutant load values based on the use of various BMPs, which is discussed in more detail in the following pages.

Figure 2.6: Map of aggregated land uses for STEPL pollutant load model input.

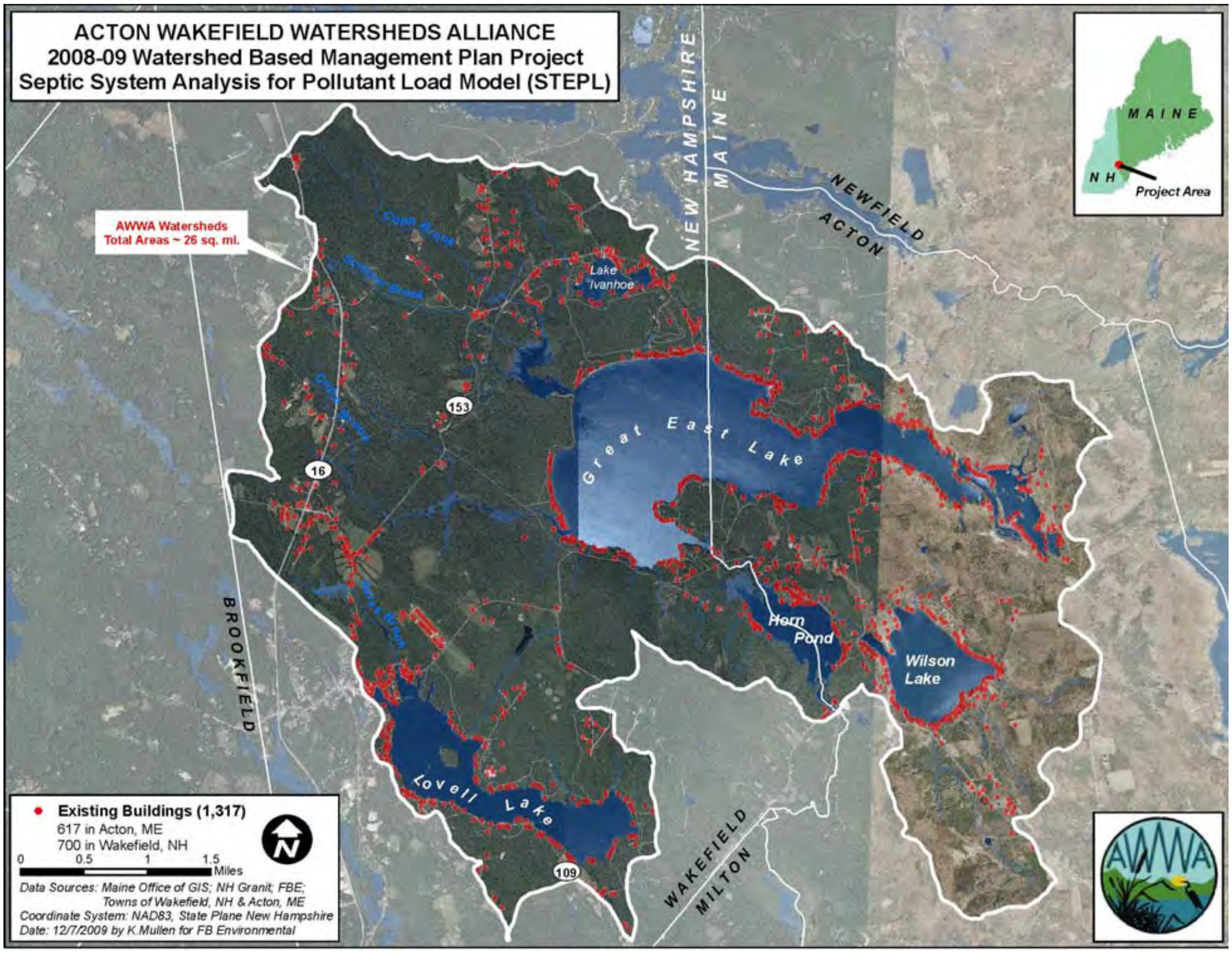


Determining Pollutant Loads from Other Sources

STEPL also allows pollutant load inputs for livestock and septic systems. No definitive animal husbandry information exists for the SF headwater lakes region and so no data could be entered into STEPL for these potential sources. However, anecdotal information suggests there are very few domesticated animals in the watershed, and those that do exist likely play very little role in pollutant load contributions to nearby surface waters. In contrast, septic systems may be contributing fairly significant pollutant loads in the watershed, particularly when poorly functioning systems are situated in close proximity to nearby surface waters.

STEPL requires inputs for the numbers of septic systems in each watershed and calculates theoretical loadings based on researched estimates of nutrient and organic concentrations. The number of septic systems was first determined separately for Acton and Wakefield based on the available data types. Acton's cadastral database contained a field denoting whether a particular parcel also had a building. Parcels with buildings were assumed to have septic systems. Wakefield's cadastral database did not identify parcels with buildings. Therefore, digital aerial photographs were used to identify the locations of buildings, which in turn were assumed to have accompanying septic systems. In both cases, the use of a GIS was instrumental in conducting the analyses, which determined that Acton has approximately 617 septic systems and Wakefield has approximately 700 septic systems. Many septic systems are located in close proximity to surface waters (Figure 2.7).

Figure 2.7: Map of residential septic system data used for STEPL pollutant load model.



Septic system numbers were then determined for each watershed, also using GIS. The Great East Lake watershed has approximately 665 septic systems; the Lovell Lake watershed has approximately 301 septic systems; the Wilson Lake watershed has approximately 184 septic systems; the Horn Pond watershed has approximately 110 septic systems; and the Lake Ivanhoe watershed has approximately 57 septic systems (Table 2.6). All of these values were entered directly into the STEPL model to estimate pollutant loads from septic systems in the watershed.

In addition to estimating sediment loads for each watershed based on the Universal Soil Loss Equation (USLE), STEPL also allows for an estimation of sediment loads based on the dimensions of various erosional features throughout the landscape (e.g., streambanks and gullies). This data was not available at the time the STEPL model was run and additional sediment loads were not determined. However, AWWA has since completed estimates of soil erosion so this data can be added to STEPL at some point in the future to calculate the sediment load from erosional features.

2.5.2 STEPL Results

For the SF headwater lakes watersheds, we used the STEPL model to evaluate total phosphorus loading only, because it is considered the limiting nutrient in freshwater lake environments. Under current conditions, it is estimated that phosphorus loading from existing land uses in the SF headwater lakes watersheds totals ~2,721 lbs P/year.

Table 2.6: Number of septic systems in the SF headwater lakes region by subwatershed.

Watershed	Acton	Wakefield	Totals
Great East Lake	338	327	**665**
Horn Pond	93	17	**110**
Lake Ivanhoe	2	55	**57**
Lovell Lake	-	301	**301**
Wilson Lake	184	-	**184**
Totals:	**617**	**700**	**1317**

Subwatershed modeling using STEPL indicated that the Great East Lake subwatershed contributes the highest load of phosphorus (1,377 lbs P/year) of the five subwatersheds, while the Lake Ivanhoe subwatershed contributes the smallest load (114 lbs P/year; Table 2.7, Figure 2.8). Because Great East Lake has the largest land area of the SF headwater lakes subwatersheds, it is reasonable for this subwatershed to contribute the largest amount of phosphorus from surrounding land uses. However, on a per acre basis, the Great East Lake subwatershed also contributes the greatest amount of phosphorus of the five subwatersheds (Table 2.8).

Table 2.7: SF headwater lakes subwatershed annual phosphorus loads.

STEPL Phosphorus Load by Subwatershed (lb/year)	
Watershed	**P Load**
Great East Lake	1377
Horn Pond	198
Lake Ivanhoe	114
Lovell Lake	619
Wilson Lake	413
Total	**2721**

Table 2.8: SF headwater lakes subwatershed per acre phosphorus loads.

STEPL Phosphorus Load by Subwatershed (lb/acre/year)	
Watershed	**P Load**
Great East Lake	8
Horn Pond	7
Lake Ivanhoe	6
Lovell Lake	6
Wilson Lake	4
Average	**7**

Phosphorus loads are heavily dependent on land uses within the subwatersheds. Table 2.9 illustrates the subwatershed loads by land use and other sources. Some sources, such as atmospheric deposition, are natural sources of phosphorus loading while others are human sources. Overall, forested land in the AWWA subwatersheds covers the most land area, and also contributes the highest annual phosphorus loads (793 lbs P/year). Pastureland, including hay land, contributes the second-highest phosphorus load at 727 lbs P/year, followed by urban (residential and commercial) land uses at 374 lbs P/year. Septic systems, atmospheric deposition, and cropland provide 321, 321, and 185 kg P/year, respectively. Table 2.9 and Figures 2.9 through 2.13, illustrate the respective phosphorus loads by source for each subwatershed. Forest and pastureland represent the highest loading sources for each of the individual subwatersheds.

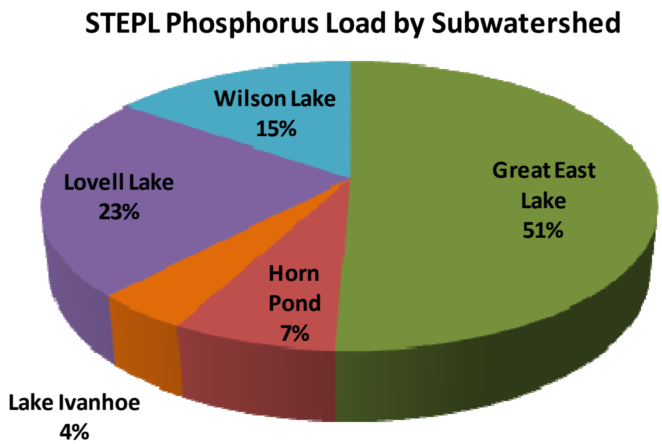


Figure 2.8: SF headwater lakes subwatershed annual phosphorus loads, by percentage.

Table 2.9: SF headwater lakes subwatershed annual phosphorus loads, by source.

STEPL Phosphorus Load by Source (lb/year)						
Watershed	**Urban**	**Cropland**	**Pastureland**	**Forest**	**Septic**	**Atmospheric**
Great East Lake	203	84	322	411	162	195
Horn Pond	18	26	33	67	27	26
Lake Ivanhoe	20	0	47	24	14	8
Lovell Lake	96	11	233	144	73	62
Wilson Lake	36	64	92	146	45	30
Total	**374**	**185**	**727**	**793**	**321**	**321**

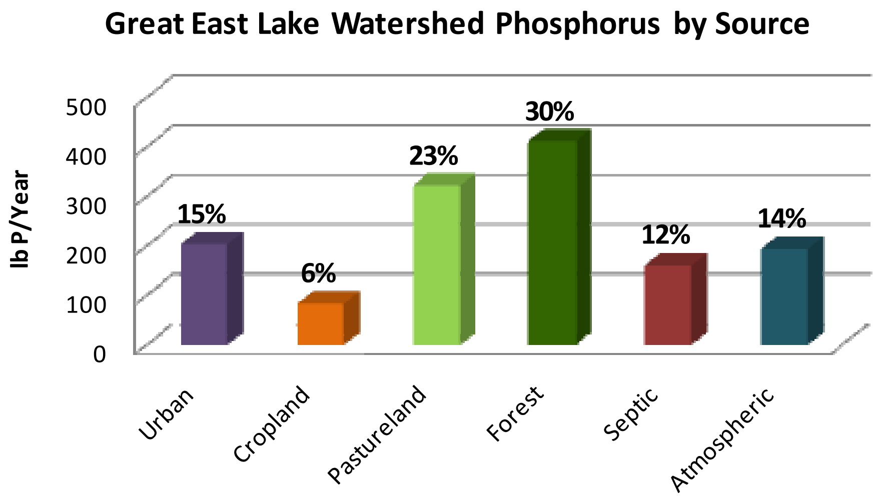


Figure 2.9: Great East Lake subwatershed phosphorus loads by source.

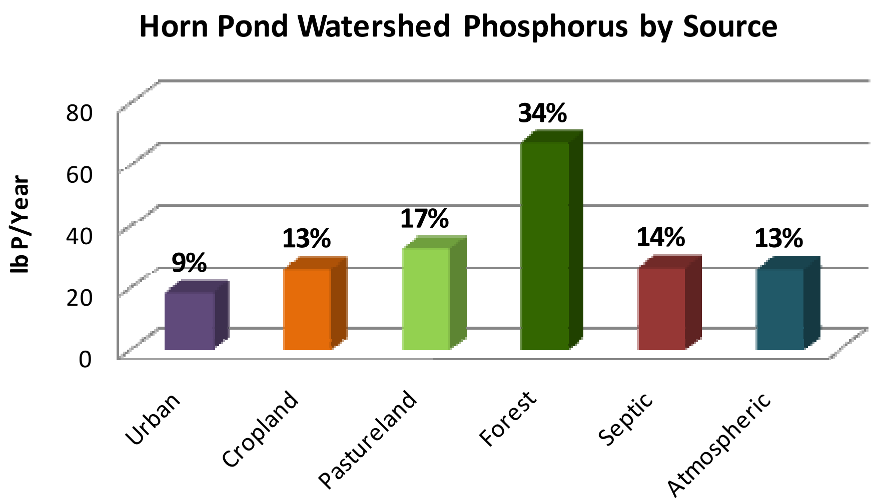


Figure 2.10: Horn Pond subwatershed phosphorus loads by source.

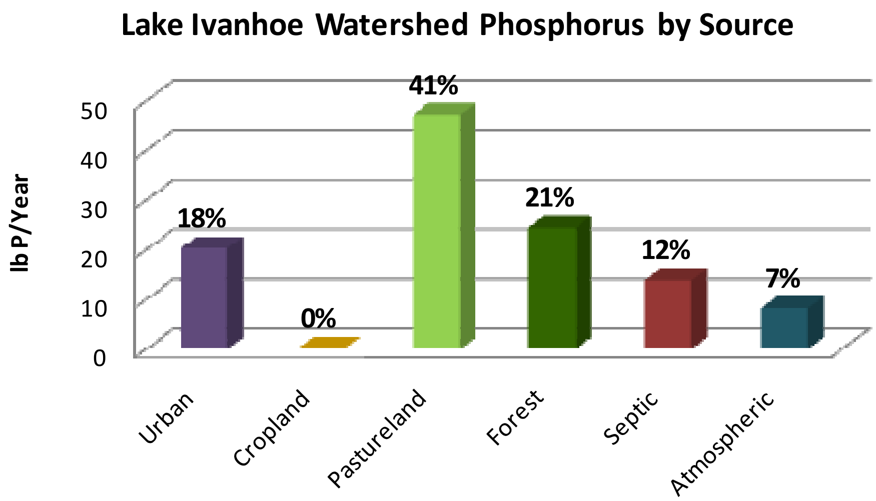


Figure 2.11: Lake Ivanhoe subwatershed phosphorus loads by source.

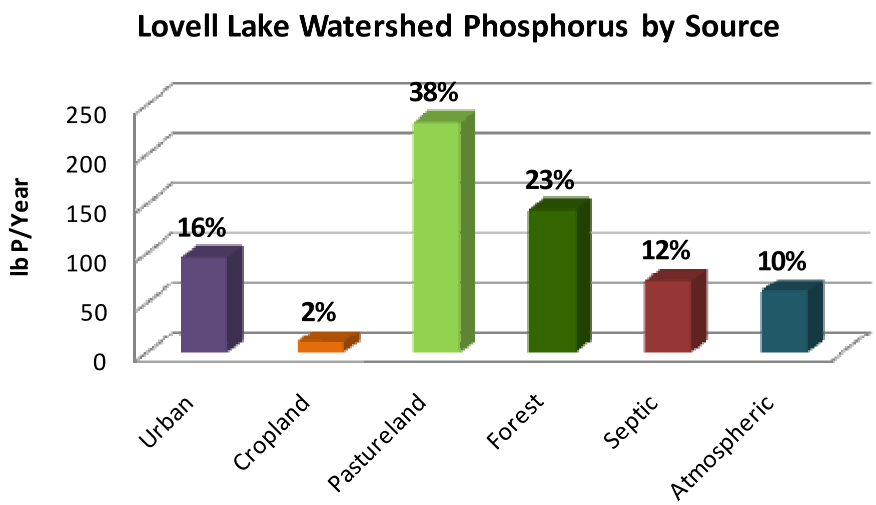


Figure 2.12: Lovell Lake subwatershed phosphorus loads by source.

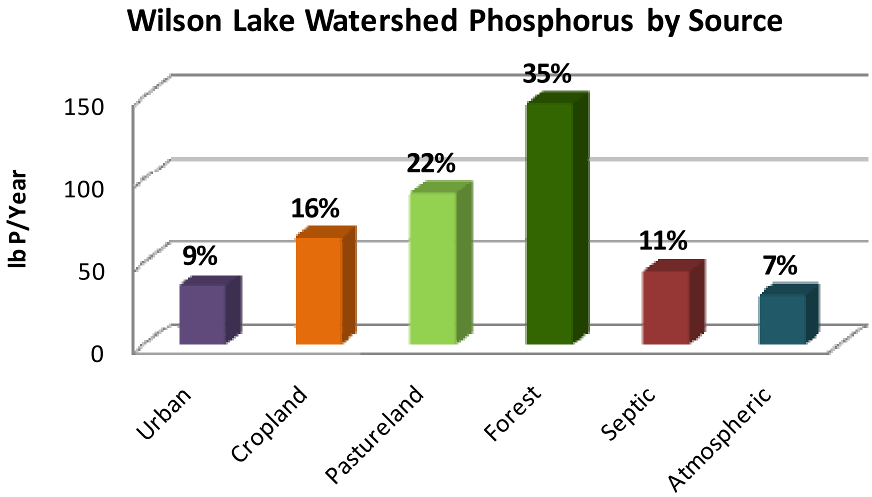


Figure 2.13: Wilson Lake subwatershed phosphorus loads by source.

3. Water Quality Assessment

This Watershed Management Plan focuses on nutrients (total phosphorus) as an indicator of lake health. This choice acknowledges that lakes with excess nutrients are generally “over productive” in terms of plant growth and algal blooms. This biological response to nutrients can serve as the “tipping point” for lake water quality, in which lakes that are rich in phosphorus often experience many symptoms of water quality decline including algal blooms, fish kills, decreased water clarity, loss of aesthetic values, and beach closures.

This section provides an overview of the water quality standards that apply to these lakes, the methodology used to assess the water quality, and the recommendations for managing these lakes to prevent water quality decline in the future. Further, this section will describe why several of the SF headwater lakes may not be considered High Quality Waters and the evidence that shows that they are experiencing a decline in water quality.

3.1 Applicable 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.*

The SF headwater lakes provide a unique opportunity to minimize differences in cross-border water quality standards between Maine and New Hampshire. Both states are required to follow federal regulations under the ***Clean Water Act (CWA)***, yet each state has some flexibility as to how those regulations are enacted. Therefore, slight differences exist among the standards and criteria used to determine if a lake is impaired or not.

Water quality regulations have several main components including designated uses, water quality standards and criteria, and antidegradation provisions. The Federal Clean Water Act, *RSA 485-A Water Pollution and Waste Control*, and the NH Surface Water Quality Regulations (Env-Wq 1700) are the regulatory authorities for water quality protection in NH. In Maine, *MRSA Title 38 §465-A Standards for Classification of Lakes and Ponds* define the criteria for classification. These authorities form the basis for many of the state’s regulatory and permitting programs related to water. States are required to submit biennial water quality status reports to Congress via EPA. The reports provide an inventory of all waters assessed by the state and indicate which waterbodies are in violation of the state’s water quality standards.

3.1.1 Designated Uses

The CWA requires states to determine designated uses for all surface waters in the state’s jurisdiction. The designated uses protect surface waters to support fish, shellfish and wildlife, and human uses including public water supply, recreation, agriculture, and others. A lake can have several designated uses.

NH's designated uses (Class B):	**Maine's designated uses (GPA Lakes):**
Drinking water after adequate treatment	Drinking water after disinfection
Primary Contact Recreation (swimming)	Recreation in and on the water
Secondary Contact Recreation (boating)	Fishing
Aquatic Life	Agriculture
Fish Consumption	Industrial process and cooling water supply
Wildlife	Hydroelectric power generation
	Navigation
	Habitat for fish and other aquatic life
	Habitat must be characterized as natural

3.1.2 Water Quality Classification

New Hampshire classifies all surface waters as being Class A or B. The classifications provide a protective framework to further support individual designated uses. Class A waters are generally of highest quality and are potentially usable as drinking water supplies. Discharge of sewage or other waste is prohibited in Class A waterbodies. Class B waters are of the second highest water quality and are suitable for multiple uses including swimming, fishing, and other recreational purposes. All lakes in the study area are Class B waterbodies and their designated uses include Drinking Water After Adequate Treatment, Primary Contact Recreation, Secondary Contact Recreation, Aquatic Life, Fish Consumption, and Wildlife. NH recognizes the deficiencies in this classification system and will be proposing a new classification system in the near future based upon inherent qualities of the surface water (Chapman, 2010).

Maine state statutes define lakes and ponds greater than ten acres in size as Great Ponds (GPA), which entail additional regulatory protections, including Shoreland Zoning, and permitting review for habitat disturbance among others. The classification system is used to direct the management of lakes and ponds and to protect water quality for their designated uses. Maine further classifies lakes into four subcategories (Outstanding, Good, Moderate-Stable, and Poor-Restorable). These management categories are based on current water quality status and fishery value, as well as the lake's sensitivity to change, and are used to set lake protection levels and limit further increases in total phosphorus as a result of new development at the watershed level. This will be discussed more in the section on establishing water quality goals (Section 3.2.4).

3.1.3 Water Quality Standards and Criteria

Both Maine and New Hampshire's water quality standards provide a baseline measure of water quality that surface waters must meet in order to support designated uses. The water quality standards are the "yardstick" for identifying water quality violations and for determining the effectiveness of state regulatory pollution control and prevention programs. Water quality criteria are designed to protect the designated uses. In order to determine if a water body meets its designated uses, water quality standards for various water quality parameters (e.g., Chlorophyll-a, Total Phosphorus and Secchi Disk Transparency) are applied to the criteria. If a waterbody meets or is better than the water quality criteria, the designated use is supported. If the water body does not meet water quality criteria, it is considered impaired for the assessed use.

In Maine, Great Ponds Class A (GPA) waters are required to have a stable or decreasing trophic state (based on appropriate measures, e.g., ***total phosphorus, chlorophyll-a, Secchi disk transparency***) that is subject only to natural fluctuations, and is free of culturally induced algal blooms that would impair their potential use and enjoyment. Maine DEP's functional definition of nuisance algal blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<30 SPU), and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll-a levels (>8 ppb).

Key Lake Water Quality Parameters

Chlorophyll-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 number, the higher the amount of algae in the lake.*

Secchi Disk Transparency *- 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).*

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

Water quality criteria for each classification and designated use in New Hampshire may be found in RSA 485A:8, IV and in the State's surface water quality regulations (NHDES 1999). However, the state is in the process of revising its current criteria. The previous phosphorus standard for NH lakes of 15 ppb was based on a one size fits all standard, such that if a lake exceeded 15 ppb it was likely to become eutrophic (symptoms include frequent algal blooms). The proposed water quality standard was set by analyzing 233 New Hampshire lakes (or about one-fourth of all lakes in NH), for phosphorus and chlorophyll-a, trophic class, and impairment status. The results determined that statistically significant impairment values for phosphorus could be determined for each trophic class: 8 ppb for oligotrophic lakes, 12 ppb for mesotrophic lakes, and 28 ppb for eutrophic lakes. These thresholds are based on summer median TP, and were incorporated into the *Consolidated Assessment and Listing Methodology* for determining impairment status for the 2010 water quality report to Congress. The impairment thresholds mean that when phosphorus levels exceed these values, the lake is likely to exhibit characteristics of lakes in the next trophic class. The ramifications of impairment for lake quality are that continued declining trends in water quality could result in the lakes losing the clarity characteristics for which they are now highly valued.

3.1.4 Antidegradation

The Antidegradation Provision (Env-Wq 1708) in NH'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. Some types of development projects, such as those requiring an Alteration of Terrain Permit or 401 Water Quality Certification from NHDES, 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 or High Quality Waters (HQW). HQW is a special designation NHDES can assign if waters are determined to be of significantly better quality than what the water quality standards afford.

In Maine, the Antidegradation Provision states that no change of land use in the watershed of a Class GPA waterbody may, by itself or in combination with other activities, cause water quality degradation that would impair designated uses of downstream GPA waters or cause an increase in their ***trophic state***. Maine's anti-degradation policy requires that "existing in-stream water uses and the level of water quality necessary to sustain those uses, must be maintained and protected."

3.1.5 Lake Nutrient Criteria

Both Maine and New Hampshire incorporate specific criteria in their water quality regulations to help determine if nutrients are affecting lake water quality. New Hampshire has a narrative nutrient criteria with a numeric translator, consisting of a "nutrient indicator" (phosphorus) and a "response indicator" (chlorophyll-a). The results from both the nutrient indicator and the response indicator are used to assess primary contact recreation (PCR) and aquatic life uses (ALU) in NH Lakes (Table 3.1).

Table 3.1: Aquatic life nutrient criteria by trophic class in NH.

Trophic State	TP (ppb)	Chl-a (ppb)
Oligotrophic	< 8.0	< 3.3
Mesotrophic	8-12	3.3- 5.0
Eutrophic	> 12-28	> 5-11

Primary Contact Recreation

Nutrient response indicators chlorophyll-a (Chl-a) and cyanobacteria scums (cyano) are secondary indicators for PCR assessments. They can cause a "not support" assessment, but, by themselves, cannot result in a "full support" designation (the primary indicator *E. coli* is needed for a "full support" assessment). The logic is that elevated Chl-a levels or the presence of cyano scums interfere with the aesthetic enjoyment of swimming and, in the case of cyano, may also pose a health hazard. Non-support for Chl-a is defined as concentrations greater than or equal to 15 ppb. Non-support for cyano scums is described as follows: "The surface water contains color, foam, debris, scum, slicks, odors and/or surface floating solids in significant amounts and for durations that significantly interfere with the primary contact recreational use, and they are not naturally occurring."

Aquatic Life Use

The Aquatic Life Use designation ensures that waters provide suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms. For ALU assessments using the lake nutrient criteria, the combination of total phosphorus (TP) and Chl-a nutrient indicators are used make support determinations. The ALU nutrient criteria vary by lake trophic class. The logic is that each trophic class has a given phytoplankton

> ***Trophic state** - the degree of eutrophication of a lake. Transparency, chlorophyll-a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion can all be used to assess trophic state.*
>
> ***Parts per billion (ppb):** A ppb is equivalent to one microgram per Liter (µg/L), a unit of measurement of a substance in the water. For example, if you are talking about 8 ppb phosphorus in a lake that means in one billion "drops" or parts of water, there are 8 "drops" or parts of phosphorus.*

biomass (Chl-a) representing a balanced, integrated and adaptive community for that trophic class, and exceedances of the Chl criterion suggest the phytoplankton community is out of balance. TP is the limiting growth nutrient for Chl-a so it is evaluated as well.

For ALU assessment determinations, the Chl-a and TP results are combined according to the decision matrix presented in Table 3.2. The Chl-a concentration will dictate the assessment if both Chl-a and TP data are available and the assessments differ.

Table 3.2: Decision matrix for aquatic life use assessment determinations in NH.

	TP threshold exceeded	TP threshold not exceeded	Insufficient information for TP
Chl-a threshold exceeded	Impaired	Impaired	Impaired
Chl-a threshold not exceeded	Fully supporting	Fully supporting	Fully supporting
Insufficient information for Chl-a	Impaired	Fully supporting	Insufficient information

The basis for Maine lake nutrient criteria methodology is the recognition of a stable or decreasing trophic state for any given lake. Maine's guidelines for trophic evaluation is similar to NH, but instead represent ranges rather than thresholds (Table 3.3).

Table 3.3: Numerical guidelines for evaluation of trophic status in Maine.

Parameter	Oligotrophic	Mesotrophic	Eutrophic
Secchi Disk Transparency	> 8.0 m	4-8 m	< 4 m
Chlorophyll-a	< 1.5 ppb	1.5-7 ppb	> 7 ppb
Total Phosphorus	< 4.5 ppb	4.5-20 ppb	> 20 ppb
Trophic State Index	0-25	25-60	> 60 and/or repeated algal blooms

Both NHDES and Maine DEP conduct trophic surveys on lakes to determine trophic status. The trophic surveys evaluate physical lake features and chemical and biological indicators. Trophic state includes: oligotrophic, mesotrophic and eutrophic. These are broad categories used to describe how productive a lake is. Generally, less productive lakes have higher water quality (oligotrophic), while very productive lakes (eutrophic) exhibit frequent algal blooms. All lakes in the this plan have been designated ***oligotrophic***, yet several of the lakes may be bordering on mesotrophic based on recent water quality modeling results.

Oligotrophic- *Refers to a class of lakes that exhibit low productivity, low levels of phosphorus and Chl-a, few rooted aquatic plants and algae, deep transparency readings [8.0 m (26.5 ft) or greater] and usually high dissolved oxygen levels throughout the water column. These lakes are considered to have excellent water quality.*

Lake Ivanhoe:

From High Quality Water to Impaired?

Lake Ivanhoe provides an example of how a lake can turn from "High Quality" to "Potentially Impaired". Further analysis by NHDES is needed to determine whether Lake Ivanhoe should be listed as Impaired and put on the State's 303(d) list of impaired waters.

Under the CWA, EPA requires states to conduct a Total Maximum Daily Load study of impaired waters to identify pollution sources, determine pollutant reductions, and describe restoration actions needed to bring the water body into compliance. Impaired water bodies are subject to more regulatory control, including antidegradation reviews (as mentioned in Section 3.1.4) at the state level to prevent further degradation.

3.1.6 Relating and Interpreting Water Quality Data and Lake Nutrient Criteria

The five lakes that make up the headwaters of the Salmon Falls River were thought to be high quality waters at the onset of this project. However, if the Lake Nutrient Criteria are applied to the results of the water quality analysis, at least three of these lakes do not meet the definition of a high quality water based on NH's Lake Nutrient Criteria (See Table 3.4). The exception is for Wilson Lake, which will follow Maine Water Quality Standards because it is located entirely in Maine. A description of the study design and data analysis is provided in the next section.

Results of this analysis are important because the SF headwater lakes were thought to be high quality waters, fully supporting their designated uses. This suggests a need for enhanced management particularly for Lake Ivanhoe, Horn Pond, and Lovell Lake to ensure that water quality standards are being met. If the assessed data indicates median TP/Chl-a in excess of the oligotrophic threshold, then a final determination of use support status by NHDES for lakes could be either "Potentially Non-supporting" or "Impaired". The determination illustrated here is for planning purposes only.

Table 3.4: Lake nutrient criteria applied to water quality assessment for each of the five Salmon Falls Headwater Lakes *.

Lake	Lake Nutrient Criteria Category
Lake Ivanhoe	**Non-supporting for Designated Uses in NH**
Great East Lake	**Fully Supporting for Designated Uses in NH**
Horn Pond	**Potentially Non-supporting for Designated Uses in NH** (P is at nutrient criterion; NHDES would make use determination)
Lovell Lake	**Potentially Non-supporting for Designated Uses in NH**
Wilson Lake	**Meets ME Standards-Lake Water Quality Category = "Good"**

** The determination illustrated here is for planning purposes only.*

3.2 Assessment Methodology

Pollution threats to the SF headwater lakes include sediment and nutrients from existing and future development, aging septic systems and roads in the watersheds. All of these land uses have the potential to deliver phosphorus, the ***limiting*** nutrient in freshwater systems, via stormwater runoff to streams and lakes in the watershed. A water quality assessment is a key component to assessing the health of the lakes and determining how watershed activities may be affecting them. The water quality assessment for this plan required several steps. This required gathering existing data, analyzing data, determining the median phosphorus concentration for each lake, determining the total, reserve, and remaining assimilative capacity, identifying whether each lake fell in Tier 2 (High Quality Waters), or Tier 1 (within the reserve assimilative capacity), organizing and meeting with a Water Quality Threshold Committee, presenting results to the committee, and setting water quality goals/thresholds.

3.2.1 Water Quality Data Acquisition

Historical water quality monitoring data was analyzed by FB Environmental to determine the median phosphorus value and the assimilative capacity for Great East Lake and Horn Pond located in both Maine and New Hampshire, Lake Ivanhoe and Lovell Lake located in New Hampshire; and Wilson Lake located in Maine. Historical water quality data for lakes in Maine is collected by the Maine Volunteer Lakes Monitoring Program (VLMP) and the Maine Department of Environmental Protection (Maine DEP). The New Hampshire Volunteer Lake Assessment Program (VLAP) and the New Hampshire Lakes Lay Monitoring Program (LLMP) are the two primary volunteer groups collecting water quality data on lakes in New Hampshire. The LLMP is administered jointly by the UNH Center for Freshwater Biology (CFB) and UNH Cooperative Extension (UNHCE). Data from the VLAP is available through the New Hampshire Department of Environmental Services Environmental Monitoring Database (EMD).

Data acquisition and analysis followed protocols set forth in the Site Specific Project Plan (SSPP) in Appendix A. Data availability was variable between lakes, dating back to the year in which each lake was first sampled and ending with the most recent sampling event (Table 3.5).

Water quality data was combined into a common spreadsheet for each lake, and then sorted by date and station for Quality Assurance/Quality Control (QA/QC) in order to avoid duplicating data sets. All duplicates were removed. An initial analysis was conducted to determine median Total Phosphorus (TP) based on all samples regardless of multiple samples on the same day, or whether it was a ***grab*** or ***epilimnetic core (EC) sample***. Data were then separated by EC only and grab only. Using EC data only, values were calculated for all EC

Limiting- *The nutrient or condition in shortest supply usually referring to growth. Plants will grow until stopped by this limitation; for example, phosphorus is typically limiting in summer and temperature or light is limiting in fall or winter.*

Grab Sample- *Grab samples are taken just below the surface or with a depth sampler at a specified depth or location in the water column.*

Epilimnetic Core (EC)- *An EC is a sample of the epilimnion, or the top layer of water, and represents a vertical sample of the water column obtained by using flexible plastic tubing, usually ½ inch in diameter. The tubing is lowered to the desired depth, clamped at the water's surface, raised, and then the sample is decanted into a collection jug. This integrated sample is then tested for TP as well as other water quality parameters.*

Table 3.5: Description of available sampling data for Salmon Falls headwater lakes.

		Water Quality Data			Phosphorus Data		
Lake	Location	First Sampled	Last Sampled	# Years Sampled	First Sampled	Last Sampled	# Years Sampled
Great East Lake	ME/NH	1974	2008	30	1974	2008	17
Lovell Lake	NH	1979	2008	23	1979	2008	23
Lake Ivanhoe	NH	1981	2008	19	1981	2008	18
Horn Pond	ME/NH	1982	2008	11	1982	2008	7
Wilson Lake	ME	1977	2007	29	1977	2006	9

Source: *NH Environmental Monitoring Database (EMD), UNH Cooperative Extension (includes data from LLMP and CFB), Maine DEP, and PEARL.*

values in all years regardless of whether they were taken on the same day. A second analysis was conducted to calculate the median EC value using a mean of samples collected on the same day. Where limited EC data was available (Horn Pond), grab samples taken on the same day at multiple depths near the surface were used in conjunction with the EC samples. A historic analysis was performed, and included samples collected before 1999, while recent data was analyzed to include all samples from 1999 to the present. A seasonal analysis included only samples that were collected between May 15 and September 30.

Lakes with multiple basins were analyzed on a per basin basis, and statistical analysis was used to determine if there were significant differences between stations within the same lake. Greater scrutiny was needed to assess multiple basins on Great East Lake. The question of interest is whether the TP conditions are similar across all stations, and whether a lake-wide average could be used for management purposes. The data used for this analysis were EC samples taken from the same date at four stations, over 20 dates between 7/11/2002 and 9/23/2008. All six pair wise comparisons (paired by date sampled) between the 4 stations were evaluated using a paired t-test, or non-parametric alternative.

3.2.2 Water Quality Analysis

The water quality analysis for the SF headwater lakes required examination of several key parameters to look for water quality trends over time (increasing, decreasing, or unchanged). In addition to a comprehensive analysis of total phosphorus for each of the five lakes (described above), the other key parameters included secchi disk transparency (also referred to as water clarity), ***dissolved oxygen***, chlorophyll-a, and ***color***. A full summary of the water quality analysis for each lake is presented in the Lake Fact Sheets (Appendix F).

Dissolved Oxygen (DO)- *a measure of the amount of oxygen dissolved in the water. All living organisms, except for certain types of bacteria, need oxygen to survive. Organisms living in the water breathe the oxygen dissolved in the water. Low oxygen can directly kill or stress organisms such that they are not able to successfully reproduce or grow, and can release phosphorus from the bottom sediments.*

Color- *tells us about the influence that soils and geology, plants and trees, and land cover type in the watershed have on a lake. Color is measured by comparing a sample of the lake water to Standard Platinum Units (SPU). Lakes that are considered colored (>25 SPU) can have reduced transparency. This does not mean the lakes are more productive, the color simply interferes with transparency test.*

As discussed in Chapter 2, each of the five headwater lakes has unique physical characteristics that affect their chemistry and biology. These characteristics include the actual size of the lake measured from bank to bank around the perimeter (area); the amount of water in the lake (volume); the number of times each year that the entire volume of the lake is replaced (flushing rate); and the average depth. Table 3.6 shows the differences in these characteristics from lake to lake.

Table 3.6: Physical characteristics of Salmon Falls headwater lakes.

Lake	Lake Area (m^2)	Lake Volume (m^3)	Flushing Rate (yr^{-1})	Mean Depth (m)
Ivanhoe	275,186	992,000	0.90	3.6
Great East	6,906,800	75,589,500	0.30	10.9
Horn	801,300	3,155,000	8.20	3.9
Wilson	1,190,000	6,756,766	0.85	5.2
Lovell	2,173,000	8,623,000	0.70	4.0

Great East Lake is clearly the largest and deepest of the five lakes. Lake Ivanhoe, which is potentially "Impaired" according to NH water quality standards, is the smallest and shallowest lake. A small, shallow lake is more prone to plant and algal growth because sunlight can penetrate through the water column to the bottom where plants can easily establish themselves. Lake Ivanhoe's measured flushing rate is low (less than a full flush every year), and the lake does not have a large source of freshwater inflow other than overland runoff. Lake Ivanhoe is the only lake of the five that does not stratify. This means that water temperature and dissolved oxygen levels are relatively the same from the surface to depth. In contrast, Horn Pond flushes more than 8 times each year.

On average, large oligotrophic lakes flush approximately 1-1.5 times each year (PEARL, 2009). So, Horn Pond exceeds the average for lakes, while the others flush less than the average. The low flushing rates of the two upstream lakes (Great East and Wilson) provide a unique hydrological setting which may effectively keep phosphorus concentrations lower in Horn Pond than would be expected of a shallow lake with a high flushing rate (Dennis 2010).

Secchi Disk Transparency

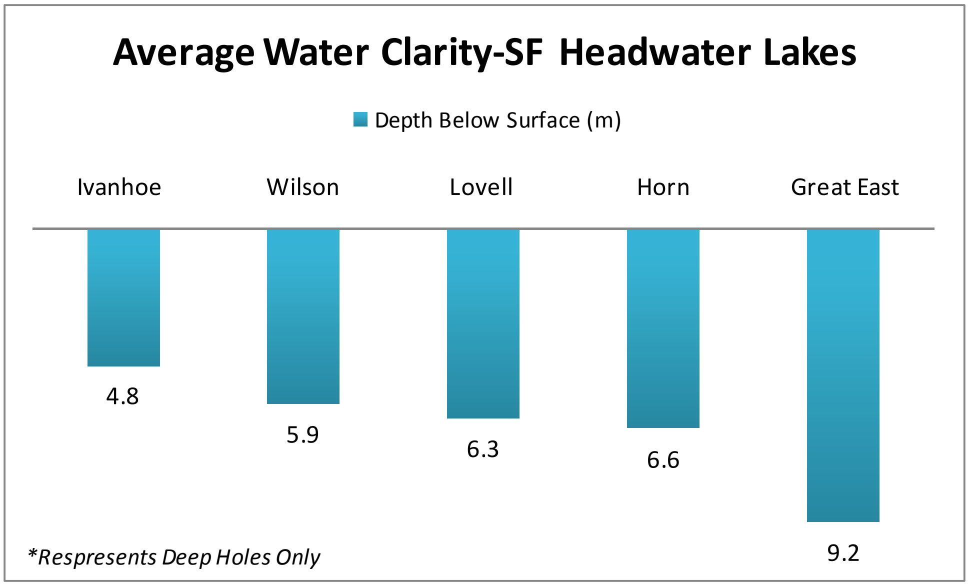


Figure 3.1: Mean water clarity for Salmon Falls headwater lakes.

Secchi disk transparency is one of the simplest techniques for tracking water quality of a lake over time. Trends in transparency over several decades are clues to how the lakes is responding to the environment. Major watershed changes may not be evident for several years after the land use change occurs (new development, land clearing, etc.). For this reason, it is important to continue these measurements on a bi-weekly basis through from spring through summer, especially at the deep holes (see monitoring recommendations, Section 6.3).

Transparency readings are reported in meters (m) where 1 meter is equivalent to 3.28 feet. Factors that reduce clarity include algae, zooplankton, watercolor and soil particles such as silt that are washed in from the watershed. Since algae have the greatest effect on clarity, measuring transparency indirectly measures the algal productivity. For the SF headwater lakes, average secchi disk transparencies ranged from a low of 4.8 m (Lake Ivanhoe) to a high of 9.2 m (Great East Lake) (Figure 3.1). Two of the five lakes (Lovell Lake and Wilson Lake) exhibit a slight decline in transparency over the period of record. The other three lakes have remained relatively the same or improved slightly.

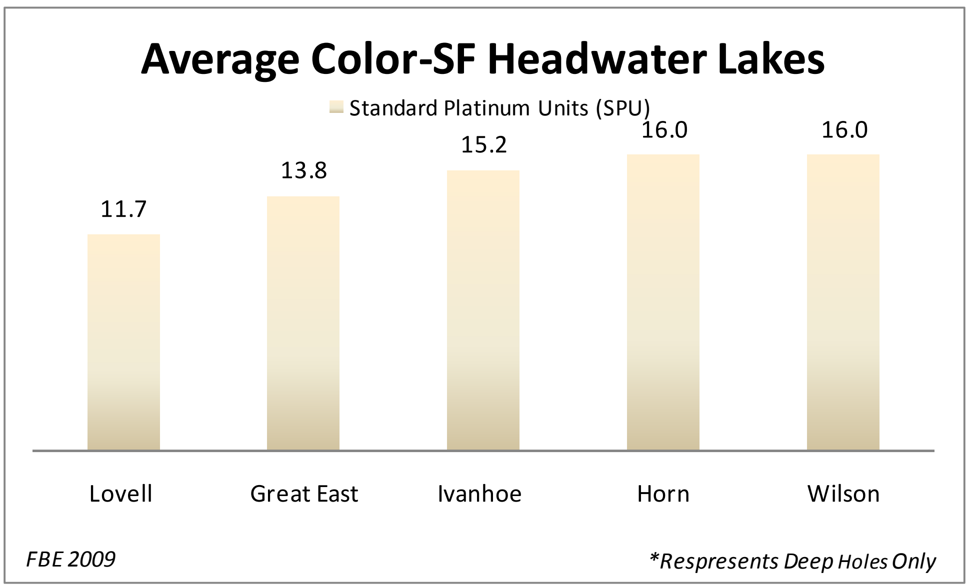


Figure 3.2: Mean water color of Salmon Falls headwater lakes.

Color

The amount of "color" in a lake refers to the concentration of natural dissolved organic acids which give the water a tea color. In Maine lakes, color varies from 0 to 250, with the average being 28 Standard Platinum Units (SPU). For the five SF headwater lakes, the average color ranges from approximately 12 (Ivanhoe) to 16 (Horn & Wilson). All five lakes are considered “non-colored”, which is one of the reasons that the water in the lakes appears relatively clear. Lake Ivanhoe, Horn Pond, and Great East Lake exhibited an increase in color over the period of record, while Wilson and Lovell both show a decrease (Figure 3.2).

Chlorophyll-a

As mentioned previously, Chlorophyll-a (Chl-a) is a measure of the green pigment found in plants, and is used to estimate algal biomass; the higher the Chl-a number, the higher the amount of algae in the lake. Since water clarity and algal biomass are intricately connected, we'd expect that the lakes with the lowest water clarity would also have the highest Chl-a values. Figure 3.3. demonstrates that the lakes with the best water clarity also have the lowest Chl-a. If we look at trends in Chl-a for all five lakes, it is Wilson and Lovell, the two lakes with the highest average Chl-a, that exhibit a trend of increasing Chl-a over the period of record. Note that Lake Ivanhoe (in NH) does not currently meet NH standards for Chl-a (< 3.3 ppb for Oligotrophic lakes).

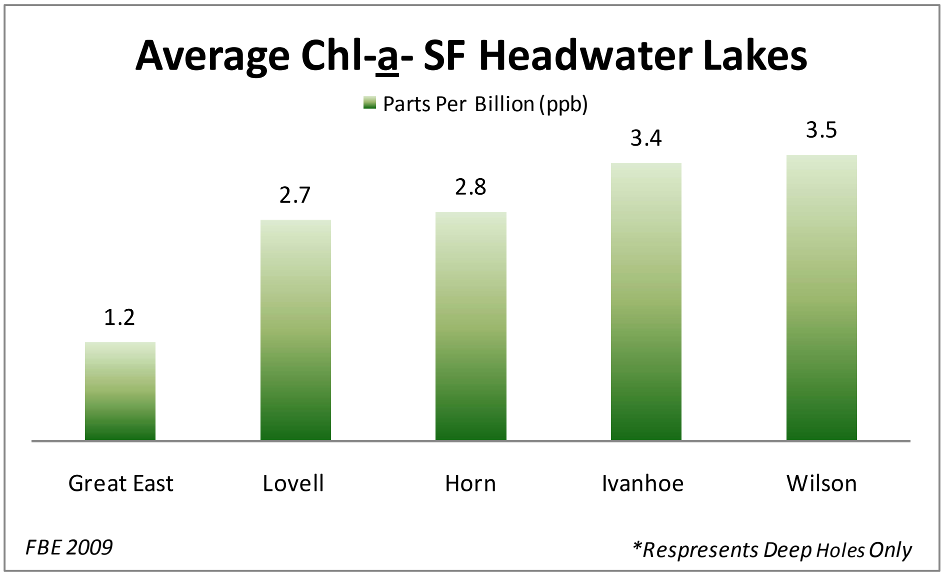


Figure 3.3: Mean chlorophyll-a for Salmon Falls headwater lakes.

Dissolved Oxygen (DO)

Organisms living in lakes breathe the oxygen dissolved in the water. Too little oxygen can severely affect aquatic communities, often reducing diversity and population sizes. Low oxygen can directly kill or stress organisms such that they are not able to successfully reproduce or grow. Dissolved oxygen (DO) less than 5 parts per million (ppm) can stress cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species.

Lakes that are productive (have lots of plant growth, especially algae) tend to have decreased oxygen levels in deep areas of the lake because decaying plant material sinks to the bottom of the lake, and uses up oxygen as it decomposes. Thermal ***stratification*** prohibits well oxygenated water at the surface from mixing with deeper water. The deep water of a productive lake can become anoxic, meaning there is less than 1ppm of dissolved oxygen in the water. Anoxia promotes the release of phosphorus from the sediments on the bottom of the lake, and can lead to excessive algal growth, especially for lakes that already have high levels of phosphorus.

***Stratification-** Refers to distinct layers of water in a lake differing in temperature and density. Deep lakes commonly stratify into three distinct layers: the epiliminion (upper), metalimnion (middle), and hypolimnion*

Closer examination of DO profiles for the five SF headwater lakes reveals that Wilson lake is exhibiting low levels of DO in deeper areas of the lake, and that the potential for phosphorus release from the sediments is high (Figure 3.4). Historical profiles for Great East Lake show little DO depletion at depth. The limited DO data available for Lovell Lake also indicates low DO at depth, while Horn Pond shows low to moderate DO depletion. Lake Ivanhoe is the exception because it is the shallowest lake, and does not stratify. Therefore, the amount of oxygen at the surface is relatively the same at the bottom. Regular DO monitoring is needed for the deep holes of all five lakes to determine how DO levels are changing over time, and to help quantify any internal phosphorus loading that may be occurring in these lakes.

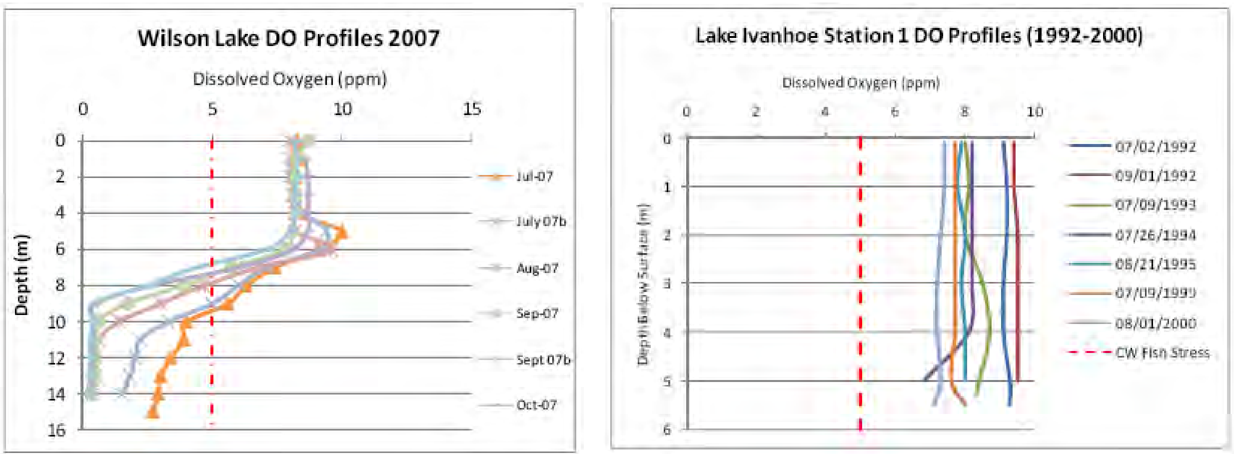


Figure 3.4: Contrasting dissolved oxygen profiles for two of the Salmon Falls headwater lakes.

Total Phosphorus (TP)

Phosphorus is what is known as a "limiting nutrient" in lakes. In a pristine setting, a lake receives inputs of phosphorus in the form of runoff from the watershed. This is because phosphorus is bound to tiny soil particles that flow into the lake as a result of erosion from rainfall and snowmelt. Phosphorus that enters lakes will either be taken up by organisms, settle to the bottom, or flow downstream. In most freshwater lake systems in the northeast, phosphorus is the limiting nutrient, a chemical necessary for algae growth, but available in quantities smaller than needed for increased growth and abundance. Increasing the limiting nutrient will increase algal populations until another nutrient is in short supply, and therefore becomes the new limiting nutrient. When excess phosphorus flows into the lake as a result of poor land management practices, phosphorus is no longer a limiting nutrient, and plants and algae will thrive. Over the long-term, these inputs can have dire consequences and lead to frequent blue/green algal blooms.

Average (median) TP was determined for each water quality monitoring station for all five lakes, and then further refined for the deep holes (since statistically significant differences were not found to occur between the deep hole and other monitoring stations on the same lake). Results of the phosphorus analysis are generally in line with the results of other water quality parameters (Figure 3.5).

Both recent (1999-present) and historic (pre-1999) data were examined to determine if recent TP values were different than the previous time period. Several of the lakes show increasing levels of TP over the period of record. Wilson Lake, Horn Pond and Great East Lake show significant increases (2-5 ppb) in the recent time period compared to the historic period. Further review of weather patterns, and development in the watershed would provide help determine if this is a real shift in trophic state, an episodic, weather driven change that will correct itself overtime, or a case of limited data. Lovell Lake (Station 2) and Lake Ivanhoe (Station 1) both exhibit a slight increase in TP over the period of record.

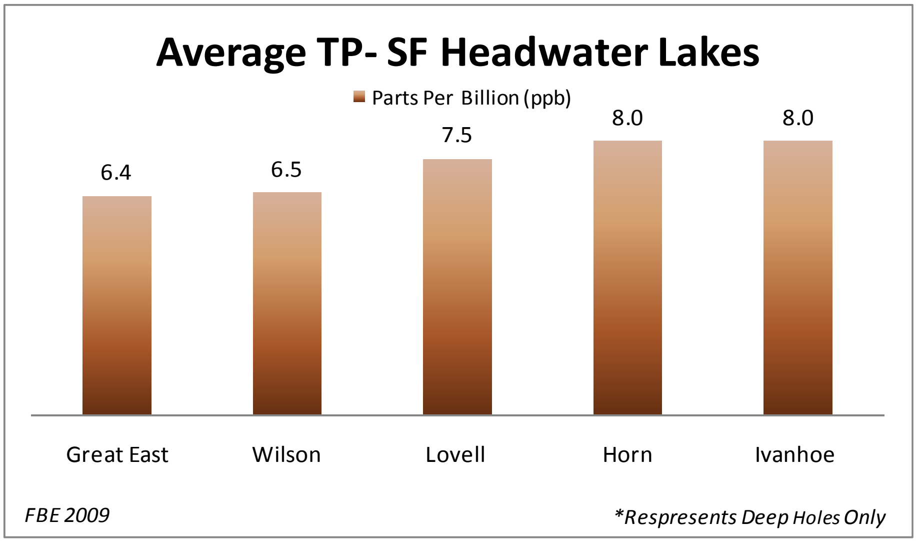


Figure 3.5: Median total phosphorus for Salmon Falls headwater

Horn Pond is currently considered "Potentially Non-supporting" according to NHDES water quality standards. Median TP for Horn Pond is close to NH's 8 ppb standard for oligotrophic lakes based on 7 years of epicore and epigrab samples collected during a specified period ending September 30th. A more robust set of epicore data is needed for Horn Pond to clearly define TP trends, and to assist NHDES with a final listing determination (supporting vs. non-supporting). Lakes with similar characteristics (shallow with a high flushing rate) typically have higher trophic states and exhibit higher Chl-a concentrations and lower secchi depths, suggesting that Horn Pond has a lower trophic state (better water quality) than would be expected of a lake of its type (Dennis 2010). Horn Pond receives 182 kg/yr of additional phosphorus from two ***indirect watersheds*** (Great East Lake accounts for 80% of the indirect load and Wilson Lake accounts for 20%). This represents one-third of the TP entering Horn Pond from the surrounding watershed. Great East Lake and Wilson Lake are deep, and have very low flushing rates, which allows P to settle out of the water column and onto the lake bottom, thereby filtering the water that flows into Horn Pond. If these upstream lakes were not there to effectively filter phosphorus from the water column, then the TP concentration in Horn Pond would be much higher (Dennis 2010). Internal recycling of phosphorus is not considered a factor that would increase TP concentrations in Horn Pond. This is because the sandy, granitic, low pH, soils in the watershed export dissolved aluminum to area lakes. The aluminum is deposited as aluminum hydroxide in the bottom sediments, effectively preventing phosphorus from being released from the sediments under anoxic (low oxygen) conditions (Dennis 2010).

Indirect Watershed– *The land area that drains to a waterbody that is immediately upstream of the study lake. Phosphorus delivered by indirect watersheds can be of particular concern, especially if the TP concentration and volume of water in the upstream lake is greater than the downstream lake.*

3.2.3 Assimilative Capacity Analysis & In-Lake Phosphorus Modeling

Assimilative Capacity- *The capability of a lake to resist the effects of landscape disturbance without water quality impairment. The Assimilative Capacity Analysis for the five Salmon Falls headwater lakes is based on each lake's ability to resist the effects of excess phosphorus from non-point source pollution in the watershed.*

Once the median water quality was determined for each of the five lakes, the total, reserve and remaining ***assimilative capacity*** for each waterbody was determined using procedures described in the Standard Operating Procedures for Assimilative Capacity Analysis for New Hampshire Waters (Table 3.7; NHDES 2008). Tier 2, or high quality waterbodies are described as having water quality in which one or more parameters is better than the water quality standard plus the reserve capacity (the reserve capacity is 10% of the total assimilative capacity). Tier 2 waters have some assimilative capacity remaining, whereas impaired and Tier 1 waters do not. The assimilative capacity analysis was conducted for total phosphorus.

Table 3.7: Results of the assimilative capacity analysis for Salmon Falls headwater lakes.

Lake	WQ Monitoring Station	Existing Median TP (ppb)	TP Water Quality Threshold (ppb)	Assimilative Capacity Threshold (ppb)	Remaining Assimilative Capacity (ppb)*	Results Assimilitave Capacity Analysis	Acceptable TP Increase (ppb)**	Impaired (Y/N)
Great East	1	6.4	8.0	7.2	0.8	Tier 2	0.8	No
Wilson	1	6.5	8.0	7.2	0.7	Tier 2	0.7	No
Ivanhoe	2	8.0	8.0	7.2	-0.8	Tier 1	0.0	No
Horn	1	8.0	8.0	7.2	-0.8	Tier 1	0.0	No
Lovell	2	7.5	8.0	7.2	-0.3	Tier 1	0.0	No

* Remaining Assimilative Capacity = (TP Threshold - Median TP) - (Reserve Capacity or 10% x TP Threshold).

** Wilson Lake is located in Maine, and therefore follows ME standards which allows for an increase of 1 ppb for TP.

For consistency and for sake of comparison, the NH methodology was applied to Wilson Lake, the only lake located entirely in Maine. Results of this analysis suggest that Great East Lake and Wilson Lake fall within the Tier 2 classification for High Quality Waters in New Hampshire, while Ivanhoe, Horn and Lovell Lake are Tier 1 waterbodies. Lovell Lake is currently on the cusp of a Tier 2 status, while Ivanhoe and Horn appear to be on the cusp of an Impaired status based on total phosphorus only.

This means that three Tier 1 lakes are within the 10% reserve remaining assimilative capacity. While Lovell Lake has a small amount of remaining capacity, Lake Ivanhoe and Horn Pond are at their threshold. This means that any new development within these watersheds may require phosphorus controls to prevent

Tier 2- *Better than the standard + reserve capacity.*

Tier 1- *Better than the standard but within the reserve capacity.*

Impaired- *Worse than the standard, no remaining assimilative capacity, and not within the reserve.*

additional phosphorus from entering these lakes, and that phosphorus controls are needed to address existing sources of phosphorus in the watershed if these lakes are going to meet Tier 2, or High Quality Water status in the future. A stated earlier, more TP data is needed for Horn Pond before a final use determination can be made by NHDES.

A second analysis was used to link watershed loading conditions with in-lake total phosphorus concentrations to predict the effect of existing watershed development on in-lake phosphorus concentrations. Referred to as total phosphorus retention modeling, the model estimates in-lake phosphorus concentrations based on physical and chemical lake characteristics including lake volume, watershed area, a precipitation runoff coefficient (which is unique to each lake) and estimated watershed phosphorus loading from STEPL (Section 2.5), as well as indirect loading calculations (for Horn Pond). Because of the imperfect nature of any model to predict processes within natural systems, the modeling compared six different in-lake phosphorus models including Vollenweider 1969; Chapra 1974; Dillon-Rigler 1976; Kirchner-Dillon 1975; Larsen-Mercier 1976; Jones-Bachman 1976; and Reckhow 1977).

Table 3.8: Results of the in-lake total phosphorus retention modeling.

Lake	STEPL Watershed TP Load (kg/yr)	Current Median TP (ppb)	Estimated In-Lake Concentration (ppb)	Diff. Between Actual & Estimated In-Lake Concentration (ppb)
Great East	625	6.4	7.3	0.9
Wilson	187	6.5	9.3	2.8
Ivanhoe	52	8.0	12.2	-4.2
Horn	273 *(91 direct + 182 indirect)*	8.0	7.7	-0.3
Lovell	281	7.5	8.6	1.1

These models are not used to set water quality goals, but instead as a tool to examine how phosphorus controls and future land use changes in the watershed will effect these lakes. These numbers are also compared to the results of the NH Assimilative Capacity Analysis (Table 3.7) to verify that the model outputs are close to actual in-lake conditions. Final modeling results for all six models were assessed to determine which model/ models were best suited to the individual lake. Final estimated in-lake phosphorus concentrations (Table 3.8) are based on either Reckhow (1977), or Jones-Bachman (1976). These results align well with the NH Assimilative Capacity Analysis methodology which shows that Lake Ivanhoe and Horn Pond have no remaining assimilative capacity, and that Great East Lake and Wilson Lake have remaining capacity to treat phosphorus. The large spread between the estimated in-lake concentration for Lake Ivanhoe compared with the current measured in-lake phosphorus concentration may indicate that existing land uses in the watershed may eventually catch up, causing a significant decline in water quality unless dealt with promptly. Lakes may not exhibit the effects of large landscape changes until several years after a disturbance occurs (Bouchard 2009). As mentioned previously, Lovell Lake is on the cusp of the Tier 1 and Tier 2 classification, meaning it is within its reserve assimilative capacity. Small improvements in the watershed to reduce soil and sediment runoff into Lovell Lake, and planned development which reduces phosphorus inputs will help Lovell Lake achieve its Tier 2 (High Quality Waters) status.

3.2.4 Establishing Water Quality Goals

Wilson Lake is the only lake of the three located entirely within the state of Maine. Photo: Jeanne Achille, AWWA

The SF headwater lakes Water Quality Threshold Committee was developed to review the results of the water quality data analysis, and to help guide the goal setting process. The committee is composed of qualified water quality experts and watershed managers from both Maine and New Hampshire including: the Acton Wakefield Watersheds Alliance, Maine DEP, NHDES, and representatives of the University of New Hampshire LLMP Center for Freshwater Biology, and facilitated by FB Environmental. The committee met in person for two separate meetings in February and April of 2009 to discuss goal setting. The committee was faced with two major challenges throughout the threshold setting process. First, several of the lakes do not meet the criteria for High Quality Waters under New Hampshire's revised water quality standards. This is because under previous draft water quality standards these lakes were considered Tier 2, but are now considered Tier 1 under the revised water quality standards. Secondly, two of the waterbodies (Great East Lake and Horn Pond) fall within the jurisdiction of both the State of Maine and New Hampshire. As described above, each state has different criteria and standards for assessing water quality, and different management strategies for addressing potential declines.

Discussions among the water quality committee focused heavily on how to harmonize Maine and New Hampshire water quality standards so that recommendations in the management plan could be regionalized across towns and states. Since acceptable increases in TP for the two border lakes (Great East and Horn Pond) differ between states (Table 3.9), the most stringent standards apply. In this case, it is the NH water quality standards that are more stringent, and therefore were used to set water quality thresholds for all but Wilson Lake, which is the only lake located entirely within Maine. Final water quality threshold recommendations combine information presented in Tables 3.7 and 3.9, and Figure 3.6.

Table 3.9: Acceptable increases in phosphorus concentrations for the Salmon Falls headwater lakes by state.

Lake	ME Water Quality Category *	ME Acceptable Increase	NH Water Quality Cateory	NH Acceptable Increase
Ivanhoe	N/A	N/A	Oligotrophic	0.0
Lovell	N/A	N/A	Oligotrophic	0.3
Great East	Good	1	Oligotrophic	0.8
Horn	Good	1	Oligotrophic	0.0
Wilson	Good	1	N/A	N/A

**"Good" refers to one of five categories of water quality for Maine lakes that are generally clear with relatively low algae and phosphorus levels. Secchi disk transparency ranges from 20-30 ft., Chl-a from 2-4 ppb, and TP from 5-10 ppb.*

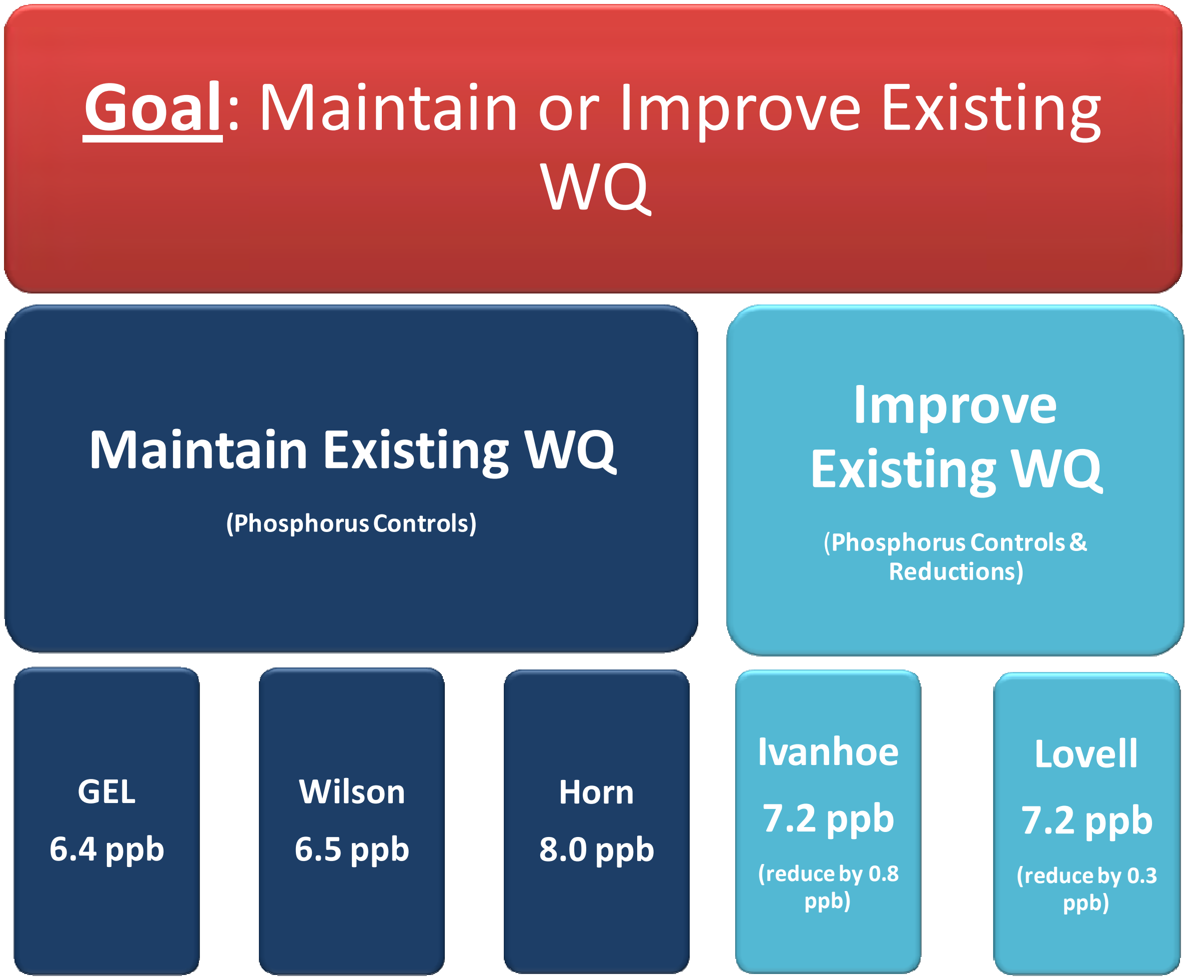


Figure 3.6: Final water quality recommendations for the Salmon Falls headwater lakes.

While only two of the five lakes (Ivanhoe and Lovell) are candidates for watershed-wide phosphorus reductions, all five lakes are candidates for phosphorus control standards, or ordinances designed to limit future phosphorus inputs from new development. The Buildout Analysis (Appendix E) clearly shows how local phosphorus control standards can help negate the impacts of future development in these watersheds. More data is needed for Horn Pond in order to clearly establish whether this lake is non-supporting according to NH water quality standards. For now, the recommended action is to maintain the existing water quality.

In order to achieve the water quality goals set forth in this plan, the two towns will need to work together to set aggressive load reduction regulations for future development, and focus efforts to implement BMPs to address existing sources of phosphorus throughout the watershed. The towns of Acton and Wakefield should set any land use standard they think is appropriate for their lakes as long as these standards meet state minimums. For the two bi-state lakes, the more conservative standard (more protective of water quality) applies.

These recommendations should be viewed as long-term management strategies for each lake, with the intention that five lake associations, two towns and two states can work together to limit future phosphorus increases to these waterbodies. AWWA will continue its efforts to bring these groups to the table to solve problems, and achieve long-term goals to protect these lakes.

3.3 Master Plan Review & Local Ordinance Review

Municipal Master (or Comprehensive) Plans are important documents that are often referred to as "road maps" for community growth and development. They provide a sense of a community's overall character and describe how, why, where, when and at what pace development will occur. Ideally, Master Plans derive from a meaningful and broadly participatory public process that creates an overall community vision.

Maine and New Hampshire both have legislation that requires communities to develop and periodically update municipal Master Plans (Maine refers to these documents as Comprehensive Plans). Maine's Comprehensive Plan Review Criteria Rule (Chapter 208) establishes the criteria used by the State Planning Office to review community comprehensive plans for consistency with the goals and guidelines of the Growth Management Act. New Hampshire's RSA 674 (Local Land Use Planning and Regulatory Powers) establishes the components of community Master Plans that will: "set down as clearly and practically as possible the best and most appropriate future development of the area under the jurisdiction of the planning board (NH Title LXIV, Chapter 674.2)."

The legislation requiring Master or Comprehensive Plans for both states explicitly expresses a concern for natural resource protection and preservation, among many other important community growth and development considerations. The Towns of Wakefield, New Hampshire and Acton, Maine have each developed their own plans that broadly address environmental concerns and more specifically refer to water resource protection. Wakefield's Master Plan identifies the importance of "preventing severe run-off and erosion (and) contamination of wetlands and ground water resources (2001), while Acton's Comprehensive Plan also addresses water quality concerns in several places throughout the document. For example, Acton's Comprehensive Plan notes that "areas of sandy, steeply sloped soils are quite vulnerable to erosion and are a concern from a water quality standpoint" and indentifies the importance of insuring that "erosion and storm water control measures are reviewed prior to approval of large development proposals and also inspected during the construction phase" in an effort to protect water resources (2005).

Both communities also have local land use regulations that provide some specific measures of protection to the SF headwater lakes water resources. A review of municipal land use ordinances for Acton and Wakefield was conducted to provide recommendations for how these documents could be better aligned with development practices that are more protective of local water quality. Acton's most recent Zoning Ordinance, Subdivision Regulations and Road Ordinance were included in the review as were Wakefield's most recent Zoning Ordinance, Subdivision Regulations and Site Plan Regulations. The reviews were based on model development principles created by the Center for Watershed Protection (CWP, 1998). These principles promote the reduction of IC, conservation of natural areas, and prevention of stormwater pollution while simultaneously preserving and enhancing the quality of life in local communities. The model principles are grouped into the following three primary categories as a means of facilitating comparisons with other municipal land use ordinances:

- Transportation infrastructure
- Residential and commercial development

- Open spaces and natural areas

The assessment methodology was used to measure and compare local land use regulations for Acton and Wakefield against CWP's model development principles, which represent an idealized development scenario. The CWP methodology assigns a relative score for "planning benchmarks," each of which assesses a single site design practice depending on how closely local development regulations conform to the ideal model ordinance. In some cases, determining scores for the ordinances was subject to interpretation since specific ordinance language could not be directly related to the model development principles. Additionally, while not all of the principles are entirely applicable to the rural nature of the SF headwater lakes region, they still provide a useful means for identifying opportunities for improving municipal land use regulations.

The highest possible overall score for the assessment is 95 and the CWP generally recommends reforming local development rules if the score is less than 80% of the total (Table 3.9). The overall scores for Acton and Wakefield are 71 and 68 (75% and 68% of the total), respectively, suggesting there are considerable opportunities for improvement by both towns (Table 3.10). Appendix D provides a more detailed discussion of the scoring results in the full Municipal Ordinance Review Report.

An additional consideration not specifically addressed in the Master Plan and Ordinance Review but of particular importance to maintaining and protecting the SF headwater lakes exceptional water quality is the establishment of phosphorus control regulations. Phosphorus is generally the essential limiting nutrient for plant growth in freshwater systems. In excessive amounts, it can result in algal growth and corresponding decreases in water quality. The most significant sources of phosphorus in lake watersheds are often closely related to development. As more undeveloped land in a watershed is converted to developed uses (e.g., residential, commercial, recreational, etc.), the likelihood that phosphorus will be transported by stormwater runoff to nearby surface waters increases.

Table 3.10: Center for Watershed Protection Community Scoring Guidelines.

SCORING (A total of 95 points are available):	
Your Community's Score	
90- 100 %	Congratulations! Your community is a real leader in protecting streams, lakes, and estuaries. Keep up the good work.
80 - 89 %	Your local development rules are pretty good, but could use some tweaking in some areas.
79 - 70 %	Significant opportunities exist to improve your development rules. Consider creating a site planning roundtable.
60 - 69 %	Development rules are inadequate to protect your local aquatic resources. A site planning roundtable would be very useful.
less than 60 %	Your development rules definitely are not environmentally friendly. Serious reform of the development rules is needed.

Table 3.11: Summary of Codes and Ordinance Worksheet scores for Acton and Wakefield.

HABITAT TYPE	CWP Maximum	***Acton's Score***	Adequate	Needs Improvement	***Wakefield's Score***	Adequate	Needs Improvement
Transportation Infrastructure	35	21		√	17		√
Residential & Commercial Development	36	26		√	30		√
Open Spaces & Natural Areas	24	24	√		21		√
Totals:	**95**	**71**	**75%** ←	**% Total**	**68**	**72%** ←	**% Total**

Fortunately, phosphorus concentrations in the SF headwater lakes have not reached the critical level at which excessive algal growth occurs. However, three of the five lakes are close to a threshold at which water quality conditions could gradually deteriorate – particularly given the desirability of the area as a residential and recreational destination. Therefore, in addition to the recommendations in the Master Plan and Ordinance Review (almost all of which will help to decrease phosphorus runoff), the towns of Wakefield and Acton should also consider establishing phosphorus control regulations to mitigate against the potential adverse effects from development. These regulations could include (but are not limited to) the following:

- A watershed or region - wide P control ordinance for all new development.
- Reduction or removal of grandfathering (for both subdivisions & shoreland zone).
- Ordinance revisions to encourage cluster development & open space.
- Ordinance revisions to require Low Impact Development principles with individual building permits.
- Increasing fines for non - compliance, especially in the shoreland zone.
- Prohibiting the use of phosphorus lawn fertilizer unless a soil test determines it is needed.
- Establishing a septic system maintenance tracking program to identify inadequate or failing systems.
- Prohibiting the use of phosphate-based detergents.

Numerous communities throughout northern New England have established phosphorus control ordinances to protect lake watersheds. In particular, many Maine communities have adopted the practices developed in *Volume II: Phosphorus Control in Lake Watershed: A Technical Guide to Evaluating New Development* (MEDEP 2008), which addresses long-term phosphorus loadings to lakes by setting standards to limit phosphorus contributions from new developments, and outlines guidelines to meet these standards. This document could prove to be a very useful guide for the towns of Wakefield and Acton should they decide to establish phosphorus control regulations.

3.4 Future Land Use Projections: Build Out Analysis

A buildout analysis was conducted by FB Environmental for the SF headwater lakes watersheds (Appendix E). The analysis combined projected population estimates, current zoning restrictions, and a host of additional development constraints (conservation lands, steep slopes, wetlands, existing buildings, soils with low development suitability, unbuildable parcels) in order to determine the extent of buildable area in the watershed. Buildable land covers 48% (8,055 acres) of the AWWA watersheds.

Based on current growth rates and municipal zoning regulations in the towns of Wakefield and Acton, full buildout within the watersheds of the target AWWA lakes is projected to occur by the year 2054, at which time the number of buildings in the watersheds would potentially increase from an estimated 1,317 to 4,239. Nearly 78% (2,274 buildings) of the new development would take place in Wakefield (Figure 3.7). Full 'Buildout' refers to the time and circumstances whereby, based on a set of restrictions (e.g. environmental constraints and current zoning), no more building growth may occur, or the point at which lots have been subdivided to the minimum size allowed and there is no more 'developable' land. At 30% buildout, it's anticipated that there will be a total of 876 new parcels developed, with the greatest number of units being build in the Great East Lake watershed (482 new units) and the Lovell Lake watershed (229 new units).

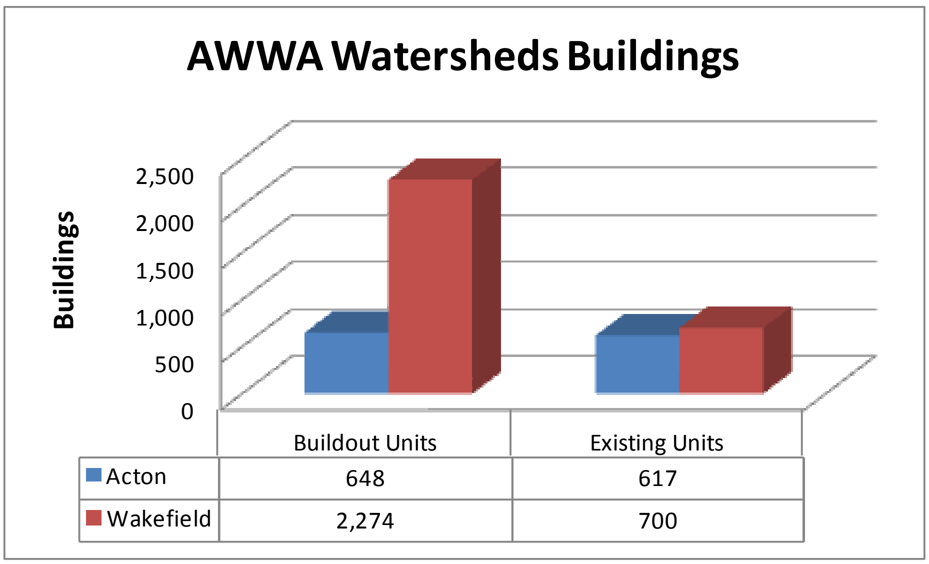


Figure 3.7: Existing and projected buildout units in Acton and Wakefield.

Results of this analysis reinforce the concept of comprehensive planning at the watershed scale in order to address future development and its effect on the water quality of the region. Projected phosphorus estimates based on the buildout analysis and using current zoning was calculated at 30% buildout, which is estimated to occur in the year 2030 based on current growth rates. Phosphorus loading from this new development without phosphorus reduction measures in place is estimated to contribute an additional 86 kg (190 lbs) of phosphorus/ year to the target AWWA waterbodies. With phosphorus controls in place (including required P management plans for all new development watershed-wide), this load would be reduced to just 3 kg more P/year.

FLASH FORWARD:
Target Salmon Falls Headwater Lake Watersheds

- ***4,239 new buildings***
- ***9,000 more people***
- ***Residential water use will increase by 500 million gallons/ year***
- ***Residential energy use will increase by >400 million BTU's/year***

3.5 Shoreline Survey Assessment

Shoreline Survey Assessments aim to identify potential pollution problems associated with stormwater runoff from properties in the immediate shoreline area. In the summer of 2008, Shoreline Survey Assessments were conducted for Great East Lake, Lovell Lake, Horn Pond, Wilson Lake, and Lake Ivanhoe by representatives from FB Environmental, NHDES, and AWWA. Surveyors assessed each lake shoreline by boat, from approximately 50 feet off shore. For all lots with dwellings, surveyors estimated both the distance between the structure and the waterline and the overall impact of the property on the water quality of the lake. Impact assessments were made by estimating both the amount of exposed soil and the width of vegetated buffers between the property and the water. Generally, shoreline properties with bare soil and inadequate vegetative buffers will have a higher impact on water quality. The impact of public areas without dwellings was also assessed. Survey findings for each lake are discussed below.

GREAT EAST LAKE


Photo: L. Schier

A majority of the shoreline development on Great East Lake consists of medium density residential (77%) with some high density development in the main basin (Figure 3.8). Approximately 8% of the shoreline is undeveloped. High density residential development accounts for 14% of all shoreline development along GEL. These lots are small with multiple rows of houses visible from the water. Overall, 64% of the structures on Great East Lake are located within 50’ of the shoreline. Only 28% of structures are set back 50’ to 100’ and approximately 8% have setbacks greater than 100’. In general, the houses on shoreline of the main basin have much smaller setbacks on average than those on the eastern basins, which have average setbacks of 50’ to 100’ from the shoreline.

Properties with shorter setbacks generally have a greater impact on water quality due to the lack of room for an adequate vegetated buffer. Vegetated buffers function to slow, absorb and filter stormwater runoff from land before it reaches the lake. On some lots, bare soil that could potentially be carried by runoff was noted, which contributed to a higher impact rating. On Great East Lake, 45% of surveyed properties were rated as high impact, 42% were rated as medium impact and 13% were assessed as having low impact. The main basin has a much greater frequency of high impact lots than the eastern basins (51% versus 31%) which correlates with the increased density along the shoreline.

Some public and private shoreline lots without structures were also examined for potential impact. A rope swing area adjacent to the canal dam was noted as a potential hotspot due to large amounts of exposed and loose soil on a sloped area. Extensive use of this public area could result in increased erosion and runoff, which could increase siltation and nutrients in the lake. All undeveloped shoreline parcels were rated as low impact.

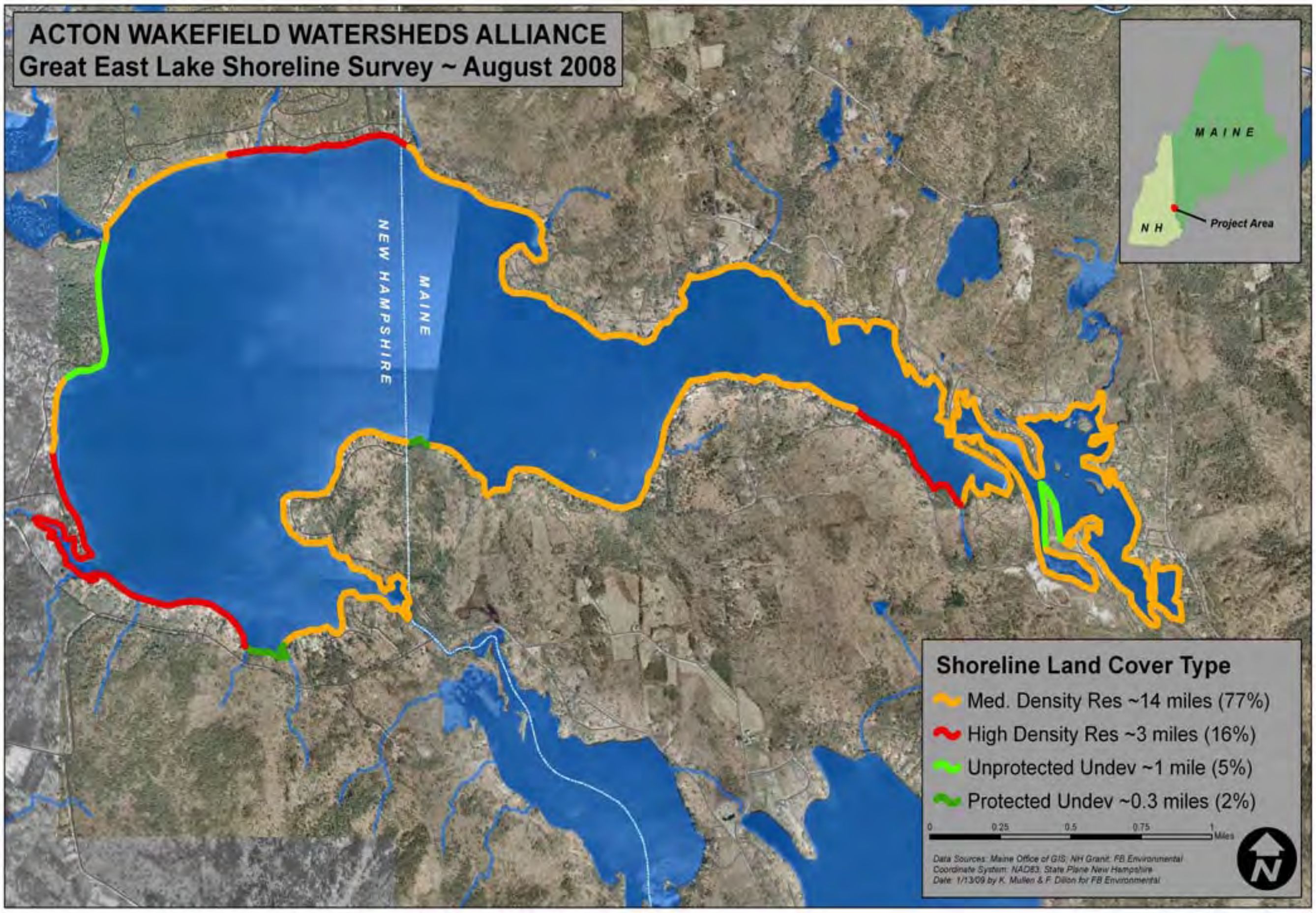


Figure 3.8: Great East Lake shoreline survey results.

LOVELL LAKE

The majority of development along the shoreline of Lovell Lake consists of low density residential (87%). High density development, consisting of many small houses and cabins clustered on the shore, is located along only 0.4 miles of the 8.4 mile lake perimeter. The islands in the west end of the lake are largely undeveloped (Figure 3.9). Of the 250 residences noted on the shore, 68% are located within 50' of the shoreline and only 14% have setbacks greater than 100'.

Due mostly to the large percentage of structures within 50' of the lake, about 46% of lots were assessed as having high impact. Medium impact lots were equally as frequent (46%) making the number of low impact lots minimal (7%). Although the Lovell Lake has large areas of natural buffers, many shorefront lots are still lacking adequate vegetated buffers, as indicated by the percentage of lots rated as high impact. On 23 lots, paved driveways between the structure and the shoreline were noted. On these properties, the estimated setback distance included the paved area, which may have increased the impact rating if loose soil or a lack of buffer was evident on the road sides.

Notable areas with a high potential water quality impact include Route 109 and the area of high density development on the northern shoreline (Figure 3.9). Route 109 is sited extremely close to the lake and offers very little opportunity for diverting and infiltrating stormwater. With heavy traffic throughout the summer months, this site has the potential to contribute high inputs of heavy metals and gasoline as well as sediment and nutrients to the lake. A small amount of conserved and/or undeveloped shorefront was also observed, along the lake's eastern shore and the two islands.

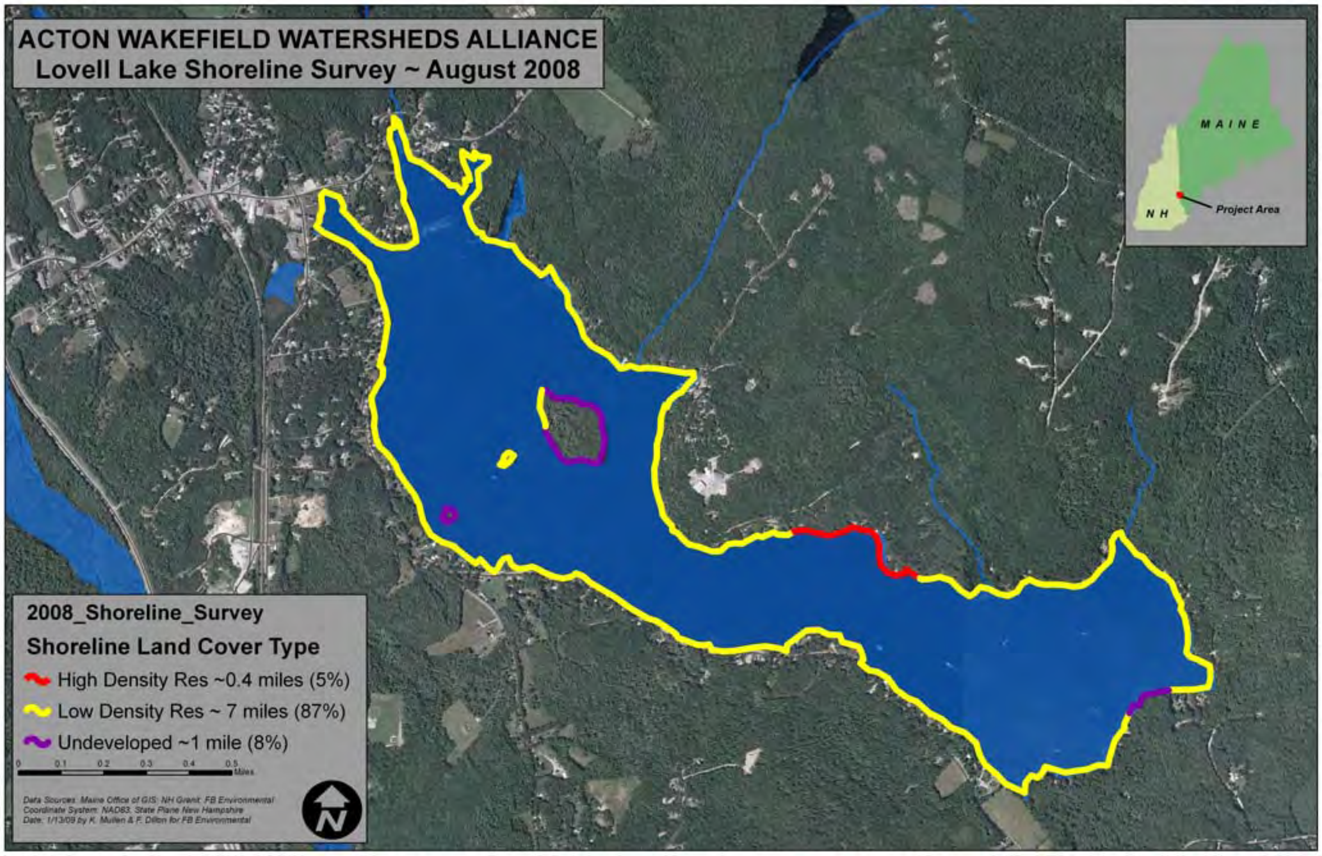


Figure 3.9: Lovell Lake shoreline survey results.

HORN POND

The shoreline of Horn Pond is the least developed of the five target SF headwater lakes, with 44% undeveloped land (Figure 3.10), and 71 dwellings observed. A majority of the developed land along Horn Pond is low density residential (51%).

Approximately 70% of structures along Horn Pond's shoreline are located within 50' of the waterline, with 20% set back 50' to 100', and the remaining 10% of structures set back greater than 100'. Despite the high percentage of low density residential and undeveloped shoreline lots, nearly 43% of Horn Pond's shoreline properties were rated as having a high impact on lake water quality, due primarily to short setback distances. Approximately 47% of the shoreline properties were rated as medium impact, indicating that vegetative buffers on these properties can be augmented and that most of the soil is stable. The remaining 10% of the properties were rated as low impact.

An additional non-residential high impact property was noted along New Bridge Road. This site is used as a public recreation area in the summer months. High pedestrian traffic, combined with steep road shoulders and bare soil, has resulted in increasing erosion and decreasing stability at this site. The remaining non-residential areas along Horn Pond are undeveloped.

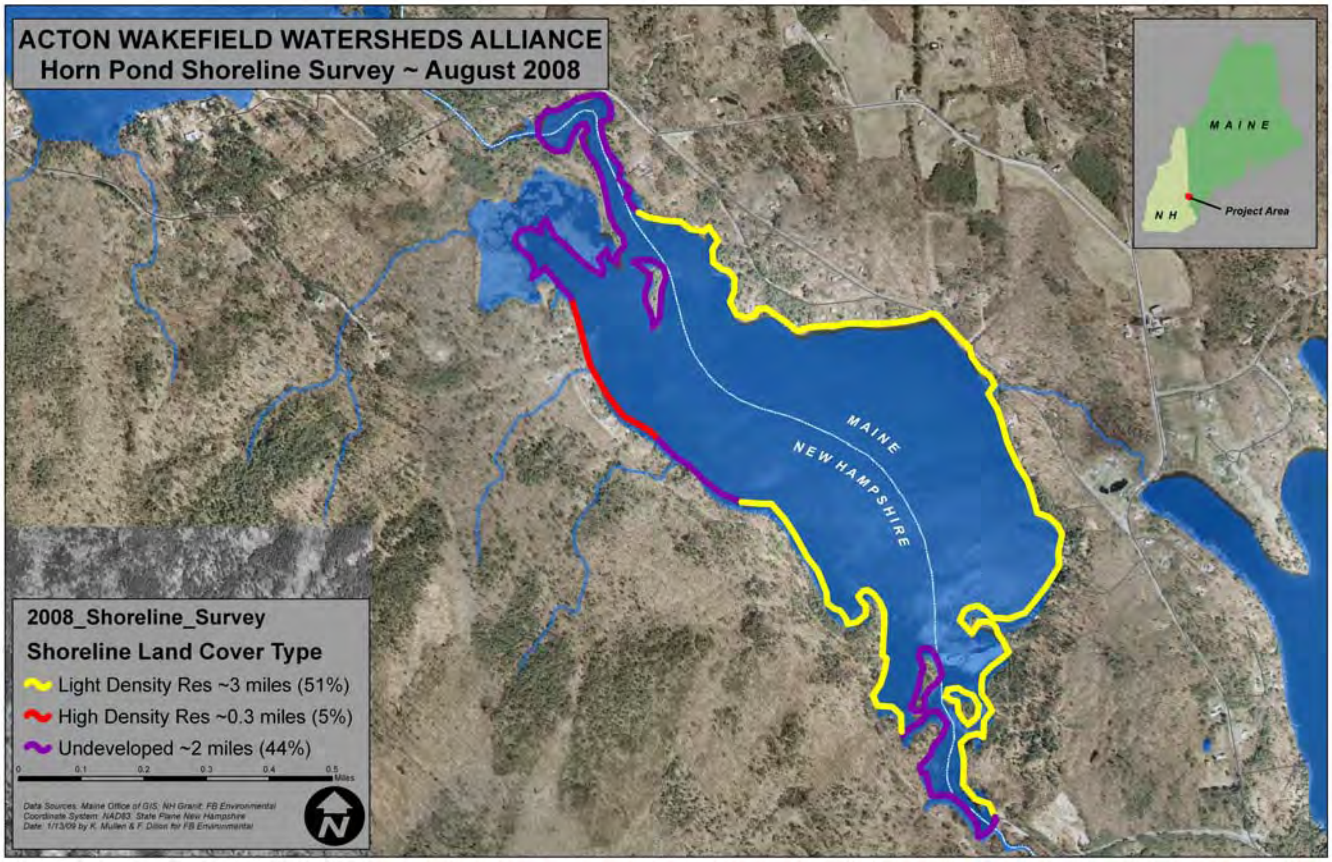


Figure 3.10: Horn Pond shoreline survey results.

WILSON LAKE

Like Lovell Lake, a majority of the shoreline development along Wilson Lake, primarily along the western shore, consists of low density residential (63%). The remaining properties (27%), along the eastern shore, are high density residential development, frequently with setbacks of less than 50' from waterline (Figure 3.11). Overall, 70% of residences are located within 50' of Wilson Lake's shoreline, 25% are set back 50' to 100' and only 5% of the structures are set back greater than 100'.

High density development along Wilson Lake was generally noted as having setbacks of 50' or less, and most were identified as high impact sites. High and medium impact lots were the most prevalent ratings at 48% and 45%, respectively, meaning that low density residential lots were also frequently ranked as high or medium impact. The remaining 7% of properties were rated as low impact.

The only non-residential area noted is used as the public boat ramp. There were no undeveloped or conserved areas observed along Wilson Lake's shoreline.

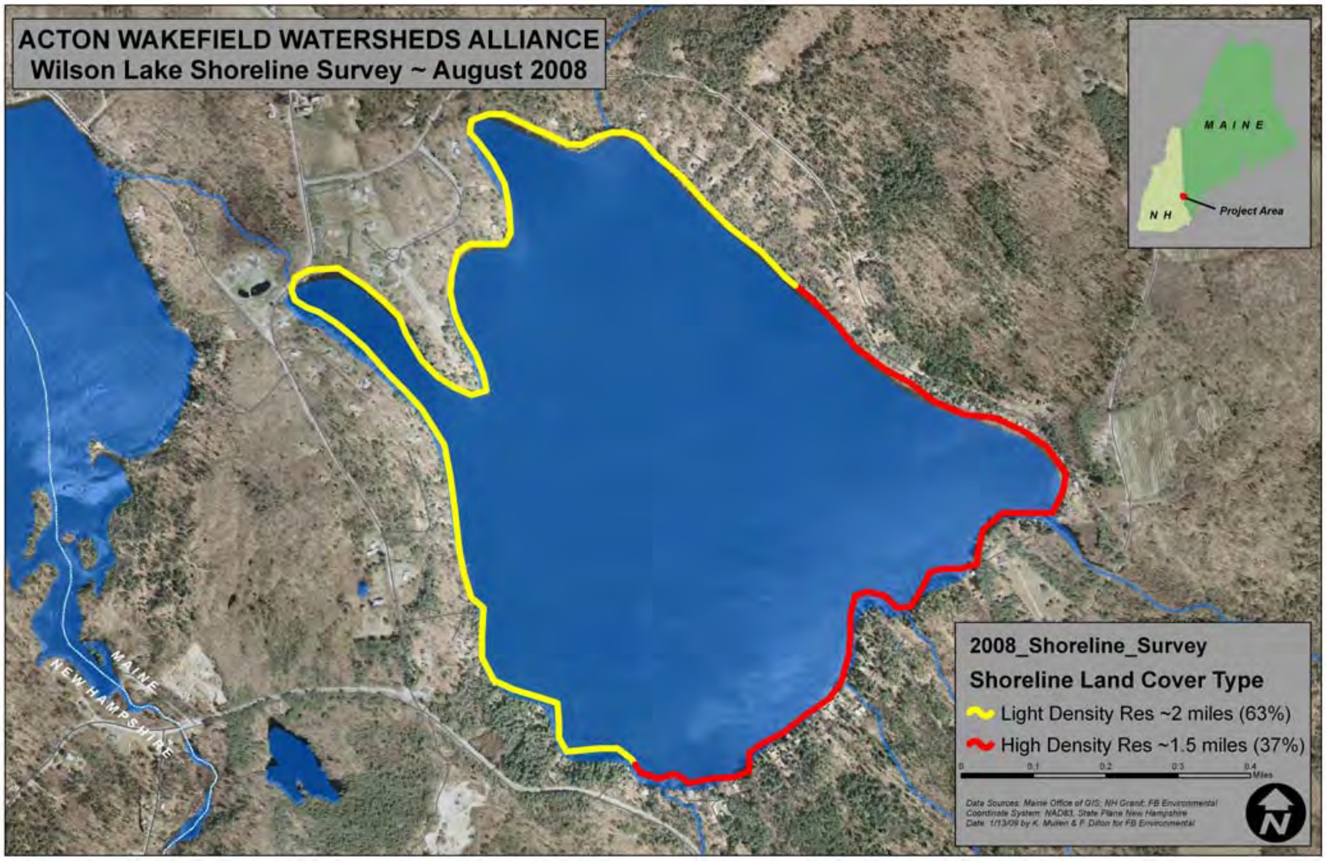


Figure 3.11: Wilson Lake shoreline survey results.

LAKE IVANHOE

With a perimeter of less than 2.5 miles, Lake Ivanhoe has 73 residences, 66% of which are low density residential development. High density development makes up 26% of the shoreline and is dispersed in short segments around the perimeter (Figure 3.12). Nearly 88% of structures are located within 50' of the waterline, 12 are set back 50' to 100' and no structures were set back greater than 100'.

Signs of erosion were noted near the Lake Ivanhoe boat launch.

Due to the close proximity of structures to Lake Ivanhoe's waterline, the majority of lots (70%) were rated as high impact. Many lots had inadequate buffers and large tracts of bare soil. Much of the shorefront was also sandy and steeply sloped which can lead to increased erosion and sedimentation in the lake. Only 4% of the lots were rated as low impact, and 26% were rated as medium impact.

The only undeveloped land was an island in the lake, and the conservation status was unknown. Additionally, the boat ramp property at the eastern end of the lake showed signs of erosion.

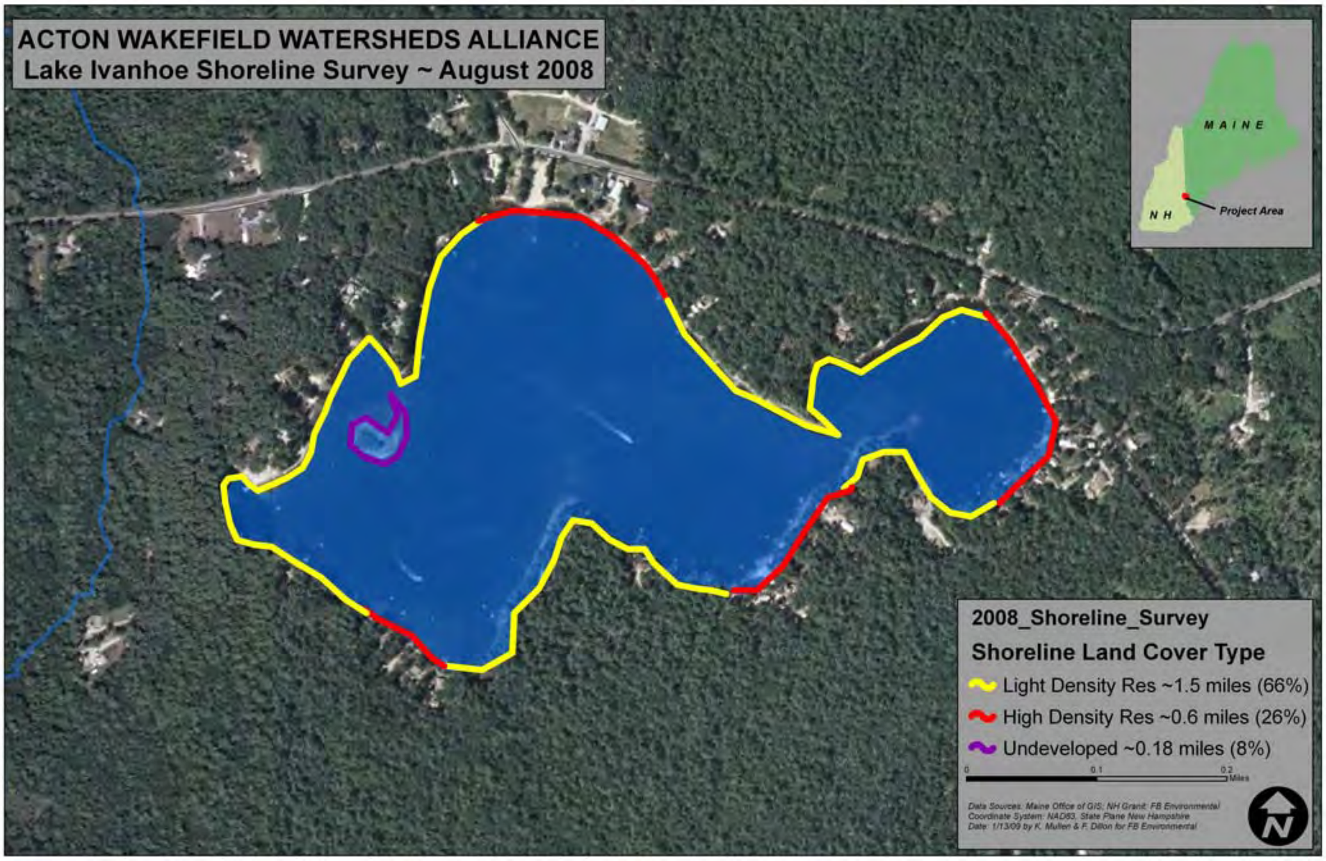


Figure 3.12: Lake Ivanhoe shoreline survey results.

4. Management Plan Rationale and Approach

4.1 Goals for Long Term Protection

The ultimate aim of the Salmon Falls Headwater Lakes WMP is to improve watershed conditions sufficiently to maintain current levels of water quality. The underlying premise supporting this ambitious effort is that existing and new development do not have to cause damage to watershed health, and that citizens, businesses, government, and other stakeholder groups can be responsible stewards of the SF headwater lakes watershed. The broad goals needed to maintain current phosphorus levels in the lakes include:

- ***Land Protection:*** Enhance current efforts in the watershed to protect high value habitat and critical areas.
- ***Improvements to Physical Habitat:*** Restore aquatic and lakeshore habitat conditions in support of key ecological functions including increased productivity, diversity and distribution of native fish and macroinvertebrate communities throughout the SF headwater lakes watersheds.

The objectives following from these goals are indicated in the Action Plan (Section 5.4). Achieving the goals and objectives for future implementation work in the SF headwater lakes will require a comprehensive and integrated set of activities as identified below.

4.2 Non-structural Restoration Rationale

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, expanded 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 Best Management Practices (BMPs):

- Planning, design and construction that minimizes or eliminates adverse stormwater impacts;
- Good housekeeping measures and education and training to promote awareness regarding the first component.

In watersheds with future development potential, it is critical for municipal staff and Boards to develop and enforce stormwater management criteria to prevent any increase in pollutant loadings that may offset reduced loads as a result of implementing watershed management plans. Zoning in the SF headwater lake watersheds presents considerable opportunity for continued development (see Build Out Analysis, Appendix E), and by extension increased threats to aquatic habitat.

In watersheds with significant development potential, the Center for Watershed Protection identifies "requiring stormwater treatment for development projects" as the single greatest mechanism for enhanced stormwater management over the long-term. Additionally, a recent publication by American Rivers identifies local land use planning and zoning ordinances as the most critical components of watershed protection despite federal Clean Water Act requirements (American Rivers, 2007). Seven guidelines outlined in the American Rivers document as vital steps toward local water policy innovation are as follows:

1. Review current zoning ordinance for regulatory barriers and quick improvements
2. Set performance based standards
3. Take additional measures to reduce impervious surfaces
4. Promote the use of a few specific Low Impact Development (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

4.3 Structural Restoration Rationale

AWWA and its stakeholders documented 491 sites that deliver an estimated 92 kg (203 lbs) of phosphorus per year to the lakes from specific sites in five watershed surveys. Consequently, structural BMPs are a necessary and important component of helping to improve and protect the water quality of these lakes that form the headwaters of the Salmon Falls River. The best method for treating these sites is to:

- Address the highest priority sites with an emphasis on sites with low-cost fixes.
- Work with landowners to get commitments for <u>treating and maintaining</u> sites.
- Work with experienced professionals on sites that require a high technical level of knowledge (engineering) to install, and ensure proper functioning of the BMP.
- Measure the pollutant load reduction for each BMP installed.

These basic criteria will help guide the proper installation of BMPs in the watershed. AWWA has a proven track record of proper installation of BMPs throughout the watershed.

4.4 Addressing Current and Future Pollutant Sources

Current pollutant sources as identified in the five watershed surveys indicate that a large amount of phosphorus is delivered annually to the project lakes. While there are undoubtedly other sources of phosphorus that are affecting the lakes, this is the "known" quantity of pollutant loading. It is important to mention that the model used for this Plan, STEPL (Section 2.5), models pollutant loads in a general sense while the watershed surveys allow for more specific pollutant load estimating. The following table (Table 4.1) represents the sites identified in the watershed surveys and combines the estimated future loads calculated as part of the watershed buildout analysis utilized for this plan.

Table 4.1: Estimated future P loads for SF headwater lakes subwatersheds.

Lake	Current: KG P per year Exported (WS survey)	Future: Loading Est. per year (30% buildout)	Total KG per year of P
Great East	40	47	87
Horn	4	3	7
Ivanhoe	16	6	22
Lovell	22	23	45
Wilson	10	7	17
TOTALS	**92**	**86**	**178**

As discussed in Section 3.4, the 86 kg represented in the in the future load estimate is derived from the number of new buildings projected in these watersheds in the next 11-20 years based on current growth rates and other factors. Combining this future estimate of pollutant loading with the current pollutant loading estimated from the 491 (identified) untreated sites in the watershed results in 178 kg per year of phosphorus that is entering SF headwater lakes. These may be treated through remediation of existing development, and by implementing phosphorus control standards for all new development.

This 178 kg per year provides watershed stakeholders with a goal for future reductions of phosphorus to the project lakes. Presumably, if all 491 sites were effectively treated with BMPs and all new development contained proper phosphorus controls, this 178 kg of P could be eliminated to near 0.

It is important to note that while this plan focused on phosphorus, 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. Other nutrients (nitrogen)
2. Bacteria
3. Heavy metals (cadmium, nickel, zinc)
4. Petroleum products

Without a monitoring program in place to determine these pollutant levels, it will be difficult to track successful reduction efforts. However, there are different spreadsheet models available that can estimate reductions in these pollutants depending on which types of BMPs are installed.

4.5 Adaptive Management Approach

An adaptive management approach is widely recommended for protecting these 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 (e.g., 2 years). Rather, adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration activities. Implementation of this approach will ensure that required restoration actions are implemented and that these waters are monitored to document restoration over an extended time period. The adaptive management components for future implementation efforts should include:

- ***Creating an Organizational Structure for Implementation.*** Since the watershed spans two municipalities, a cooperating group representing both towns and states should be established for the implementation of future efforts in the watershed and to help coordinate the implementation of restoration activities. In addition to municipal officials, this collaborative should 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 the financial resources to ensure that lake watershed restoration actions can move forward over an extended time period. 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. Clearly, 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 identified in the five watershed surveys). All recommendations were developed by AWWA, technical consultants (FBE), and NHDES in collaboration with the project stakeholder group. 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 SF headwater lakes Watershed Management Plan has greatly benefited from the active involvement of an engaged group of watershed stakeholders with a diversity of skills and interests. The implementation of the Plan 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 watershed tributaries) is necessary to track the aquatic health of the SF headwater lakes. Indeed, the overall goal of the watershed management planning process is the protection of the aquatic health of these lakes. For more information on future monitoring please see Section 6.3.

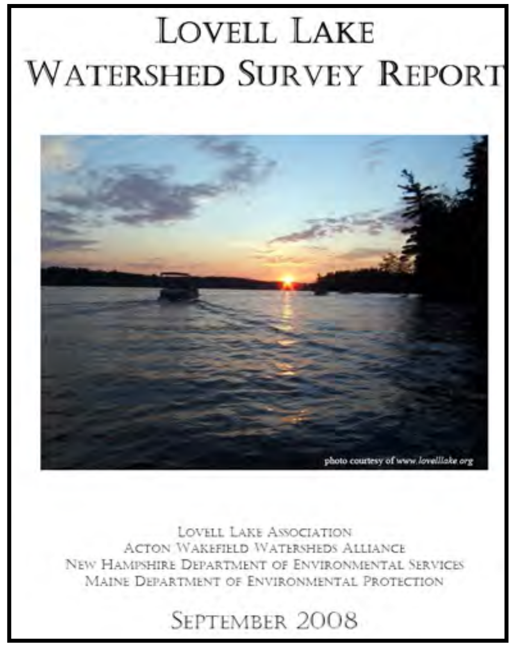
- ***Establishing Measurable Milestones.*** A restoration schedule that includes milestones for measuring the implementation of restoration actions and monitoring activities in the SF headwater lakes is critically important. Once the level of funding has been established to determine the extent of recommended action strategies that can be implemented each year, a detailed schedule featuring step-by-step implementation and monitoring activities should be developed. A list of measurable milestones are listed later in this document in Chapter 6.

5. Plan Implementation

5.1 Structural NPS Reduction Opportunities

Installation of Best Management Practices (BMPs) in the lake watersheds is necessary for the long term protection of SF headwater waterbodies. AWWA staff and partners have identified opportunities within focus areas that exhibit the most potential for water quality enhancement with minimum costs and maximum partnership potential. Many recommendations have been identified through field evaluation and some sites will require detailed survey and engineering design in order to determine the appropriate final implementation strategy for maximum water quality benefits.

Watershed surveys resulted in the identification of several hundred individual BMP opportunities. Field evaluation of BMP opportunities was accomplished through working with watershed citizens and technical staff from AWWA, Maine DEP, NHDES, and York County SWCD. These teams focused on identifying sites in both shoreline and upland areas. These sites were organized and given rankings based on impact to the lake, estimated remediation cost, and site remediation priority. Details on the results of the surveys are summarized in Chapter 1.3.1 and Appendix C. Complete copies of the survey reports are available online at awwatersheds.org/programs/watershed-surveys/.



Watershed Survey reports have been completed for all five SF headwater lakes featured in this watershed management plan.

Example Structural BMPs

Generally, lake protection and restoration structural BMPs are categorized by the land use that they are designed to treat. A brief summary appears below.

- **Roadways**- Roadways often contribute large amounts of sediment to lake watersheds. In northern New England, many private roadways (often referred to as camp roads) are poorly designed and maintained and are often need of repair and continued maintenance. Types of roadway BMPs that will need to be installed in SF headwater lakes watersheds include proper ditching, turnouts, proper crowning of roads, and proper installation of culverts.
- **Shoreline Residential-** Shoreline residential areas can also contribute high volumes of pollutants including phosphorus to these lakes. It is commonly believed that the cumulative impact of many problematic properties can contribute to lake degradation. Common shoreline BMPs that have and will be installed for these waterbodies include rain gardens, infiltration steps, rain barrels, vegetated shoreline buffers and driveway repair and maintenance.

Rain Gardens are often effective residential BMPs for treating stormwater on-site.

- **Septic Systems–** Septic systems can provide excess nutrients to lakes, particularly where systems are poorly sited or excessively drained (sandy) soils are present. Observations of shoreline lots indicate that there is potential for septic leachate to reach the lakes to close proximity of septic fields to the lake and the age of many of the dwellings which may not have had septic systems updated. The BMPs for septic systems are straightforward: 1) Replace failing systems and 2) have the functioning systems pumped on a regular basis (every two to three years).

5.2 Non-structural and Land Protection Opportunities

Stormwater Best Management Practices (BMPs) are technology and education based controls that reduce the discharge of pollutants from impervious surfaces and developed land areas. Non-structural BMPs generally refer to operational activities and educational measures that are employed to reduce the release and discharge of pollutants. For the purposes of this plan, non-structural BMPs refer to stormwater runoff management techniques that do not require extensive construction efforts and either limit the generation of stormwater runoff or reduce the amount of pollutants contained in the runoff. The EPA promotes the use of non-structural BMPs to increase awareness of the primary need for pollution prevention rather than treatment in long-term watershed management programs. However, watershed management plans often do not emphasize the importance of non-structural BMPs in overall restoration efforts. The EPA recommends that a comprehensive management plan includes the implementation of a combination of non-structural and structural BMPs for existing and new development to ensure long-term restoration success.

There are two primary components of non-structural BMPs:

1. Planning, design and construction that minimizes or eliminates adverse stormwater impacts;
2. Good housekeeping, education and training to promote increased awareness of the previous component.

Recommendations offered below for the planning non-structural BMP components is based on watershed characteristics, expected reliability, implementation potential, and anticipated community and environmental acceptance.

5.2.1 Land Use Planning Recommendations

Land use planning plays a critical role in watershed management and restoration. The American Rivers report on Local Water Policy Innovation expresses the importance of local planning solutions for stormwater pollution based on the following:

- Local governments have the experience and authority to regulate land use;
- The site plan review process is ideal for stormwater regulations;

- Local governments can remove barriers to Low Impact Development;
- Local action is vital to the Federal Clean Water Act permitting system; and
- Individuals have the power to make changes on a local level.

There are a variety of planning tools available to address stormwater management issues as summarized below.

Specific Recommendations: Implement Code, Zoning and Design Guidelines Revisions

The SF headwater lakes watersheds include land area within two municipalities, in two states. Much of the currently developed land occurs primarily in near the lakeshores of the watershed. Much watershed land area available for development exists in the upland portions of the watershed. These existing and future potential land uses highlight the relevance of the following restoration tools, some combination of which are likely to be critical for future water resource protection in each municipality.

- **Consider exceeding ME and NH stormwater thresholds for new development.** Sites with less than one acre of impervious surface can contribute to stormwater pollution but are not currently required to provide post-construction stormwater management. Reduced performance standards could be considered for less than one acre sites (e.g. detain and filter 0.5 inch of runoff from impervious surfaces) and more flexible BMP design standards could be allowed to maximize designer opportunities and minimize cost.
- **Modify and/or clarify redevelopment stormwater management requirements.** Current state stormwater management laws do not comprehensively require redevelopment projects to meet post-construction stormwater management standards. Consider modifying local code or redevelopment definitions to require post-construction stormwater management on projects that modify existing drainage infrastructure, change traffic patterns or modify the existing land use of a given parcel. Simply relying on hydraulic capacity changes to a parcel will not guarantee stormwater structural BMPs.
- **Reduce or eliminate regulatory barriers in local code, design standards and guidelines.** A 2008 national study by American Rivers indicates that architects, developers and builders have cited existing code standards and requirements as the primary barrier to using/applying Low Impact Development (LID) techniques on new and redevelopment projects. The basis of LID techniques is the minimization of impervious surfaces on a developed site. Recommendations for these techniques specific to Acton and Wakefield appear in Chapter 5.3.

5.2.2 Good Housekeeping, Training and Education

There are two primary types of good housekeeping and training/pollution prevention tools that can help to minimize polluted stormwater runoff from impervious surfaces in the Acton-Wakefield region. These include: Pavement sweeping, and proper ditching and road maintenance. The removal of winter sands is a practice that is increasingly utilized in urban areas and areas with high-value water resources. With heavy spring rains much of the winter sands can be washed into ditches, tributaries and eventually the lakes. Some communities have combined resources to purchase or rent vacuum sweepers to remove this sand as early in the spring as possible.

Proper ditching and road maintenance is a concern that can be easily addressed by providing hands-on training to public works employees. It is critical that these trainings include all personnel working on roads, not just the directors or foremen.

5.3 Other Opportunities

5.3.1 Municipal Ordinance Revisions

The efforts of the Acton Wakefield Watersheds Alliance (AWWA) and other affiliated lake associations are crucial in ensuring the long-term protection of the waters in the Acton-Wakefield region. However, in the absence of adequate land use controls on development, the potential exists for adverse impacts to the region's valuable water resources. Numerous studies have shown that the extent and type of development can degrade water quality. Municipal land use regulations are a guiding force for where and what type of development can occur in the SF headwater lakes watersheds, and therefore how water quality is impacted as a result of this development.

A Municipal Ordinance Review was conducted by FB Environmental to supplement this WMP (Appendix D). The review suggests that the Towns of Wakefield and Acton have considerable room for improvement in order to protect the water quality of these waterbodies into the future. Three categories of town regulations were reviewed: transportation infrastructure; residential and commercial development; and open space and natural areas. The review, based on guidelines put forth by the Center for Watershed Protection (CWP), scored towns ordinances within each category. The highest possible overall score for the review is 100 and the CWP generally recommends reforming local development rules if the score is less than 80. As Table 5.1 illustrates, both Acton and Wakefield are in need of ordinance reforms, with overall scores of 71 and 64 points, respectively.

Table 5.1: Summary of the CWP codes and regulations worksheet score for Acton and Wakefield.

HABITAT TYPE	Acton	Wakefield	CWP Maximum
Transportation Infrastructure	21	15	40
Residential & Commercial Development	26	30	36
Open Spaces & Natural Areas	24	19	24
Totals:	**71**	**64**	**100**

Following are examples of recommendations from the Acton-Wakefield Municipal Ordinance Review (additional recommendations for each town are included in Appendix E):

- ***Transportation Infrastructure:*** Recommendations include establishing mechanisms that encourage or require the use of shorter street lengths; allowing narrower right-of-ways for new development projects; reducing sidewalk widths; and allowing for a reduction in cul-de-sac radius, among others.
- ***Residential and Commercial Development:*** Recommendations include allowing for minimum side

setbacks of 8' or less between buildings; allowing minimum sidewalk widths of 4' or less; allowing sidewalks to be sloped to adjacent lawns or pervious areas to direct stormwater runoff away from streets or gutters; allowing driveways to be built to a width of 9' or less, among others.

- ***Open Spaces and Natural Areas:*** Recommendations in this category are applicable to Wakefield, as Acton achieved the maximum score in this category. Recommendations include increasing the buffer requirement for all significant local water resources to at least 75'; requiring that a portion of shoreline, wetland and stream buffers consists of native vegetation; and allowing developers some flexibility in meeting regulatory or conservation requirements.

Additionally, both are encouraged to consider promoting the use of Low Impact Development type BMPs for future development projects.

The Action Plan (Section 5.4) lists additional recommendations to improve ordinances in Wakefield and Acton. These recommendations are in keeping with the Municipal Ordinance Review.

5.3.2 Watershed Education and Outreach

This WMP includes an educational component that will be used to enhance public understanding of the project and encourage community participation in watershed restoration and protection activities. AWWA is committed to coordinating with local, state and regional agencies, watershed residents, and other interest groups on issues of water quality and watershed protection. As a critical community resource for relevant and timely information regarding the state of the region's surface waters, AWWA will serve as the primary entity to implement this portion of the Plan. Efforts will be made to encourage people to understand the current problems associated with declining water quality in the waterbodies, and help promote lake/watershed stewardship. The educational goal of the plan is to elevate public understanding of the connections between land use and water quality and to encourage actions that maintain the highest water quality and a healthy watershed ecosystem. Action items related to education and outreach are outlined in the Action Plan (Section 5.4).

5.4 Watershed Action Strategy including Schedule and Estimated Costs

A. INTRODUCTION

This Action Plan was developed through contributions from area stakeholders and participants at a community forum and two successive meetings held during the winter and spring of 2009. Preliminary action items are presented here as ideas to foster further thinking about long-term strategies for protecting the high-quality waters and related natural resources located within the SF headwater lakes watersheds, and to promote communication between citizens, municipalities, Maine DEP and NHDES. This Action Plan incorporates these ideas and outlines responsible parties, potential funding sources, approximate costs (where available), and an implementation schedule for specific tasks within each of the five categories identified below. Current cost estimates for each action item will need to be adjusted based on further research and site design considerations.

The SF headwater lakes Steering Committee, which is an important outgrowth of the stakeholder participation process, will work toward refining and improving the Action Plan, which consists of action items within five major categories:

1. *Private and Public Roadway BMPs*
2. *Community Planning & Development*
3. *Residential BMPs- Riparian Buffers, Low Impact Development and Septic Systems*
4. *Education and Outreach*
5. *Land Conservation*

The Action Plan will be incorporated into the Watershed Management Plan for implementation by the SF headwater lakes Steering Committee. It is important for local stakeholders to take an interest in and gain valuable knowledge from water quality management, assessment, and improvement strategies. As such, the SF headwater lakes Steering Committee will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce NPS pollution in the Acton-Wakefield region. This effort will require the support of a number of other entities, including the municipalities of Acton and Wakefield, the York County Soil and Water Conservation District, Maine DEP, NHDES, consultants/contractors, area schools, local business owners, and individual landowners.

Each of the five Action Plan categories are presented below with identified threats and a table of proposed action items (compiled from the community forum and subsequent meetings). The tables contain several acronyms which are defined as follows:

- **CELCP-** Coastal and Estuarine Land Conservation Program
- **NHDES 319 –** New Hampshire Department of Environmental Services Clean Water Act Funds
- **Maine DEP 319 –** Maine Department of Environmental Protection Clean Water Act Funds
- **PREP –** Piscataqua River Estuary Partnership
- **NH DOT –** New Hampshire Department of Transportation
- **Maine DOT –** Maine Department of Transportation
- **FEMA –** Federal Emergency Management Agency

B. COMPONENTS of the ACTION PLAN

1. Private & Public Roadway BMPs

Stakeholder concerns focused on improper culverts, eroding stream banks around crossings, and eroding road shoulders. Action items on this issue involve installing BMPs such as diversions for stormwater, check dams on hillsides, and vegetated ditches along roadways. Reducing sediment loads to the lakes and tributary streams is a priority and can be accomplished through the stabilization and reinforcement of road crossings and roadsides to trap pollutants before entering the watercourses. In all cases, stakeholders recommended distinguishing between private, local and state roads since BMP implementation strategies will be somewhat unique for each ownership type.

Identified Roadway Threats: *Specifications for gravel road layout and design; maintenance restrictions; lack of education regarding stormwater runoff for state & local road maintenance crews; excessive winter road sand and salt applications and inadequate post-winter sand removal; soil erosion on camp roads; lack of understanding about camp road maintenance; improperly / inadequately maintained roads; considerations for paving roads; regulations defining impervious surface limitations; lack of funds to fix roads.*

ROAD BMP ACTION ITEMS	How?	Who?	Funding	Schedule	Suggested Annual Cost*
1. Develop and deliver contractor training and certification program	Convene meeting of potential stakeholders to develop and implement training & certification program. Use T2 Roads Scholar program for camp road maintenance practices (including certification component) and ME NEMO's training materials as resources.	UNH, AWWA, Lake and Road Associations	DES 319, PREP	2010 and ongoing	$25,000
2. Initiate formation of private road associations	Provide training on "How to Form a Road Association" and follow-up with assistance/capacity building (refer to ME's Guide to Forming Road Associations).	AWWA, Lake Associations, Residents	DES 319, PREP	2010 and ongoing	$5,000
3. Standardize camp road maintenance practices	1) Develop and adopt camp road maintenance standards including considerations for ongoing maintenance needs (refer to UNH Roads Scholar Program and ME Camp Road Maintenance Manual). 2) Develop a list of certified contractors.	Private Road Associations, Contractors	Volunteer	1) 2011 2) 2012 and ongoing	N/A
4. Install / Implement BMPs on private roads	1) Use watershed survey results to identify priority action areas. 2) Select and implement appropriate BMPs using UNH Roads Scholar references & Maine Camp Road Manual (including considerations for winter sand removal).	Landowners, contractors, Road Associations, NH Stormwater Center	FEMA, DES 319, DEP 319	1) 2009 and ongoing 2) 2010 and ongoing	$75,000

5. Install / Implement BMPs on public roads	1) Use watershed survey results to identify priority action areas. 2) Select and implement appropriate BMPs using UNH Roads Scholar references (including considerations for winter sand removal).	NHDOT, ME DOT and local road crews, road agents & commissioners	FEMA, DES 319, DEP 319	2010 and ongoing	$200,000
6. Evaluate all tributary crossings in consideration of stream ecology and stability (geomorphology)	1) Identify stream crossings that do not meet specifications according to the *New Hampshire Stream Crossings Guidelines* (UNH, 2009) 2) Work with towns and DOT to develop a plan to replace non-conforming stream crossings 3) Replace non-conforming stream crossings	NHDOT, ME DOT, local road crews, road agents & commissioners, NH Fish & Game (F & G), NH DES	FEMA, DES 319, DEP 319 (??), NHF&G	2010-2012 (survey); 2012-ongoing (planning and replacement)	$20,000
Total Annual Cost					**$325,000**

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

2. Community Planning & Development

The importance of responsible community planning and development in providing adequate shoreland and water resource protection cannot be overstated. Proper planning and development are essential not only to maintain and enhance the water quality and scenic value of New Hampshire's shores, which are so critically important to its $9.7 billion dollar tourism industry, but also to protect property investments on shorelines vulnerable to erosion. While New Hampshire's Comprehensive Shoreland Protection Act (CSPA) has established the basic mechanisms to protect its scenic and ecologically valuable shorelines, the Act in its present form, and the ability of NHDES to provide adequate regulatory oversight, enforcement and education, are often ineffective. Maine's experience might provide a useful model in supporting local community efforts to protect scenic shorelines for the mutual benefit of the tourism economy and private property owners. Maine's popular LakeSmart Program effectively engages local and regional organizations (e.g., Lake Associations, Soil & Water Conservation Districts) in collaborative partnerships to remove barriers for lake water quality protection and restoration efforts. Additionally, the recently completed municipal ordinance review for the towns of Acton and Wakefield provides numerous recommendations for strengthening the role of community planning and development in water resource protection. The steering committee should identify whether there is a need for a Watershed District that would help coordinate watershed efforts across state, town and county political lines.

Identified Community Planning & Development Threats: *The NH Comprehensive Shoreline Protection Act (CSPA) alienates residents; permitting issues make it difficult to fix erosion problems; perceived conflict between individual rights & community use of lakes; enforcement is a problem at both local & state levels; need to build public support for town decisions/initiatives (including municipal ordinance revisions to provide greater water resource protection); inadequate enforcement/education; disregard for rules/laws; inconsistency of enforcement.*

COMMUNITY PLANNING & DEVELOPMENT ACTION ITEMS	How?	Who?	Funding	Schedule	Suggested Annual Cost*
1. Coordinate with DES and DEP enforcement staff to address local and state regulatory concerns.	Establish a working group to meet with DES/DEP staff to request more consistent application / enforcement of regulations from DES.	Towns / AWWA / Consultants	DES & DEP 319	2009 and ongoing	$1,500
2. Strengthen ordinances to control impact from polluted runoff	1) Provide recommendations for local ordinances (use the WBMP Ordinance Review and "Innovative Land Use Guide" as references).	Towns / AWWA / Consultants	DES 319, PREP	1) 2010 and ongoing 2) 2010	$25,000

3. Encourage and implement installation of LID practices	1) Use local ordinances to protect WQ through promotion of LID measures.	AWWA, Towns	DES 319, DEP 319, Stimulus Funds	1) 2009 and ongoing 2)2011 and ongoing	$60,000
4. Increase and improve existing enforcement	1)Ensure that town boards are aware of enforcement issues. 2) Strengthen enforcement at the parcel level. 3) Include Code Enforcement staff in regulatory/plan reviews. 4) Consider providing training workshops for CEO's. 5) Promote increased funding at local level to provide adequate regulatory oversight and enforcement. 6) Develop greater local capacity to enforce state regs.	Towns / AWWA / Consultants	Towns	1-6) 2011 - 2014	$7,500
5. Develop build out analysis for watershed and develop action items related to results	1) Being completed as part of watershed based plan. 2) Present findings / recommendations to planning boards in support of needed changes to local ordinances.	AWWA, DES, FBE	DES 319	2009	N/A
6. Consider establishing a Watershed District	1) If substantial headway is not being made to implement planning strategies, and lake water quality continues to decline then a watershed district should be seriously considered	AWWA, Towns, Legislators	Tax revenus set aside, permit fees, grants	Examine changes in water quality	TBD
Total Annual Cost					**$94,000**

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

3. Residential BMPs - Riparian Buffer, LID, and Septic Systems

The residential action items place a strong emphasis on improving protection of shoreland vegetated buffers, promoting and demonstrating low impact development (LID) techniques, and proper operation and maintenance of septic systems. Action items include encouraging stewardship through a variety of social marketing techniques, and a preliminary assessment of septic systems to identify the potential extent of system failures. This latter action item will first require identifying the communities' capacity to conduct a cursory septic system evaluation entirely on their own or with the assistance of a consultant. In all cases, coordination with the landowners will be crucial because mitigation measures will frequently need to be implemented on private land (including privately owned roads). This set of tasks will also strongly encourage the use of native plant species.

Identified Threats from Residential Land Uses: *Shoreline vegetation clearing along SF headwater lakes; stormwater runoff from roads, roofs & steep sites without buffers; lack of buffers on small streams; inadequately maintained and malfunctioning septic systems.*

RESIDENTIAL BMP ACTION ITEMS	How?	Who?	Funding	Schedule	Suggested Annual Cost*
1. Enhance current residential BMP and technical assistance program	1) Develop Technical Assistance pledge sheets. 2) Continue promoting YCC services to property owners with identified erosion problems. 3) Design and Install BMPs.	AWWA, Lake Associations	DES 319	1-4) 2009 and ongoing	$50,000
2. Initiate incentive-based watershed wide erosion control BMP installation program	1) Implement program to encourage land owners to install erosion control BMPs with cost share option for plants and materials. 2) Install demonstration projects throughout watershed.	AWWA, land owners, lake associations	DES 319	2010 and ongoing	$25,000

3. Conduct a sanitary survey to identify potential problem septic systems	1) Conduct cursory assessment of malfunctioning septic systems to estimate extent of potential impact and establish clear need for survey (e.g., review septic files at town offices, inspect lots via survey from boat or on land). 2) Identify capacity to administer project; if inadequate establish capacity improvement plan. 3) Have road associations accept some role in helping to facilitate survey project.	AWWA, Towns, Road Associations, Consultants	DES 319, PREP	1-3) 2011 - 2013	$20,000
Total Annual Cost					**$95,000**

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

4. Education and Outreach

Education and outreach are vital components to watershed protection and improvement. Fortunately, AWWA has already established an exceptional capacity and reputation in this regard. The organization has served as a critical community resource for relevant and timely information regarding the state of the region's surface waters. As such, AWWA will continue to play a central role in helping to coordinate efforts among various stakeholders and interest groups in the region, particularly with local lake associations. They will also be instrumental in any efforts to communicate with seasonal residents as emphasized by comments at recent community forums. Refining water quality monitoring activities to provide the most relevant data will also be an important aspect of the Education and Outreach action items. The Watershed Management Plan includes numerous recommendations for enhancing current water quality monitoring efforts, including sample collection from various tributaries and consideration for establishing an invasive species screening program. Since volunteers typically conduct so many monitoring activities, it will be critical to continue building on the success of AWWA's ongoing education and outreach program.

Identified Threats from Inadequate Awareness: *Lack of knowledge of rules & laws and the impact of human activities; lack of understanding about how water quality is important for the entire community; inadequate awareness for non-shorefront property owners and visitors about how their activities can adversely affect water quality; negative impacts of ATV activity; poor communication with landowners; seasonal residents aren't engaged enough with water quality protection efforts.*

EDUCATION & OUTREACH ACTION ITEMS	How?	Who?	Funding	Schedule	Suggested Annual Cost*
1. Develop comprehensive strategic education & outreach plan that coordinates and unifies efforts of various organizations.	1) Convene meeting of potential stakeholders (e.g., lake associations, towns, land trusts, etc.) to develop unified E&O strategy. 2) Develop initiative to encourage greater citizen involvement in planning and regulatory process through improved E&O.	AWWA	Dorr Foundation	1) 2009 2) 2010	$10,000
2. Provide more tools to lake associations to promote "lake smart" practices.	1) Strengthen relationships between AWWA and lake associations. 2) Press releases, on-boat education program, media tools (e.g., ThinkBlue ME's Rubber Ducky and / or YouTube videos). All should have sound scientific basis.	AWWA	DES 319	2010 and ongoing	$5,000
3. Implement wide scale education and outreach program	Expand existing efforts with help of committees.	AWWA	DES 319, DEP 319	2011	$35,000

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

4. Seek citizen participation for expanded monitoring and evaluation program (based on WBMP recommendations) that include watershed streams.	1) Implement monitoring recommendations from WBMP. 2) Identify critical tributaries and develop appropriate sampling study design. 3) Recruit volunteers to participate in the Volunteer River Assessment Program for tributary monitoring. Also revitalize lake monitoring programs through involvement of local schools. 4) Present WQ monitoring results to town boards. 5) Establish volunteer-based invasive species assessment programs (aquatic & terrestrial) for areas where they don't currently exist.	DES-VRAP, Lake Associations, AWWA	DES 319	1&2) 2011 3-5) 2012 and ongoing	$20,000
6. Provide education for summer residents and short-term visitors	1) Conduct a survey to identify behaviors, barriers to change, and incentives to promote desired outcomes. 2) Develop program to provide incentives for behavior change.	AWWA	DES 319	1) 2010 2) 2011	$15,000
7. Provide watershed-based education so that people "identify" with their watershed	Provide flyers and maps to people to help them visualize their watershed connection.	AWWA	PREP, DES 319, DEP 319	2011	$2,000
Total Annual Cost					**$87,000**

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

5. Land Conservation

Land Conservation can have tremendous benefits for water quality protection. Protection of the “upland” areas of the SF headwater lakes watersheds will ensure that some land remains in an undisturbed state, which will help reduce total phosphorus runoff. Efforts for land conservation need to be coordinated among the local land trusts, regional planning commissions, lake associations, and the municipalities, so that the tasks are shared and communication is open and ongoing.

Identified Threats from Inadequate Land Conservation: *Development is improperly planned; particular focus needed for upper watershed development; expansions and seasonal modifications of waterfront properties are inadequately monitored; threats posed from commercial development are not adequately understood.*

LAND CONSERVATION ACTION ITEMS	How?	Who?	Funding	Schedule	Suggested Annual Cost*
1. Develop coordinated and unified land acquisition strategy that relates direcly to (and informs) local development rules to maximize program effectiveness.	1) Convene stakeholder meeting to identify initial program goals and objectives. 2) Develop clear plan for sustaining land acquistion program. 3) Coordinate with towns to integrate land protection considerations into their development rules.	Land Trusts in collaboration with Towns and Lake Associations	CELCP	1-3) 2010 - 2011 and ongoing	widely variable
2. Identify and purchase ecologically and aesthetically sensitive land.	1) Identify critical lands and potential funding sources. 2) Initiate land owner contact. 3) Strengthen ties to and coordinate activities with local land trusts.	Land Trusts in collaboration with Towns and Lake Associations	CELCP	1-3) 2011 and ongoing	widely variable

** Suggested Annual Costs will likely need to be revised following review of watershed survey results and other related research.*

C. CONCLUSIONS

The elements described in the preceding Action Plan will be a major part of the Watershed Management Plan, particularly in providing a “road map” for the Salmon Falls headwater lakes Steering Committee. The Steering Committee will work toward implementing the Action Plan, which outlines responsible parties, potential funding sources, approximate costs, and an implementation schedule for each task within five major categories: Private and Public Roadways BMPs; Community Planning & Development; Residential BMPs; Education and Outreach; and Land Conservation. **The total estimated annual cost to complete all of the associated tasks is approximately $600,000.**

The Steering Committee shall meet (at a minimum) annually to provide periodic updates to the plan, track any progress made, maintain and sustain the action items, and make the plan relevant on an ongoing basis. An adaptive management approach is recommended in order to assess annual progress, determine key projects and focus areas for the following year, and provide a venue for sharing information within the Salmon Falls headwater lakes region. Adaptive management is the process by which new information about the health of the watershed is incorporated into the WMP. 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, will be tracked. The Steering Committee will use established indicators within the watershed-based management plan to determine the effectiveness of the Plan.

6. Methods for Measuring Success

6.1 Measurable Milestones

Establishing interim milestones to measure progress provides short term input on how successful the plan has been in meeting the established goals and objectives for the watershed. These interim measures, or measureable milestones, are used to determine whether management practices or other control actions are being implemented, and to outline what needs to be accomplished over time to fully implement the practice or management measure. Establishing measurable milestones provides for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant on an ongoing basis. In addition to water quality monitoring the following environmental, social, and programmatic indicators will be used to measure the progress of the SF Headwater Lakes WMP. The following indicators are intricately tied to the action items identified in the Action Plan (Section 5.4):

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.

- Amount of funding secured for plan implementation
- Number of BMPs installed on private roads
- Number of BMPs installed on public roads
- Number of stream crossings that meet the *New Hampshire Stream Crossings Guidelines* (UNH, 2009)
- Number of new road associations formed
- Number of LID practices implemented
- Number of residential BMPs installed
- Number of residential BMP demonstration projects completed
- Number of septic systems assessments or septic system upgrades
- Number of acres of protected critical lands
- Number of watershed-based educational materials distributed
- Completion of a draft bi-state phosphorus control ordinance

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

- Number of new AWWA members
- Number of homeowners who participate in residential demonstration projects
- Number of people who sign Technical Assistance Pledge sheets
- Number of homeowners who participate in residential stormwater educational programs
- Number of contractors completing a training and certification program

- Citizen support as evidenced by the number of ordinances amended to support the plan
- Decrease in number of ordinance violations
- Number of volunteers participating in the Volunteer River Assessment Program for tributary monitoring
- Number of new volunteer-based invasive species assessment programs established and volunteers trained under existing programs

Environmental Indicators are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions.

- Improvement in water clarity
- Reduction in the phosphorus concentration in the lake
- Improvement in the dissolved oxygen levels in deep areas of the lakes and ponds
- Reduction in the frequency of peak flows
- Reduction of visual NPS pollution during storm events

6.2 Criteria for Measuring Load Reductions

In addition to establishing interim measures to track implementation of activities over time (Section 6.1), this plan also provides indicators to help determine whether load reductions are being achieved over time and progress is being made toward overall watershed goals. The indicators outlined below will provide quantitative and qualitative measurements of progress toward meeting the WMP goals.

Tracking Implemented BMPs to Measure Load Reductions

The BMPs that are proposed in this plan are projected to provide a reduction in total phosphorus loading. Careful tracking of successful BMP projects that occur as a result of this plan is needed, and will be used to calculate phosphorus load reduction estimates using methods approved and recommended by the EPA. These include both structural and non-structural BMPs (ordinance revisions, education and outreach activities, etc.). For structural BMPs, the first step in checking BMP projects includes a visual inspection by the Project QA Officer to ensure that the BMPs were installed properly and are functioning as designed. This inspection occurs after a rainfall event that results in significant runoff. This includes no visible sediment deposition into the waterway and no visible signs of erosion or transport of sediment. If the visible inspection shows that the BMPs are not performing as designed, the Project QA Officer records the failures in a notebook and has crews correct the construction. An additional inspection occurs following a significant rain event subsequent to the repairs or modifications. AWWA's Youth Conservation Corps (YCC) uses this inspection method for all YCC soil stabilization projects implemented in the Acton-Wakefield region, and will continue to provide ongoing tracking of YCC 319 BMP implementation projects into the future.

Tracking Water Quality to Measure Load Reductions

A plan for long-term water quality assessment and monitoring is outline below in Section 6.3. Tracking changes and improvements in measured water quality can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality goals. Criteria that can be monitored over time to track load reductions include:

- Improved lake water clarity and transparency;
- Measured reduction in phosphorus concentrations;
- Measured reduction in chlorophyll-a concentrations;
- Visibly less turbidity; and
- Visible reductions in sediments deposits.

As described in the Action Plan, annual meetings will be organized to review the status of goals and objectives in this WMP. An adaptive management approach should be used to assess annual progress and determine key projects and focus areas for the following year and provide a venue for sharing information. Adaptive management is the process by which new information about the health of the watershed is incorporated into the WMP. 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, and number of sites documented, will be tracked. The stakeholders will use the established indicators (Section 6.1) to determine the effectiveness of the Plan.

6.3 Long-Term Monitoring and Assessment Program

A well designed monitoring program is crucial to evaluating the effectiveness of watershed planning activities, and to determine if water quality goals are being achieved over the long-term. With two lakes in New Hampshire, one lake in Maine, and two lakes in both states, water quality monitoring, data collection, and ongoing data analyses is mandatory to ensure that the right type of data is collected, at the right time of year, included into the existing historical trend analysis that was conducted for this plan, and presented to the threshold committee on an annual basis.

Water quality analysis for this plan began in 2008 for all five SF headwater lakes. Currently there is no central clearinghouse for collecting, storing and analyzing sampling data on a regional, bi-state level. For example, water quality data for Horn Pond was retrieved from four different entities including Maine Department of Environmental Protection (Maine DEP), Maine Volunteer Lake Monitoring Program (VLMP), UNH Lay Lakes Monitoring Program (LLMP) and the NH Department of Environmental Services (NHDES). This required a major effort to cross reference data points to ensure that the results captured all the data that had been collected without redundancies.

The LLMP is in the final stages of developing a Quality Assurance Project Plan (QAPP) specific to the sampling of all five lakes. This means that in the future, the LLMP will be the primary data source in NH for these lakes. The VLAP and VLMP are volunteer monitoring programs that will continue indefinitely monitoring these lakes. Volunteer monitors provide valuable data that is essential for tracking long-term trends in these lakes on a bi-weekly basis. VLAP data is sent to NHDES which in turn will be sent to the LLMP. The VLMP data is sent to Maine DEP, which in turn gets posted on the PEARL website (a site sponsored by the University of Maine).

Recommendations for each lake in this section were developed by the SF headwater lakes Water Quality Threshold Committee over the course of several meetings, emails, and phone conferences between February 2009 and May 2009. Specific monitoring recommendations are listed below for each lake, followed by general recommendations for all five lakes.

LAKE IVANHOE


Photo: AWWA

Results of the water quality analysis suggest that Lake Ivanhoe is a potentially impaired waterbody, and requires a phosphorus reduction of 0.8 ppb to meet the definition of a high quality water. This is because the median phosphorus concentrations is at its limit (8 ppb) and chlorophyll-a (Chl-a) values (3.4 ppb) exceed the state standard (< 3.3 ppb). Lake Ivanhoe is at a critical tipping point and requires the State's immediate attention to determine if the decline in water quality is indicative of impairment. Ongoing monitoring of both phosphorus (epicore) and Chl-a on a monthly basis is imperative to track any changes in the water quality over time at the two primary sampling locations (Station 2-deep, and Station 1).

GREAT EAST LAKE


Photo: AWWA

Great East Lake has seven different sampling locations (Map 8, Appendix B). Station 1 (deep hole) was used for the primary water quality analysis, while data from other sites was used as supporting evidence of changing trends. Secchi disk readings from Station 1 showed that there may be a slight decline in minimum water quality over the period of record. Phosphorus trends suggest that between 1978 and 1998 phosphorus values were fairly stable, while data from 1999-2008 appear to be on the rise. Further review of weather patterns, and development in the watershed would provide further insight into whether a real shift in trophic state exists, or an episodic, weather driven change occurred that will correct itself overtime. The following recommendations should be part of this monitoring plan:

1) Increase sampling frequency and frequency of field replicates to better characterize current conditions, on a monthly basis, especially over the next three years to determine if TP is on the rise.
2) Be watchful of 2nd Basin and Canal sampling sites due to higher TP concentrations.

3) Report back to WQ Committee if median TP continues to increase on an annual basis, the goal is to maintain a median TP concentration of 6.5 ppb for Station 1.

HORN POND

Photo: AWWA

According to NH Lake Nutrient Criteria, Horn Pond is considered "Potentially Non-supporting". This is because the median phosphorus concentration is at the tipping point (8 ppb) between a high quality lake (< 8 ppb) and the lower classification (> 8 and < 12ppb). The limited amount of sampling data (2 years for P and 2 years for Chl-a) suggest that more data is needed to determine any specific trend. In Maine, the criteria are slightly different from NH, and Horn Pond is not considered impaired (Bouchard 2009). Based on NH standards, there is no acceptable increase in P concentration in Horn Pond. NHDES will make a final use determination once sufficient TP data has been collected. More discussion is needed among NHDES and Maine DEP staff to align management strategies for this lake. Below are monitoring recommendations for Horn Pond.

1) Ensure that secchi disk measurements are collected at a minimum, monthly through the field season.
2) Collect epicore phosphorus and Chl-a samples monthly from May to the end of September to determine if trends are indeed increasing (data from 2004 and 2008 only), and if P values remain high in the future.
3) Monitor P concentrations and report back to threshold committee annually if median value increases.

WILSON LAKE

Photo: AWWA

Wilson Lake is the only lake of the five located solely in Maine. Therefore, any recommended management strategies will be based on Maine water quality criteria. Wilson Lake has a median P concentration of 6.5 ppb, and has exhibited low dissolved oxygen levels (< 2ppm) in deep areas of the lake which can release phosphorus into the water column. Like Great East Lake, it is still unclear whether or not a recent increase in P is episodic in nature, or is indicative of a shift in trophic state. Careful land use planning is needed to maintain the existing in-lake TP concentration and ensure that this lake remains high quality waters in the future.

1) Ensure that secchi disk, epicore TP and Chl-a measurements are collected at least monthly from May through the end of September.
2) Increase sampling frequency and frequency of field replicates to better characterize current conditions,

especially over the next three years to determine if TP is on the rise (the last epicore TP sample was collected in 2004).

LOVELL LAKE

Lovell Lake is considered Potentially Non-supporting NH because it falls within the Tier 1 water quality classification (which indicates that Lovell Lake has limited capacity to treat additional phosphorus from the land). Water quality trends in Lovell Lake exhibit a slight decrease in water clarity. Like both Lake Ivanhoe and Horn Pond, recommendations for Lovell Lake include a phosphorus reduction of 0.3 ppb to meet the definition of a high quality water and to improve the existing in-lake phosphorus concentrations in Lovell Lake.

1) Ensure that secchi disk, TP and Chl-a measurements are collected at both sampling locations at least monthly from May through the end of September.

GENERAL RECOMMENDATIONS

Sampling will be conducted by certified volunteer monitors and tracked by LLMP for data collected May through September. Lake Associations for each respective lake will be responsible for ensuring that an adequate number of volunteer monitors are trained annually to conduct monitoring according to standard procedures. Sampling should be conducted at two locations in Lake Ivanhoe, at four locations (Station 1, 2 Canal, 3 Mmann, and 2nd Basin) in Great East Lake, one location in Horn Pond, one location in Wilson Lake, and four locations in Lovell Lake. The following general recommendations should be considered for all five SF headwater lakes beginning in 2010:

1) Conduct biweekly sampling for temperature, dissolved oxygen, and secchi depth. Phosphorus sampling (epicore) and Chl-a will be collected according to standard methods monthly beginning early spring (after May 15) through fall (before September 30), with an emphasis on the deep holes.
2) Enter all water quality data into a common database to enable tracking and reporting of results on an annual basis. LLMP will report results to the SF Headwater Lakes Water Quality Threshold Committee on an annual basis.
3) Lake Associations for each lake will provide trained volunteers to conduct frequent routine surveys for aquatic invasive plants throughout the summer, and support courtesy boat inspections at public ramps.
4) Successful BMP implementation projects that occur as a result of this plan, and carried out by the AWWA Youth Conservation Corps, will track phosphorus load reduction estimates using methods approved and recommended by the EPA. These include both structural and non-structural (ordinance revisions, education and outreach activities, etc.).
5) Review monitoring plan annually for each of the five lakes to determine if additional monitoring is needed.

7. Sustaining the Plan

7.1 Inter-Local and Inter-State Cooperation

It is imperative that local cooperation occurs between landowners, residents, businesses and policy makers in order to prevent further water quality declines in the five lakes that form the headwaters of the Salmon Falls River. This includes voluntary compliance with local and state environmental regulations.

Since watersheds do not follow political boundaries, it is explicitly important that towns and states work together to implement watershed management strategies. This plan presents several ways that towns and states can work together. This includes: annual meetings attended by a bi-state steering committee made up of representatives from all five lakes and both towns; annual coordination of monitoring and water quality data analysis and reporting; and working together to align water quality ordinances (including a regional phosphorus control ordinance for all new development as well as redevelopment).

Another approach, which has been successful in many locations in Maine, New England, and beyond, is to form a Watershed district. Watershed districts are special government entities in the U.S. that monitor and regulate the use of water in watersheds surrounding lakes. The Districts are run by a board of managers who are appointed by County Commissioners. District boards coordinate watershed planning activities with state, county, town, and soil and water conservation districts.

Cobbossee Watershed District in Central Maine is an example of a District which has been successful at bringing state and local stakeholders together to address water quality problems. The success of the District has been nationally recognized (see insert).

A Watershed District at Work:

In the 1960s water quality in Cobbossee Lake began to deteriorate. Elevated phosphorus levels spurred the growth of noxious blue-green algae, which reduced water clarity, formed green surface scums, and depleted oxygen in the bottom waters of the lake. The excess phosphorus in Cobbossee Lake's watershed was caused by soil erosion and runoff from agricultural, residential, and commercial lands, and the gradual conversion of forested land into developed land. The other significant source of phosphorus came from Annabessacook Lake, immediately upstream of Cobbossee.

The Cobbossee Watershed District (CWD) was formed in 1973 to coordinate lake water levels and arrest declining water quality of major lakes. The District includes 13 towns in 2 counties, 22 dams, and 29 lakes and ponds over a watershed area of 240 square miles.

The CWD has helped towns and landowners adopt erosion control BMPs at homes, on town roads, and on private camp roads. In the early 1990s, five towns adopted ordinances requiring that new developments be designed to meet strict phosphorus allocation standards for stormwater runoff. Under two EPA section 319-funded projects in the 1990s, a significant number of erosion control and nutrient management practices were installed on dairy farms, along roads, and on residential properties.

Cobbossee Lake now meets water quality standards, which in Maine means that the lake has a stable or improving trophic state and has been free of culturally induced algae blooms. Maine DEP removed Cobbossee Lake from the state's 303(d) list in 2006.

Local cooperation and voluntary compliance with existing state and local environmental regulations remains a central focus of the District (EPA, 2009).

7.2 Sustainable Funding Mechanisms

The annual amount of estimated funds needed to complete all of the tasks listed in the Action Plan (Section 5.4) is $601,000. This number is intended to be a realistic number that is attainable to be managed by the Town of Acton, the Town of Wakefield, and their partners including AWWA.

The following table summarizes the five action categories, primary and secondary potential sources of funds and the total annual amount needed to address the tasks in the action Plan.

Table 7.1: Primary and secondary potential funding sources.

Action Item	Primary Funding Source	Secondary Funding Source	Total Annual Amount Needed
Roadways	NHDES319/ ME 319	NH DOT/ME DOT	$325,000
Community Planning and Development	NHDES 319/ME 319	PREP	$94,000
Residential BMPs	NHDES 319	Maine DEP 319	$95,000
Education and Outreach	NHDES 319	Foundations	$87,000
Land Conservation	CELCP	Foundations	N/A
TOTAL			**$601,000**

The challenge with funding watershed implementation work is that there are limited funds available for the work. In the likely absence of large amounts of funds to treat structural issues, watershed stakeholders should consider focusing on obtaining funds for non-structural measures. These non-structural measures including ordinances and training often have "more bang for the buck" and can greatly accelerate action in the watershed. The New Hampshire 319 and Maine 319 programs (Section 319 of the Clean Water Act – managed by the corresponding State environmental agencies) are well suited to funding non-structural tasks. These grant programs often fund watershed implementation projects at a level of $50,000 - $150,000 for two-to-three years of implementation work. Watershed organizations have creatively managed this work and spread funds in such a way that many sites are addressed. This is a good approach since the cumulative impact of untreated sites on a waterbody can have a substantial impact on water quality. However, complete protection of the project lakes will only be attained if the most severe sites are addressed.

There are many sources of short-term funding that are available for watershed groups including mini-grants, foundation grants, and project-related grants from various agencies. Diversifying funding sources is a positive step to take to ensure sustainability of project-related funds. Some of these funds could be used to maintain and grow the capacity of AWWA, who is charged with protecting the region's waters. The best source for funding can be found on the EPA search engine dedicated to watershed funding:
http://cfpub.epa.gov/fedfund/.

Other potential funding sources:

- NHDES: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm
- NOAA: http://www.nmfs.noaa.gov/habitat/restoration/funding_opportunities/nonfunding.html
- PREP: http://www.nhep.unh.edu/programs/grant-programs.htm
- Maine DEP: http://www.maine.gov/dep/blwq/docgrant/319.htm

Long-term, sustainable funding for lake watershed projects can be difficult to plan for. Several areas have developed stormwater utilities or watershed management districts to help manage watersheds with complex issues. Given its rural nature, the Acton-Wakefield region may not be the ideal location for this type of arrangement. However a formal, cooperative agreement between Acton and Wakefield could greatly help encourage collaboration and funding for future watershed protection efforts. Fortunately this model is already in place due to continued funding of the AWWA YCC program. A formalization of this agreement in the form of an "interlocal agreement" would allow for combining resources and further breaking down town and state boundaries for watershed protection. Interlocal agreements have worked well in the Bangor and Portland metropolitan areas of Maine. Since interlocal agreements are generally formed between municipalities in the same State, there may be obstacles towards formalizing an agreement through ordinance or resolution.

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APPENDICES

APPENDIX A:
Site Specific Project Plan (SSPP)

Site Specific Project Plan

Watershed-Based Plan for High Quality Waters in the AWWA Region

FB Environmental Associates
December 29, 2008

SITE SPECIFIC PROJECT PLAN FOR:

WATERSHED BASED-PLAN FOR HIGH QUALITY WATERS IN THE ACTON WAKEFIELD WATERSHEDS ALLIANCE (AWWA) REGION

(NHDES PROJECT #B-08-C-02)

Under the New Hampshire 319 Nonpoint Source Grant Program Quality Assurance Project Plan dated October 17, 2008 (RFA# 08262)

Final Draft
December 29, 2008

Prepared by:
FB Environmental Associates
97A Exchange St., Suite 305
Portland, ME 04101

Project Manager: ______________________________
Signature/Date
Linda Schier, AWWA

Technical Project Manager/QA Officer: ______________________________
Signature/Date
Forrest Bell, FBE

NHDES Project Manager: ______________________________
Signature/Date
Sally Soule, NHDES

Program Quality Assurance Coordinator: ______________________________
Signature/Date
Jillian McCarthy, NHDES

NHDES Quality Assurance Manager: ______________________________
Signature/Date
Vincent Perelli, NHDES

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1. Distribution List

Table 1 (below) lists people who will receive copies of the approved Site Specific Project Plan (SSPP) under the Watershed Based-Plan for High Quality Waters in the Acton Wakefield Watersheds Alliance (AWWA) Region dated December 29, 2008.

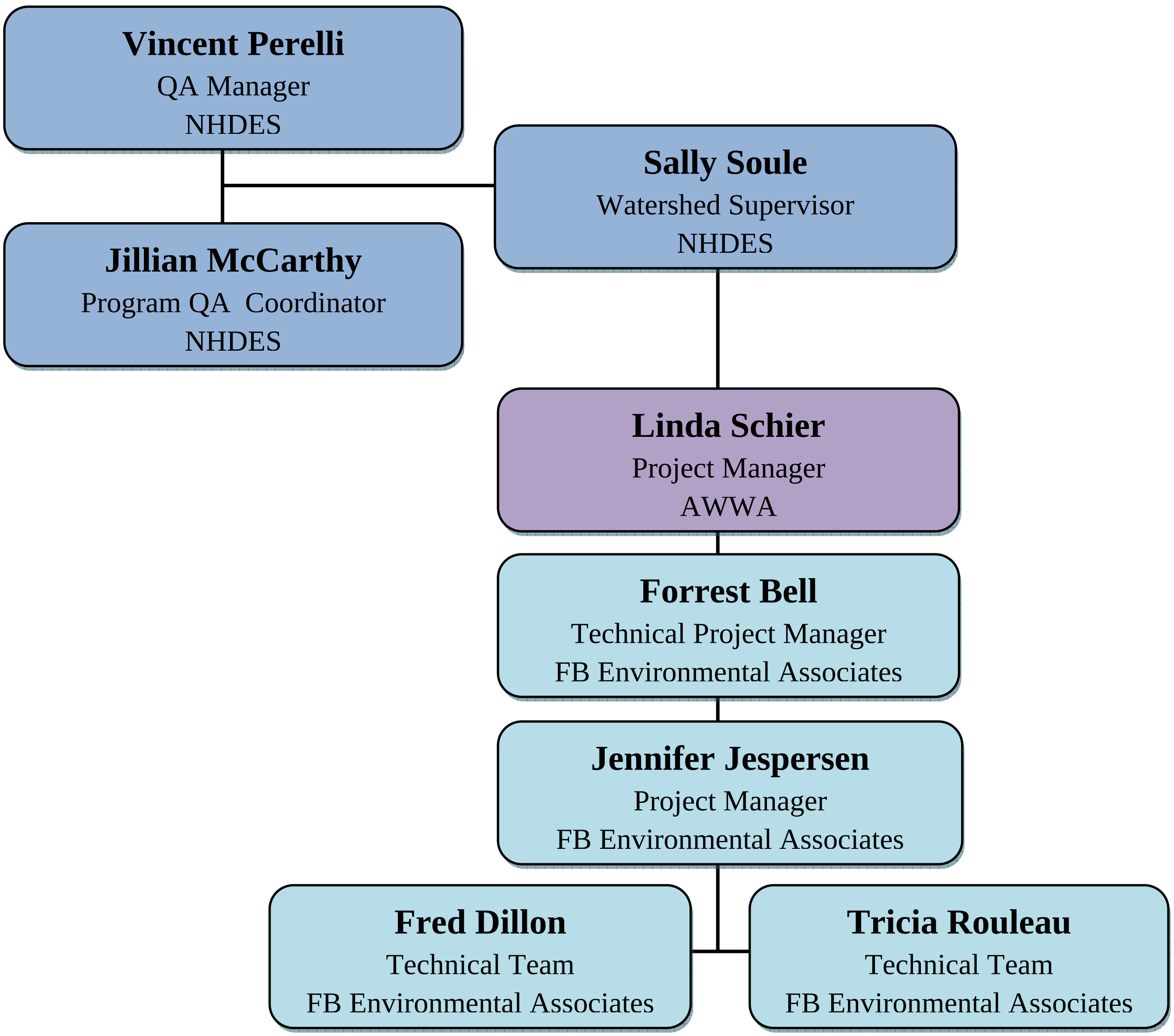
Table 1. SSPP Distribution List

SSPP Recipient Name	Project Role	Organization	Telephone number and e-mail address
Forrest Bell	Technical Project Manager	FB Environmental Associates	207-221-6699 info@fbenvironmental.com
Linda Schier	Project Manager	Acton Wakefield Watersheds Alliance	207-473-2500 info@AWwatersheds.org
Sally Soule	Coastal Watershed Supervisor	NHDES, Watershed Assistance Section	603-559-0032 sally.soule@des.nh.gov
Jillian McCarthy	Program QA Coordinator	NHDES, Watershed Management Bureau	603-271-8475 jmccarthy@des.state.nh.us
Vince Perelli	NHDES QA Manager	NHDES, Planning, Prevention, & Assistance Unit	603-271-8989 vperelli@des.state.nh.us

2. Project Task Organization

Figure 1 (below) outlines the organization structure of the project personnel.

Figure 1. Project Organizational Chart



3. Project Description and Methodology

A. Problem Statement

The communities within the Acton Wakefield Watersheds Alliance (AWWA) region are fortunate to have waters of exceptional quality. The natural amenities that make the AWWA region so unique and attractive also make it vulnerable to the impacts of increasing development. For example, according to the Strafford Regional Planning Commission, the Town of Wakefield, New Hampshire has experienced a population growth of nearly 57% from 1990 – 2005 (NHES 2007). Pollution threats related to development include sediment, nutrients and bacteria from existing and future shoreland development, aging septic systems and roads in the watershed.

The purpose of this project is to develop a Watershed-Based Plan that will help maintain or improve the high quality waters and habitat of the AWWA region lakes. Watershed modeling is a large component of this project, and will be used to determine long-term water quality goals, identify sources of pollution and estimate pollutant load reductions needed to accommodate future watershed development.

B. Historical Data

What type of data is going to be used? What is the Source of the data? What process will be used to determine that the quality of the data is acceptable for use in calculating existing water quality? Please describe.

Several different types of data will be used to complete the Watershed Based Plan for the High Quality Waters of the Acton Wakefield Watershed Alliance (AWWA) Region. The first major data component to be collected is the GIS land use data. These data will be used for determining the total land use area by land use type (in acres) for input into the watershed loading model (see below for model selection criteria). GIS land use data are available from State GIS websites for both Maine and New Hampshire. The Maine land use data, MECLD, is derived primarily from Landsat Thematic Mapping imagery from the years 1999-2001, which was further refined using panchromatic imagery from the spring and summer months of 2004 (MEGIS). The New Hampshire land use data, NH Land Cover Assessment 2001 or NHLC01, consists of the most recent and detailed classification of land cover in New Hampshire based on satellite images acquired between 1990 and 1999, with further revisions in 2001 (GRANIT).

The second major data component is the historical water quality monitoring data for determining the median water quality value and assimilative capacity. These data will be obtained for all five AWWA lakes which include: Great East Lake and Horn Pond located in both Maine and New Hampshire, Lake Ivanhoe and Lovell Lake located in New Hampshire; and Wilson Lake located in Maine. Historical water quality data for lakes in Maine is collected by the Maine Volunteer Lakes Monitoring Program (VLMP) and the Maine Department of Environmental Protection (Maine DEP). Both groups follow an approved Quality Assurance Project Plan developed by Maine DEP (Maine DEP, 2004) which includes Sampling and Analysis Plans (SAP) that follow Standard Operating Procedures (SOP) for all aspects of lake monitoring, from field procedures to data entry.

The New Hampshire Volunteer Lake Assessment Program (VLAP) and the New Hampshire Lakes Lay Monitoring Program (LLMP) are the two primary volunteer groups collecting water quality data on lakes in New Hampshire. Data is also collected by the UNH Center for Freshwater Biology (CFB). UNH Cooperative Extension (UNHCE) manages all data sampled by the LLMP and the CFB. Data from the VLAP is available through the New Hampshire Department of Environmental Services Environmental Monitoring Database (EMD). Only data that is flagged as final in the EMD will be used. UNHCE will follow the *Watershed-based Management Plan for High Quality Waters in the AWWA Region Water Quality Monitoring Quality Assurance Project Plan* that was developed specifically for this project (UNHCFB and UNHCE, 2008). Data from the UNHCE will only be used if QA/QC measures as outlined in the QAPP have been documented and followed.

Data availability varies by lake, dating back to the year in which each lake was first sampled and ending with the most recent sampling event. Phosphorus data is not always available for each year that data was collected. However, there is a deep data set (Table 2, below) that will be used to establish target water quality goals.

Table 2. Years of available sampling data for AWWA lakes

		Water Quality Data			Phosphorus Data		
Lake	Location	First Sampled	Last Sampled	# Years Sampled	First Sampled	Last Sampled	# Years Sampled
Great East Lake	ME/NH	1974	2008	30	1974	2008	17
Lovell Lake	NH	1979	2008	23	1979	2008	23
Lake Ivanhoe	NH	1981	2008	19	1981	2008	18
Horn Pond	ME/NH	1982	2008	11	1982	2008	7
Wilson Lake	ME	1977	2007	29	1977	2006	9

Source: NH Environmental Monitoring Database (EMD), UNH Cooperative Extension (includes data from LLMP and CFB), Maine DEP, and PEARL.

Water quality data will be combined to determine the median water quality and assimilative capacity for the two waterbodies that are situated within both Maine and New Hampshire (Great East Lake, and

Horn Pond). Where multiple stations exist for these lakes, best professional judgment will be used to determine which station is most representative of the whole lake. Where data was collected by two different state entities at the same sampling location, data will be combined to determine the median value.

Where available and applicable, shoreline and watershed surveys are a third data component that will be used in conjunction with the GIS land use data to model the external watershed load. Shoreline surveys were conducted by FB Environmental, AWWA, and NH DES staff on all five lakes during the summer/fall of 2008. Watershed surveys have been completed for Great East Lake, Lovell Lake, and Horn Pond.

Additional data needed for input into the watershed loading model include: the hydrological soil group and soil nutrient concentrations, which can be acquired from the USDA/NRCS STATSGO2 database, the number of agricultural animals, population using septic tanks, which can be acquired from the 2000 US Census Bureau; and the number of agricultural animals which can be estimated from the USDA 1997 Census of Agriculture.

C. Establishing Water Quality Goals

What pollutants are water quality goals being established for? What process will be used to determine the water quality goals? Please describe.

Pollution threats to the high quality waters of the AWWA region include sediment and nutrients from existing and future development, aging septic systems and roads in the watersheds. All of these land uses have the potential to deliver phosphorus, the limiting nutrient in freshwater systems, via stormwater runoff to streams and lakes in the watershed. As such, the water quality goals for the five lakes of the AWWA Region will focus on Total Phosphorus in the watershed.

Once the median water quality has been determined for each of the five waterbodies, the total, reserve and remaining assimilative capacity for each waterbody will be determined using procedures described in the *Standard Operating Procedures for Assimilative Capacity Analysis for New Hampshire Waters* (NH DES, 2008), on file on the NHDES Watershed Management Bureau network drive (H Drive). Tier 2, or high quality waterbodies are described as having water quality in which one or more parameters is better than the standard plus the reserve capacity (the reserve capacity is 10% of the total assimilative capacity). Tier 2 waters have some assimilative capacity remaining, whereas impaired and Tier 1 waters do not.

The process of establishing water quality goals will be guided by data analyses conducted by FB Environmental (FBE). FBE will first determine whether the current median water quality of each waterbody is greater than the reserve assimilative capacity. If median water quality values for each waterbody are greater than the reserve assimilative capacity (Tier 2- exceeds standards), then the water quality goal will be considered based on the current median value and historic water quality data. If the median water quality values fall within the reserve capacity (Tier 1), then the water quality goal will be determined based on historical water quality and potential reductions needed to get water quality values back to the high quality range.

A duplicate analysis will be conducted for calculating both the median water quality values and the assimilative capacity. Once the initial calculations have been completed, an advisory group consisting of town selectmen, conservation commission, and planning board members for the Towns of Acton and Wakefield, representatives of area lake associations, and NH DES staff will help finalize the water quality goals.

D. Loading Models

For each model please include the name, date, revision number, name of the organization or individual who developed the model/method, and the person(s) responsible for running the model as well as reference the user manual or method for the model.

Which model will be used to estimate the current and future pollution sources and loadings?

The US EPA Spreadsheet Tool for Estimating Pollutant Load (STEPL) Model will be used to estimate current nutrient and sediment loads from different land uses, and the load reductions that would result from the implementation of different best management practices (BMPs). This model provides the best fit for the watershed based on land use types (limited amount of agriculture), and is a commonly used and accepted model for watershed planning nationwide. Tricia Rouleau, Project Manager for FBE will be running the model. Tricia is proficient in the use of running watershed loading models, including direct experience with AVGWLF, PREDICT, and the USEPA Region 5 Model. FBE Senior Scientist, Ken Hickey, has direct experience using the STEPL model, and will provide necessary training and technical oversight of the modeling process.

The STEPL version 4.0 model and manual were downloaded directly from the US EPA STEPL website at: http://it.tetratech-ffx.com/stepl/. Jennifer Jespersen, Project Manager for FBE will verify the input values and conduct a duplicate run to identify and correct potential transcription errors. STEPL version 4.0 was last updated on November 26, 2006, and was designed for the Grants Reporting and Tracking System of the U.S. Environmental Protection Agency (EPA) by the following individuals: EPA Work

Assignment Manager, Romell Nandi and Andrea Matzke; Tetra Tech Manager, Ting Dai; Tetra Tech developers, Ting Dai, Xingwen Chen, Jian Ouyang, Mira Chokshi, Khalid Alvi, and Henry Manguerra.

Which model will be used to estimate in-situ pollutant concentrations, and as a result, the pollutant reductions or limitations needed to meet the water quality goals?

Total Phosphorus Retention Model

The Dillon-Rigler model (Dillon and Rigler, 1974) will be used to model the increased phosphorus source loading under future watershed loading conditions and the reductions needed to meet in-lake phosphorus water quality goals. Previous use of the Dillon-Rigler type empirical model has been shown to be an effective approach for linking watershed total phosphorus (external) loadings to in-lake total phosphorus concentrations for thirty-two Maine Total Maximum Daily Load (TMDL) lakes between 2000 and 2008.

Indirect Watershed Loading Model

A simple indirect watershed loading model will be used to determine loading estimates from indirect watersheds. An indirect watershed contains a lake or pond that is hydrologically connected to the waterbody of interest without first passing through another waterbody. The indirect loading model has been utilized extensively by Maine DEP through their TMDL process to determine the extent of phosphorus loading to downstream lakes from their upstream counterparts. The indirect load is determined on the basis of [*flushing rate x lake volume x total phosphorus concentration]* of the upstream waterbody. Alternately, if an external watershed load was previously determined for the indirect watershed through other modeling methods (as described in A. above), then those data will used.

Future Loading Model/Build-Out Analysis

FB Environmental has proposed two different methods for analyzing the effects of new development on the lakes in the AWWA region. The first is a simple, yet inherently conservative method for calculating phosphorus loading from new development, as it provides for relatively high-end regional growth estimates, and largely non-mitigated P-export from new development. Developed by Dennis et al. (1992), this method has been used exclusively in Maine for estimating loading from new development to TMDL lakes. The simple calculation multiplies a 1ppb change in trophic state (kg) by a known constant (either 0.75 if development pressure is high, or 0.5 if development pressure is considered moderate/low). The second method that has been proposed is a build-out analysis using GIS zoning data and CommunityViz software to estimate future development within the watershed. This method will determine the % of developable area in the watershed including the number of residential and commercial buildings, as well as their associated environmental impacts. This method will project future phosphorus loading under full build-out and an assessment of the potential effects of future development as it relates to water quality goals.

The Dillon-Rigler, indirect watershed loading model and future phosphorus loading estimate using Dennis et al. (1992) will be run by Jennifer Jespersen, Project Manager for FBE. Jennifer used these models to determine assimilative capacity, indirect watershed loading, and future loading for TMDL lakes in Maine (for the Maine Department of Environmental Protection and US EPA) between 2005 and 2008. Tricia Rouleau, Project Manager for FBE will verify the input values and conduct a duplicate run to identify and correct potential transcription errors. If the build-out analysis is added to the current AWWA/FBE contract, the Build-Out analysis will be conducted by Fred Dillon, Project Manager for FBE. Fred is an experienced GIS technician. His capstone at the University of Southern Maine involved running a build-out analysis for Penjajawok Stream Watershed in Bangor, Maine, which was utilized for watershed planning by both the City of Bangor and the Maine DEP.

References

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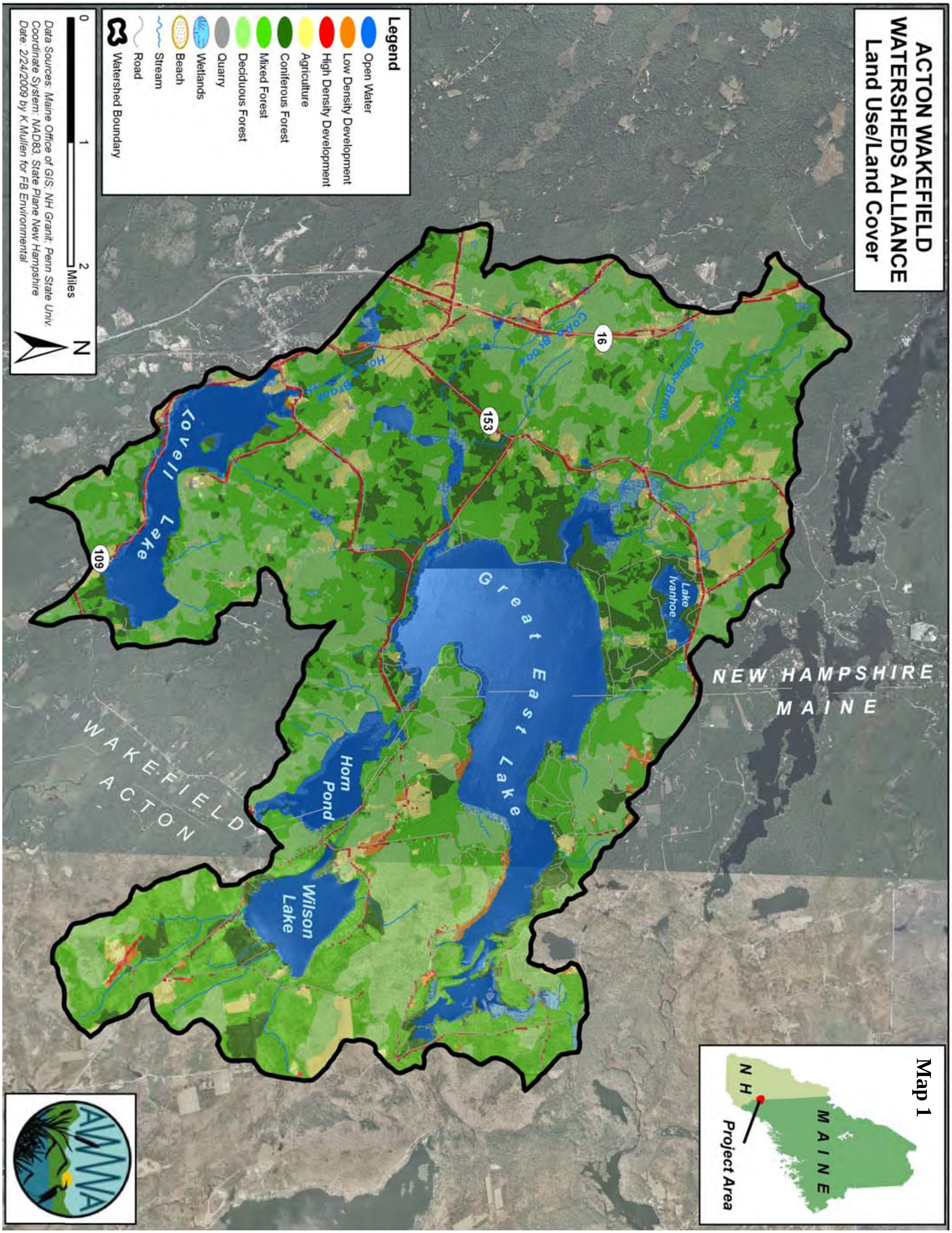
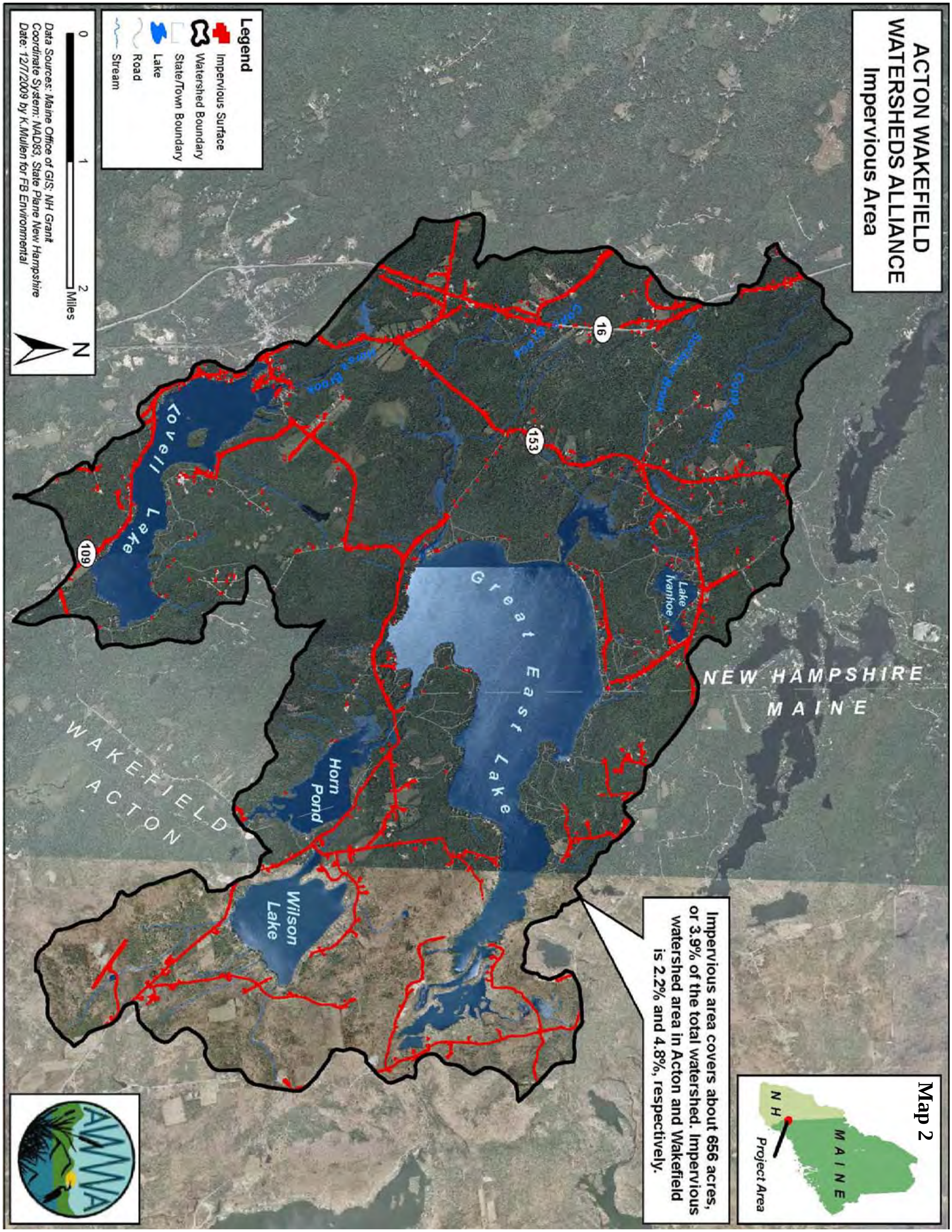
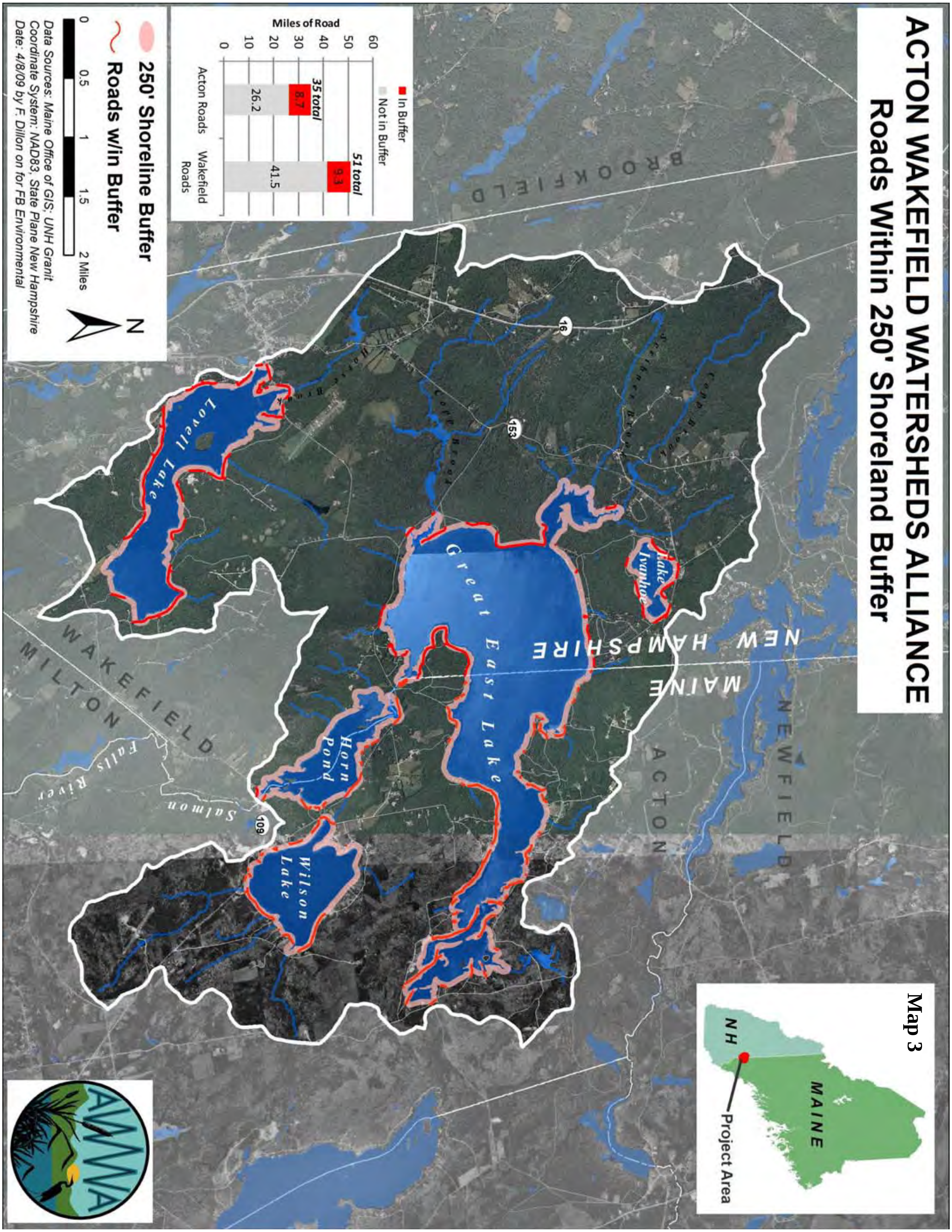
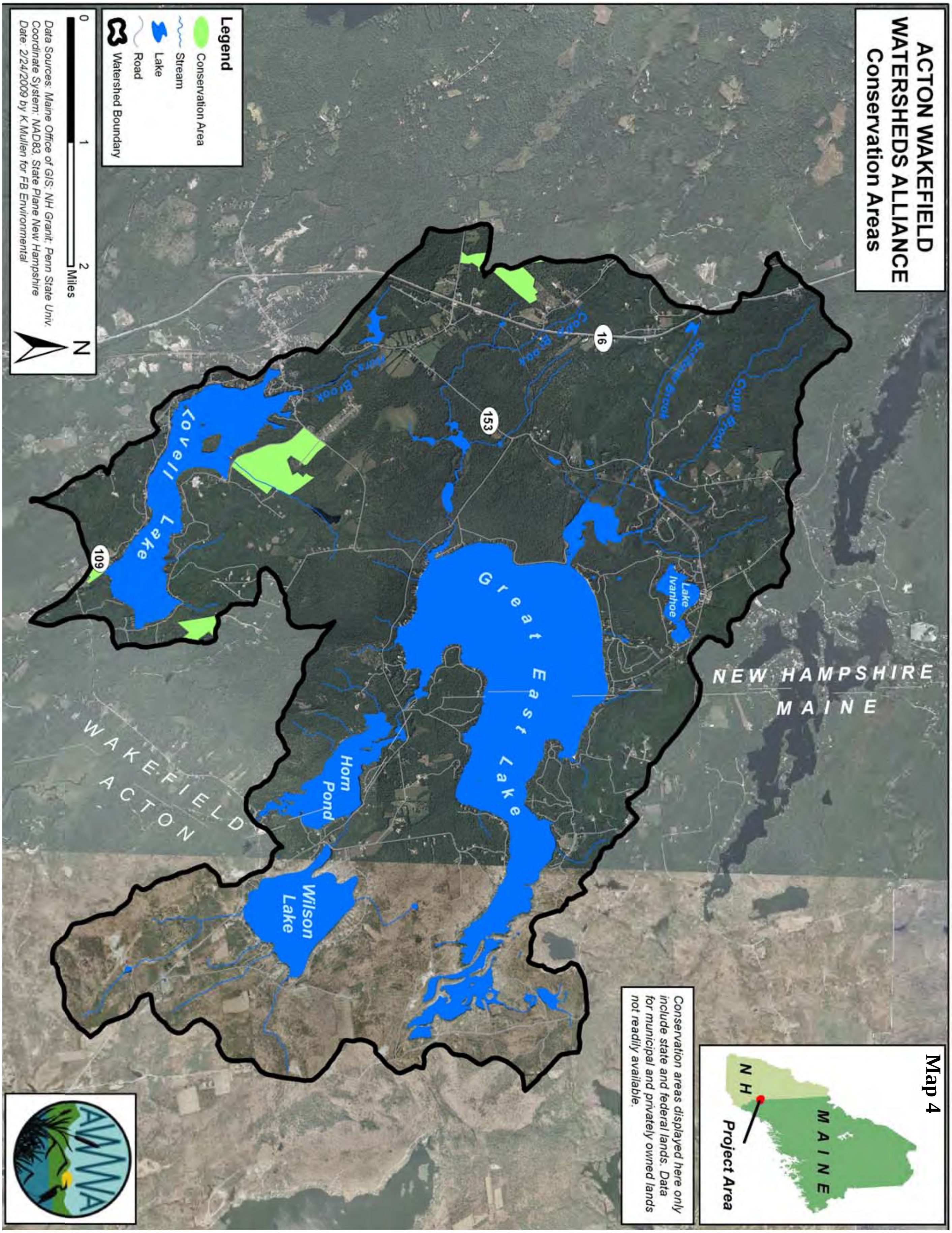
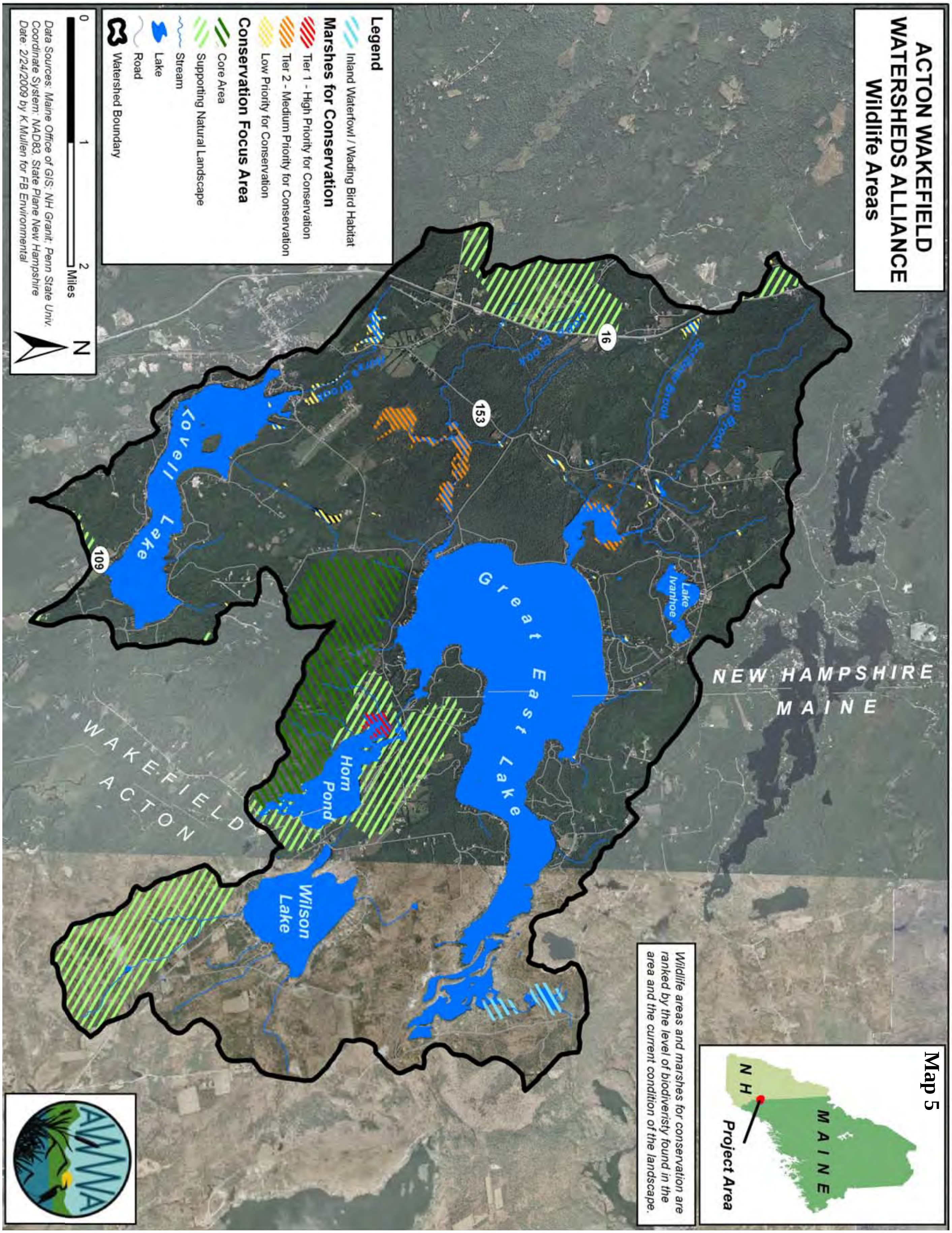
APPENDIX B:
Watershed Maps

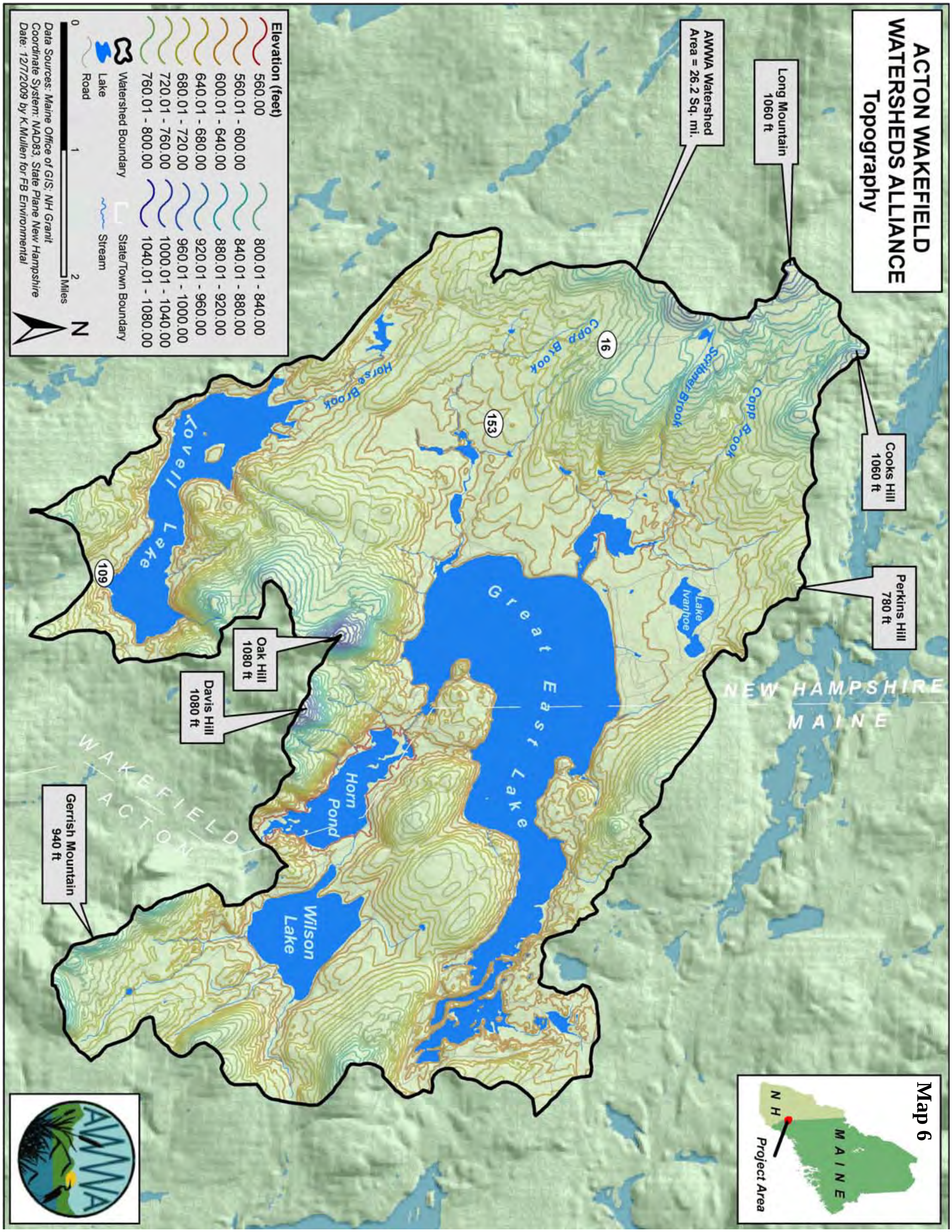

ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Land Use/Land Cover
Legend
Open Water
Low Density Development
High Density Development
Agriculture
Coniferous Forest
Mixed Forest
Deciduous Forest
Quarry
Wetlands
Beach
Stream
Road
Watershed Boundary
0 1 2 Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Lovell Lake
Great East Lake
Lake Ivanhoe
Horn Pond
Wilson Lake
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
16
153
109
Map 1
NH
MAINE
Project Area

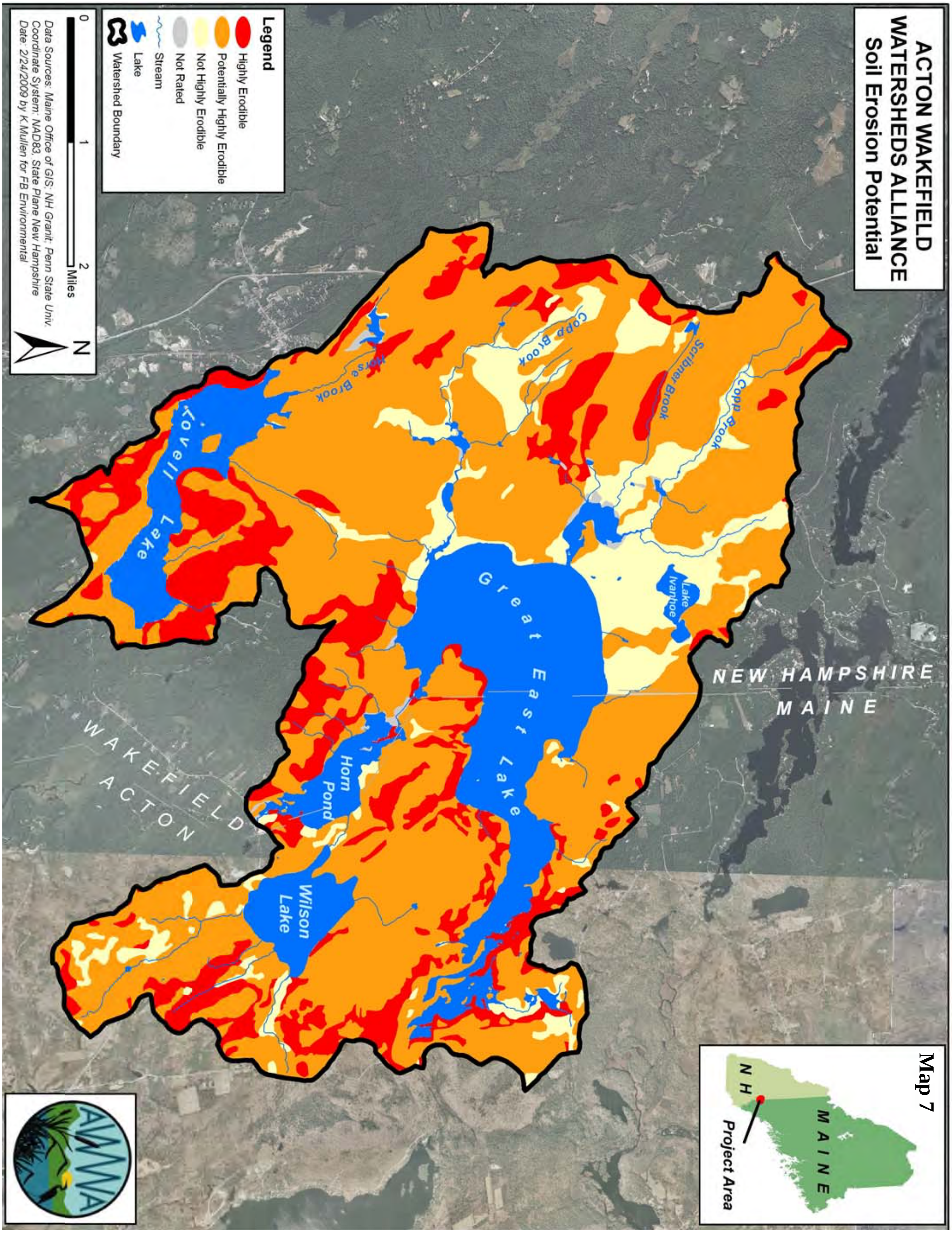

ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Impervious Area
Legend
Impervious Surface
Watershed Boundary
State/Town Boundary
Lake
Road
Stream
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Grant
Coordinate System: NAD83, State Plane New Hampshire
Date: 12/7/2009 by K.Mullen for FB Environmental
Lovell Lake
109
16
153
Great East Lake
Lake Ivanhoe
Horn Pond
Wilson Lake
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Impervious area covers about 656 acres,
or 3.9% of the total watershed. Impervious
watershed area in Acton and Wakefield
is 2.2% and 4.8%, respectively.
Map 2
NH
MAINE
Project Area

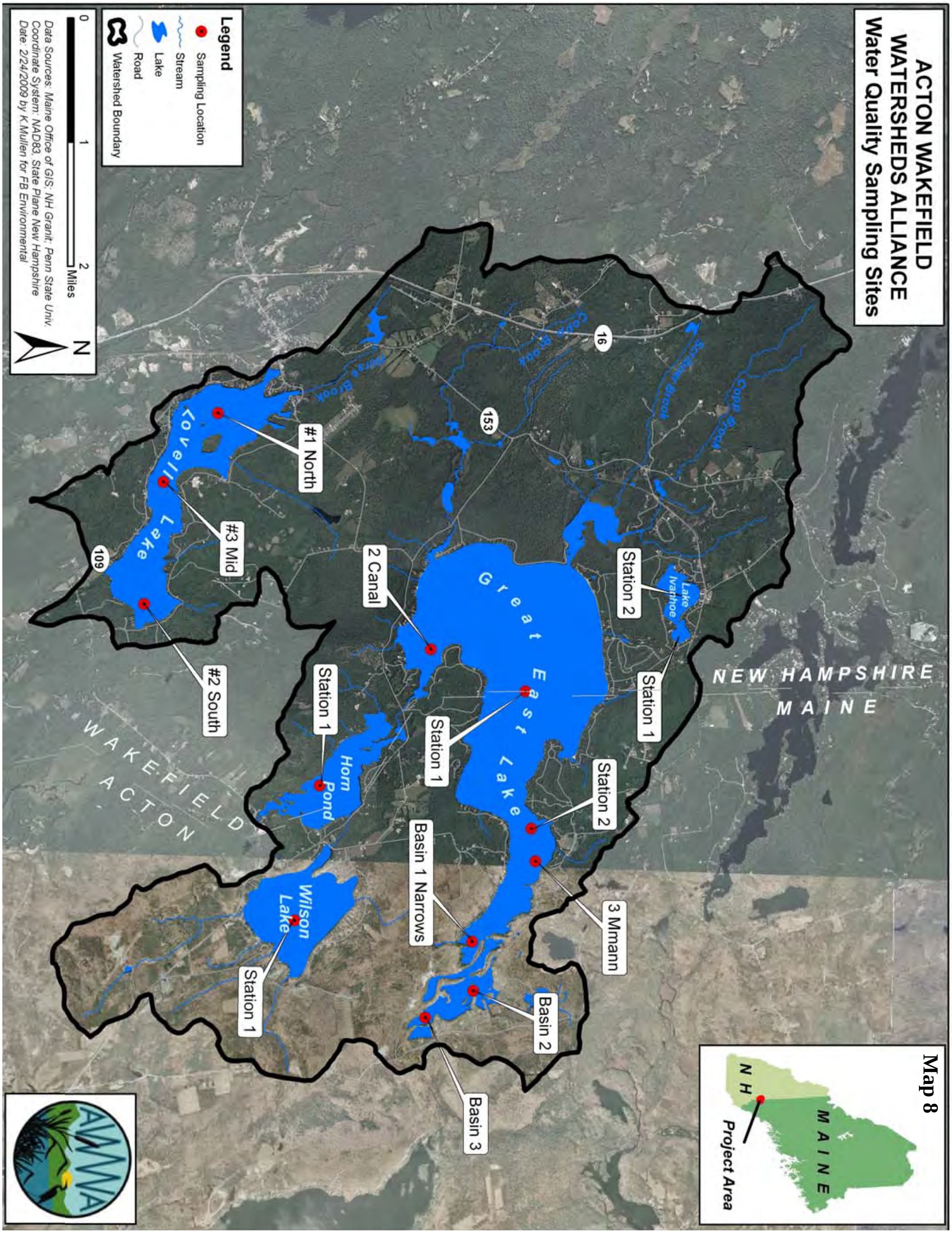

ACTON WAKEFIELD WATERSHEDS ALLIANCE
Roads Within 250' Shoreland Buffer
Map 3
Miles of Road
In Buffer
Not in Buffer
0
10
20
30
40
50
60
35 total
8.7
26.2
51 total
9.3
41.5
Acton Roads
Wakefield Roads
250' Shoreline Buffer
Roads w/in Buffer
0
0.5
1
1.5
2 Miles
N
Data Sources: Maine Office of GIS; UNH Granit
Coordinate System: NAD83, State Plane New Hampshire
Date: 4/8/09 by F. Dillon on for FB Environmental
NH
MAINE
Project Area
BROOKFIELD
WAKEFIELD
MILTON
NEW HAMPSHIRE
MAINE
NEWFIELD
ACTON
Lovell Lake
Great East Lake
Lake Ivanhoe
Horn Pond
Wilson Lake
Salmon Falls River
Copp Brook
Scribners Brook
Horse Brook
16
153
109
AWWA


ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Conservation Areas
Map 4
Legend
Conservation Area
Stream
Lake
Road
Watershed Boundary
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Conservation areas displayed here only include state and federal lands. Data for municipal and privately owned lands not readily available.
N H
M A I N E
Project Area
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Lovell Lake
Great East Lake
Lake Ivanhoe
Horn Pond
Wilson Lake
Cope Brook
Branch River
Copp Brook
Brook
16
153
109

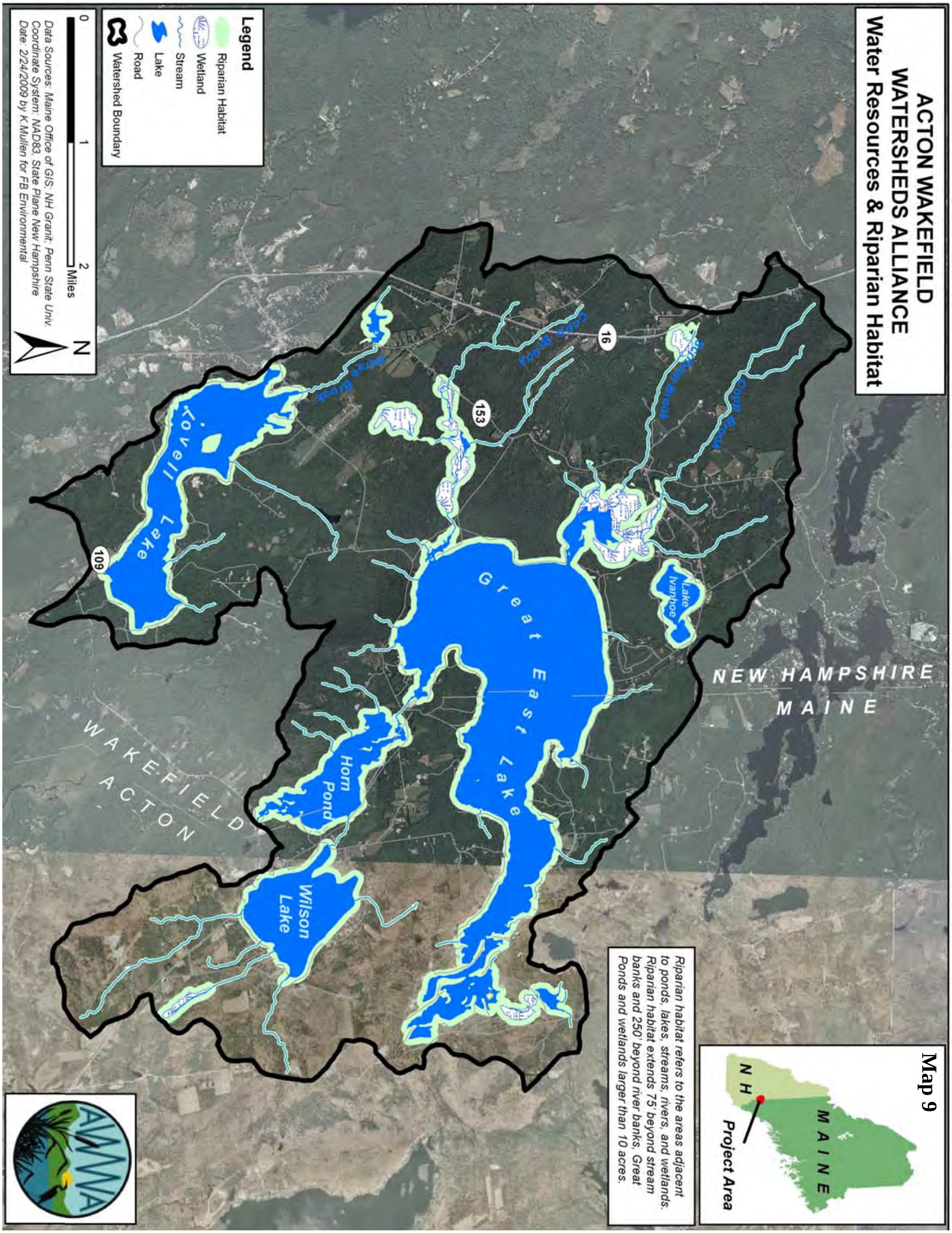

ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Wildlife Areas
Legend
Inland Waterfowl / Wading Bird Habitat
Marshes for Conservation
Tier 1 - High Priority for Conservation
Tier 2 - Medium Priority for Conservation
Low Priority for Conservation
Conservation Focus Area
Core Area
Supporting Natural Landscape
Stream
Lake
Road
Watershed Boundary
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Map 5
NH
MAINE
Project Area
Wildlife areas and marshes for conservation are ranked by the level of biodiveristy found in the area and the current condition of the landscape.
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Great East Lake
Lovell Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Cope Brook
Scribner Brook
16
153
109

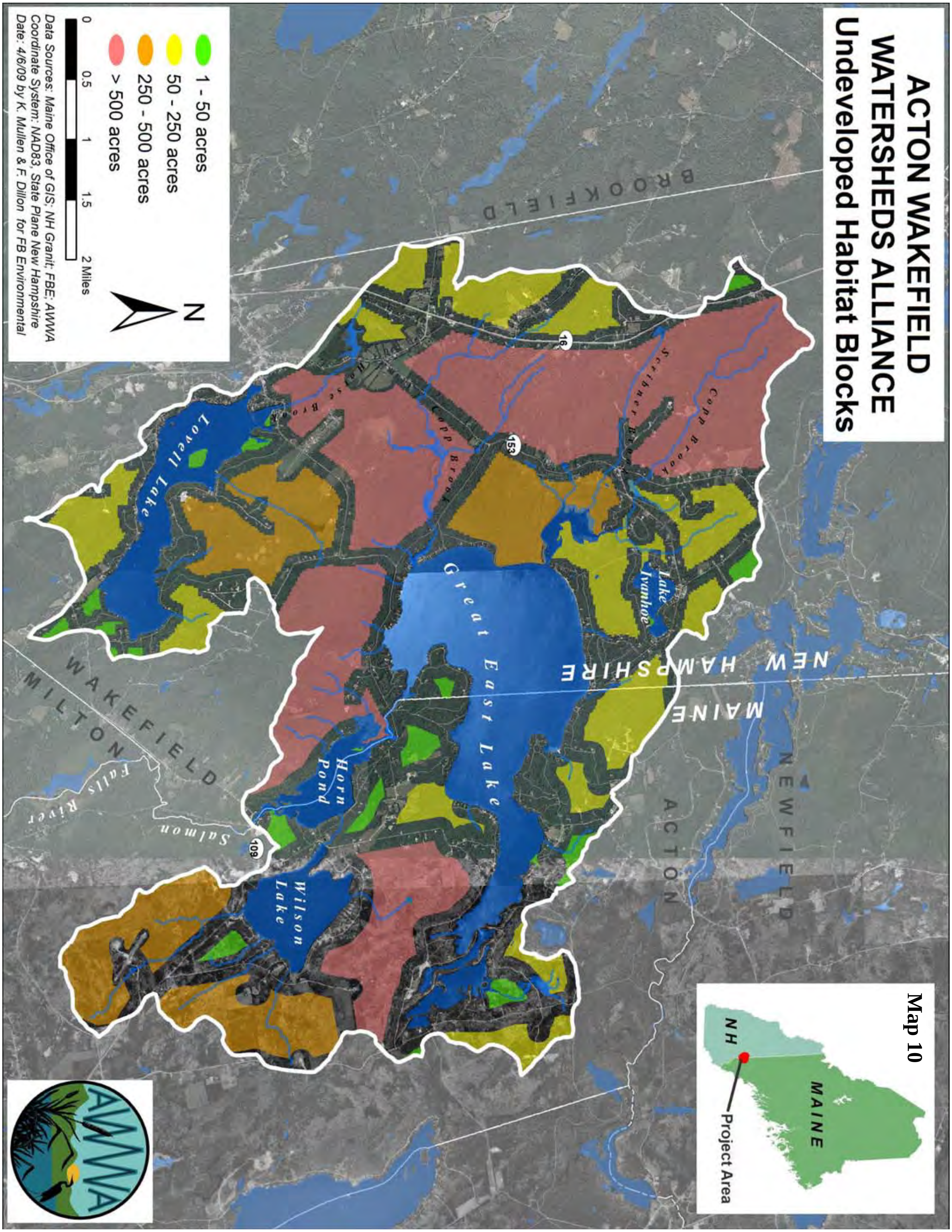

ACTON WAKEFIELD WATERSHEDS ALLIANCE
Topography
Map 6
Long Mountain 1060 ft
AWWA Watershed Area = 26.2 Sq. mi.
Cooks Hill 1060 ft
Perkins Hill 780 ft
Oak Hill 1080 ft
Davis Hill 1080 ft
Gerrish Mountain 940 ft
Great East Lake
Lovell Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Copp Brook
Scribner Brook
Horse Brook
16
153
109
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Elevation (feet)
560.00
560.01 - 600.00
600.01 - 640.00
640.01 - 680.00
680.01 - 720.00
720.01 - 760.00
760.01 - 800.00
800.01 - 840.00
840.01 - 880.00
880.01 - 920.00
920.01 - 960.00
960.01 - 1000.00
1000.01 - 1040.00
1040.01 - 1080.00
Watershed Boundary
State/Town Boundary
Lake
Stream
Road
0 1 2 Miles
N
Data Sources: Maine Office of GIS; NH Granit
Coordinate System: NAD83, State Plane New Hampshire
Date: 12/7/2009 by K.Mullen for FB Environmental
NH
MAINE
Project Area
AWWA

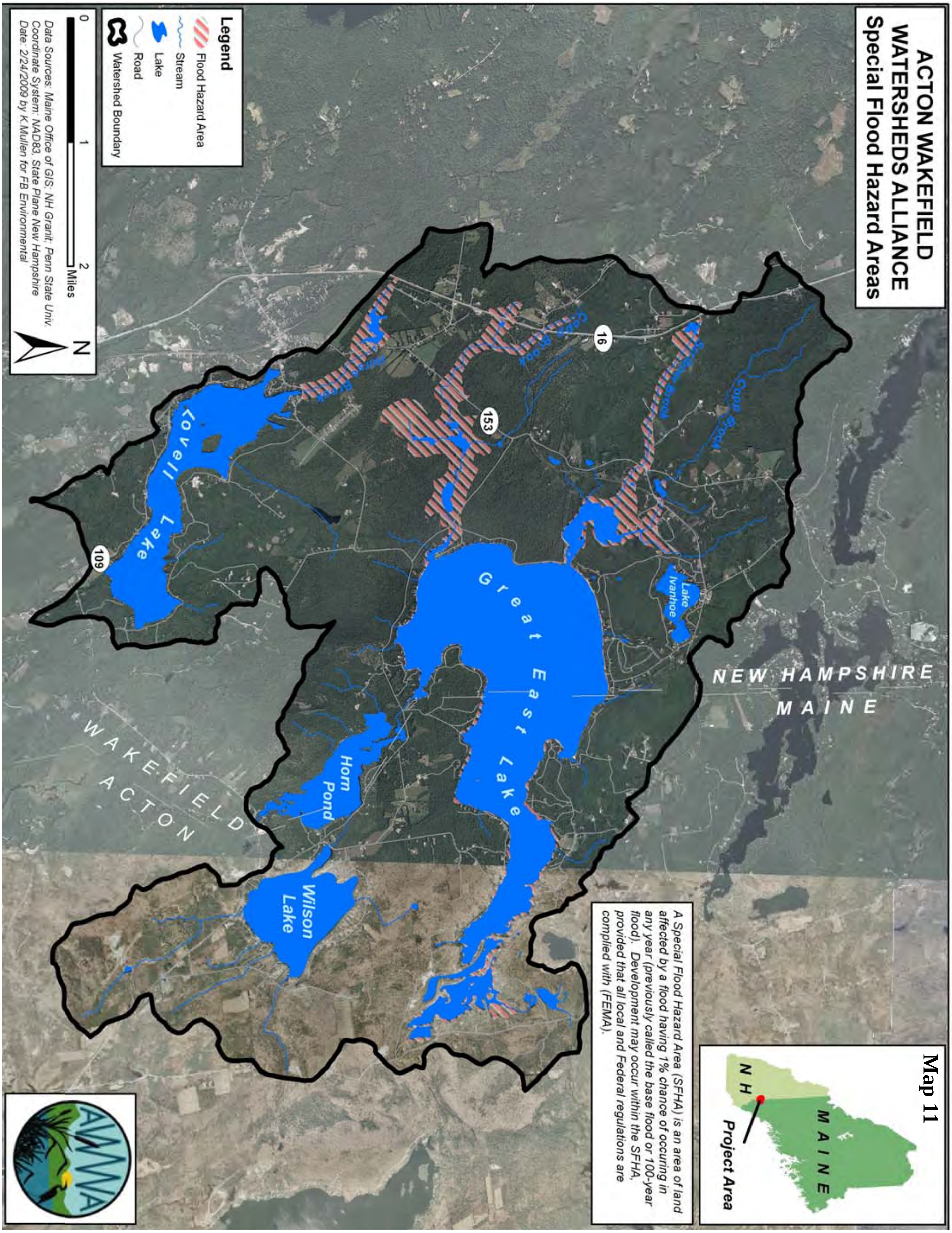

ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Soil Erosion Potential
Legend
Highly Erodible
Potentially Highly Erodible
Not Highly Erodible
Not Rated
Stream
Lake
Watershed Boundary
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Map 7
N H
M A I N E
Project Area
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Great East Lake
Lovell Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Copp Brook
Scribner Brook
Horse Brook



ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Water Quality Sampling Sites
Legend
Sampling Location
Stream
Lake
Road
Watershed Boundary
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Map 8
N H
M A I N E
Project Area
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Great East Lake
Lovell Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Copp Brook
Pike Brook
Scribner Brook
16
153
109
#1 North
#3 Mid
#2 South
2 Canal
Station 1
Station 2
Station 1
Station 1
Station 2
Station 1
3 Mmann
Basin 1 Narrows
Basin 2
Basin 3
Station 1


ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Water Resources & Riparian Habitat
Map 9
Legend
Riparian Habitat
Wetland
Stream
Lake
Road
Watershed Boundary
0 1 2 Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
Lovell Lake
Great East Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Copp Brook
16
153
109
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Riparian habitat refers to the areas adjacent to ponds, lakes, streams, rivers, and wetlands. Riparian habitat extends 75' beyond stream banks and 250' beyond river banks, Great Ponds and wetlands larger than 10 acres.
NH
MAINE
Project Area


ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Undeveloped Habitat Blocks
1 - 50 acres
50 - 250 acres
250 - 500 acres
> 500 acres
0
0.5
1
1.5
2 Miles
N
Data Sources: Maine Office of GIS; NH Granit; FBE; AWWA
Coordinate System: NAD83, State Plane New Hampshire
Date: 4/6/09 by K. Mullen & F. Dillon for FB Environmental
Map 10
NH
MAINE
Project Area
BROOKFIELD
WAKEFIELD
MILTON
NEW HAMPSHIRE
MAINE
NEWFIELD
ACTON
Great East Lake
Lovell Lake
Horn Pond
Wilson Lake
Lake Ivanhoe
Salmon Falls River
Copp Brook
Scribner Brook
Horse Brook
16
153
109



ACTON WAKEFIELD
WATERSHEDS ALLIANCE
Special Flood Hazard Areas
Map 11
N H
M A I N E
Project Area
A Special Flood Hazard Area (SFHA) is an area of land affected by a flood having 1% chance of occuring in any year (previously called the base flood or 100-year flood). Development may occur within the SFHA, provided that all local and Federal regulations are complied with (FEMA).
Legend
Flood Hazard Area
Stream
Lake
Road
Watershed Boundary
0
1
2
Miles
N
Data Sources: Maine Office of GIS; NH Granit; Penn State Univ.
Coordinate System: NAD83, State Plane New Hampshire
Date: 2/24/2009 by K.Mullen for FB Environmental
NEW HAMPSHIRE
MAINE
WAKEFIELD
ACTON
Great East Lake
Lovell Lake
Lake Ivanhoe
Horn Pond
Wilson Lake
16
153
109
Copp Brook
Cope Brook

APPENDIX C:
Watershed Survey Summary Sheets

LAKE IVANHOE WATERSHED SURVEY SUMMARY FACT SHEET

BACKGROUND:

The Lake Ivanhoe Watershed (all the land that drains to Lake Ivanhoe) covers 455 acres (0.71 square miles) in Wakefield, New Hampshire . Lake Ivanhoe has 1.7 miles of shoreline.

Lake Ivanhoe's water quality has historically been classified as above average, according to the NH Department of Environmental Services (NH DES). Recently the lake has been classified as "potentially impaired" based on analysis of recently collected water quality parameters. Soil erosion is the single greatest source of pollution to Lake Ivanhoe.

- Soil contains phosphorus, a nutrient that helps plants like algae grow. When extra phosphorus enters a lake and causes excess algae to grow the lake can experience an algae bloom. Algae blooms make it undesirable for people to recreate on lakes.
- When algae living in a lake dies, it decomposes, depleting the oxygen level of the lake. Below certain oxygen levels animals living in the lake are unable to survive.
- Algae growth directly contributes to turbidity (cloudiness of water). Studies have shown that as water clarity decreases, property values also drop.

WATERSHED SURVEY:

In June 2009, a team of 46 volunteers and technical leaders fanned out around the Lake Ivanhoe and Great East Lake watersheds in 10 teams to identify areas of erosion that contribute pollution to the lakes. Technical leaders for the survey teams were from Acton Wakefield Watersheds Alliance, York County SWCD, NH DES, and Maine DEP .

The volunteers took careful notes using standardized data sheets. They also photographed the site for future reference. On each site where erosion was evident volunteers characterized the impact that the site was having on the lake, estimated the cost to remediate the problem and made BMP recommendations.

Volunteers and technical staff identified 25 sites that are impacting or have the potential to impact water quality of Lake Ivanhoe. They estimated that 3 of the sites have a potentially high impact on water quality, 13 had a moderate potential impact, and 9 sites are expected to have a low level of impact on water quality.

Volunteer photos of erosion sites documented during the survey.

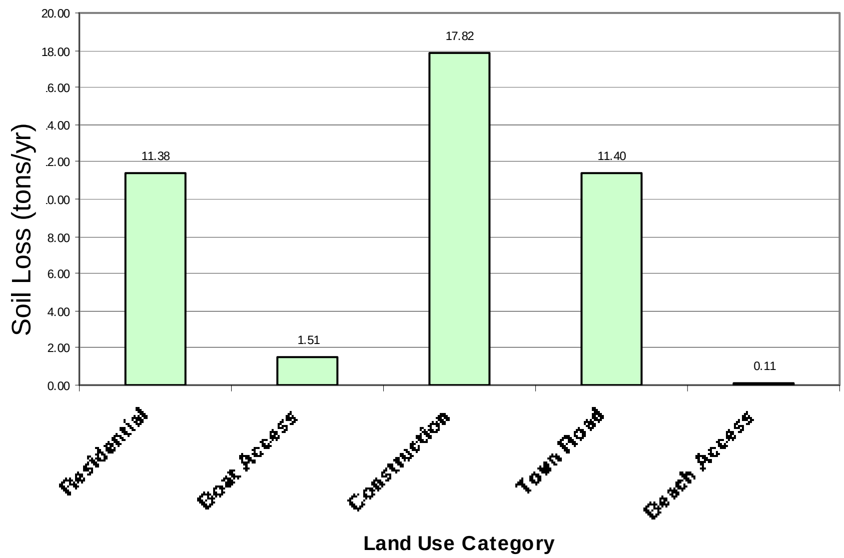
KEY SURVEY RESULTS:

- Residential properties accounted for 20 of the identified sites (80%) . Most of these sites have a low or medium impact on water quality and will be inexpensive to fix (less than $500) using some simple best management practices, often easily fixed by the landowner. Currently these residential sites are contributing an estimated 11.4 tons of soil per year to the lake.
- Problems with Beach and Boat access areas accounted for 3 of the sites identified (12%).
- One town road and one logging road/ construction area were assessed to have high potential impact on the lake, contributing 11.4 and 17.82 tons of soil per year respectively. These sites were both assessed to have a high cost to repair and are likely to require technical expertise for adequate remediation.
- The estimated soil loss to the lake from erosion sites identified during the survey is 42.2 tons per year.

PROJECT PARTNERS:

Great East Lake Improvement Association, AWWA, York County Soil & Water Conservation District, NH Department of Environmental Services, and Maine Department of Environmental Protection

Soil Loss To Lake Estimates



Erosion sites were identified all around the watershed and on 5 different types of land uses and soil loss was estimated in each of these categories. Everyone has a role to play in protecting Lake Ivanhoe. The Town of Wakefield, waterfront property owners, road associations, and even people living far from the lake can all help reduce pollution entering the lake to protect this treasured resource.

NEXT STEPS:

- The information gathered from the watershed survey will be utilized in the creation of a watershed-based management plan for the Headwater Lakes of the Salmon Falls River .
- AWWA and the Round Pond Association will work together to apply for grants to help landowners, road associations, and the towns to fix some of the larger erosion problems identified in the survey.
- Landowners of identified sites will have the opportunity to meet with the AWWA Technical director and receive a site-specific remediation design as well as be considered as a YCC project host.
- Letters will be mailed to all landowners with identified erosion problems to encourage them to take action to fix their property and to provide them with access to the necessary resources.

FOR MORE INFORMATION:

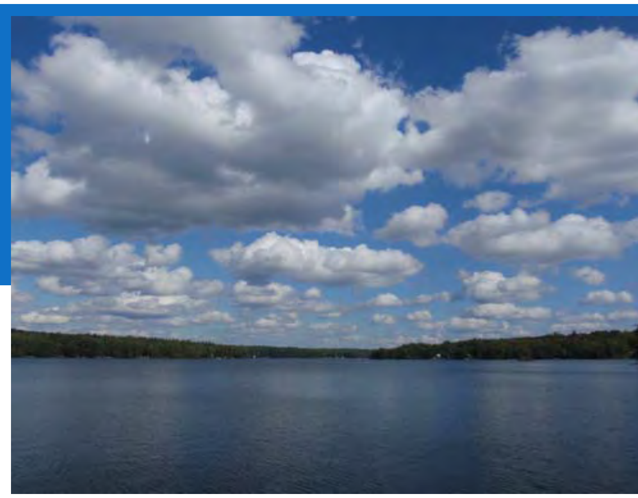
A digital copy of the full survey report is available online at *www.AWwatersheds.org*. If you would like information about fixing erosion problems on your property or a copy of the Lake Ivanhoe Watershed Survey Report, contact:

David Giunta, President, Round Pond Association
(603) 522-3592
roundpond@ourlakehouse.net

Acton Wakefield Watersheds Alliance
info@awwatersheds.org
(603) 473-2500

Funding for this project was provided in part by a grant from the NH Department of Environmental Services with funding from the US Environmental Protection Agency under Section 319 of the Clean Water Act

GREAT EAST LAKE WATERSHED SURVEY SUMMARY FACT SHEET



BACKGROUND:

The Great East Lake Watershed (all the land that drains to Great East Lake) covers 9,990 acres (15.6 square miles) in the towns of Wakefield, New Hampshire and Acton, Maine.

Great East Lake's water quality is above average, according to the NH Dept. of Environmental Services (DES) and Maine Department of Environmental Protection. Soil erosion is the single greatest source of pollution to Great East Lake.

- Soil contains phosphorus, a nutrient that helps plants like algae grow. When extra phosphorus enters a lake and causes excess algae to grow the lake can experience an algae bloom. Algae blooms make it undesirable for people to recreate on lakes.
- When algae living in a lake dies, it decomposes, depleting the oxygen level of the lake. Below certain oxygen levels animals living in the lake are unable to survive.
- Algae growth directly contributes to turbidity (cloudiness of water). Studies have shown that as water clarity decreases, property values also drop.

WATERSHED SURVEY:

In June 2009, a team of 46 volunteers and technical leaders fanned out around the Great East and Lake Ivanhoe watersheds in 10 teams to identify areas of erosion that contribute pollution to the lakes. Technical leaders for the survey teams were from Acton Wakefield Watersheds Alliance, York County SWCD, NH DES, and Maine DEP.

The volunteers took careful notes when they identified a source of erosion using standardized data sheets. They also photographed the site for future reference. On each site where erosion was evident volunteers characterized the impact that the site was having on the lake, estimated the cost to remediate the problem and made BMP recommendations.

Volunteers and technical staff identified 177 sites that are impacting or have the potential to impact water quality.

Great East Lake Watershed

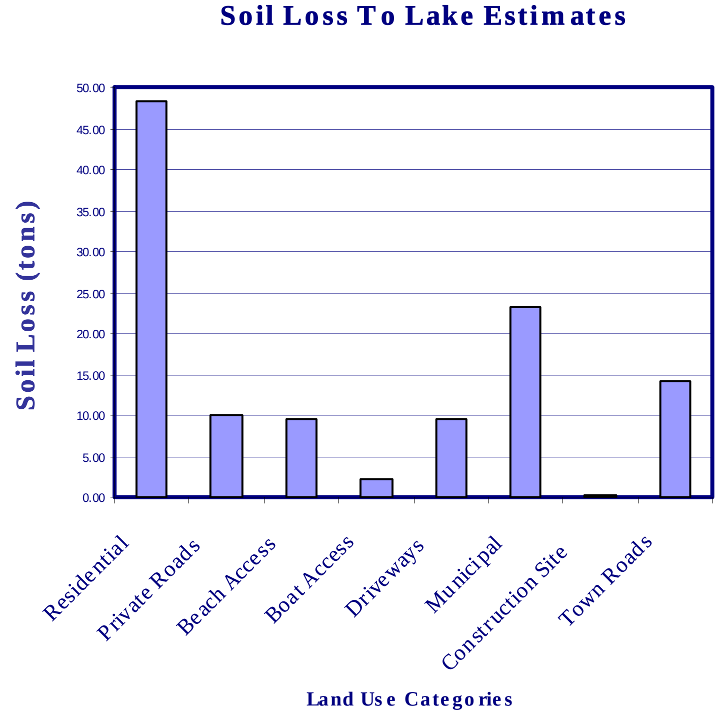
Volunteer photos of erosion sites documented during the survey.

KEY SURVEY RESULTS:

- Residential properties accounted for 108 of the identified sites (62%) . Most of these sites have a low impact on water quality and will be inexpensive to fix (less than $500) using some simple best management practices, often easily fixed by the landowner. Currently these residential sites are contributing an estimated 48.3 tons of soil per year to the lake.
- Private and state roads accounted for 29 of the sites identified (16%) . These sites have the potential to have a severe impact on the lake with higher associated costs (greater than $2500) and often require technical experience to properly solve the erosion problems. In the Great East Lake watershed town and private roads currently add 24.1 tons of soil per year to the lake.
- The estimated soil loss to the lake from erosion sites identified during the survey is over 105 tons per year.

PROJECT PARTNERS:

Great East Lake Improvement Association, AWWA, York County Soil & Water Conservation District, NH Department of Environmental Services, and Maine Department of Environmental Protection



Erosion sites were identified all around the watershed and on 9 different types of land uses and soil loss was estimated in 8 different land use categories. Everyone has a role to play in protecting Great East Lake. The Towns of Wakefield and Acton, waterfront property owners, road associations, and even people living far from the lake can all help reduce pollution entering the lake to protect this treasured resource.

NEXT STEPS:

- The information gathered from the watershed survey will be utilized in the creation of a watershed-based management plan for the Headwater Lakes of the Salmon Falls River.
- AWWA and GELIA will work together to apply for grants to help landowners, road associations, and the towns to fix some of the larger erosion problems identified in the survey.
- Landowners of identified sites will have the opportunity to meet with the AWWA Technical director and receive a site-specific remediation design as well as be considered as a YCC project host.
- Letters will be mailed to all landowners with identified erosion problems to encourage them to take action to fix their property and to provide them with access to the necessary resources.

FOR MORE INFORMATION:

A digital copy of the full survey report is available online at *www.awwatersheds.org*. If you would like information about fixing erosion problems on your property or a copy of the Great East Lake Watershed Survey Report, contact:

Bess Smith, GELIA President
pres@greateastlake.org

Acton Wakefield Watersheds Alliance
info@awwatersheds.org
(603) 473-2500

Funding for this project was provided in part by a grant from the NH Department of Environmental Services with funding from the US Environmental Protection Agency under Section 319 of the Clean Water Act

HORN POND WATERSHED SURVEY SUMMARY FACT SHEET

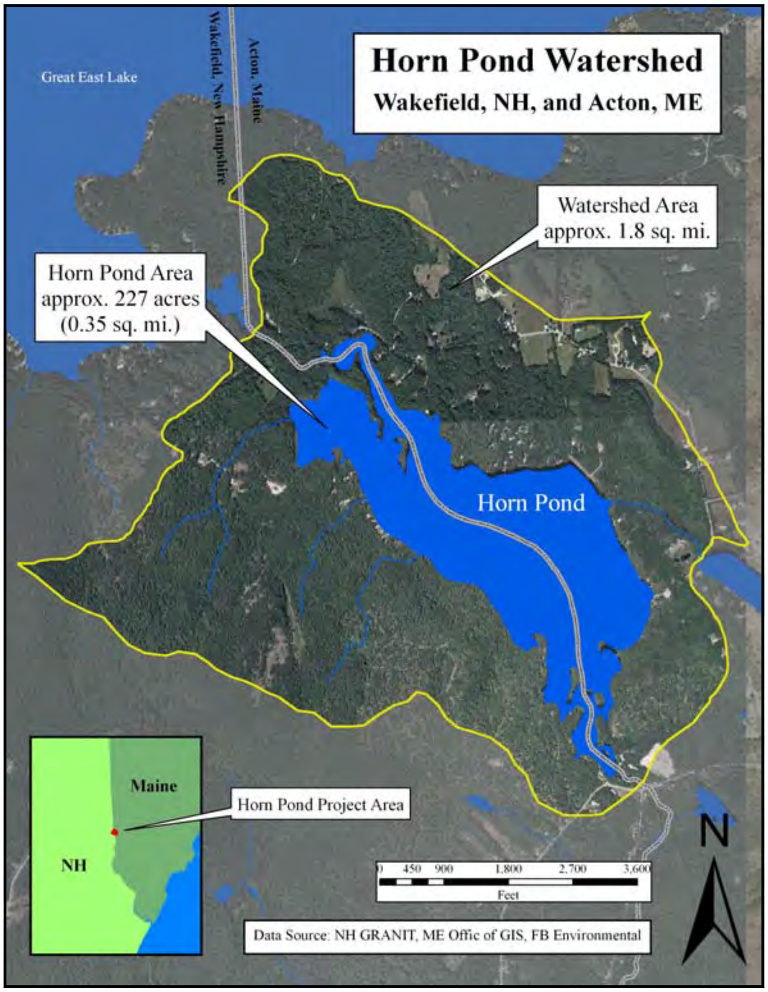
photo courtesy of Saugus Photos Online

BACKGROUND:

The Horn Pond watershed (all the land that drains to Horn Pond) covers 1.8 square miles in the towns of Wakefield, NH, and Acton, ME.

Horn Pond's water quality is above average according to the NH Dept. of Environmental Services (DES) but it is threatened by polluted runoff. Soil erosion, in particular, is the single greatest source of pollution to Horn Pond.

- Soil contains the nutrient, phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen through the breakdown process, and fish and animals are unable to survive.
- Algae blooms also turn water green and make a lake virtually unusable.
- Studies have shown that as water clarity decreases, property values also drop.



Examples of Identified Erosion Problems

WATERSHED SURVEY:

In June 2008, a team of 20 local volunteers and technical staff from Acton Wakefield Watersheds Alliance, York County SWCD, NH DES, and Maine DEP conducted a survey of the watershed and identified 55 sites that are contributing polluted runoff to Horn Pond.

Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Teams made recommendations to remediate each source using erosion control practices and rated impact and cost to fix.

Results and recommendations were compiled in the ***Horn Pond Watershed Survey Report***.

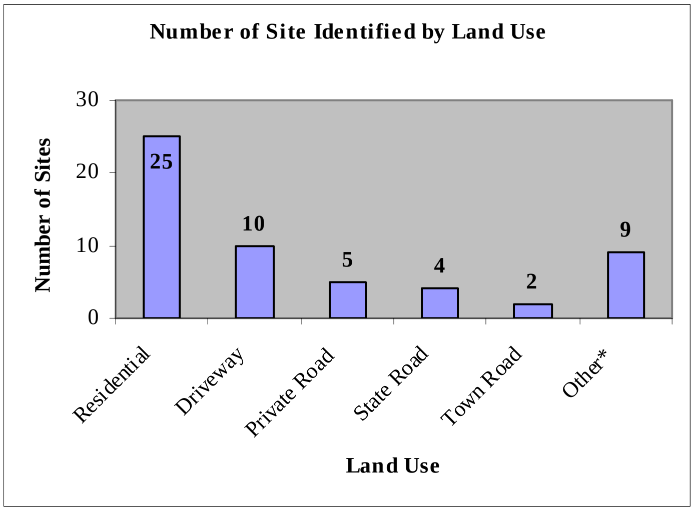
KEY SURVEY RESULTS:

Volunteers and technical staff identified 55 sites in the Horn Pond Watershed that are impacting or have the potential to impact water quality.

- 25 of the identified sites (45%) were found on residential properties. Most of these sites have a low impact on water quality and will be inexpensive to fix (less than $500) with little technical expertise required. These tend to be simple fixes that can be done by the landowners themselves.
- 11 of the sites identified (24%) are associated with roads: State, town, and private. These sites tend to have a more severe impact on the lake with higher associated costs (greater than $2500) and required technical knowledge. Also, the procedures involved with remediating these sites are more time and resource consuming.
- Canal Road and New Bridge Road pose serious problems for the lake. These paved roads produce a large amount of surface runoff during periods of precipitation. The roads are also pitched in such as way as to shed the majority of this runoff towards the lake. Winter sand, road salt, oil and gas, heavy metals, and other pollutants wash off the road and are carried into the lake, creating a water quality hazard. Canal Road drains directly into the Great East Lake Canal that flows into Horn Pond. The buffer between New Bridge Road and the lake is severely limited. In some areas only a few feet separate the two.

Project Partners:

Acton Wakefield Watersheds Alliance, NH DES, York County SWCD, Maine DEP, Town of Wakefield, NH, Town of Acton, ME



* Other includes: Construction Site (3), Boat Access (3), Trail or Path (2), Beach Access (1)

Erosion sites were identified all around the watershed and on 9 different types of land uses (see above). As such, everyone has a role to play in lake protection. The Towns of Wakefield and Acton, waterfront landowners, road associations, and even people living far from the lake can all help reduce lake pollution.

NEXT STEPS:

- The information gathered from the watershed survey will be utilized in the creation of a Watershed Based Management Plan for the Headwaters of the Salmon Falls River Watersheds.
- Residents of the Horn Pond Watershed will be encouraged to form a lake association to address concerns impacting the community. Lake associations are powerful tools that can promote effective solutions to the problems identified in this survey.
- The Acton Wakefield Watersheds Alliance will apply for grants to help landowners, road associations, and the town to fix some of the larger erosion problems identified in the survey.
- Letters will be mailed to all landowners with identified erosion problems to encourage them to take action to fix their property and to provide them with access to the necessary resources.
- Landowners of identified sites will have the opportunity to meet with the Technical Director and receive a site-specific remediation design as well as be considered as a YCC project host.

FOR MORE INFORMATION:

If you would like information about fixing erosion problems on your property or a copy of the Horn Pond Watershed Survey Report, contact:

Acton Wakefield Watersheds Alliance
www.awwatersheds.org
info@awwatersheds.org
(603) 473-2500

Funding for this project was provided in part by a grant from the NH Department of Environmental Services with funding from the US Environmental Protection Agency under Section 319 of the Clean Water Act

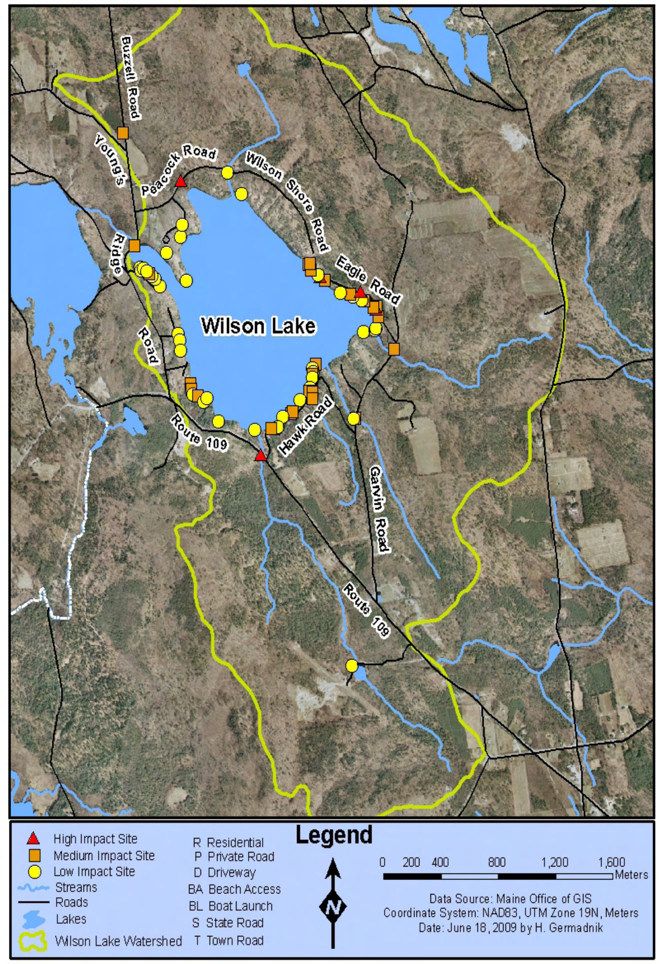
WILSON LAKE WATERSHED SURVEY SUMMARY FACT SHEET

BACKGROUND:

The Wilson Lake watershed (all the land that drains to Wilson Lake) covers 3.86 square miles in the Town of Acton, Maine.

According to the Maine Department of Environmental Protection (DEP), Wilson Lake's water quality is about average but low oxygen levels indicate that it is threatened by polluted runoff. Soil erosion, in particular, is the single greatest source of pollution to Wilson Lake.

- Soil contains the nutrient, phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen through the breakdown process, and fish and animals are unable to survive.
- Algae blooms also turn water green and make a lake virtually unusable.
- Studies have shown that as water clarity decreases, property values also drop.



Sediment delta in Wilson Lake due to severe erosion on Eagle Road.

WATERSHED SURVEY:

In the Spring of 2009 a team of 32 local volunteers and technical staff from the Wilson Lake Association, York County SWCD, Acton Wakefield Watersheds Alliance, Maine DEP and New Hampshire DES conducted an survey of the watershed and identified 71 sites with soil erosion that are contributing polluted runoff to Wilson Lake.

Teams documented erosion problems on roads, properties, driveways and trails on standardized field data sheets. Teams made recommendations to remediate each source using erosion control practices and rated impact and cost to fix.

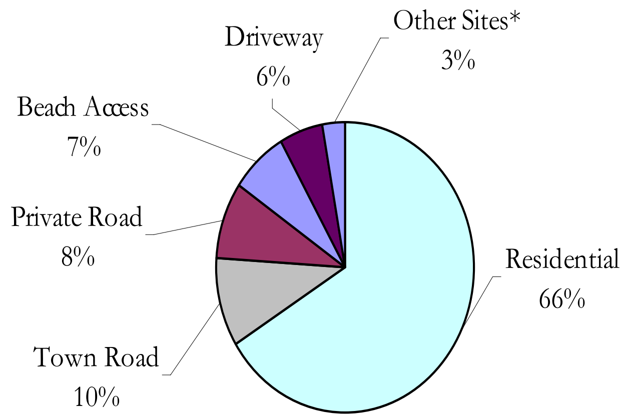
Results and recommendations were compiled in the ***Wilson Lake Watershed Survey Report***.

KEY SURVEY RESULTS:

Volunteers and technical staff identified 71 sites in the Wilson Lake Watershed that are impacting or have the potential to impact water quality.

- 47 of the identified sites (66%) were found in residential areas. These sites tend to have less severe erosion and can be fixed easily with low cost. Individual landowners can play a big role in helping address these problems.
- A significant percentage (25%) of the remaining erosion sites were associated with roads (town, private and state roads and driveways). These sites tend to be larger erosion problems with greater lake impacts.
- Erosion sites were identified all around the watershed and on seven different types of land uses. As such, everyone has a role to play in lake protection. The Town of Acton, property owners, business owners, road associations, lakefront landowners and even people living far from the lake can all take measures to reduce lake pollution.

Percentage of Sites by Land Use



*Other includes 1 state road and 1 boat launch.

Project Partners:

Wilson Lake Association
Maine Department of Environmental Protection
Acton Wakefield Watersheds Alliance
York County Soil and Water Conservation District
New Hampshire Department of Environmental Services

NEXT STEPS:

- Now that the watershed survey and report are complete, fixing the sites identified in this survey will require efforts by individuals, the Wilson Lake Association, road associations and municipal officials.
- York County SWCD, AWWA and Wilson Lake Association can use survey findings to apply for a DEP 319 grant to help landowners, road associations and towns fix some of the larger erosion problems identified in the survey. Property owners can also contact AWWA if they would like help from the Youth Conservation Corps.
- Letters will be mailed to all property owners with identified erosion problems. Hopefully, many of these people will take the initiative to start fixing the problems.

FOR MORE INFORMATION:

If you would like information about fixing erosion problems on your property or a copy of the Wilson Lake Watershed Survey Report, contact:

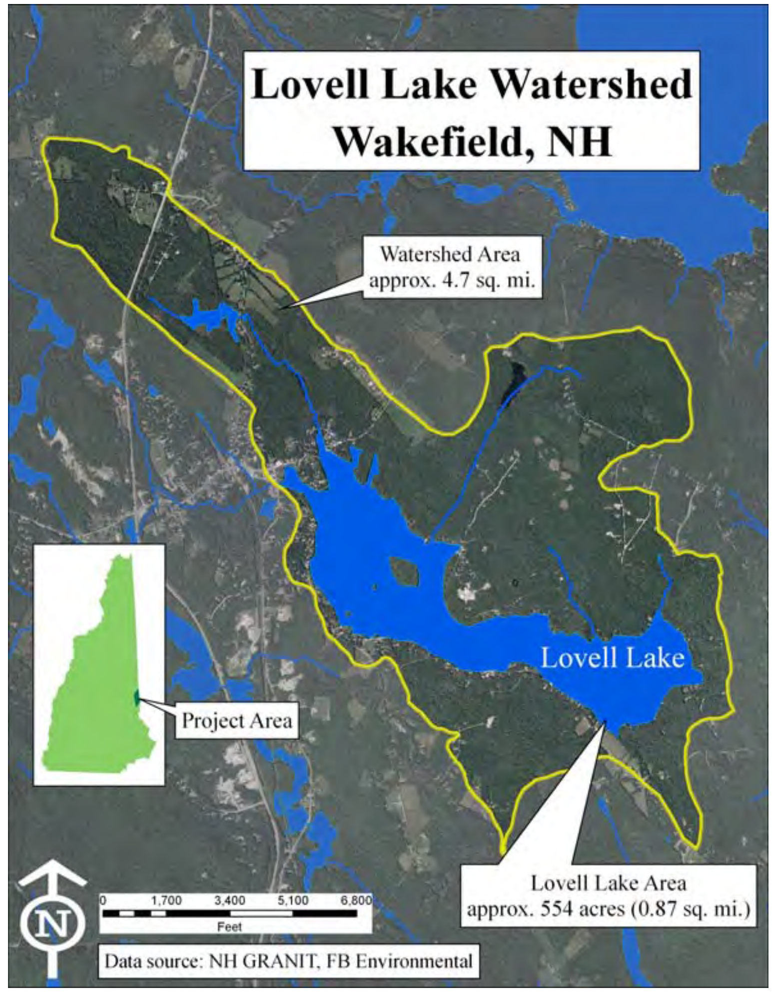
Wilson Lake Association
Jeanne Achille, Survey Coordinator
E-mail: jach28@gmail.com
Tel: (207) 477-0310

York County SWCD
Joe Anderson, Project Manager
E-mail: janderson@yorkswcd.org
Tel: (207) 324-0888

Acton Wakefield Watersheds Alliance
Linda Schier, Executive Director
E-mail: info@AWwatersheds.org
Tel: (603) 473-2500

Maine DEP
Wendy Garland
E-mail: wendy.garland@maine.gov
Tel: (207) 822-6320

LOVELL LAKE WATERSHED SURVEY SUMMARY FACT SHEET



BACKGROUND:

The Lovell Lake watershed (all the land that drains to Lovell Lake) covers 4.7 square miles in the village of Sanbornville in the town of Wakefield.

Lovell Lake's water quality is above average, according to the NH Dept. of Environmental Services (DES), but it is threatened by polluted runoff. Soil erosion, in particular, is the single greatest source of pollution to Lovell Lake.

- Soil contains the nutrient phosphorus which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen through the breakdown process, and fish and animals are unable to survive.
- Algae blooms also turn water green and make a lake virtually unusable.
- Studies have shown that as water clarity decreases, property values also drop.

Examples of Identified Erosion Problems

WATERSHED SURVEY:

In September 2008, a team of 32 local volunteers and technical staff from Acton Wakefield Watersheds Alliance, York County SWCD, NH DES, and Maine DEP conducted a survey of the watershed and identified 161sites that are contributing polluted runoff to Lovell Lake.

Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Teams made recommendations to remediate each source using erosion control practices and rated the impact and cost to fix.

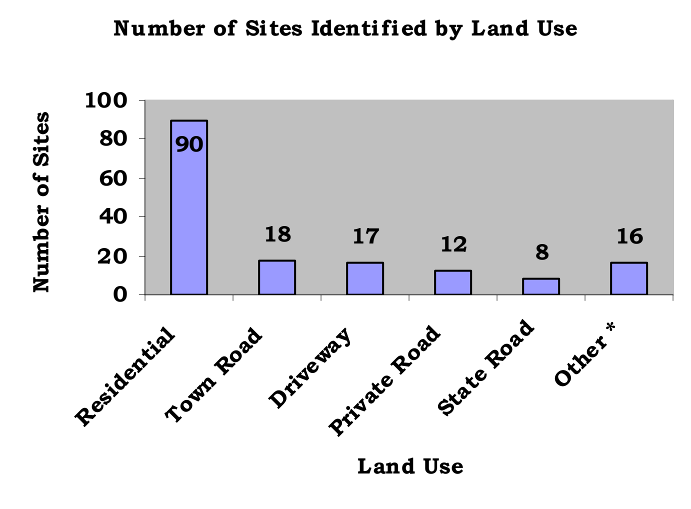
Results and recommendations were compiled in the ***Lovell Lake Watershed Survey Report***.

KEY SURVEY RESULTS:

Volunteers and technical staff identified 161 sites in the Lovell Lake Watershed that are impacting or have the potential to impact water quality.

- 90 of the identified sites (57%) were found on residential properties. Most of these sites have a low impact on water quality and will be inexpensive to fix (less than $500) with little technical expertise required. These tend to be simple fixes that can be done by the landowners themselves.
- 38 of the sites identified (24%) are associated with roads: State, town, and private. These sites tend to have a more severe impact on the lake with higher associated costs (greater than $2500) and required technical knowledge. Also, the procedures involved with remediating these sites are more time and resource consuming.
- Route 109 poses a serious problem for the lake. This paved road produces a large amount of surface runoff during periods of precipitation. The road is also pitched in such as way as to shed the majority of this runoff towards the lake. Winter sand, road salt, oil and gas, heavy metals, and other pollutants wash off the road and are carried into the lake, creating a water quality hazard. The buffer between the road and the lake is severely limited. In some areas only a few feet separate the two.

Project Partners:
Lovell Lake Association, Acton Wakefield Watersheds Alliance, NH DES, York County SWCD, Maine DEP, Town of Wakefield



* Other includes: Beach Access (7), Boat Access (4), Commercial (3), and Municipal/Public (2)

Erosion sites were identified all around the watershed and on 8 different types of land uses (see above). As such, everyone has a role to play in lake protection. The Town of Wakefield, waterfront landowners, road associations, and even people living far from the lake can all help reduce lake pollution.

NEXT STEPS:

- The information gathered from the watershed survey will be utilized in the creation of a Watershed Based Management Plan for the Headwaters of the Salmon Falls River .
- The Lovell Lake Association will work with the Acton Wakefield Watersheds Alliance to apply for grants to help landowners, road associations, and the town to fix some of the larger erosion problems identified in the survey.
- Letters will be mailed to all landowners with identified erosion problems to encourage them to take action to fix their property and to provide them with access to the necessary resources.
- Landowners of identified sites will have the opportunity to meet with the AWWA Technical Director and receive a site-specific remediation design as well as be considered as a YCC project host.
- Grants will be sought by the LLA and AWWA for assistance with remediation of larger projects.

FOR MORE INFORMATION:

If you would like information about fixing erosion problems on your property or a copy of the Lovell Lake Watershed Survey Report, contact:

Tim Sherrill
President, Lovell Lake Association
tsherrill@andovercos.com

Acton Wakefield Watersheds Alliance
www.awwatersheds.org
info@awwatersheds.org
(603) 473-2500

Funding for this project was provided in part by a grant from the NH Department of Environmental Services with funding from the US Environmental Protection Agency under Section 319 of the Clean Water Act

APPENDIX D:
Municipal Ordinance Review

Acton Wakefield Watersheds Alliance Municipal Ordinance Review

Linking Development Rules to Water Quality Protection

March 2009

Prepared by:
FB Environmental Associates, Inc.
97A Exchange Street, Suite 305
Portland, ME 04101
www.fbenvironmental.com

TABLE OF CONTENTS

Aerial Photo of Wakefield, NH on Cover: Microsoft Live Search Maps (http://maps.live.com/)

1. INTRODUCTION

The border region between Acton, Maine and Wakefield, New Hampshire is host to a variety of relatively unspoiled natural resources. In particular, the exceptional water quality of the region's lakes has long been an attraction for people seeking rest, relaxation and recreation. As more people move to the area to enjoy its unique and special character, increasing development will likely place greater stress on lake water quality. This will primarily occur through polluted runoff, which originates from diffuse areas distributed across the landscape and is considered one of the leading threats to water quality in the United States. There are many potential types of activities and land uses that contribute polluted runoff to local water resources. These include construction sites, residential neighborhoods, commercial developments, and farm fields, among many others. Rainfall or snowmelt picks up pollutants – such as bacteria, nutrients and heavy metals – and carries them to nearby surface waters. The unfortunate result is often a decline in water quality.

The important efforts of the Acton Wakefield Watersheds Alliance (AWWA) and other affiliated lake associations have been critical for ensuring the long-term protection of the high quality waters in the AWWA region. However, in the absence of adequate land use controls on development, the potential exists for adverse impacts to the region's valuable water resources. Numerous studies have shown that the extent and type of development can degrade water quality. In particular, increases in ***impervious cover*** pose significant risks to aquatic ecosystems. Once the level of impervious cover in a developing watershed exceeds 10%, it is usually accompanied by a measureable decrease in water quality (CWP, 1998). Further increases in impervious cover continue this downward trend until it becomes difficult and costly to restore water quality to pre-development levels (Figure 1). The current extent of impervious cover in the AWWA region is less than 5%, well below the 10% threshold at which water quality begins to decline. However, poorly managed development can still have adverse impacts even at low impervious cover levels depending on how and where it occurs.

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

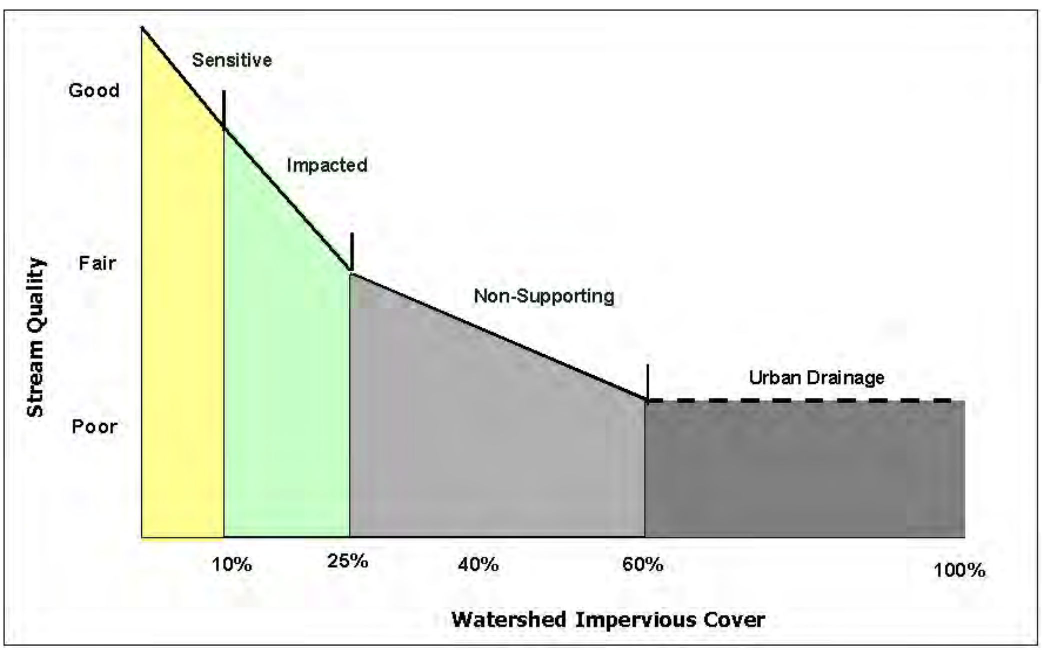


Figure 1. Relationship Between Stream Quality and Watershed Impervious Cover (Source: CWP, 2003).

The AWWA region has experienced considerable population growth over the last several decades (though increases in dwelling units have been more modest). From 1990-2005, Wakefield experienced the largest average annual and overall population growth rates – 3.4% and 56.5%, respectively – of all the communities in Strafford County (NHOEP, 2008). While Acton's population increase from 1990-2000 was more modest compared to other York County communities (it had 9th highest growth rate of the 29 towns in the county), its average annual and overall growth rates were 2.2% and 24.2%, respectively (SMRPC, 2004). Given the AWWA region's unique character and desirability as a residential and recreational destination, it is likely significant growth will continue to occur in Wakefield and Acton well into the future. Consequently, both communities should carefully consider the effects of current municipal land use regulations on local water resources.

2. METHODOLOGY

To help ensure that the AWWA region's water resources continue to be of high quality, FB Environmental conducted a review of municipal land use ordinances for Acton and Wakefield to provide recommendations for how these documents could be better aligned with more sustainable development practices. Acton's most recent Zoning Ordinance, Subdivision Regulations and Road Ordinance were included in the review as were Wakefield's most recent Zoning Ordinance, Subdivision Regulations and Site Plan Regulations. The reviews were based on model development principles created by the Center for Watershed Protection (CWP, 1998). These principles promote the reduction of impervious cover, conservation of natural areas, and prevention of stormwater pollution while simultaneously preserving and enhancing the quality of life in local communities. The model principles are grouped into the following three primary types of "habitat" as a means of facilitating comparisons with other municipal land use ordinances:

- Transportation infrastructure (car habitat)
- Residential and commercial development (parcel habitat)
- Open spaces and natural areas (wildlife habitat)

The CWP's Codes and Ordinance Worksheet (Appendix 1) was used to measure and compare local land use regulations for Acton and Wakefield against model development principles. The results of this comparison are presented below.

3. RESULTS / FINDINGS

The Codes and Ordinance Worksheet consists of 22 model development principles that are further subdivided into 66 site planning benchmarks (Appendix 1). Each benchmark measures a single site design practice and assigns a relative value or score depending on how closely local development regulations conform to the model ordinance. In some cases, determining scores for the ordinances was subject to interpretation since specific ordinance language could not be directly related to the model development principles. Additionally, while not all of the principles are entirely applicable to the rural nature of the AWWA region, they still provide a useful means for identifying opportunities for improving municipal land use regulations.

The highest possible overall score for the Codes and Ordinance Worksheet is 100 and the CWP generally recommends reforming local development rules if the score is less than 80. The overall scores for Acton and Wakefield are 71 and 64, respectively (Table 1, p. 3), suggesting there are considerable opportunities for improvement by both towns. A more detailed discussion of the scoring results for each of the three "habitat" types is provided immediately below. Completed worksheets for both communities are included in Appendix 2.

Table 1. Summary of Codes and Ordinance Worksheet scores for Acton and Wakefield

HABITAT TYPE	CWP Maximum	***Acton's Score***	Adequate	Needs Improvement	***Wakefield's Score***	Adequate	Needs Improvement
Transportation Infrastructure	40	21		√	15		√
Residential & Commercial Development	36	26		√	30		√
Open Spaces & Natural Areas	24	24	√		19		√
Totals:	**100**	**71**			**64**		

3.A. Transportation Infrastructure

This section of the worksheet focuses on the regulations specifying the size, shape and construction of roads, driveways and parking lots. The basic premises for optimizing the design of transportation infrastructure so that it does not adversely affect local water quality is to reduce impervious cover and effectively manage stormwater runoff. The maximum number of points allowed for this section is 40, although a few of the development principles are not very applicable to the AWWA region (e.g., queuing streets, mass transit and parking garages). Acton and Wakefield scored 21 and 15, respectively, which indicates considerable opportunity for improvement.

3.B. Residential and Commercial Development

This worksheet section addresses regulations that determine lot size and shape, housing density and overall neighborhood design. All of the development principles in the section are applicable to the AWWA region. As with transportation infrastructure, impervious cover reduction and stormwater management are the primary goals for local water quality protection along with open space preservation and protection. The maximum number of points allowed for this section is 36. Acton and Wakefield scored 26 and 30, respectively, indicating opportunities for improvement for both communities.

3.C. Open Spaces and Natural Areas

The preservation of wildlife habitat is the ultimate aim for this section of the worksheet. It seeks to assess how local land use regulations either promote (or hamper) efforts to protect natural areas and incorporate open spaces into new development projects. The primary means for providing this protection consist of maintaining adequate native vegetated buffers around shoreline and wetland areas, minimizing the extent of soil disturbance for new construction projects and preventing the discharge of untreated stormwater into sensitive aquatic habitats. The maximum number of points allowed for this section is 24. Acton and Wakefield scored 24 and 19, respectively, indicating that Acton's land use regulations are adequately protective of water quality from a natural areas perspective while Wakefield's regulations could benefit from some improvements.

4. RECOMMENDATIONS

The recommendations offered in this section should be viewed as the starting point to reforming municipal development rules as a means of providing improved protection to the AWWA region's water resources. They are intended to inform the public dialogue about which particular rules really need to be changed (or added) since considerable effort will be required to codify any potential changes. More research will likely be needed to determine how proposed changes to local land use rules may affect development costs, property values and public safety, among others.

It will be critical to involve key community members in this dialogue in order to strengthen municipal development rules. This includes participants from local government responsible for implementing land use rules, developers and real estate professionals, environmental groups and citizens, among others. A broad consensus will likely be needed to make any substantial changes and the process needed to achieve this consensus could benefit from the assistance of an outside facilitator. Such a facilitator can ensure that all perspectives and views are included in the decision making process and can help guide the participants to action.

4.A. Transportation Infrastructure
Acton and Wakefield both scored well below the maximum of 40 points for this section of the Codes and Ordinance Worksheet (21 and 15, respectively). As such, both communities have numerous opportunities to strengthen their municipal development rules for enhanced protection of the AWWA region's water resources. Recommendations for each applicable model development principle are provided below.

Principle 1. Street Width: This development principle consists of two benchmarks, including minimum pavement width (4 points) and an allowance for queuing streets in municipal development rules (3 points). Both communities received 4 points for minimum pavement width since their land use rules allow for street widths of 20' or less. Narrower street widths will reduce the rate of increase in impervious cover for future development projects and thereby decrease potential impacts to local water quality. Neither community has provisions in their land use rules for queuing lanes and therefore received no points for the second benchmark of this design principle.

RECOMMENDATION 1: Acton and Wakefield both allow for minimum street widths of 20' and are therefore in keeping with this design principle. Both communities could consider establishing allowances or requirements for queuing lanes for new development projects (particularly for subdivisions).

Principle 2. Street Length: This development principle is intended to decrease the creation of impervious cover for new development projects and accounts for 1 point in the overall worksheet score. Neither community has provisions in their respective land use rules requiring or promoting the reduction of street lengths for new projects and therefore received no points for this development principle.

RECOMMENDATION 2: Acton and Wakefield should both consider establishing mechanisms that encourage or require the use of shorter street lengths in new development projects as a means of reducing potential impacts to water quality from increases in impervious cover.

Principle 3. Right-of-Way Widths: This development principle consists of two benchmarks, including minimum overall right-of-way width (3 points) and an allowance for the placement of utilities under pavement (1 point). Land use rules for both Acton and Wakefield do not allow for minimum right-of-way widths of 45' or less and therefore received no points for the first benchmark. Both communities do, however, allow for utilities to be placed under pavement and therefore received 1 point for the second benchmark.

RECOMMENDATION 3: Both communities should consider allowing narrower right-of-ways for new development projects. This could be accomplished by allowing for pavement width reductions (Principle 1), sidewalk width reductions, placing sidewalks on only one side of new streets, and by reducing border width requirements between sidewalks and streets. No further action is recommended for utility placement.

Principle 4. Street Cul-de-sac Design: This development principle consists of three benchmarks, including minimum allowable cul-de-sac radius (1 point); allowances for landscaped center islands (1 point); and allowances for alternative turnarounds (1 point). Acton's land use rules allow for a minimum radius of 38' for new cul-de-sacs and therefore earned 1 point for the first benchmark; Wakefield's land use rules exceed the minimum criteria established in the Codes and Ordinance Worksheet and therefore did not receive any points. Both communities allow the center islands of cul-de-sacs to be landscaped and therefore received 1 point for the second benchmark. Acton allows for alternative turnarounds and therefore received 1 point for the third benchmark; Wakefield does not allow for alternative turnarounds and therefore received no points.

RECOMMENDATION 4: Wakefield should consider allowing for a reduction in cul-de-sac radius as a means of reducing impervious cover for new development projects. It should also consider allowing for alternative turnaround designs. Examples include T-shaped turnarounds, smaller radius turnarounds without center islands and loop roads.

Principle 5. Vegetated Open Channels: This development principle consists of two benchmarks, including curb and gutter requirements (2 points) and swale design criteria (2 points). The underlying premise for this principle is that paved streets generally produce stormwater runoff with higher pollutant loads than runoff from vegetated swales. Acton allows for new developments to be built without curbs and gutters provided the road shoulders will not be prone to erosion as a result. Therefore, it received 1 point for the first benchmark. Wakefield requires all new developments to be built with curbs and gutters and therefore received no points. Acton also has established design criteria for vegetated swales to convey stormwater and therefore received 1 point for the second benchmark. Wakefield has no such criteria and therefore received no points.

RECOMMENDATION 5: Wakefield should consider allowing new developments to be built without curbs or gutters and establishing vegetated swale design criteria for stormwater conveyance.

Principle 6. Parking Ratios: This development principle consists of four benchmarks including, minimum parking ratios for professional office buildings (1 point); minimum parking ratios for shopping centers (1 point); minimum parking requirement for single family homes (1 point); and maximum or median (rather than minimum) parking requirements (2 points). All of these benchmarks are intended to curb the construction of excess parking spaces as a means of minimizing impervious cover for future development projects.

Land use rules for Acton and Wakefield do not meet the minimum office building or shopping center parking ratios (<3 and <4.5, respectively) established by the Codes and Ordinance Worksheet and therefore received no points for either of these benchmarks. Both communities earned 1 point for allowing two or fewer parking spaces for single family homes. Neither community received any points for having maximum or median parking requirements.

RECOMMENDATION 6: When (and if) applicable, both communities should consider reducing parking ratios for professional office buildings and commercial shopping centers. Establishing maximum or median parking ratios (in lieu of minimum ratios) should also be considered by both communities.

Principle 7. Parking Codes: This development principle consists of four benchmarks, including promotion of shared parking areas (1 point); development of model shared parking agreements (1 point); allowance for reduced parking ratios with participation in shared parking agreements (1 point); and parking ratio reduction for connections to mass transit (also 1 point, though not very applicable for AWWA region). As with Principle 6, these practices are intended to minimize the extent of excess parking capacity built for new development projects.

Both communities promote the use of shared parking and therefore received 1 point for the first benchmark. Neither community has allowances for the use of shared parking agreements, reduced parking ratios for participating in shared parking agreements, nor reduced ratios for encouragement of mass transit use (which is not available in the AWWA region). Therefore, neither community received any points for these three benchmarks.

RECOMMENDATION 7: Both communities should consider allowing for shared parking agreements along with reduced parking ratios for participating in these agreements. The viability of mass transit for the AWWA region is questionable given the seasonality of residences and relatively low development densities (not enough commuters available to justify transit service).

Principle 8. Parking Lots: This development principle consists of four benchmarks, including minimum parking stall width (1 point); minimum parking stall length (1 point); percent allocation of parking lot for compact cars (1 point); and allowance for pervious materials for spillover parking areas (2 points). Both Acton and Wakefield earned 1 point for allowing minimum parking stall widths of 9'; however, neither community meets the minimum parking stall length of 18' established by the Codes and Ordinance Worksheet and therefore received no points for the second benchmark. Neither community requires parking lots to have 30% of the spaces set aside for compact cars and therefore received no points for this benchmark. Both communities received 1 point for allowing the use of pervious materials in spillover parking areas.

RECOMMENDATION 8: Both communities should consider reducing the requirements for parking stall length to 18' (or less). Both communities should also consider establishing a requirement for new parking lots to be constructed with 30% of the spaces set aside for compact cars.

Principle 9. Structured Parking: This development principle consists of establishing incentives for the construction of parking garages in lieu of surface parking lots and is not really applicable to the AWWA region given its relatively low development density and scarcity of commercial land uses. Consequently, neither community received the 1 point allowed for this principle.

RECOMMENDATION 9: This development principle does not apply well to the AWWA region and therefore no recommendation is warranted.

Principle 10. Parking Lot Runoff: This development principle consists of two benchmarks, including minimum percentage required for landscaping (2 points); and allowance for the use of stormwater BMPs (2 points). Both communities have provisions for both benchmarks in their land use rules and therefore received 2 points for each component.

RECOMMENDATION 10: Both communities may want to consider specifically promoting the use of Low Impact Development type BMPs for future development projects.

4.B. Residential and Commercial Development

Acton and Wakefield both scored below the maximum of 36 points for this section of the Codes and Ordinance Worksheet (26 and 30, respectively). Therefore, both communities have numerous opportunities to strengthen their development rules for enhanced protection of the AWWA region's water resources. Recommendations for each applicable model design principle are offered below.

By-right *open space development allows an open space plan that meets the requirements of the ordinance to go through the same permit and approval process as a conventional development. The by-right form of development prohibits denial of an open space plan in favor of a conventional plan assuming the open space plan meets the provisions of the ordinance (EPA, 2006).*

Principle 11. Open Space Design: This development principle consists of five benchmarks, including allowance for open space / cluster design (3 points); establishing goals for land conservation and impervious cover reduction (1 point); extent of review requirements for open space design projects relative to conventional projects (1 point); allowance for open space / cluster projects to be a ***by-right*** form of development (1 point); and availability of flexible site design criteria in utilizing open space / cluster design options (2 points). All of these benchmarks are intended to promote smaller lot sizes as a means of reducing overall impervious cover (and stormwater runoff) for a particular development project. Indeed, one of the primary benefits of open space design relative to conventional development is impervious cover reduction (Figure 2). Additional benefits include decreased construction costs, conservation of natural areas, creation of community recreational space, and enhanced protection of local water resources. Land use rules for both communities address all the benchmarks of this development principle and therefore each received the maximum of 8 points allowed for it.

RECOMMENDATION 11: While ordinances for both communities allow for the creation of open space / cluster developments, both may want to consider actively promoting the use of open space projects to prospective developers for the numerous benefits they provide. Additionally, both towns may want to consider promoting infill development in their town centers, establishing designated growth areas for cluster development and identifying critical rural zones that limit development.

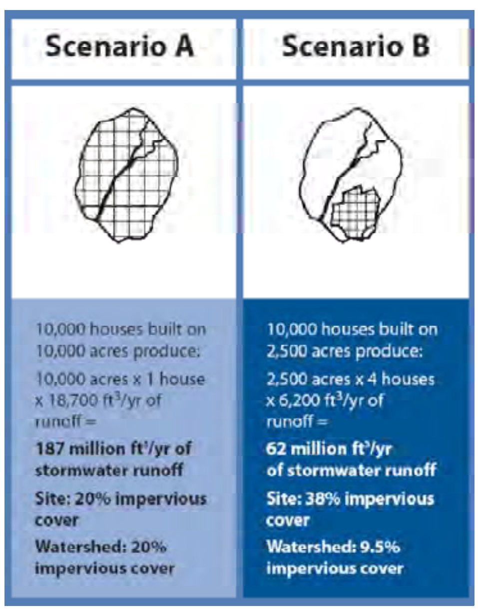


Figure 2. Effects of Development Density on Amounts of Impervious Cover and Stormwater Runoff Volumes (EPA, 2008).

<u>Principle 12. Setbacks and Frontages:</u> This development principle consists of five benchmarks and is primarily intended for developments with small lot sizes (~½ acre). These include an allowance for irregularly shaped lots (1 point); allowance for minimum front setback of 20' or less (1 point); allowance for minimum rear setback of 25' or less (1 point); allowance for minimum side setback of 8' or less (1 point); allowance for minimum frontage distance of less than 80' (2 points). The intent of this principle is to reduce setback distances as a means of decreasing road and driveway lengths in new developments.

Both Acton and Wakefield allow for irregularly shaped lots and each received 1 point for the first benchmark. Wakefield allows for minimum front setbacks of less than 20' and therefore received 1 point for this benchmark whereas Acton has no such allowance and received no points as a result. Both communities allow for minimum rear setbacks of less than 25' and therefore each received 1 point for the third benchmark. Neither community allows for minimum side setbacks of less than 8' and therefore received no points for this benchmark. Wakefield allows for a minimum frontage distance of less than 80' and therefore received 2 points for the final benchmark; Acton has no such allowance and received no points as a result.

RECOMMENDATION 12: Acton should consider allowing for minimum front setbacks of 20' or less, minimum side setbacks of 8' or less and minimum frontage distances of less than 80'. Wakefield should consider allowing for minimum side setbacks of 8' or less.

<u>Principle 13. Sidewalk Design:</u> This development principle consists of four benchmarks, including allowance for minimum width of 4' or less (2 points); allowance to provide sidewalks on only one side of the street (2 points); allowance to slope runoff to adjacent yards (1 point); and allowance for alternate pedestrian networks. The goals of this practice are to reduce the amount of impervious cover and direct stormwater runoff away from street and gutters to the pervious areas in new development projects (1 point).

Wakefield allows for a minimum sidewalk width of 4' or less and therefore received 2 points for the first benchmark; Acton does not allow for sidewalks this narrow and received no points as a result. Both communities allow for sidewalk placement on only one side of the street for new developments and therefore each received 2 points. Neither community has a provision allowing for sidewalks to be sloped to adjacent yards or pervious areas as a means of reducing stormwater runoff to streets or gutters and consequently neither received any points for the third benchmark. Both communities allow for alternate pedestrian networks (trails) and therefore received 1 point for the final benchmark.

RECOMMENDATION 13: Acton should consider allowing new developments to be built with minimum sidewalk widths of 4' or less. Both communities should consider provisions to allow sidewalks to be sloped to adjacent lawns or pervious areas to direct stormwater runoff away from streets or gutters.

<u>Principle 14. Driveway Design:</u> This development principle consists of four benchmarks, including allowance for minimum width of 9' or less (2 points); allowance for use of pervious materials (grass, gravel, porous pavement) for single family home driveways (2 points); allowance for use of "two track" driveway design (1 point); allowance for use of shared driveways in residential developments (1 point).

Neither community allows for driveways to be narrower than 9' and therefore received no points for this benchmark. Both communities allow driveways to be constructed with pervious materials and each received 2 points as a result. Neither community has provisions for the use of a "two track" driveway design.

RECOMMENDATION 14: Both communities should consider allowing driveways for new development or redevelopment projects to be built to a width of 9' or less while also creating provisions for the use of two track driveway designs as a means of reducing impervious cover.

Principle 15. Open Space Management: This development principle consists of five benchmarks, including allowance for establishing associations for the effective management of open spaces (2 points); requirement for consolidation of open spaces into larger units (1 point); requirement for minimum percentage of open space to be managed in natural condition (1 point); established definitions for allowable and prohibited uses for open spaces in residential developments (1 point); and allowance for management of open spaces by third party, land trust or conservation easement (1 point). The intent of this development principle is to ensure that designated open spaces are effectively managed and maintained while retaining as much open space as possible in a natural condition.

Both communities allow for the formation of associations as a means of effectively managing open spaces held in common and therefore both received 2 points for this benchmark. Acton has a requirement for the consolidation of open spaces into larger units and received 1 point for the second benchmark as a result. Wakefield has no such requirement and therefore received no points. Both communities have requirements or provisions for all of the remaining Open Space Management benchmarks and each received 3 points as a result.

RECOMMENDATION 15: Wakefield should consider establishing a requirement for the consolidation of open spaces into larger units as a means of protecting larger blocks of sensitive lands from development and enhancing wildlife habitat.

Principle 16. Rooftop Runoff: This development principle has two benchmarks, including allowance for discharge of rooftop runoff to adjacent yards or pervious areas (2 points); and allowance for site grading or drainage to provide temporary stormwater ponding in yards or on rooftops (2 points). The primary intent of this principle is to reduce the volume and intensity of stormwater runoff to paved areas and piped stormwater conveyance systems. Both communities have provisions in their development rules that allow for stormwater discharge from rooftops to yards or adjacent vegetated areas and temporary stormwater ponding for stormwater runoff reduction. Each town therefore received 4 points for this development principle.

RECOMMENDATION 16: Both communities meet the intent of this development principle. Therefore, no further action is recommended.

****ADDITIONAL RECOMMENDATION:*** Phosphorus is one of the most significant limiting nutrients in freshwater ecosystems and can result in unsightly and harmful algal blooms when it reaches excessive levels. Therefore, communities with sensitive or high value water bodies like Acton and Wakefield may want to consider incorporating phosphorus control measures into their local land use rules. There are numerous examples throughout the country that could serve as useful models for the developing similar measures in the AWWA region.

4.C. Open Spaces and Natural Areas
Acton scored the maximum of 24 points allowed for this section of the Codes and Ordinance Worksheet; Wakefield scored 19 of 24 points indicating some opportunities to strengthen development rules for enhanced protection of the AWWA region's water resources. Recommendations for each applicable model design principle are provided below.

Principle 17. Buffer Systems: This development principle consists of three benchmarks, including provisions in land use rules to provide stream buffers within which minimal development occurs (2 points); if such provisions are in effect, buffer requirement of 75' or greater (1 point); and inclusion of expanded buffer for freshwater wetlands, steep slopes or the 100 year floodplain (1 point). The intent of this principle is to provide a variable width naturally vegetated system that provides enhanced protection for adjacent shorelines, wetlands and streams. Acton's land use rules contain provisions for each of these benchmarks and therefore received the maximum allowable score of 4 points. Wakefield's land use rules contain provisions for the first and third benchmarks and therefore received 3 points for this practice.

RECOMMENDATION 17: Wakefield should consider increasing the buffer requirement for all significant local water resources to at least 75'.

Principle 18. Buffer Maintenance: This development principle consists of three benchmarks, including requirements in the land use ordinance to maintain part of the buffer system with native vegetation (2 points); identification of allowable (or prohibited) uses within the buffer area (1 point); and identification of post-construction enforcement and education mechanisms (1 point). The main intent of this principle is to ensure the preservation or restoration of native vegetation throughout the entire development process. Acton's development rules address all of these benchmarks and therefore received a score of 4 points. Wakefield does not have a requirement for the maintenance of native vegetation but does address the second and third benchmarks and therefore received 2 points.

RECOMMENDATION 18: For new or redevelopment projects, Wakefield should consider requiring that a portion of shoreline, wetland and stream buffers consists of native vegetation to provide for enhanced water quality protection.

Principle 19. Clearing and Grading: This development principle consists of two benchmarks, including requirements or encouragement in land use rules for preservation of natural vegetation at residential development sites (2 points); and allowance for reserve septic field areas to remain vegetated until they are needed for future use (1 point). The intent of this principle is to conserve as much of a development site in its natural state as possible thereby retaining most of the natural hydrologic characteristics. Clearing should be generally limited to the immediate area around the building footprint while allowing for construction access and setbacks to provide for adequate safety (Figure 3). Both communities address both benchmarks in their development rules and therefore each received 3 points for this development principle.

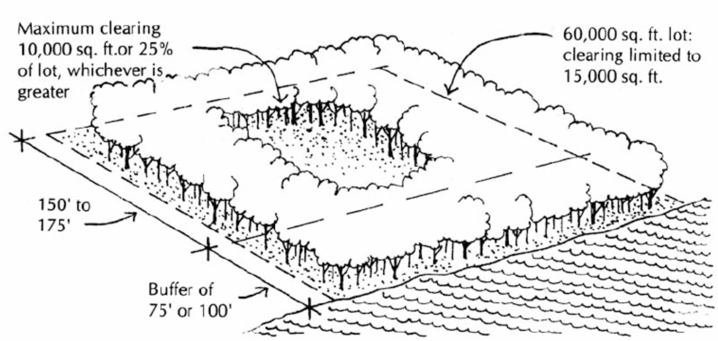


Figure 3. Example of Limits on Clearing for Shoreline Lot (Schueler, 2001 - drawing by Brian Kent)

RECOMMENDATION 19: Both communities meet the intent of this development principle. Therefore, no further action is recommended.

Principle 20. Tree Conservation: This development principle consists of two benchmarks, including requirements to preserve some of the forest or specimen trees at residential development sites (2 points); and requirements to adequately show limits of disturbance on construction plans to prevent clearing of natural vegetation during construction (1 point). As with the previous development principles in this section of the Codes and Ordinance assessment, the intent of this principle is to preserve existing natural vegetation and encourage the use of native plants for revegetation projects. Both communities have provisions in their development rules that address both of these benchmarks and therefore each received 3 points.

RECOMMENDATION 20: Both communities meet the intent of this development principle. Therefore, no further action is recommended.

Principle 21. Land Conservation Incentives: This development principle consists of two benchmarks, including the use of incentives to developers or landowners for the conservation of non-regulated land (2 points); and flexibility for developers to meet regulatory or conservation requirements (2 points). The intent of this development principle is to promote the conservation of vegetated buffers around significant water resources. Both communities provide incentives for land conservation and therefore each received 2 points for this benchmark. Acton allows for some flexibility in its land use rules for developers to meet regulatory or conservation requirements and therefore received 2 points for this benchmark. Wakefield does not allow for this flexibility and received no points as a result.

RECOMMENDATION 21: Wakefield should consider allowing developers some flexibility in meeting regulatory or conservation requirements. Examples include density compensation, buffer averaging, transferable development rights and off-site mitigation, among others.

Principle 22. Stormwater Outfalls: This development principle consists of four benchmarks, including requirements to treat stormwater before discharge to significant water resources (2 points); use of effective design criteria for stormwater BMPs (1 point); prohibition for discharge of untreated stormwater to jurisdictional wetland (1 point); and restriction or prohibition for development within 100 year floodplain (2 points). The intent of this design practice is to prevent the discharge of untreated stormwater to significant water resources (Figure 4). Both communities have provisions in their land use rules for all the benchmarks and therefore received 6 points allowed for this development principle.

Figure 4. A Stormwater Outfall Discharging Untreated Runoff to a Stream (*Photo: FB Environmental*)

RECOMMENDATION 22: Both communities meet the intent of this development principle. Therefore, no further action is recommended.

5. CONCLUSIONS

Development rules for Acton and Wakefield already have substantial protections in place for the AWWA region's valuable water resources. However, as indicated by the preceding assessment, both communities could benefit from further protections – particularly given the high likelihood that the area will continue to grow well into the future. The quality of the AWWA region's water resources is currently exceptional. Unfortunately, there are far too many examples of previously "clean" lakes in Maine and New Hampshire that have experienced the slow and barely perceptible impacts from surrounding development followed by significant declines in water quality. In conducting a review of municipal ordinances (and developing a Watershed Management Plan), AWWA has taken proactive and meaningful steps to ensure that its lakes do not suffer a similar fate. The information contained in this report should help inform local decision makers on how to effectively manage growth and development so the clarity and beauty of the AWWA region's lakes can be preserved in perpetuity for future generations. Ensuring that municipal staff have the resources needed to provide adequate oversight of development practices under improved land use rules will also be of critical importance.

As of this writing (March 2009), the Town of Acton is reviewing their municipal ordinances and Comprehensive Plan for improvements. These improvements will be incorporated into the local land use regulations and presented to the public for a vote in June 2009. It is hoped that this ordinance review is consistent with and provides support for the efforts currently underway in the Town of Acton.

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Appendix 1: Center for Watershed Protection Code and Ordinance Worksheet

CODE AND ORDINANCE WORKSHEET

About the Adobe Acrobat Form

Note: Acrobat Reader will not save the information entered into a form. Saving changes is only possible with a full version of Acrobat.

- The blue fields indicate that an answer is required.
- The gray fields are for notes and are not required, but highly recommended.
- The green fields will automatically summarize the points – no input is needed here.

To fill out a form:

1. Select the hand tool .
2. Position the pointer inside a form field, and click. The I-beam pointer allows you to type text. If your pointer appears as a pointing finger, you can select an item from a list (i.e., YES or NO).
3. After entering text or making a selection, press Tab to accept the form field change and go to the next or previous field.
4. Once you have filled in the appropriate form fields, do both of the following:
   - Choose File > Export > Form Data to save the form data in a separate FDF file. Type a filename and click save.
   - Print the form so that you have a hard copy for your records.

And Most Importantly…
Send CWP a copy! Let us know how you did!

The Code and Ordinance Worksheet allows an in-depth review of the standards, ordinances, and codes (i.e., the development rules) that shape how development occurs in your community. You are guided through a systematic comparison of your local development rules against the model development principles. Institutional frameworks, regulatory structures and incentive programs are included in this review. The worksheet consists of a series of questions that correspond to each of the model development principles. Points are assigned based on how well the current development rules agree with the site planning benchmarks derived from the model development principles.

The worksheet is intended to guide you through the first two steps of a local site planning roundtable.

Step 1: Find out what the Development Rules are in your community.

Step 2: See how your rules stack up to the Model Development Principles.

The homework done in these first two steps helps to identify which development rules are potential candidates for change.

PREPARING TO COMPLETE THE CODE AND ORDINANCE WORKSHEET

Two tasks need to be performed before you begin in the worksheet. First, you must identify all the development rules that apply in your community. Second, you must identify the local, state, and federal authorities that actually administer or enforce the development rules within your community. Both tasks require a large investment of time. The development process is usually shaped by a complex labyrinth of regulations, criteria, and authorities. A team approach may be helpful. You may wish to enlist the help of a local plan reviewer, land planner, land use attorney, or civil engineer. Their real-world experience with the development process is often very useful in completing the worksheet.

Identify the Development Rules

Gather the key documents that contain the development rules in your community. A list of potential documents to look for is provided in Table 1. Keep in mind that the information you may want on a particular development rule is not always found in code or regulation, and maybe hidden in supporting design manuals, review checklists, guidance document or construction specifications. In most cases, this will require an extensive search. Few communities include all of their rules in a single document. Be prepared to contact state and federal, as well as local agencies to obtain copies of the needed documents.

Table 1: Key Local Documents that will be Needed to Complete the COW
Zoning Ordinance
Subdivision Codes
Street Standards or Road Design Manual
Parking Requirements
Building and Fire Regulations/Standards
Stormwater Management or Drainage Criteria
Buffer or Floodplain Regulations
Environmental Regulations
Tree Protection or Landscaping Ordinance
Erosion and Sediment Control Ordinances
Public Fire Defense Masterplans
Grading Ordinance

Identify Development Authorities

Once the development rules are located, it is relatively easy to determine which local agencies or authorities are actually responsible for administering and enforcing the rules. Completing this step will provide you with a better understanding of the intricacies of the development review process and helps identify key members of a future local roundtable. Table 2 provides a simple framework for identifying the agencies that influence development in your community. As you will see, space is provided not only for local agencies, but for state and federal agencies as well. In some cases, state and federal agencies may also exercise some authority over the local development process (e.g., wetlands, some road design, and stormwater).

USING THE WORKSHEET: HOW DO YOUR RULES STACK UP TO THE MODEL DEVELOPMENT PRINCIPLES?

Completing the Worksheet

Once you have located the documents that outline your development rules and identified the authorities responsible for development in your community, you are ready for the next step. You can now use the worksheet to compare your development rules to the model development principles. The worksheet is presented at the end of this chapter. The worksheet presents seventy-seven site planning benchmarks. The benchmarks are posed as questions. Each benchmark focuses on a specific site design practice, such as the minimum diameter of cul-de-sacs, the minimum width of streets, or the minimum parking ratio for a certain land use. You should refer to the codes, ordinances, and plans identified in the first step to determine the appropriate development rule. The questions require either a yes or no response or specific numeric criteria. If your development rule agrees with the site planning benchmark, you are awarded points.

Calculating Your Score

A place is provided on each page of the worksheet to keep track of your running score. In addition, the worksheet is subdivided into three categories:

- Residential Streets and Parking Lots (Principles No. 1 - 10)
- Lot Development (Principles No. 11 - 16)
- Conservation of Natural Areas (Principles No. 17 - 22).

For each category, you are asked to subtotal your score. This "**Time to Assess**" allows you to consider which development rules are most in line with the site planning benchmarks and what rules are potential candidates for change.

The total number of points possible for all of the site planning benchmarks is 100. Your overall score provides a general indication of your community's ability to support environmentally sensitive development. As a general rule, if your overall score is lower than 80, then it may be advisable to systematically reform your local development rules. A score sheet is provided at end of the Code and Ordinance Worksheet to assist you in determining where your community's score places in respect to the Model Development Principles. Once you have completed the worksheet, go back and review your responses. Determine if there are specific areas that need improvement (e.g., development rules that govern road design) or if your development rules are generally pretty good. This review is key to implementation of better development: assessment of your current development rules and identification of impediments to innovative site design. This review also directly leads into the next step: a site planning roundtable process conducted at the local government level. The primary tasks of a local roundtable are to systematically review existing development rules and then determine if changes can or should be made. By providing a much-needed framework for overcoming barriers to better development, the site planning roundtable can serve as an important tool for local change.

Table 2: Local, State, and Federal Authorities Responsible for Development in Your Community				
Development Responsibility		**State/Federal**	**County**	**Town**
Sets road standards	Agency:			
	Contact Name:			
	Phone No.:			
Review/approves subdivision plans	Agency:			
	Contact Name:			
	Phone No.:			
Establishes zoning ordinances	Agency:			
	Contact Name:			
	Phone No.:			
Establishes subdivision ordinances	Agency:			
	Contact Name:			
	Phone No.:			
Reviews/establishes stormwater management or drainage criteria	Agency:			
	Contact Name:			
	Phone No.:			
Provides fire protection and fire protection code enforcement	Agency:			
	Contact Name:			
	Phone No.:			
Oversees buffer ordinance	Agency:			
	Contact Name:			
	Phone No.:			
Oversees wetland protection	Agency:			
	Contact Name:			
	Phone No.:			
Establishes grading requirements or oversees erosion and sediment control program	Agency:			
	Contact Name:			
	Phone No.:			
Reviews/approves septic systems	Agency:			
	Contact Name:			
	Phone No.:			
Review/approves utility plans (e.g., water and sewer)	Agency:			
	Contact Name:			
	Phone No.:			
Reviews/approves forest conservation/ tree protection plans	Agency:			
	Contact Name:			
	Phone No.:			

Development Feature	***Your Local Criteria***

1. Street Width

What is the minimum pavement width allowed for streets in low density residential developments that have less than 500 daily trips (ADT)? _______ feet

*If your answer is between **18-22 feet**, give yourself **4** points*

At higher densities are parking lanes allowed to also serve as traffic lanes (i.e., queuing streets)? YES/ NO

*If your answer is **YES**, give yourself **3** points*

Notes on Street Width (include source documentation such as name of document, section and page #):

2. Street Length

Do street standards promote the most efficient street layouts that reduce overall street length? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Street Length (include source documentation such as name of document, section and page #):

3. Right-of-Way Width

What is the minimum right of way (ROW) width for a residential street? _______ feet

*If your answer is **less than 45 feet**, give yourself **3** points*

Does the code allow utilities to be placed under the paved section of the ROW? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on ROW Width (include source documentation such as name of document, section and page #):

4. Cul-de-Sacs

What is the minimum radius allowed for cul-de-sacs? _______ feet

*If your answer is **less than 35 feet**, give yourself **3** points*

*If your answer is **36 feet to 45 feet**, give yourself **1** point*

Can a landscaped island be created within the cul-de-sac? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Are alternative turnarounds such as "hammerheads" allowed on short streets in low density residential developments? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Cul-de-Sacs (include source documentation such as name of document, section and page #):

5. Vegetated Open Channels

Are curb and gutters required for most residential street sections? YES/ NO

*If your answer is **NO**, give yourself **2** points*

Are there established design criteria for swales that can provide stormwater quality treatment (i.e., dry swales, biofilters, or grass swales)? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Vegetated Open Channel (include source documentation such as name of document, section and page #):

6. Parking Ratios

What is the minimum parking ratio for a professional office building (per 1000 ft^2 of gross floor area)? _______ spaces

*If your answer is **less than 3.0 spaces**, give yourself **1** point*

What is the minimum required parking ratio for shopping centers (per 1,000 ft^2 gross floor area)? _______ spaces

*If your answer is **4.5 spaces or less**, give yourself **1** point*

What is the minimum required parking ratio for single family homes (per home)? _______ spaces

*If your answer is **less than or equal to 2.0 spaces**, give yourself **1** point*

Are your parking requirements set as maximum or median (rather than minimum) requirements? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Parking Ratios (include source documentation such as name of document, section and page #):

7. Parking Codes

Is the use of shared parking arrangements promoted? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Are model shared parking agreements provided? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Are parking ratios reduced if shared parking arrangements are in place? YES/ NO

*If your answer is **YES**, give yourself **1** point*

If mass transit is provided nearby, is the parking ratio reduced? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Parking Codes (include source documentation such as name of document, section and page #):

Subtotal Page 6

8. Parking Lots

What is the minimum stall width for a standard parking space? _______ feet

*If your answer is **9 feet or less**, give yourself **1** point*

What is the minimum stall length for a standard parking space? _______ feet

*If your answer is **18 feet or less**, give yourself **1** point*

Are at least 30% of the spaces at larger commercial parking lots required to have smaller dimensions for compact cars? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Can pervious materials be used for spillover parking areas? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Parking Lots (include source documentation such as name of document, section and page #):

9. Structured Parking

Are there any incentives to developers to provide parking within garages rather than surface parking lots? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Structured Parking (include source documentation such as name of document, section and page #):

10. Parking Lot Runoff

Is a minimum percentage of a parking lot required to be landscaped? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Is the use of bioretention islands and other stormwater practices within landscaped areas or setbacks allowed? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Parking Lot Runoff (include source documentation such as name of document, section and page #):

Time to Assess: Principles 1 - 10 focused on the codes, ordinances, and standards that determine the size, shape, and construction of parking lots, roadways, and driveways in the suburban landscape. There were a total of **40** points available for Principles 1 - 10. What was your total score?

Subtotal Page 5 ____ + Subtotal Page 6 ____ + Subtotal Page 7 ____ = **0**

Where were your codes and ordinances most in line with the principles? What codes and ordinances are potential impediments to better development?

11. Open Space Design

Are open space or cluster development designs allowed in the community? YES/ NO
*If your answer is **YES**, give yourself **3** points*
*If your answer is **NO**, skip to question No. 12*

Is land conservation or impervious cover reduction a major goal or objective of the open space design ordinance? YES/ NO
*If your answer is **YES**, give yourself **1** point*

Are the submittal or review requirements for open space design greater than those for conventional development? YES/ NO
*If your answer is **NO**, give yourself **1** point*

Is open space or cluster design a by-right form of development? YES/ NO
*If your answer is **YES**, give yourself **1** point*

Are flexible site design criteria available for developers that utilize open space or cluster design options (e.g., setbacks, road widths, lot sizes) YES/ NO
*If your answer is **YES**, give yourself **2** points*

Notes on Open Space Design (include source documentation such as name of document, section and page #):

Development Feature	*Your Local Criteria*

12. Setbacks and Frontages

Are irregular lot shapes (e.g., pie-shaped, flag lots) allowed in the community? YES/ NO

*If your answer is **YES**, give yourself **1** point*

What is the minimum requirement for front setbacks for a one half (½) acre residential lot? ________ feet

*If your answer is **20 feet or less**, give yourself **1** point*

What is the minimum requirement for rear setbacks for a one half (½) acre residential lot? ________ feet

*If your answer is **25 feet or less**, give yourself **1** point*

What is the minimum requirement for side setbacks for a one half (½) acre residential lot? ________ feet

*If your answer is **8 feet or less**, give yourself **1** points*

What is the minimum frontage distance for a one half (½) acre residential lot? ________ feet

*If your answer is **less than 80 feet**, give yourself **2** points*

Notes on Setback and Frontages (include source documentation such as name of document, section and page #):

13. Sidewalks

What is the minimum sidewalk width allowed in the community? ________ feet

*If your answer is **4 feet or less**, give yourself **2** points*

Are sidewalks always required on both sides of residential streets? YES/ NO

*If your answer is **NO**, give yourself **2** points*

Are sidewalks generally sloped so they drain to the front yard rather than the street? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Can alternate pedestrian networks be substituted for sidewalks (e.g., trails through common areas)? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Sidewalks (include source documentation such as name of document, section and page #):

14. Driveways

What is the minimum driveway width specified in the community? ________ feet

*If your answer is **9 feet or less (one lane) or 18 feet (two lanes)**, give yourself **2** points*

Can pervious materials be used for single family home driveways (e.g., grass, gravel, porous pavers, etc)? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Can a “two track” design be used at single family driveways? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Are shared driveways permitted in residential developments? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Driveways (include source documentation such as name of document, section and page #):

15. Open Space Management

Skip to question 16 if open space, cluster, or conservation developments are not allowed in your community.

Does the community have enforceable requirements to establish associations that can effectively manage open space? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Are open space areas required to be consolidated into larger units? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Does a minimum percentage of open space have to be managed in a natural condition? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Are allowable and unallowable uses for open space in residential developments defined? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Can open space be managed by a third party using land trusts or conservation easements? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Open Space Management (include source documentation such as name of document, section and page #):

16. Rooftop Runoff

Can rooftop runoff be discharged to yard areas? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Do current grading or drainage requirements allow for temporary ponding of stormwater on front yards or rooftops? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Rooftop Runoff (include source documentation such as name of document, section and page #):

Time to Assess: Principles 11 through 16 focused on the regulations which determine lot size, lot shape, housing density, and the overall design and appearance of our neighborhoods. There were a total of **36** points available for Principles 11 - 16. What was your total score?

Subtotal Page 8 ____ + Subtotal Page 9 ____ + Subtotal Page 10 ____ = **0**

Where were your codes and ordinances most in line with the principles? What codes and ordinances are potential impediments to better development?

17. Buffer Systems

Is there a stream buffer ordinance in the community? YES/ NO

*If your answer is **YES**, give yourself **2** points*

If so, what is the minimum buffer width? ____ feet

*If your answer is **75 feet or more**, give yourself **1** point*

Is expansion of the buffer to include freshwater wetlands, steep slopes or the 100-year floodplain required? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Buffer Systems (include source documentation such as name of document, section and page #):

18. Buffer Maintenance

If you do not have stream buffer requirements in your community, skip to question No. 19

Does the stream buffer ordinance specify that at least part of the stream buffer be maintained with native vegetation? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Does the stream buffer ordinance outline allowable uses? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Does the ordinance specify enforcement and education mechanisms? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Buffer Systems (include source documentation such as name of document, section and page #):

19. Clearing and Grading

Is there any ordinance that requires or encourages the preservation of natural vegetation at residential development sites? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Do reserve septic field areas need to be cleared of trees at the time of development? YES/ NO

*If your answer is **NO**, give yourself **1** point*

Notes on Buffer Maintenance (include source documentation such as name of document, section and page #):

20. Tree Conservation

If forests or specimen trees are present at residential development sites, does some of the stand have to be preserved? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Are the limits of disturbance shown on construction plans adequate for preventing clearing of natural vegetative cover during construction? YES/ NO

*If your answer is **YES**, give yourself **1** point*

Notes on Tree Conservation (include source documentation such as name of document, section and page #):

21. Land Conservation Incentives

Are there any incentives to developers or landowners to conserve non-regulated land (open space design, density bonuses, stormwater credits or lower property tax rates)? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Is flexibility to meet regulatory or conservation restrictions (density compensation, buffer averaging, transferable development rights, off-site mitigation) offered to developers? YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Land Cons. Incentives (include source documentation such as name of document, section and page #):

Development Feature	*Your Local Criteria*

22. Stormwater Outfalls

Is stormwater required to be treated for quality before it is discharged? — YES/ NO

*If your answer is **YES**, give yourself **2** pointS*

Are there effective design criteria for stormwater best management practices (BMPs)? — YES/ NO

*If your answer is **YES**, give yourself **1** point*

Can stormwater be directly discharges into a jurisdictional wetland without pretreatment? — YES/ NO

*If your answer is **NO**, give yourself **1** point*

Does a floodplain management ordinance that restricts or prohibits development within the 100-year floodplain exist? — YES/ NO

*If your answer is **YES**, give yourself **2** points*

Notes on Stormwater Outfalls (include source documentation such as name of document, section and page #):

Code and Ordinance Worksheet *Subtotal Page 13* 0

Time to Assess: Principles 17 through 22 addressed the codes and ordinances that promote (or impede) protection of existing natural areas and incorporation of open spaces into new development. There were a total of 24 points available for Principles 17 - 22. What was your total score?

Subtotal Page 11 ____ + Subtotal Page 12 ____ + Subtotal Page 13 ____ = 0

Where were your codes and ordinances most in line with the principles? What codes and ordinances are potential impediments to better development?

To determine final score, add up subtotal from each **Time to Assess**

Principles 1 - 10 (Page 8)	
Principles 11 - 16 (Page 11)	
Principles 17 - 22 (Page 13)	0

TOTAL 0

SCORING (A total of **100** points are available):	
Your Community's Score	
90- 100	Congratulations! Your community is a real leader in protecting streams, lakes, and estuaries. Keep up the good work.
80 - 89	Your local development rules are pretty good, but could use some tweaking in some areas.
79 - 70	Significant opportunities exist to improve your development rules. Consider creating a site planning roundtable.
60 - 69	Development rules are inadequate to protect your local aquatic resources. A site planning roundtable would be very useful.
less than 60	Your development rules definitely are not environmentally friendly. Serious reform of the development rules is needed.

Appendix 2: Municipal Ordinance Review Results (following pages)

AWWA Region Municipal Ordinance Review - March 2009		Acton, Maine			
		Requirement	Points	Source	Section
Transportation Infrastructure					
1. Street width	Min. pavement width 18-22"	20 ft	4	Road Ordinance	G.1.a
	Queuing streets allowed (N/A?)	No	0	Subdivision Ordinance	10.15.1.A.9.c
2. Street length	Standards promoting length reduction	No	0	Road Ordinance	G.1.a
3. Right-of-way	Min. allowed width less than 45'	50 ft	0	Road Ordinance	G.1.a
	Pavement over utilities allowed	Yes	1	Road Ordinance	G.1.b.2
4. Cul-de-Sacs	Min. radius allowed <35' or 36'-45'	38 ft	1	Subdivision Ordinance	10.15.1.B.2.l
	Landscaped center island allowed	Yes	1		
	Alternative turnarounds allowed	Yes	1	Road Ordinance	G.1.a.2
5. Vegetated open channels	Curb & gutters required for most streets	No	2	Subdivision Ordinance	10.15.1.B.2.h.i
	Established swale design criteria	Yes	2	Zoning Ordinance	5.2.f.6 & 7
6. Parking ratios	Min. for office building (<3 per 1000 sq ft)	>3	0	Zoning Ordinance	5.11.2.h
	Min. for comm. centers (<4.5 per 1000 sq ft)	6	0	Zoning Ordinance	5.11.2.f
	Min. for 1 family homes (2 or less per home)	2	1	Zoning Ordinance	5.11.2.a
	Max. or median space requirement	No	0	Zoning Ordinance	5.11.2
7. Parking codes	Shared parking promoted	Yes	1		
	Model shared parking agreements	No	0		
	Ratios reduced w/shared parking	No	0		
	Ratios reduced w/mass transit (N/A?)	No	0		
8. Parking lots	Min. stall width 9' or less	9 ft	1	Zoning Ordinance	6.6.4.7.6.3
	Min. stall length 18' or less	24 ft	0	Zoning Ordinance	6.6.4.7.6.3
	30% spaces for compact cars	No	0		
	Pervious materials allowed	Yes	2		
9. Structured parking	Incentives for parking garages (N/A?)	No	0	Zoning Ordinance	5.11.4
10. Parking lot runoff	Min. % required to be landscaped	Yes	2	Zoning Ordinance	5.6.2.D
	Allowance for other stormwater BMPs	Yes	2	Zoning Ordinance	5.6.2.D
Residential and Commercial Development					
11. Open space design	Open space/cluster design allowed	Yes	3	Subdivision Ordinance	10.13
	Goal for land conservation / IC reduction	Yes	1		
	Review requirements > conventional dev.	No	1		
	By-right form of development	Yes	1		
	Flexible site design criteria	Yes	2	Subdivision Ordinance	10.13.B.3
12. Setbacks and frontages	Irregualr lot shapes allowed	Yes	1	Zoning Ordinance	2.5.3
	Min. front setback 20' or less	75 ft	0	Zoning Ordinance	4.2.5.2.c
	Min. rear setback 25' or less	25 ft	1	Zoning Ordinance	4.2.5.2.c
	Min. side setback 8' or less	25 ft	0	Zoning Ordinance	4.2.5.2.c
	Min. frontage distance 80' or less	250 ft	0	Zoning Ordinance	4.2.5.1
13. Sidewalks	Min. width 4' or less	5 ft	0	Road Ordinance	G.1.a
	Required both sides	No	2	Road Ordinance	G.1.a.4
	Slope runoff to yard	No	0		
	Alternate pedestrian networks allowed	Yes	1		
14. Driveways	Min. width allowed (1 lane=<9'; 2 lanes= <18')	12 to 16 ft	0		
	Use pervious materials allowed	Yes	2	Zoning Ordinance	6.6.4.7.6.2
	Use of "two track" design allowed	No	0		
	Shared driveways allowed	Yes	1		
15. Open space management	Associations for open space management	Yes	2	Subdivision Ordinance	10.6.E.4 & 5
	Requirment for open space consolidation	Yes	1		
	Req. for min. % open space to be natural	Yes	1	Subdivision Ordinance	10.6.B.4
	Allowable uses for open spaces defined	Yes	1	Subdivision Ordinance	10.6.B
	Management by third party allowed	Yes	1	Subdivision Ordinance	10.6.E.2
16. Rooftop runoff	Discharge to yard allowed	Yes	2		
	Temporary yard ponding allowed	Yes	2	Zoning Ordinance	6.6.4.7.8.1
Open Spaces and Natural Areas					
17. Buffer Systems	Stream buffer ordinance	Yes	2	Zoning Ordinance	4.1.2.6
	Min. width 75' or greater	75 ft	1	Zoning Ordinance	4.1.2.7
	Includes wetland, slopes, floodplain	Yes	1		
18. Buffer maintenance	Requirment for retaining native vegetation	Yes	2	Zoning Ordinance	6.6.4.7.9
	Allowable uses defined	Yes	1	Zoning Ordinance	5.16.2
	Enforcement and education specified	Yes	1	Zoning Ordinance	6.6.4.2
19. Clearing and grading	Requirement to preserve natural vegetation	Yes	2	Zoning Ordinance	5.6.2.R & S
	Requirement to clear future septic fields	Yes	1		
20. Tree conservation	Requirement to preserve tree stand	Yes	2	Subdivision Ordinance	10.6.A.3
	Plans required to show conservation	Yes	1	Zoning Ordinance	5.16
21. Land conservation incentives	Non-regulated land conservation incentives	Yes	2		
	Flexible conservation requirements	Yes	2	Subdivision Ordinance	10.6.B.8
22. Stormwater outfalls	Requirement to treat before discharge	Yes	2	Zoning Ordinance	5.17.1
	Effective design criteria for BMPs	Yes	1	Zoning Ordinance	5.2.f.6
	Direct untreated discharge to wetland	No	1	Zoning Ordinance	5.17.1
	100-year floodplain restrictions	No	2	Subdivision Ordinance	1.2.M
		TOTAL:	**71**		

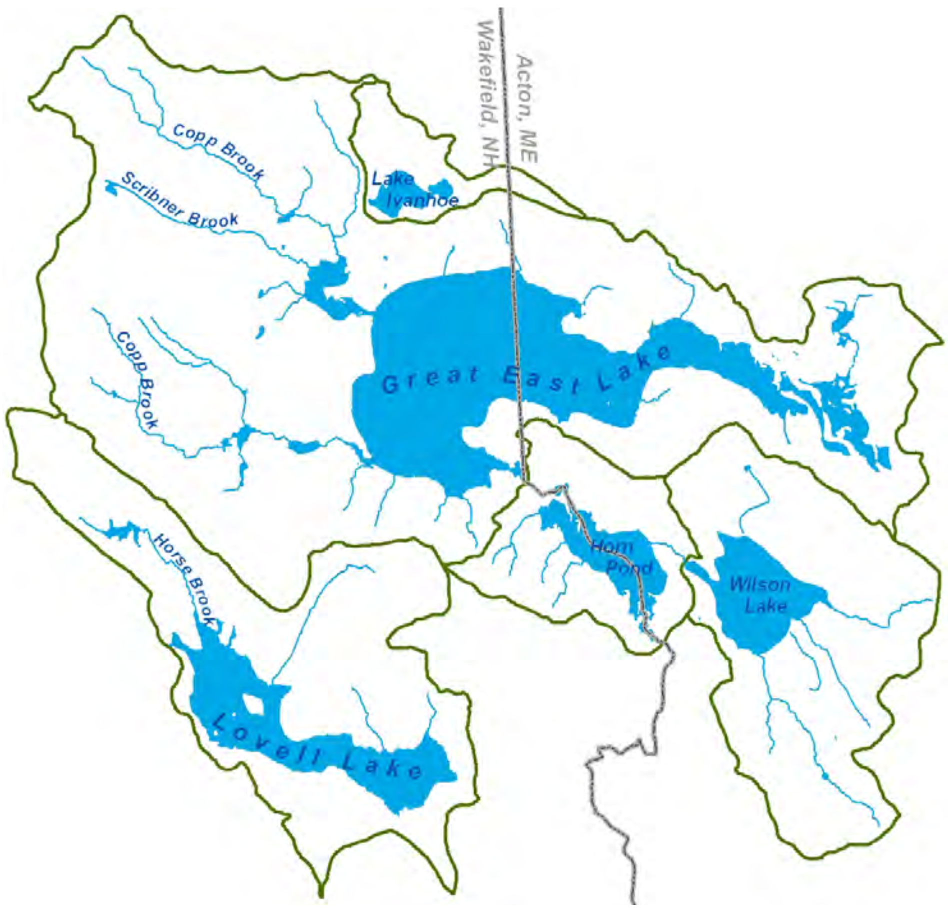
AWWA Region Municipal Ordinance Review - March 2009		**Wakefield, New Hampshire**			
		Requirement	Points	Source	Section
Transportation Infrastructure					
1. Street width	Min. pavement width 18-22"	20 ft	4		
	Queuing streets allowed (N/A?)	No	0		
2. Street length	Standards promoting length reduction	No	0		
3. Right-of-way	Min. allowed width less than 45'	50 ft	0	Subdivision Ordinance	3.11.B.2
	Pavement over utilities allowed	Yes	1		
4. Cul-de-Sacs	Min. radius allowed <35' or 36'-45'	65 ft	0	Subdivision Ordinance	3.11.B.13
	Landscaped center island allowed	Yes	1	Subdivision Ordinance	3.11.B.14
	Alternative turnarounds allowed	No	0		
5. Vegetated open channels	Curb & gutters required for most streets	Yes	0	CEO	
	Established swale design criteria	No	0	Site Plan Regulations	3.15.c
6. Parking ratios	Min. for office building (<3 per 1000 sq ft)	4 spaces	0	Site Plan Regulations	3.17.B
	Min. for comm. centers (<4.5 per 1000 sq ft)	5 spaces	0		
	Min. for 1 family homes (2 or less per home)	2 spaces	1	Zoning Ordinance	12.C.7
	Max. or median space requirement	No	0		
7. Parking codes	Shared parking promoted	Yes	1	Zoning Ordinance	12.C.4b
	Model shared parking agreements	No	0		
	Ratios reduced w/shared parking	No	0	Site Plan Regulations	3.14.F
	Ratios reduced w/mass transit (N/A?)	No	0		
8. Parking lots	Min. stall width 9' or less	9 ft	1	Site Plan Regulations	3.17.G
	Min. stall length 18' or less	20 ft	0		
	30% spaces for compact cars	No	0		
	Pervious materials allowed	Yes	2	Site Plan Regulations	3.17.N
9. Structured parking	Incentives for parking garages (N/A?)	No	0		
10. Parking lot runoff	Min. % required to be landscaped	Yes	2	Site Plan Regulations	3.19.A.1
	Allowance for other stormwater BMPs	Yes	2	Site Plan Regulations	3.19.A.2
Residential and Commercial Development					
11. Open space design	Open space/cluster design allowed	Yes	3	Zoning Ordinance	12.A
	Goal for land conservation / IC reduction	Yes	1	Zoning Ordinance	12.A.11 & 12
	Review requirements > conventional dev.	No	1	Zoning Ordinance	12.A
	By-right form of development	Yes	1	Zoning Ordinance	12.C.1
	Flexible site design criteria	Yes	2		
12. Setbacks and frontages	Irregualr lot shapes allowed	Yes	1	Site Plan Regulations	3.2.3
	Min. front setback 20' or less	20 ft	1	Site Plan Regulations	3.11.B.24
	Min. rear setback 25' or less	10 ft	1	Zoning Ordinance	Table 2
	Min. side setback 8' or less	20 ft	0	Zoning Ordinance	Table 2
	Min. frontage distance 80' or less	75 ft	2	Zoning Ordinance	Table 3
13. Sidewalks	Min. width 4' or less	4 ft	2	Subdivision Ordinance	3.11.A.10.a
	Required both sides	No	2	Subdivision Ordinance	3.11.A.10.a
	Slope runoff to yard	No	0	Subdivision Ordinance	3.11.A.10.a
	Alternate pedestrian networks allowed	Yes	1		
14. Driveways	Min. width allowed (1 lane=<9'; 2 lanes= <18')	12 to 16 ft	0	CEO	
	Use pervious materials allowed	Yes	2	Zoning Ordinance	12.C.4c
	Use of "two track" design allowed	No	0		
	Shared driveways allowed	Yes	1	Zoning Ordinance	12.C.4b
15. Open space management	Associations for open space management	Yes	2	Zoning Ordinance	12.F & 12.G
	Requirment for open space consolidation	No	0	Zoning Ordinance	12.2
	Req. for min. % open space to be natural	Yes	1	Zoning Ordinance	12.C.13
	Allowable uses for open spaces defined	Yes	1	Zoning Ordinance	12.C.13
	Management by third party allowed	Yes	1	Zoning Ordinance	12.C.14
16. Rooftop runoff	Discharge to yard allowed	Yes	2	Subdivision Ordinance	3.13.B & B.4
	Temporary yard ponding allowed	Yes	2	Subdivision Ordinance	3.13.B & B.5
Open Spaces and Natural Areas					
17. Buffer Systems	Stream buffer ordinance	Yes	2	Zoning Ordinance	12.13.c
	Min. width 75' or greater	20 ft	0	Zoning Ordinance	15.A
	Includes wetland, slopes, floodplain	Yes	1	Zoning Ordinance	12.c.13
18. Buffer maintenance	Requirment for retaining native vegetation	No	0		
	Allowable uses defined	Yes	1	Zoning Ordinance	15.A
	Enforcement and education specified	Yes	1	Subdivision Ordinance	2.27.A & B
19. Clearing and grading	Requirement to preserve natural vegetation	Yes	2	Subdivision Ordinance	1.04
	Requirement to clear future septic fields	No	1		
20. Tree conservation	Requirement to preserve tree stand	Yes	2	Subdivision Ordinance	3.20
	Plans required to show conservation	Yes	1		
21. Land conservation incentives	Non-regulated land conservation incentives	Yes	2	Design Standards	3.00
	Flexible conservation requirements	No	0		
22. Stormwater outfalls	Requirement to treat before discharge	Yes	2	Subdivision Ordinance	3.13.B
	Effective design criteria for BMPs	Yes	1	Subdivision Ordinance	3.16.B
	Direct untreated discharge to wetland	No	1		
	100-year floodplain restrictions	Yes	2	Zoning Ordinance	11.H.2.a &H.2.b
		TOTAL:	**64**		

APPENDIX E:
Buildout Analysis

Acton Wakefield Watersheds Alliance

Buildout Analysis

Acton, ME & Wakefield, NH



September 2009

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Figures

Tables

Acknowledgements

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Dan Camera, Strafford Regional Planning Commission

Fred Dillon, FB Environmental Associates

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Tricia Rouleau, FB Environmental Associates

Linda Schier, Acton Wakefield Watersheds Alliance

1. Introduction

FB Environmental (FBE) performed a buildout analysis for the Acton Wakefield Watersheds Alliance (AWWA), within the towns of Acton, Maine and Wakefield, New Hampshire. The high quality waters of the AWWA region form the headwaters of the Salmon Falls River. Waterbodies in the Acton and Wakefield watersheds include Great East Lake, Horn Pond, Lake Ivanhoe, Lovell Lake, Wilson Lake and all their tributaries. The AWWA buildout analysis results provide estimates of the number of potential lots and the number of new units the watershed towns may see developed at some point in the future. Full 'Buildout' refers to the time and circumstances whereby, based on a set of restrictions (e.g. environmental constraints and current zoning), no more building growth may occur, or the point at which lots have been subdivided to the minimum size allowed and there is no more 'developable' land.

Performing a buildout analysis shows a locality what land is available for development, how much development can occur and at what densities. Localities can use the analysis as a snapshot, worse-case scenario tool for planning. The buildout analysis is also a valuable tool to help model potential impacts from future development on water and other natural resources. The Geographic Information System (GIS) based buildout analyses for the Acton and Wakefield watersheds were conducted using ESRI ArcGIS 9.2 and CommunityViz.

What is CommunityViz?

CommunityViz is a GIS-based decision-support tool designed to help planners and resource managers visualize, analyze, and communicate about important land-use decisions. While there are many components to CommunityViz, for the purposes of this study two tools were utilized: The 'Buildout Wizard' was used to calculate the development capacity of the watershed land (numerically and spatially), and the 'Time Scope Analysis' tool was used to visualize how development might occur over time.

Using these tools, this study explores several basic questions about the future of the Acton and Wakefield watersheds:

- How much 'developable land' is there is the watershed?
- How much new development can theoretically occur in the watershed, based on current zoning and other constraints? (*Buildout Analysis*)
- At its current growth rate, how will the watershed's appearance potentially change over time? (*Time Scope Analysis*)

2. Methodology

The AWWA buildout analysis was performed following these general steps:

1) Collect information on existing conditions in the watershed: existing buildings, zoning, and growth rates.

2) Collect GIS data and development constraints layers.

3) Based on constraints layers, determine where development may occur.

4) Analyze watershed buildout potential using Buildout Wizard.

5) Determine how development might occur over time using the Time scope Analysis tool.

6) Present results in tables and maps.

Existing Conditions

Existing Buildings

The location and number of existing buildings in the Wakefield watershed area was determined using high resolution digital orthophotographs produced from aerial photos collected in the spring of 2003 by the National Agriculture Imagery Program (NAIP), and downloaded from New Hampshire's Statewide Geographic Information System Clearinghouse, NH GRANIT. Aerials from the websites http://maps.live.com and http://earth.google.com/ were then used to pinpoint more recent development in the AWWA watershed. Using these images, a new GIS layer was created, with a point representing each existing building (700 buildings total). A determination of existing buildings in the entire Town of Acton was conducted by the Southern Maine Regional Planning Commission (SMRC) using similar methods. FBE utilized the resulting GIS layer to determine the number of existing buildings within the watersheds of interest in the Town of Acton (617 buildings total).

Zoning

Crucial to a buildout analysis is the feasibility of modeling zoning requirements. Certain zoning requirements are too site-specific to be able to incorporate into the analysis. With that in mind, this analysis made use of the following caveats in the determination of buildout zoning restrictions:

- Future lots will be made the smallest size allowable for the zoning district, taking into account minimum lot size and minimum buildable area.
- Potential unit types are not specified.
- Road and shoreland frontage requirements are not specified.

Zoning information utilized in the AWWA buildout analysis is shown below in Table 1. This information represents restrictions that apply only in the sections of each town that fall within the watershed boundary. In addition to the zoning restrictions listed below, each watershed town also follows the minimum Shoreland Zoning restrictions required in Maine and New Hampshire (see ‘Development Constraints’ below)

Table 1: Acton and Wakefield Watershed Zoning Restrictions

Zone	Building Setbacks	Road Setbacks	Min. Lot Size	Lot Coverage	Right-of-Ways	Building Size Restrictions
ACTON						
Commercial C	side – 50 ft, rear – 50 ft	75 ft	3 ac	Max 20% (Residential Uses)	50 ft	NA
Village	side – 25 ft, rear – 25 ft	75 ft	2 ac (< 2 ac with approval)	Max 20% (Residential Uses)	50 ft	NA
Transitional	side – 25 ft, rear – 25 ft	75 ft	2 ac	Max 20% (Residential Uses)	50 ft	NA
Rural	side – 25 ft, rear – 25 ft	75 ft	3 ac	Max 20% (Residential Uses)	50 ft	NA
Critical Rural	side – 25 ft, rear – 25 ft	75 ft	5 ac	Max 20% (Residential Uses)	50 ft	NA
WAKEFIELD						
Residential I	side – 20 ft, rear – 10 ft	20 ft	1 ac	NA	50 ft	Min. Living Area - 1,150 ft^2, Max. Height – 35 ft
Residential II	side – 20 ft, rear – 10 ft	20 ft	1 ac	NA	50 ft	Min. Living Area - 1,150 ft^2, Max. Height – 35 ft
Residential III – Rural	side – 50 ft, rear – 10 ft	50 ft	3 ac	NA	50 ft	Min. Living Area - 1,150 ft^2, Max. Height – 35 ft
Business & Commercial	side – 20 ft, rear – 10 ft	20 ft	20,000 ft^2	NA	50 ft	Max. Height – 35 ft
Village/ Residential	side – 20 ft, rear – 10 ft	20 ft	20,000 ft^2	NA	50 ft	Min. Living Area - 1,150 ft^2, Max. Height – 35 ft
Agricultural	side – 20 ft, rear – 15 ft	50 ft	5 ac	NA	50 ft	Min. Living Area - 1,150 ft^2, Max. Height – 35 ft

Population Growth Rates

The AWWA region has experienced considerable population growth over the last several decades (though increases in dwelling units have been more modest). From 1990-2005, Wakefield experienced the largest average annual and overall population growth rates – 3.4% and 56.5%, respectively – of all the communities in Strafford County (NHOEP, 2008). While Acton's population increase from 1990-2000 was more modest compared to other York County communities (it had 9th highest growth rate of the 29 towns in the county), its average annual and overall growth rates were 2.2% and 24.2%, respectively (SMRPC, 2004). Given the AWWA region's unique character and desirability as a residential and recreational destination, it is likely significant growth will continue to occur in Wakefield and Acton well into the future. Consequently, both communities should carefully consider the effects of current municipal land use regulations on local water resources. The annual growth estimates presented above (3.4% for Wakefield and 2.2% for Acton) were used in the Time Scope Analysis (p. 10).

Development Constraints

Constraints to development in a buildout analysis are those areas that are considered undevelopable, or areas where no future buildings may be built. To determine where development may occur in the watershed, buildout calculations deduct land due to physical constraints to development including environmental restrictions (e.g. soils, slopes, wetlands), zoning restrictions (e.g. shoreland zoning, street ROWs and building setbacks), and practical design considerations (e.g. lot layout inefficiencies). Existing buildings may also reduce the available capacity for new development.

Below is a list of GIS data used to model development constraints in the Acton and Wakefield watersheds:

1) Conservation Land
2) Steep slopes (*>20%*)
3) NWI wetlands
4) Existing buildings
5) Hydric soils
6) Highly erodible soils
7) Street ROW *(50 ft.)*
8) Unbuildable parcels (*parcels with an existing building and less than double the minimum lot size (i.e. lots that cannot be subdivided)*)
9) Shoreland zoning:
    a. *Resource Protection restrictions –*
        i. Acton Only: Areas within 250 feet of the upland edge of freshwater wetlands, salt marshes and salt meadows, and wetlands associated with great ponds and rivers, which are rated "moderate" or "high" value waterfowl and wading bird habitat, including nesting and feeding areas. (*ME Office of GIS "shorezone_iwwh" layer*)
        ii. Both Towns: 100 year floodplain as designated on the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps or Flood Hazard Boundary Maps. (*ME Office of GIS "FIRM" layer")*
        iii. Acton Only: Areas of 2 or more contiguous acres with sustained slopes of 20% or greater. (*This does not apply within the Acton shoreland zone, but steep slopes in the rest of the watershed were used as a constraint layer (#2.)*)
    b. *Building setbacks outside of the Resource Protection Zone –*
        i. Acton Only: 100 feet from the normal high-water line of great ponds classified GPA and rivers that flow to great ponds classified GPA, and 75 feet from the normal high-water line of other water bodies, tributary streams, or the upland edge of a wetland. (*75 foot buffer around all streams and wetlands, and 100 foot buffer around great ponds and associated rivers.*)

ii. Wakefield Only: 50 feet from the normal high-water line of waterbodies, and 30 feet from the upland edge of a wetland. (*50 foot buffer around all waterbodies, and 30 foot buffer around wetlands.*)

Buildout Assumptions

To determine how many units can be built on the available buildable land in the watershed, various density and other design factors are considered, based on the zoning requirements for each town. The assumptions specified below refer to methods used in the Wakefield portion of the buildout analysis. A separate buildout for Town of Acton was completed by the Southern Maine Regional Planning Commission (SMRPC), using similar methods based on the zoning restrictions outlined in Table 1 above. FB Environmental utilized the results of the SMRPC analysis to extrapolate results for the Acton portion of the AWWA watershed. For simplification purposes, some assumptions used in the analysis, such as road setbacks and street right-of-ways (ROWS) are based on the average requirements for all zones in the town. The minimum lot size requirements are based on each zone's specific requirements.

- **Building setbacks** were estimated based on the average front and rear setback specified in Wakefield's zoning ordinance (15 feet between structures). Setbacks are measured from building center points in Community Viz. To account for this, building footprints need to be estimated to avoid building overlap. The dimensions of the minimum building footprint, roughly based on Wakefield zoning rules, were estimated to be 30 feet x 30 feet. This number was then divided by two (15 feet), and the "Minimum Separation Distance" used in Community Viz was 30 feet (15 + 15 = 30) (Lingeman & Bradt, 2008).

- **Minimum lot size requirements** used were based on requirements for each zone, as specified in Table 1.

- **Street ROWs** were estimated to be 50 feet, based on zoning requirements. A 15 foot building footprint factor was then added. Therefore, the total ROW entered into CommunityViz was 65 feet.

- **Efficiency factors** adjust density values to reflect common density losses. They are entered as a percentage where 100% means complete efficiency (no density lost), and 0% means no buildings will be estimated for that land-use. In the AWWA buildout, an 80% EF was used, based on recommendations in the CommunityViz manual (Placeways, LLC, 2007).

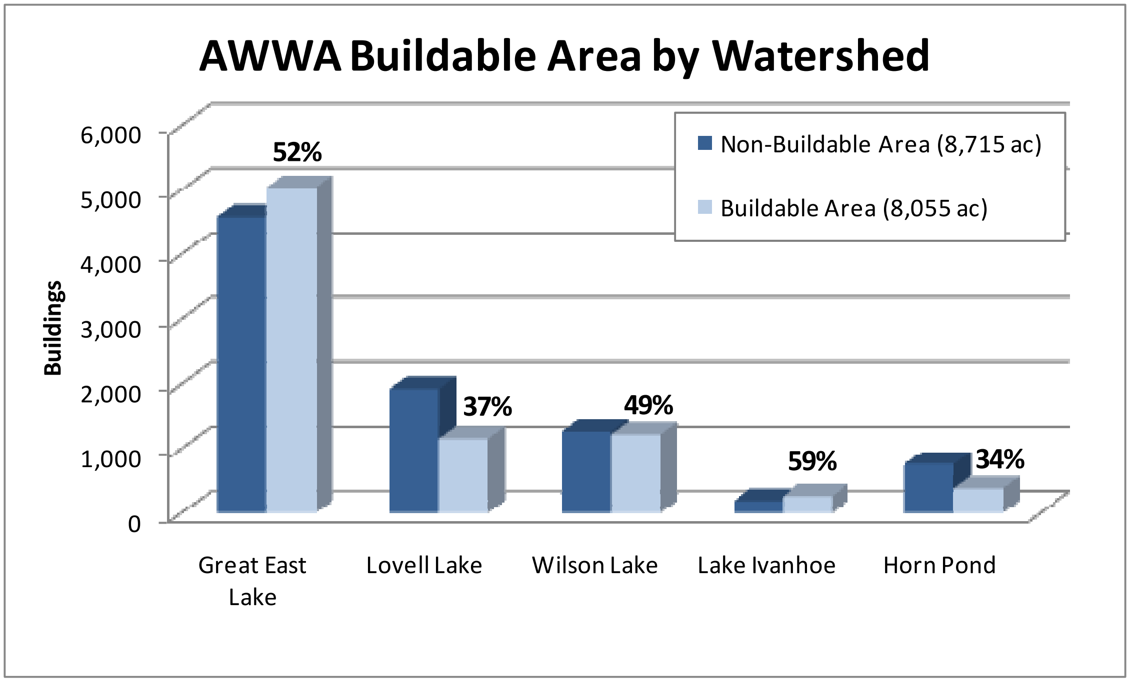
3. Acton and Wakefield Watersheds Buildout Results

Buildout Results

Table 2: Acton and Wakefield Buildable Area by Watershed

Watershed	Total Area (acres)	Buildable Area (acres)	Percent Buildable Area
ACTON			
Great East Lake	2,799	937	33%
Horn Pond	555	213	38%
Lake Ivanhoe	49	41	84%
Wilson Lake	2,479	1,216	49%
Acton Totals	*5,882*	*2,407*	*41%*
WAKEFIELD			
Great East Lake	6,821	4,101	60%
Horn Pond	584	169	29%
Lake Ivanhoe	407	227	56%
Lovell Lake	3,076	1,151	37%
Wakefield Totals	*10,888*	*5,648*	*52%*
Grand Totals	***16,770***	***8,055***	***48%***

Figure 1: Acton and Wakefield Buildable vs. Non-Buildable Area by Watershed



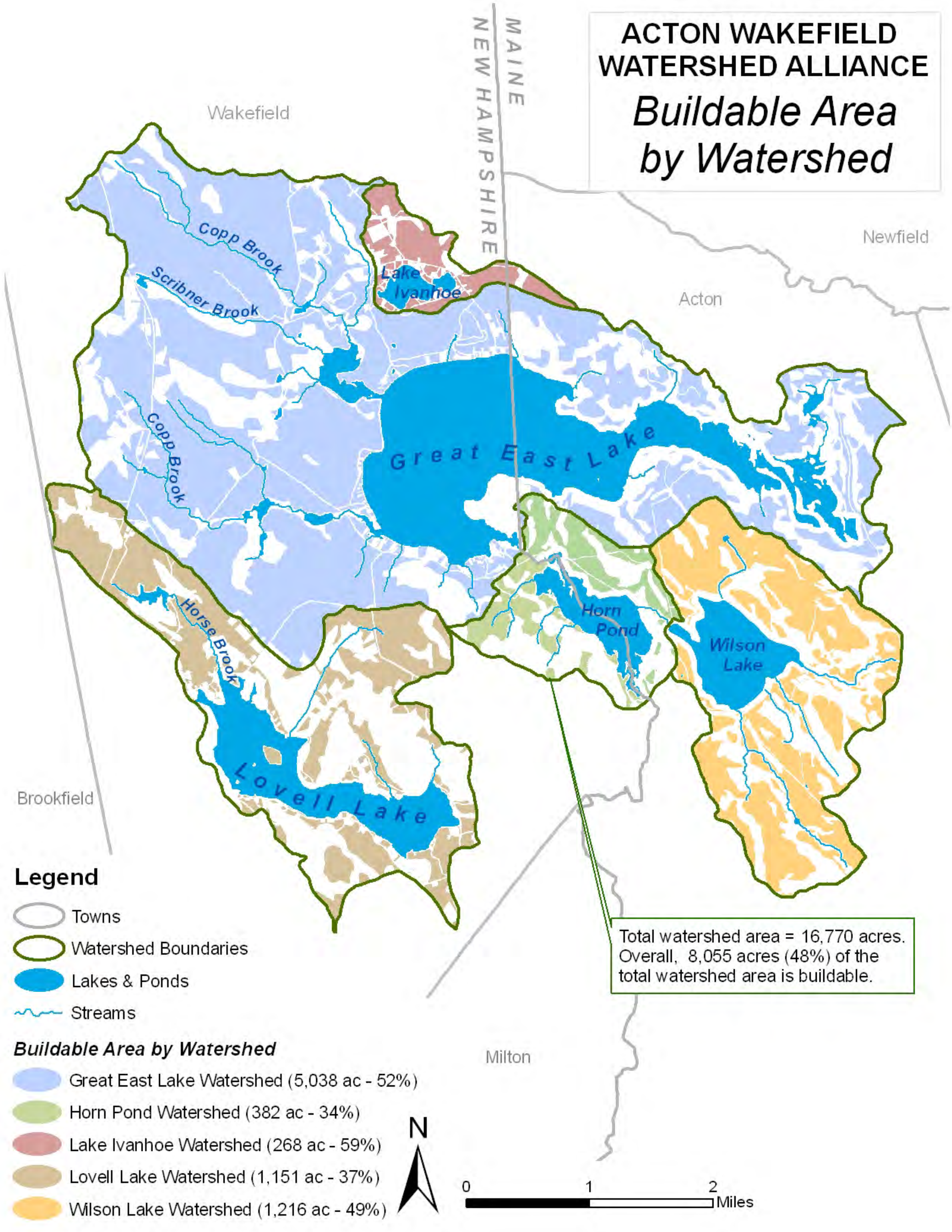


Figure 2: Acton and Wakefield Watersheds Buildable Area Map

Table 3: Acton and Wakefield Full Buildout Results, by Watershed

Watershed	Buildout Units	Existing Units	Total
ACTON			
Great East Lake	218	338	556
Horn Pond	53	93	146
Lake Ivanhoe	12	2	14
Wilson Lake	365	184	549
Acton Totals	*648*	*617*	*1265*
WAKEFIELD			
Great East Lake	1,347	327	1,674
Horn Pond	86	17	103
Lake Ivanhoe	197	55	252
Lovell Lake	644	301	945
Wakefield Totals	*2,274*	*700*	*2974*
Grand Totals	***2,922***	***1,317***	***4,239***

Figure 3: Acton and Wakefield Full Buildout Results, by Watershed

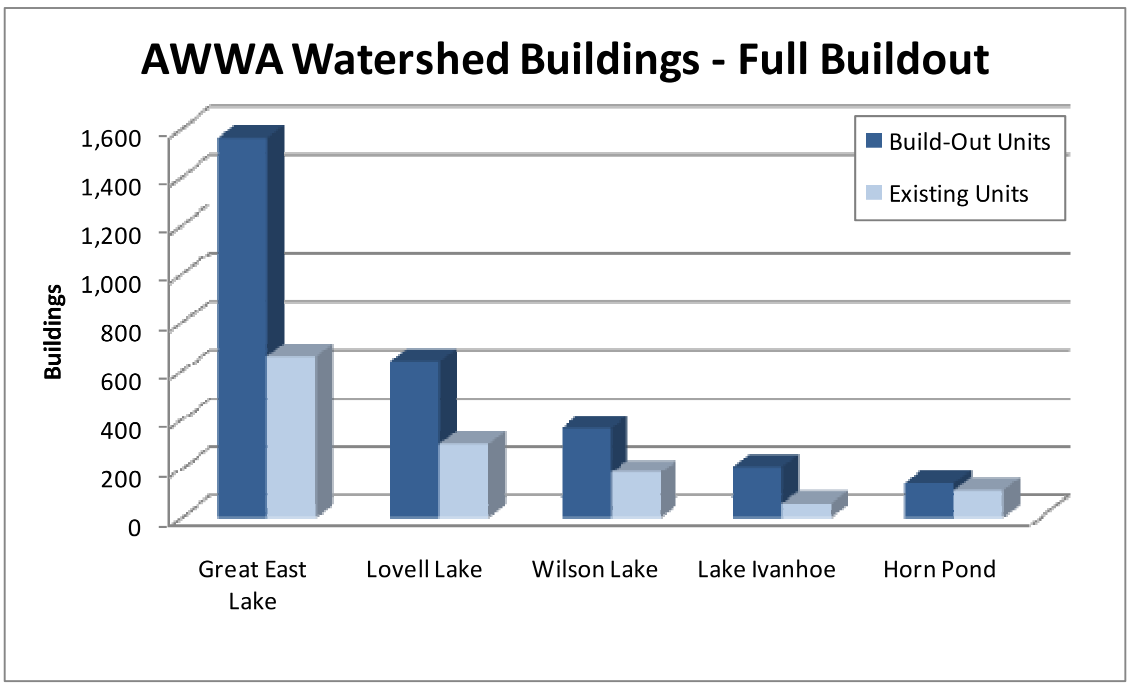


Table 4: Acton and Wakefield Full Buildout Results, by Zoning District

Zoning District	Buildout Units
ACTON	
Commercial C	6
Critical Rural	41
Rural	588
Transition	11
Village	2
Existing Buildings	*617*
Acton Totals	*1,265*
WAKEFIELD	
Business & Commercial	116
Residential I	145
Residential II	661
Residential III - Rural	956
Village	16
Agricultural	356
Historic	24
Existing Buildings	*700*
Wakefield Totals	*2,974*
Grand Totals	***4,239***

Discussion

Based on the development restraints and zoning requirements outlined earlier, there are an estimated 4,152 acres of developable land in the AWWA watershed (25% of the total watershed area). Buildout results estimate that this developable area, under current zoning, can accommodate an additional 4,239 buildings, or approximately 200% more than the current number of existing buildings in the watershed. At full buildout, population would increase by over 9,000 people, residential water use would increase by over 500 million gallons per year, and residential energy use would increase by over 400,000 BTUs per year (based on a CommunityViz 'Common Impacts' analysis).

Although the exact amount of additional development may vary based on the amount of land protected as open space, zoning and other regulations, and socioeconomic factors, the buildout analysis indicates that significant additional development could occur in the watershed. This buildout analysis reinforces the idea that comprehensive watershed scale planning is needed to address future development impacts.

Time scope Analysis Results

The time scope analysis estimates are based on a projected per-year population growth rate of 2.2% for Acton and 3.4% for Wakefield (p. 3). (This information is based on currently available projections, but long-term growth rates may vary.) If this growth rate remains consistent, which may be unlikely, full buildout would not occur watershed-wide until the year 2054. On an individual town basis, full buildout in the Town of Acton will occur in 2041 (Table 5), and in 2054 in the Town of Wakefield (Table 6). The analysis assumes development will occur on parcels closest to existing roads first. (Note: An additional 20 buildings were added at the start of the analysis to help account for any houses that may have been missed in the existing buildings count.)

Table 5: Time-Scope Analysis Results for the Town of Acton (assuming a 2.2% annual growth rate)

Buildout Date	Total New Buildings	Total Buildings (Incl. Existing)
2015	99	716
2020	182	799
2025	275	892
2030	379	996
2035	495	1,112
2040	624	1,241
2041	648	1,265

Table 6: Time-Scope Analysis Results for the Town of Wakefield (assuming a 3.4% annual growth rate)

Buildout Date	Total New Buildings	Total Buildings (Incl. Existing)
2015	164	864
2020	319	1,019
2025	501	1,201
2030	717	1,417
2035	973	1,673
2040	1,273	1,973
2045	1,630	2,330
2050	2,051	2,751
2054	2,274	2,974

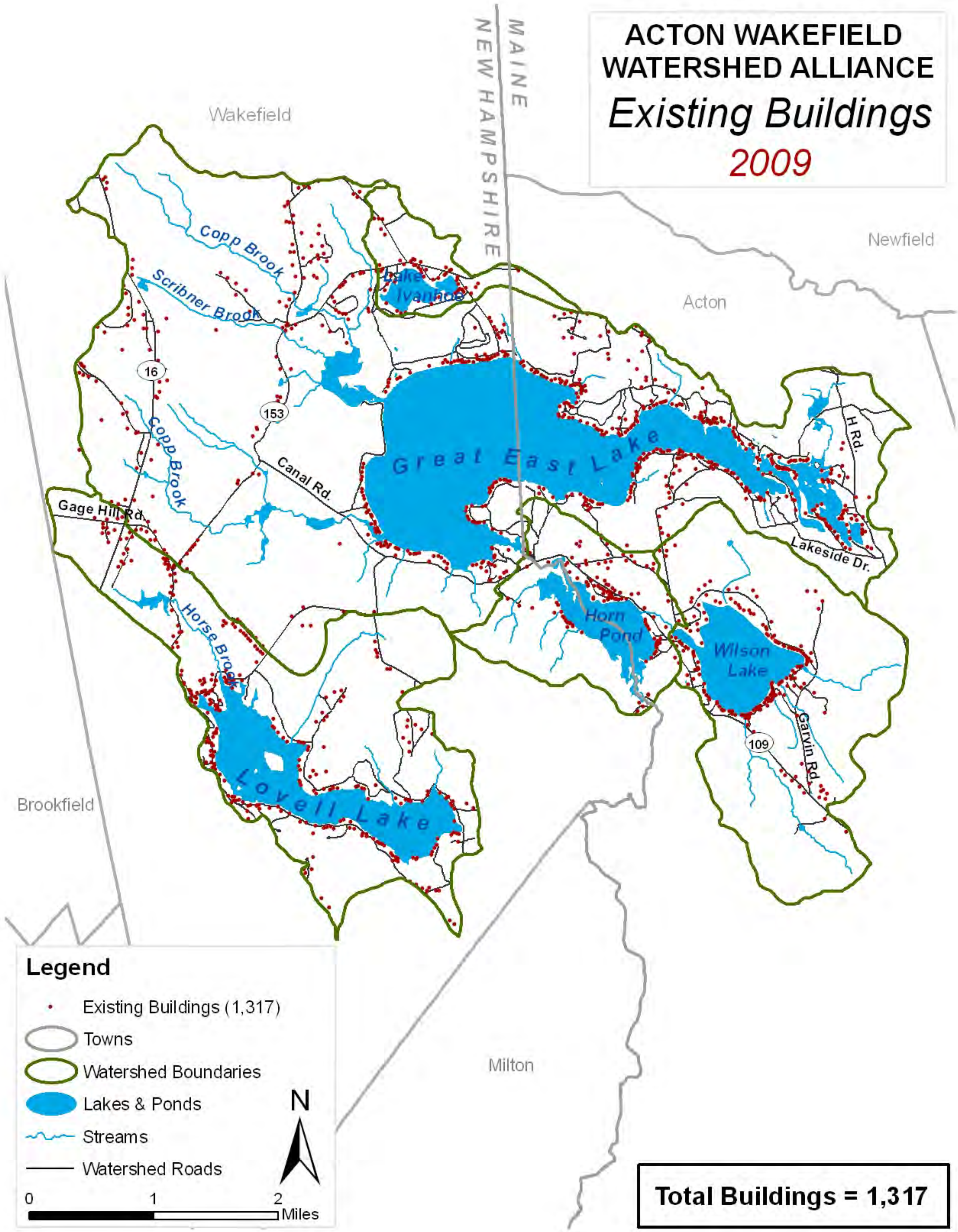


Figure 4: AWWA Existing Buildings Map

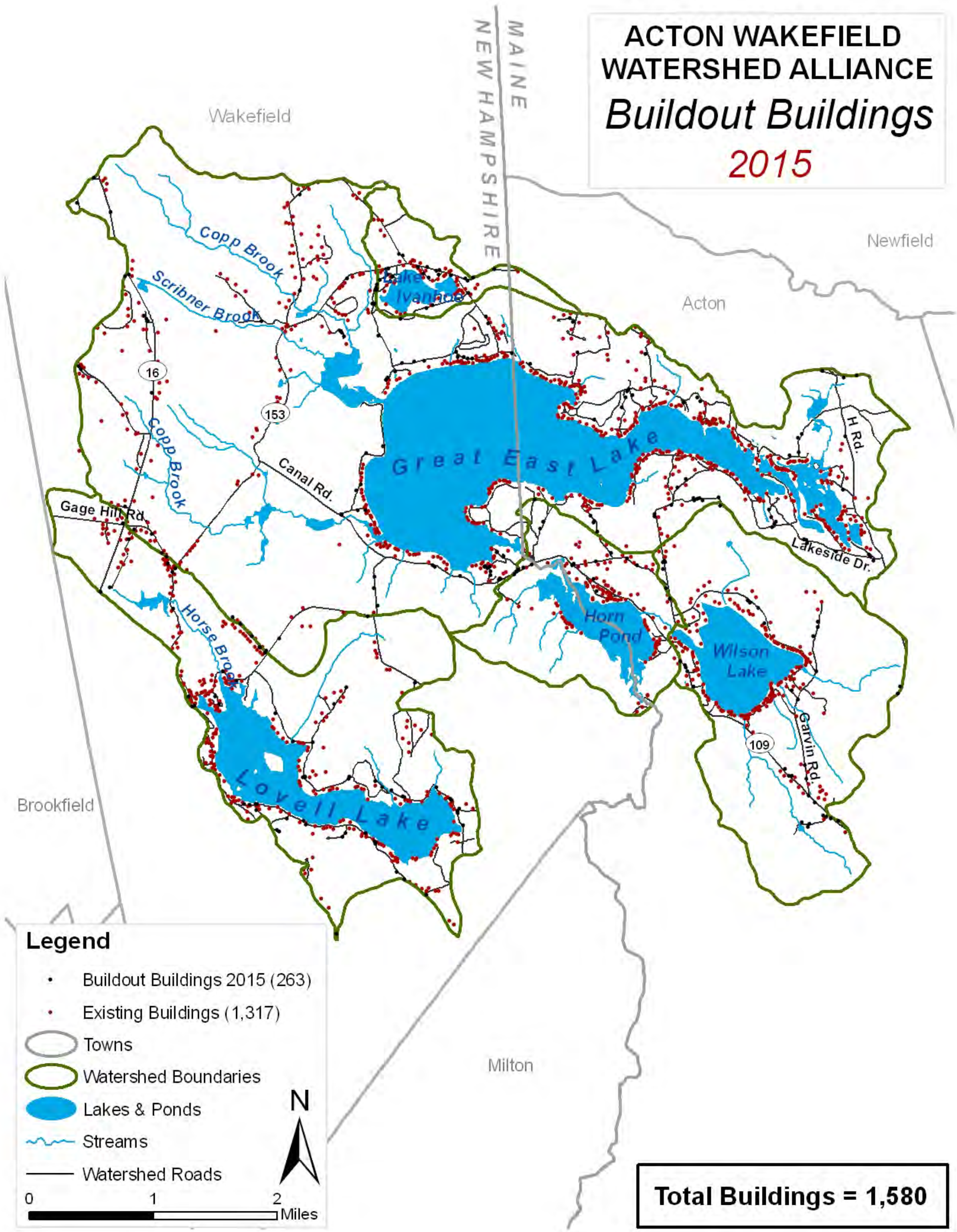


Figure 5: AWWA Buildout Year 2015 Map

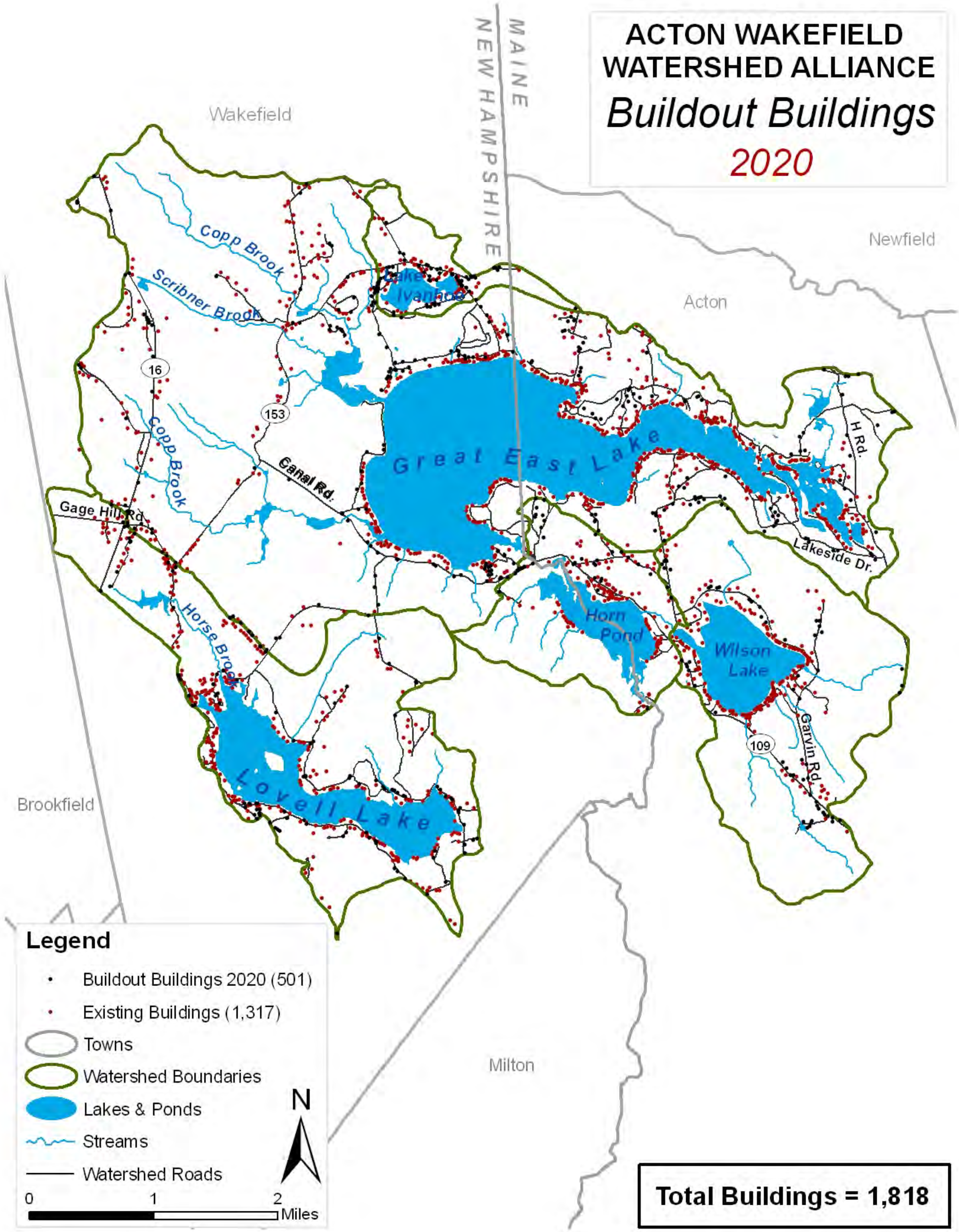


Figure 6: AWWA Buildout Year 2020 Map

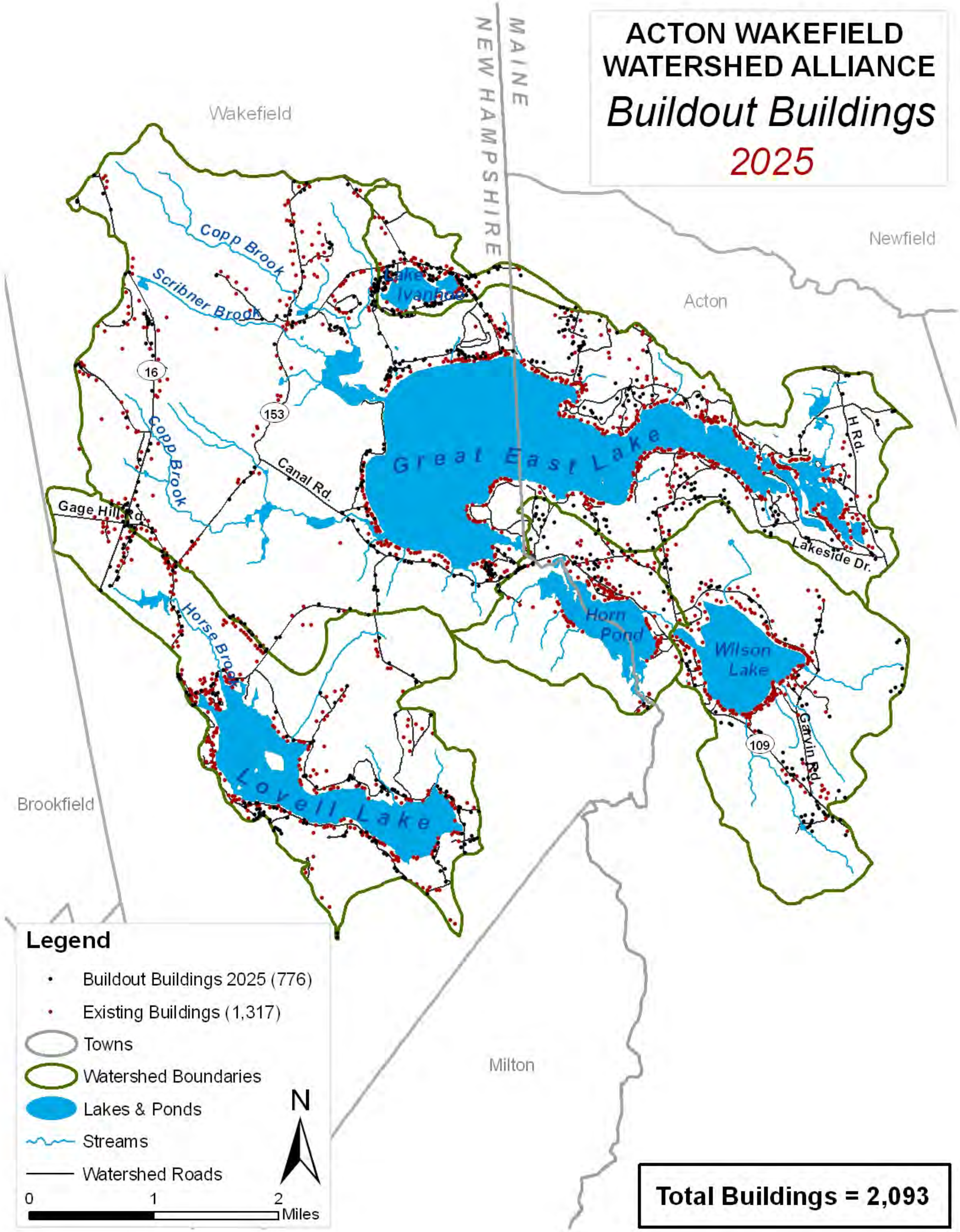


Figure 7: AWWA Buildout Year 2025 Map

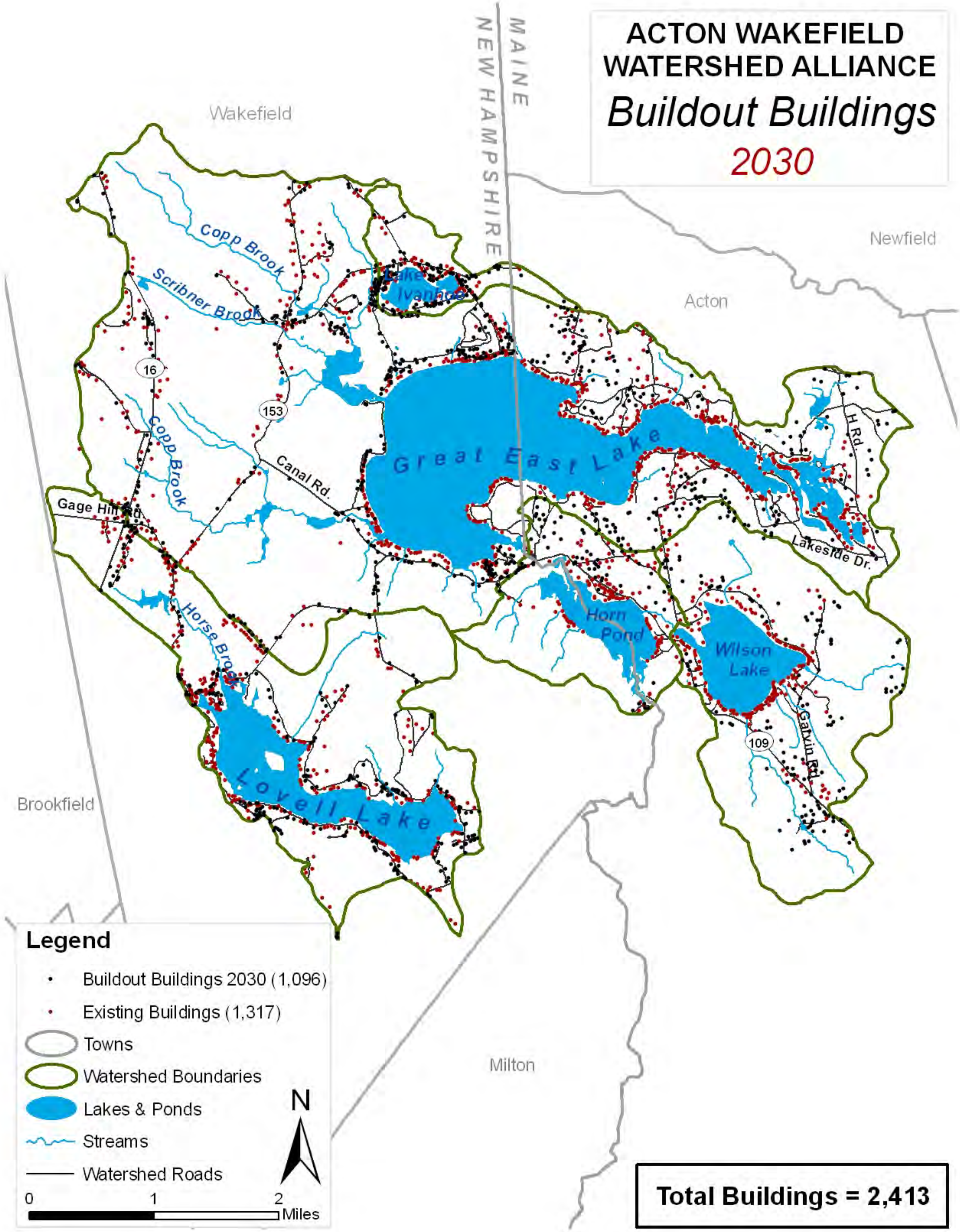


Figure 8: AWWA Buildout Year 2030 Map

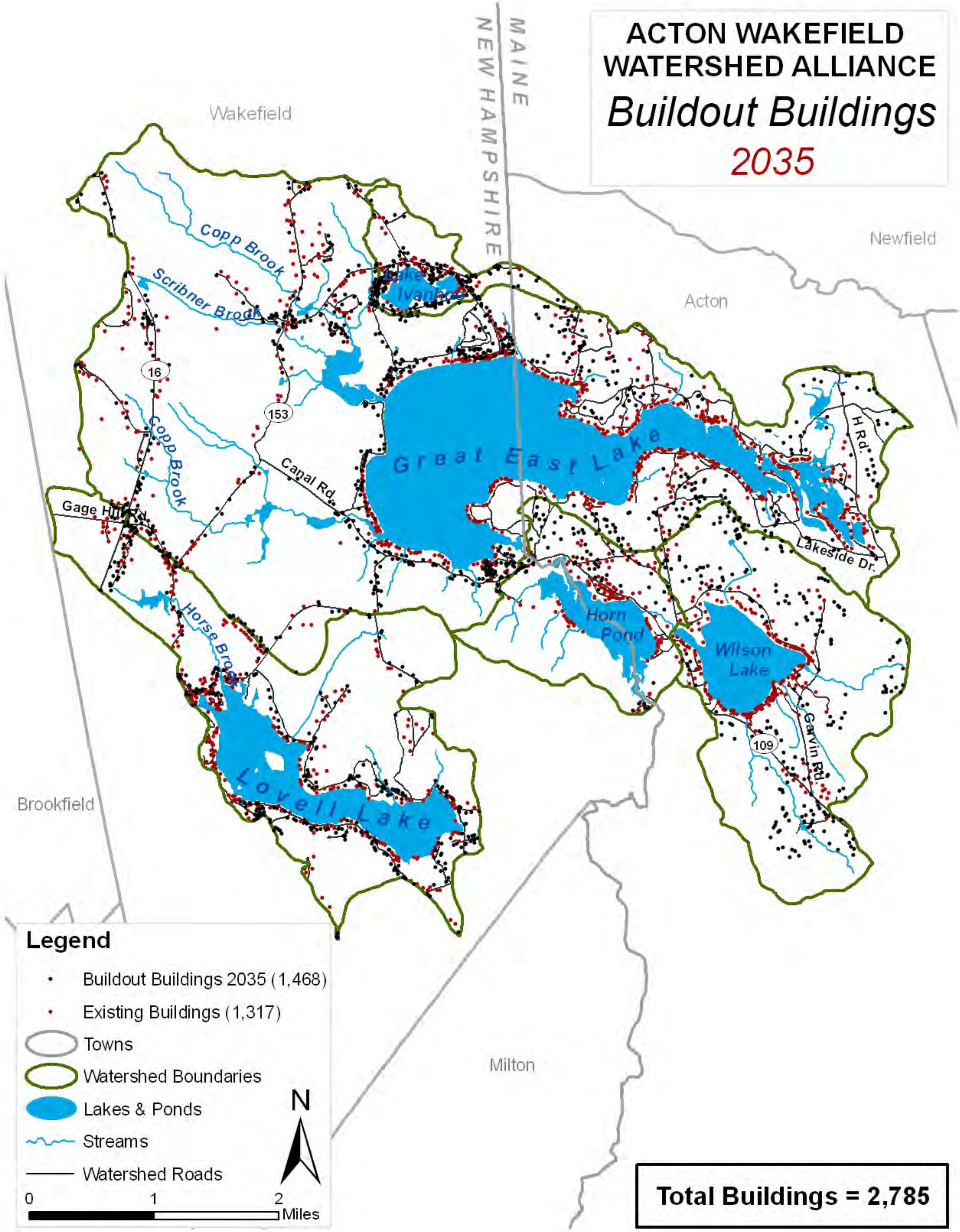


Figure 9: AWWA Buildout Year 2035 Map.

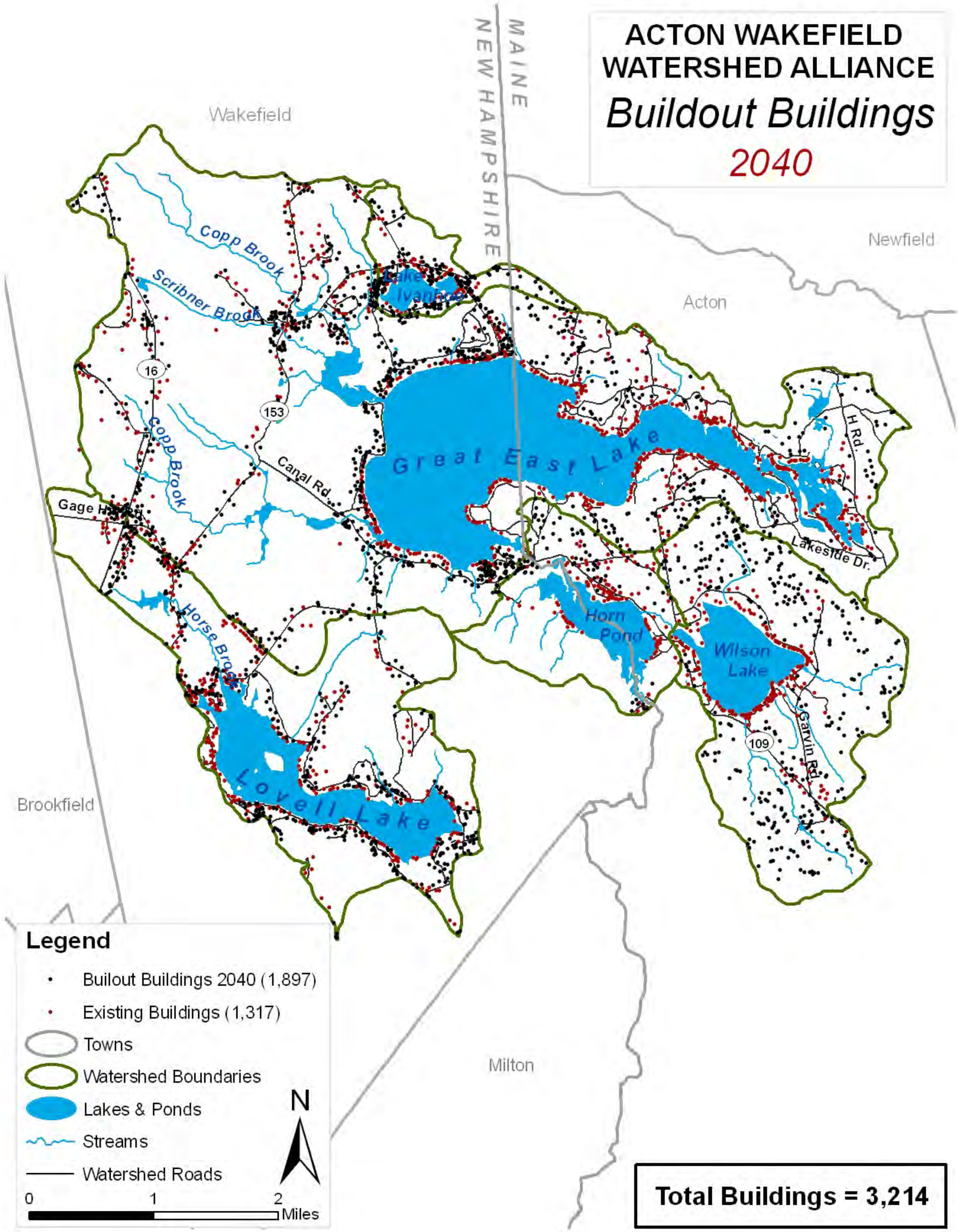


Figure 10: AWWA Buildout Year 2040 Map

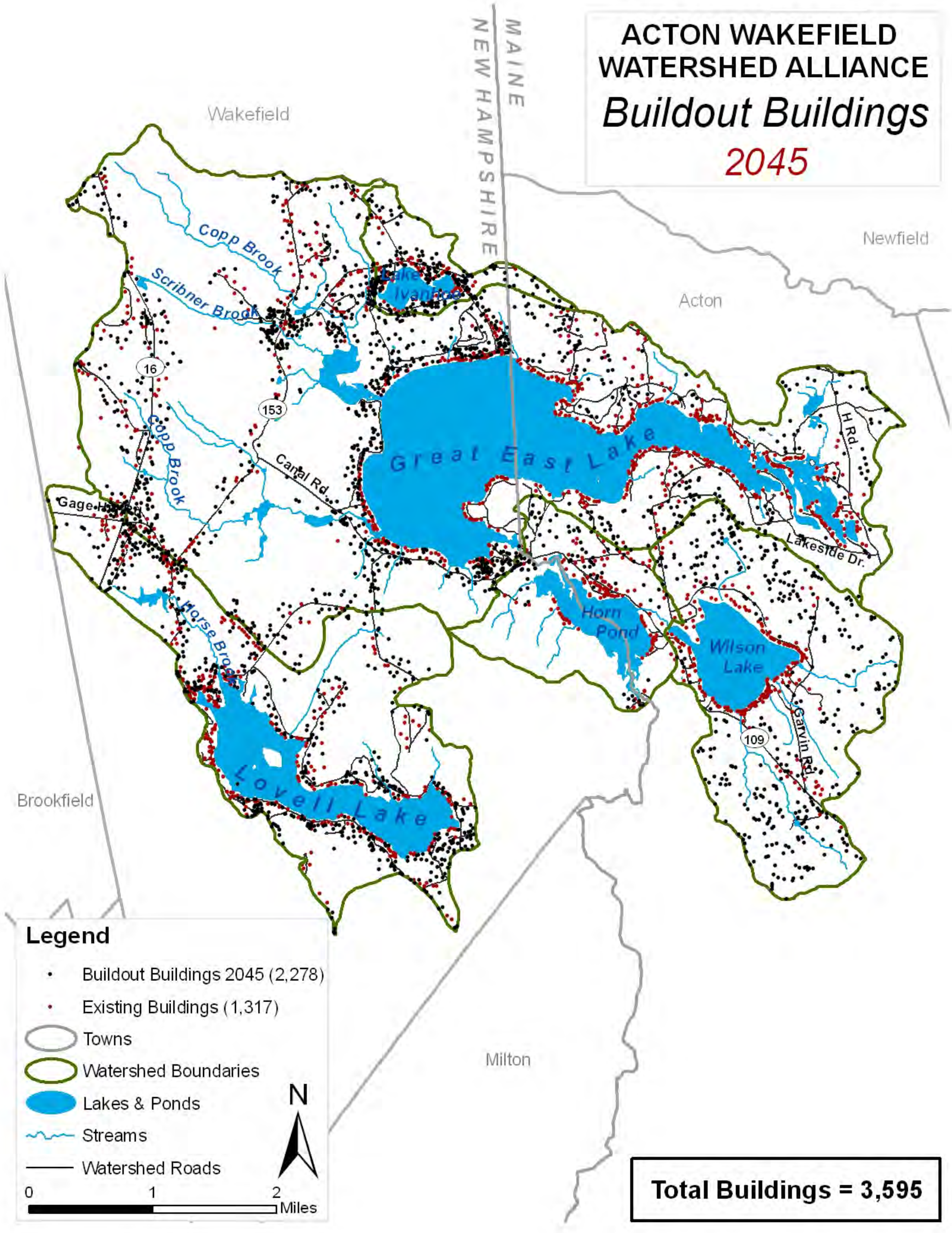


Figure 11: AWWA Buildout Year 2045 Map

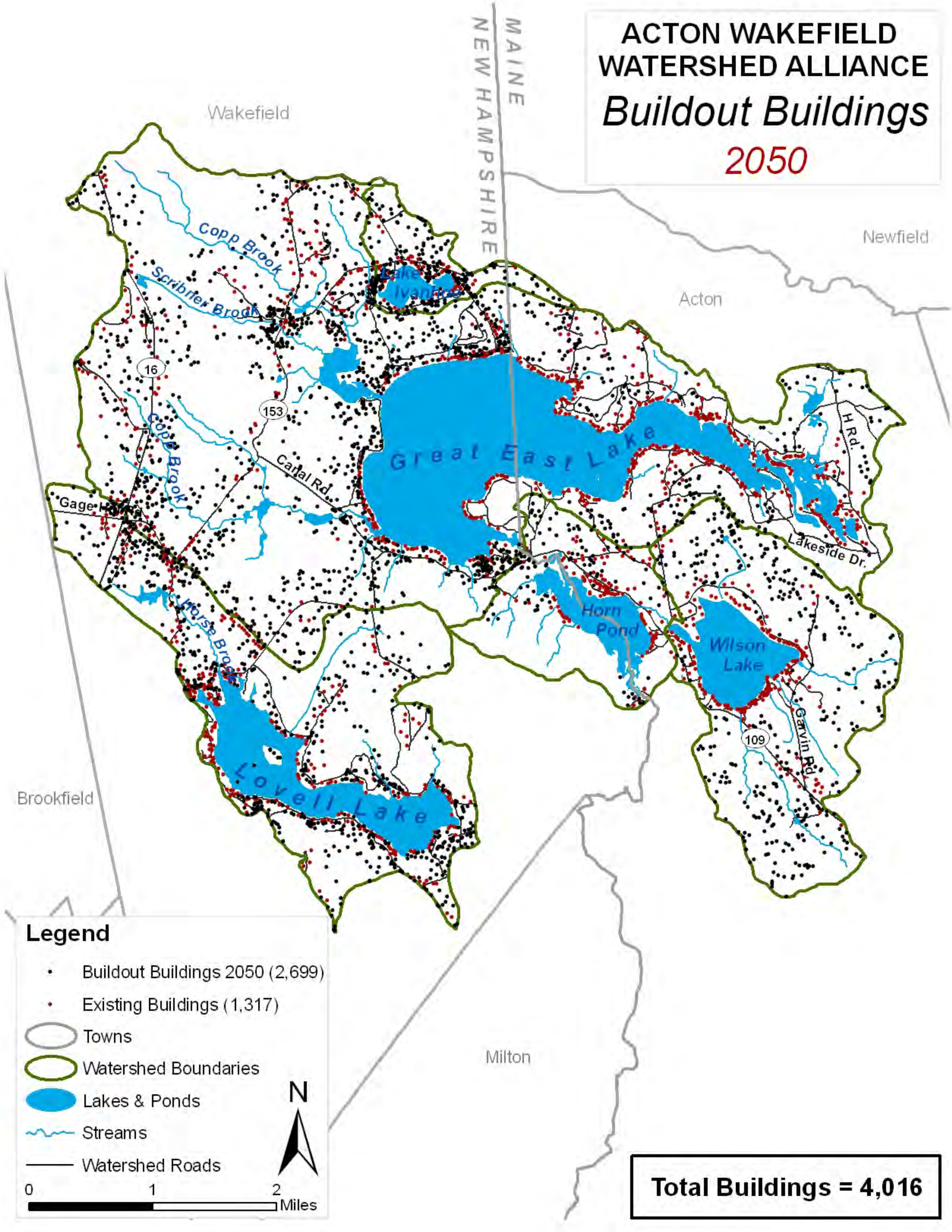


Figure 12: AWWA Buildout Year 2050 Map

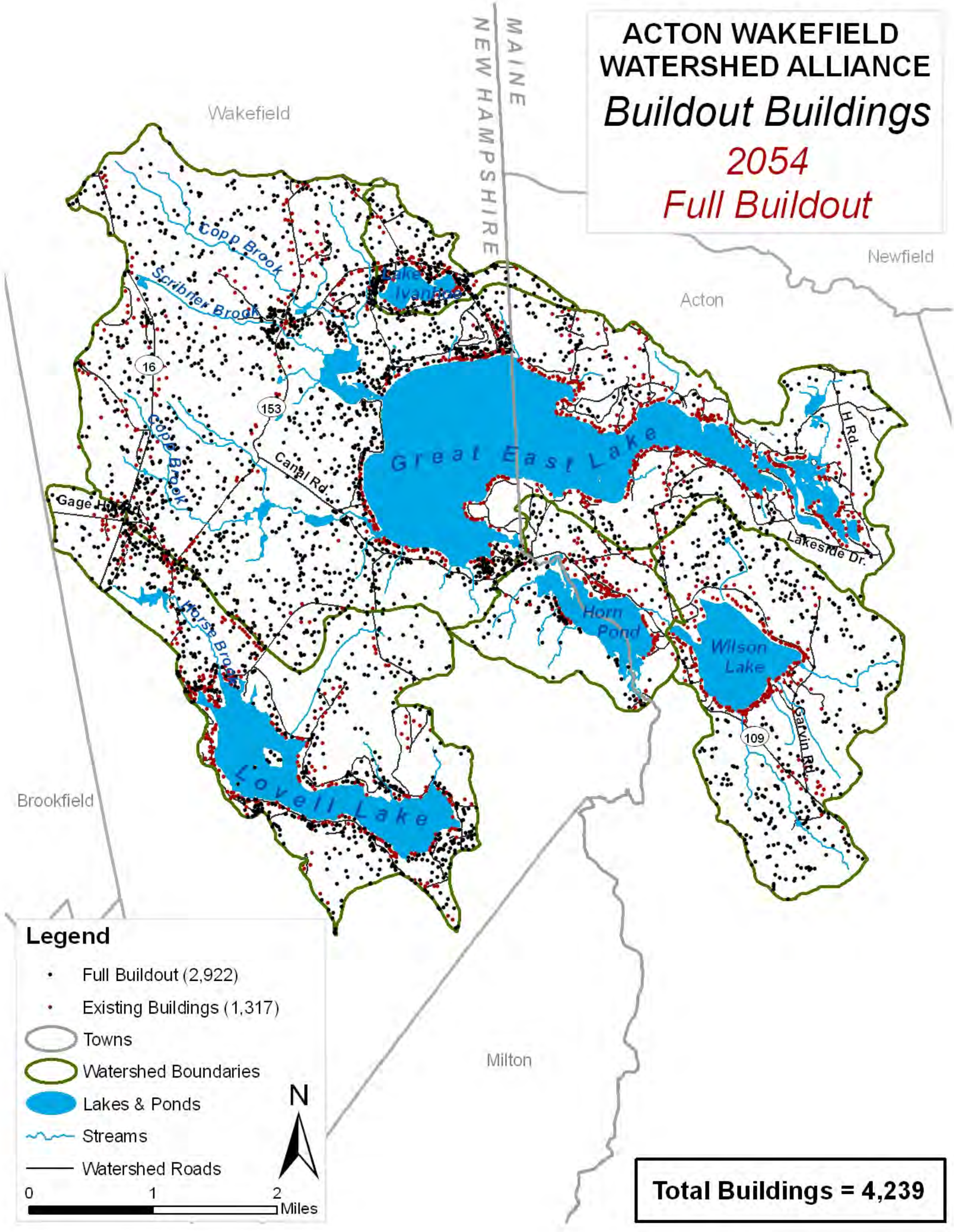


Figure 13: AWWA Full Buildout Map

Buildout Phosphorus Load Estimate

An increase in watershed development could lead to more phosphorus (P) entering AWWA waterbodies from the surrounding watershed each year. Phosphorus serves to "fertilize" the lake and decreases water clarity. Excess phosphorus can also harm fish habitat and lead to nuisance algae blooms. A spreadsheet was used to estimate the additional annual phosphorus load that could result from buildout in the AWWA watershed. Based on recommendations from Maine DEP, the analysis was based on 30% of total buildout, or 2,193 new units, rather than on full buildout. In the Town of Acton, 30% buildout (194 units) would occur around the year 2021, while 30% buildout in the Town of Wakefield (682 units) would occur in approximately 2030. Table 7 and Figures 14 and 15 below illustrate the extent of 30% buildout in the Acton and Wakefield watersheds.

Table 7: Acton and Wakefield 30% Buildout Results, by Watershed

Subwatershed	Buildout Units	Existing Units	Total
ACTON			
Great East Lake	98	338	436
Horn Pond	28	93	121
Lake Ivanhoe	1	2	3
Wilson Lake	67	184	251
Acton Totals	*194*	*617*	*811*
WAKEFIELD			
Great East Lake	384	327	711
Horn Pond	10	17	27
Lake Ivanhoe	59	55	114
Lovell Lake	229	301	530
Wakefield Totals	*682*	*700*	*1382*
Grand Totals	***876***	***1,317***	***2,193***

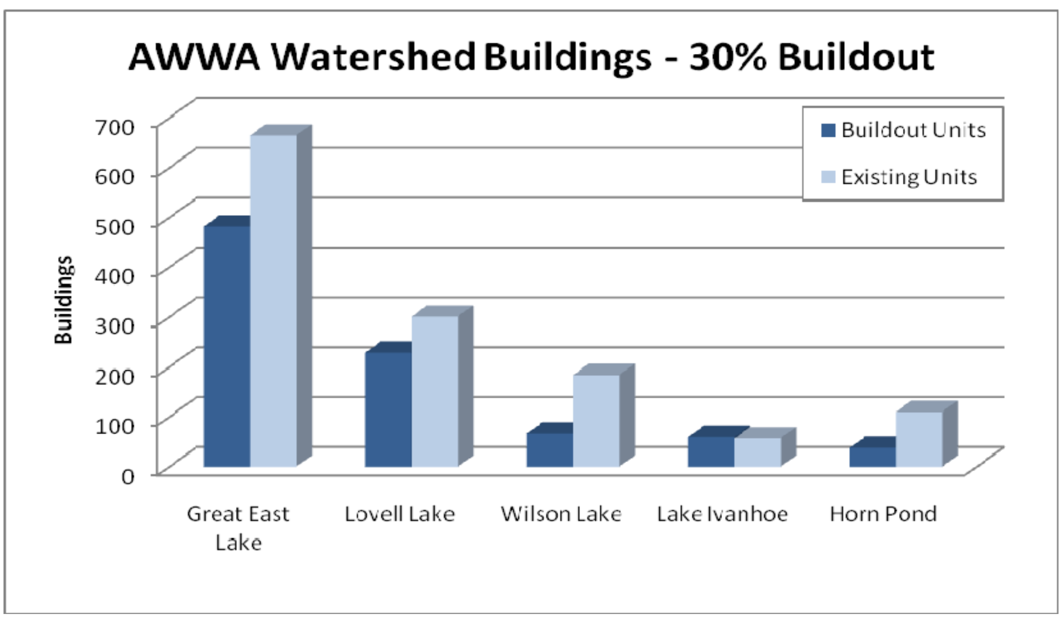


Figure 14: Acton and Wakefield 30% Buildout Results, by Watershed

Phosphorus load analyses were conducted for two scenarios:

1. The first analysis estimates phosphorus loads at 30% buildout.
2. The second analysis estimates phosphorus loads at 30% buildout, assuming that all new development incorporates phosphorus reduction BMPs.

Final phosphorus loading numbers were calculated in a spreadsheet, using estimated export coefficients for residential properties, agriculture, roadways, and other types of development (including commercial development, parks and cemetaries, and forest land, among others). The following methods were used to estimate P loads at 30% buildout:

- For each new building, it was assumed that the total developed area (including house, driveway, lawn, and any accessory buildings) covers 20% of the minimum lot size. This estimate is based on the 20% maximum lot coverage estimate. Minimum lot sizes for individual development zones in each town were used (see Table 1).

- The buildout unit locations were buffered to create a developed area covering 20% of the minimum lot size. This layer was then compared to existing land uses to determine what types of land uses the new lots were created on. The new area for each land use type was then recalculated and adjusted accordingly on the spreadsheet.

- The first scenario uses a phosphorus export coefficient of 0.5 kg P/ha/year for all new residential development. This is the same coefficient used in similar analyses in Maine.

- The second scenario uses a lower export coefficient of 0.056 kg P/ha/year for all new residential development. This assumes that phosphorus reduction measures have been applied on all new development. The coefficient for this scenario is based on the per acre phosphorus allocations for the watersheds within the Town of Acton as outlined in *Phosphorus Control in Lake Watersheds: A Technical Guide for Evaluating New Development* (MDEP, 2008). Because no similar data was available for Wakefield, the Acton coefficient was used in Wakefield. The final coefficient represents the allocation for the Horn Pond watershed, the highest allocation among the Acton watersheds.

Under existing conditions, the annual phosphorus load delivered to the AWWA waterbodies from the surrounding watershed is estimated to be 1,245 kg P/year (2,744 lbs/year, Table 8). According to analysis results, under 30% buildout, the annual phosphorus load delivered to the AWWA waterbodies from the surrounding watershed would increase to 1,330 kg P/year (2,932 lbs/acre, Table 9). This is 86 more kg (190 lbs) of P per year than under current conditions. Under ideal conditions, if phosphorus reduction measures were in place on all newly developed parcels, this estimate would be reduced to an near 1,248 kg P/year (2,751 lbs/acre), 3 kg more than under existing conditions.

Table 8: AWWA Watershed Phosphorus Loading Under Existing Conditions

LAND USE CLASS	Total Area Acres	Land Area %	TP Coeff. Avg. kg/TP/ha	TP Export Load kg TP	TP Export %
ACTON					
Developed Land					
Hayland/Pasture	405	7%	0.64	105	25%
Low Density Development	181	3%	0.50	37	9%
Medium Density Development	89	2%	1.00	36	8%
High Density Development	100	2%	1.40	57	13%
Parks/Cemetaries	49	1%	0.80	16	4%
Septic Systems	-	-	-	72	17%
Non-Developed Land					
Unmanaged Forest	3,887	66%	0.04	25	6%
Surface Water (Atmospheric)	1,170	20%	0.16	76	18%
Acton Totals:	***5,880***	***100%***		***423***	***100%***
WAKEFIELD					
Developed Land					
Hayland/Pasture	1,036	10%	0.64	268	33%
Low Density Development	881	8%	0.50	178	22%
Medium Density Development	349	3%	1.00	141	17%
High Density Development	28	0.3%	1.40	16	2%
Parks/Cemetaries	7	0.1%	0.80	2	0.3%
Septic Systems	-	-	-	77	9%
Non-Developed Land					
Scrub Shrub	15	0.1%	0.15	0.9	0.1%
Unmanaged Forest	6,468	60%	0.04	44	5%
Surface Water (Atmospheric)	2,102	19%	0.11	94	11%
Wakefield Totals:	***10,886***	***100%***		***822***	***100%***
COMBINED TOTALS	***16,766***			***1,245***	

***Conversion factors:** *1kg/hectare = 0.89 lbs/acre; 1kg = 2.2lbs*

Table 9: AWWA Watershed Additional Phosphorus Loading Under 30% Buildout

		30% Buildout Estimated P Load (kg P/year)	
	Estimated New Units	*Without* Phosphorus Reduction Measures	*With* Phosphorus Reduction Measures
Acton	194	24	1
Wakefield	682	62	2
	Total Additional P:	***86***	***3***

***Conversion factors:** *1kg/hectare = 0.89 lbs/acre; 1kg = 2.2lbs*

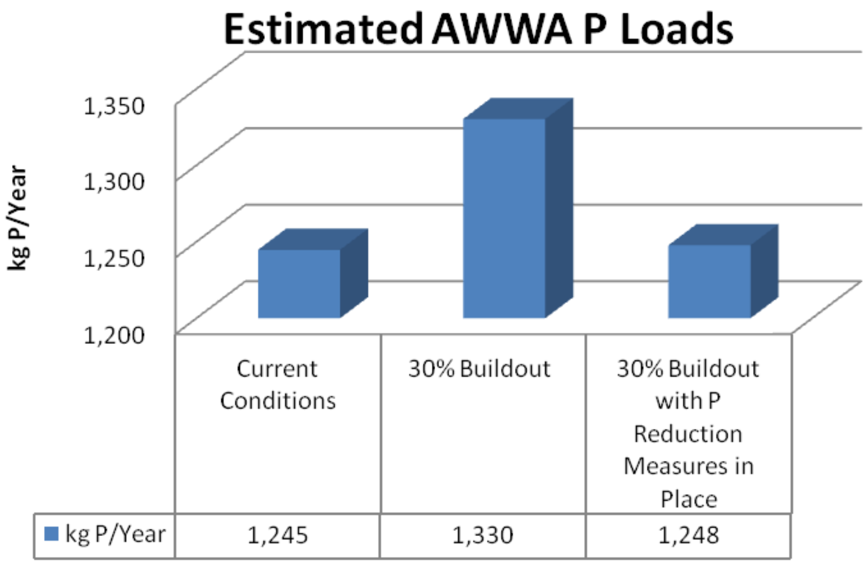


Figure 15: AWWA Phosphorus Loads Under Existing and Future Conditions

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APPENDIX F:
Lake Fact Sheets

Lake Fact Sheet

Lake Ivanhoe

Lake Ivanhoe, originally known as Round Pond, sits between Acton Ridge Road and Round Pond Road near Wakefield, New Hampshire's eastern border with Maine. The lakeshore is developed with numerous homes and camps, as well as a campground on Acton Ridge Road. Historically, a small stream drained the lake at its western end, crossing Wansor Road, and then south through a small area of forest and into Great East Lake. Local residents report that the stream outlet was filled in years ago during a construction project, and that water flowing out of Lake Ivanhoe is currently flowing over land toward Great East Lake causing serious flooding problems including flooding of septic systems. Great East Lake, to the south, forms the headwaters of the Salmon Falls River, the natural borderline between the two states which empties into the tidal waters of the Piscataqua River in Portsmouth, New Hampshire.

The water quality of Lake Ivanhoe is classified as "Potentially Impaired" based on recent analysis of measured water quality parameters. Lake Ivanhoe is potentially impaired because its in-lake phosphorus concentration exceeds the water quality standard for oligotrophic lakes in NH (< 8 ppb) as well as for chlorophyll-a (< 3.3 ppb). NH DES will determine whether Lake Ivanhoe should be listed as a federally impaired waterbody. Reducing in-lake phosphorus by 0.8 ppb will enable Lake Ivanhoe to once again be considered a high quality waterbody.

The Lake Ivanhoe direct watershed covers 0.71 square miles (455 acres). The lake is threatened by polluted runoff from development in the surrounding watershed and along its well developed shoreline. Soil erosion, in particular, is the single greatest source of pollution to Lake Ivanhoe. Soil contains the nutrient phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen, affecting fish and animals who depend on the lake water.

In the spring of 2009, in an effort to address this concern, a team of local volunteers and technical staff from the Great East Lake Improvement Association, Acton Wakefield Watersheds Alliance, York County SWCD, NHDES, and Maine DEP conducted a survey of the watershed and identified sites that are contributing polluted runoff to Lake Ivanhoe. Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Survey results and remediation recommendations were compiled in the *Lake Ivanhoe Watershed Survey Report (*Appendix C).

LAKE FACTS

Watershed: Wakefield, NH

Counties: Carroll

Midas Number: N/A

Mean Depth: 12 feet (3.7 m)

Max Depth: 20 feet (6.1 m)

Surface Area: 68 acres (0.12 mi^2)

Volume: 992,000 m^3

Perimeter: 8,858 feet

Flushing Rate: 0.90 flushes/year

Avg. Transparency: 5.1 meters (19 ft)

Watershed Area: 455 acres (0.71 mi^2)

Drains to: Great East Lake

Major Drainage Basin: Salmon Falls River

Current Water Quality Trends - LAKE IVANHOE

Water Quality Information

Water quality monitoring data for Lake Ivanhoe has been collected since 1981. This includes 16 years of secchi disk transparencies, 17 years of total phosphorus (TP) data (including 2 years of epicore samples), 16 years of chlorophyll_a (Chl-a) and color data, and 14 years of dissolved oxygen (DO) profiles. The UNH Lay Lakes Monitoring Program (LLMP) and Center for Freshwater Biology (CFB), and NH Department of Environmental Services (NHDES) have collaborated in the collection of lake data to collect water quality data for Lake Ivanhoe in order to evaluate present water quality, track algae blooms, and determine water quality trends.

According to NH Lake Nutrient Criteria, Lake Ivanhoe is considered "Potentially Impaired". This is because the median phosphorus concentration is at the tipping point (8 ppb) between a high quality lake (<8 ppb) and the lower classification (>8 and <12ppb), and the Chl-a value exceeds the state standard (<3.3 ppb).

Lake Ivanhoe has a relatively low flushing rate (0.9 flushes/ year) which can make it sensitive to pollution. The average Maine and NH lake flushes 1 to 1.5 times per year. Phosphorus loading reductions have been recommended for Lake Ivanhoe to halt future water quality declines.

Sampling Locations

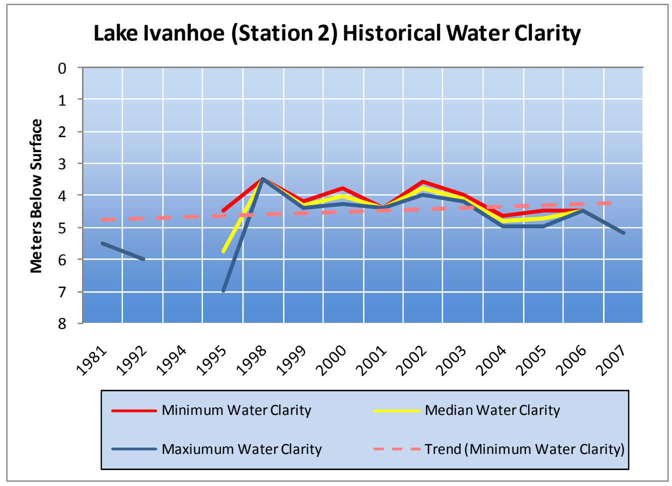
Lake Ivanhoe has two sampling locations. Station 2 (deep hole) is located in the large, western basin of the lake, and Station 1 is located within the smaller eastern basin.

Water Clarity

Secchi Disk Transparency (SDT) is a quick, simple, inexpensive, and accurate method for determining the clarity of a lake. Factors that limit the depth of clarity include algae, zooplankton, water color, and silt. Generally, as algal populations increase, SDT readings decrease. SDT readings have been conducted in Lake Ivanhoe for over 16 years at Station 2, with a mean annual SDT of 4.8 m (15.7 ft) at Station 2, and 5.1 m (16.7 ft) at Station 1.

Sampling Results for Station 2 (1981-2008)

Sampling Parameter	Station 2
Mean Color (SPU)	15.2
Median EpiCore P (ppb)	8.0
Mean Secchi (m)	4.7
Mean Chl-a (ppb)	3.4

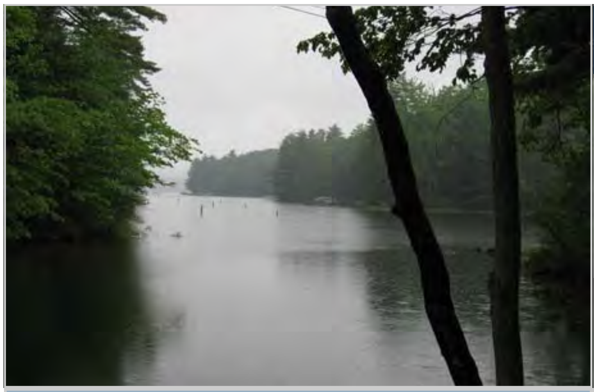


Dissolved Oxygen

Dissolved oxygen (DO) in the lake is critical to the survival of all plants and animals, and is therefore an indicator of water quality and the level of life a lake can support. DO levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species. Low DO at the bottom of the lake is of particular concern because it can result in the release of phosphorus from bottom sediments- leading to increased algal production. Historic and more recent profiles confirm that Lake Ivanhoe is not stratified. Therefore, the potential for TP to be released from bottom sediments and become available to algae in the water column (internal loading) is low.

Total Phosphorus

Phosphorus is an essential element for plant growth, yet is found in limited amounts in lake systems. Therefore, small increases in phosphorus in Lake Ivanhoe can lead to substantial increases in algal growth Lake Ivanhoe over the period from 1981 to 2007 for Station 1 is 2 – 24 parts per billion (ppb) with a median of 8 ppb. A reduction of 0.8 ppb of total phosphorus is recommended for this lake.



Lake Fact Sheet

Great East Lake

LAKE FACTS

Watershed: Acton, ME & Wakefield, NH

Counties: York (ME) & Carroll (NH)

Midas Number: 3922

Mean Depth: 35 feet (11 m)

Max Depth: 102 feet (31 m)

Surface Area: 1,707 acres (2.7 mi^2)

Volume: 75,589,500 m^3

Perimeter: 95,144 feet

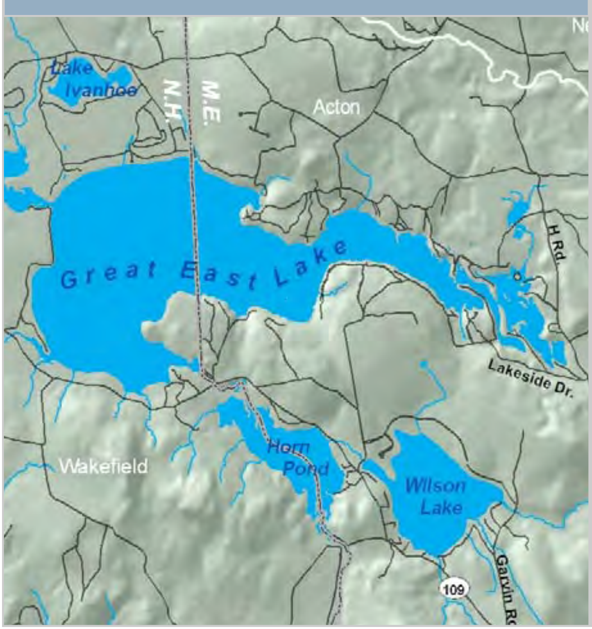
Flushing Rate: 0.3 flushes/year

Avg. Transparency: 9.2 meters (30.2 ft)

Watershed Area: 9,939 acres (15.53 mi^2)

Drains to: Horn Pond

Major Drainage Basin: Salmon Falls River



Great East Lake lies on the Maine and New Hampshire border with 763 acres (45%) of its 1,707 acre surface area in Acton, Maine and 944 acres (55%) in Wakefield, New Hampshire. The outlet of Great East Lake flows over a dam and through an 800 foot canal where it enters Horn Pond near Canal Road. Great East Lake forms the headwaters of the Salmon Falls River, the natural borderline between the two states which empties into the tidal waters of the Piscataqua River in Portsmouth, New Hampshire. Copp Brook and Scribner Brook feed into Great East Lake from the north-west as well as some smaller tributaries including JoDo Brook.

With nearly 18 miles of shoreline, Great East Lake is the largest of the Salmon Falls Headwater Lakes. The lake is regarded as a high quality waterbody, known for its natural beauty and abundance of wildlife. Great East Lake is managed for both coldwater and warmwater fisheries. The extensive rocky, gravelly shoreline serves as an excellent spawning and nursery habitat for smallmouth bass. The lake is home to 21 species of fish, two species of crayfish, and one species of freshwater mussel.

Numerous camps and residences dot the perimeter of Great East Lake. A town-owned boat launch is located on the north side of the lake, and a state-owned boat launch, located adjacent to the outlet off Canal Road, provides boat access. Great East Lake dam, operated by the NH Department of Environmental Services (NH DES), is located at the southeast end of the lake near the Maine-New Hampshire border in Wakefield. Water levels are maintained at full capacity during the summer, with seasonal fall drawdown to three feet below full lake level beginning in October.

The Great East Lake direct watershed covers 15.53 square miles (9,939 acres). The direct watershed area for Great East Lake is the largest of all of the five target AWWA subwatersheds, and therefore has a strong influence on downstream water quality. A watershed survey was conducted in the Great East Watershed in the Spring of 2009. Results of this survey are summarized in Appendix C.

Water Quality Information

The Maine Department of Environmental Protection (Maine DEP), the Maine Volunteer Lake Monitoring Program (VLMP), the UNH Lay Lakes Monitoring Program (LLMP) and Center for Freshwater Biology (CFB), and the NH Department of Environmental Services (NHDES) have collaborated in the collection of lake data to collect water quality

Current Water Quality Trends - GREAT EAST LAKE

data for Great East Lake in order to evaluate present water quality, track algae blooms, and determine water quality trends.

Water quality monitoring data for Great East Lake has been collected since 1974. This includes 29 years of secchi disk transparencies, 23 years of total phosphorus (TP) data (including 21 years of epicore samples), 20 years of chlorophyll-a, (Chl-a) data 20 years of color data, and 7 years of dissolved oxygen profiles.

Great East Lake is on the cusp of an "outstanding" and "good" classification in Maine, and qualifies as a high quality waterbody in New Hampshire. Outstanding lakes exhibit average secchi disk transparency (SDT) greater than 9.1 meters (30 feet), have very low algae levels (Chl-a of <2 ppb) and have very low phosphorus concentrations (2 to 5 ppb). These lakes are rare and unique resources, which are particularly sensitive to small increases in phosphorus concentrations. As such, management actions are needed to limit future phosphorus increases in Great East Lake.

The ultimate goal for Great East Lake is maintain or improve existing water quality by limiting future inputs of phosphorus from the watershed. This can be accomplished by controlling non-point source pollution (e.g. soil erosion) from existing development and restricting phosphorus loading from new development through watershed-wide planning efforts.

Sampling Locations

Great East Lake has four regular sampling locations: Station 1 (Center Hole) located in the deepest area of the lake; Station 2 (Canal); Station 3 (Maine Mann); and Basin 2. Two additional sites, Basin 3 and Basin 1 (Narrows) are sampled occasionally.

Water Clarity

Secchi Disk Transparency (SDT) is a quick, simple, inexpensive, and accurate method for determining the clarity of a lake. Factors that limit the depth of clarity include algae, zooplankton, water color, and silt. Generally, as algal populations increase, SDT readings decrease. SDT readings have been conducted over 29 years at Station 1, with an average SDT reading of 9.2 m (30.2 ft). There is some evidence to suggest this lake may be changing over time toward reduced minimum transparency and higher TP.

Sampling Results for Station 1 (1974-2008)

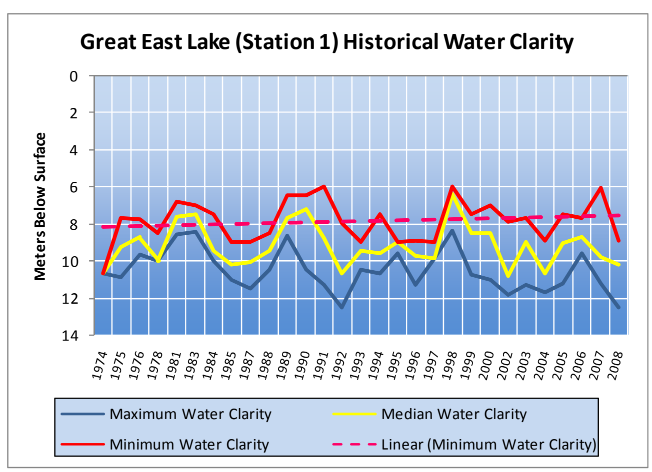
Sampling Parameter	Station 1
Mean Color (SPU)	13.8
Median EpiCore P (ppb)	6.4
Mean Secchi (m)	9.2
Mean Chl-a (ppb)	1.2

Dissolved Oxygen (DO)

Dissolved oxygen (DO) in the lake is critical to the survival of all plants and animals, and is therefore an indicator of water quality and the level of life a lake can support. DO levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species. Historic profiles show little DO depletion in deep areas of Great East Lake.

Total Phosphorus (TP)

The range of water column TP for Great East Lake from 1976 to 2008 for Station 1 is 0.9 – 17.8 parts per billion (ppb) with a median of 6.4 ppb. High quality lakes with low flushing rates, such as Great East, may be particularly sensitive to small increases in phosphorus, making management measures to limit phosphorus inputs from the watershed particularly important. The existing in-lake TP concentration should be maintained or improved.



Lake Fact Sheet

Horn Pond

LAKE FACTS

Watershed: Acton, ME & Wakefield, NH

Counties: York (ME) & Carroll (NH)

Midas Number: 3924

Mean Depth: 13 feet (3.9 m)

Max Depth: 31 feet (9.4 m)

Surface Area: 227 acres (0.35 mi^2)

Volume: 3,155,000 m^3

Perimeter: 25,544 feet

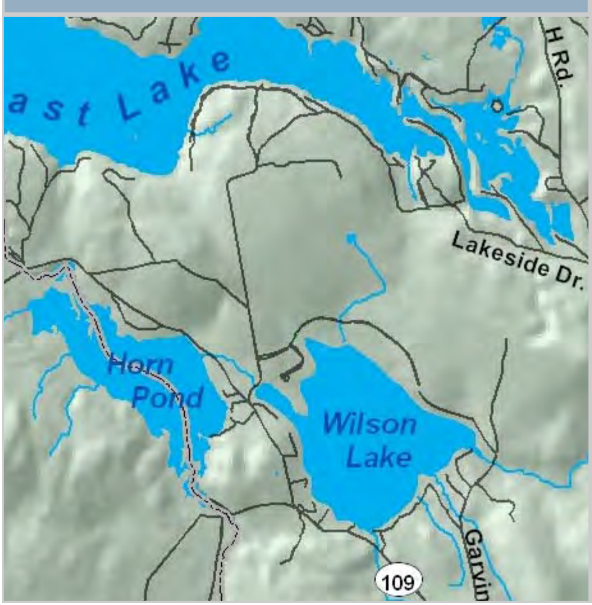
Flushing Rate: 8.2 flushes/year

Avg. Transparency: 6.6 meters (21.7 ft)

Watershed Area: 1,139 acres (1.78 mi^2)

Upstream Waterbodies: Great East Lake, Wilson Lake

Major Drainage Basin: Salmon Falls River



Horn Pond lies on the Maine and New Hampshire border with 119 acres (52%) of its 227 acre surface area in Acton, Maine and 108 acres (48%) in Wakefield, New Hampshire. The lake is both spring-fed and fed by outflow from Great East Lake to the north, and Wilson Lake to the east. Wilson Lake flows into Horn Pond via a wide rushing stream that flows through a large culvert under New Bridge Road on the eastern shore. The outlet for Great East Lake enters south of Canal Road. Horn Pond is natural pond raised by a dam on the Salmon Falls River. The Salmon Falls River forms a natural borderline between Maine and New Hampshire and eventually empties into the tidal waters of the Piscataqua River in Portsmouth, New Hampshire.

Horn Pond is currently considered “Potentially Non-supporting” according to the State of NH revised water quality standards for oligotrophic lakes. Oligotrophic lakes are characterized as being nutrient-poor, having rocky substrates and shorelines, deeper water, limited algae and aquatic plant growth, and an abundance of dissolved oxygen, even in deep water. This profusion of dissolved oxygen is crucial for productive fish habitat and is exemplified by the abundance of fish in the lake. Horn Pond is managed for both coldwater and warmwater fisheries.

The Horn Pond direct watershed covers 1.78 square miles (1,139 acres). Although Horn Pond’s water quality is good, the lake is threatened by polluted runoff from development in the surrounding watershed and along it’s well developed shoreline. Soil erosion, in particular, is the single greatest source of pollution to Horn Pond. Soil contains the nutrient phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen, affecting fish and animals who depend on the lake water.

In June 2008, in an effort to address this concern, a team of 20 local volunteers and technical staff from Acton Wakefield Watersheds Alliance, York County SWCD, NHDES, and Maine DEP conducted a survey of the watershed and identified 55 sites that are contributing polluted runoff to Horn Pond. Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Survey results and remediation recommendations were compiled in the *Horn Pond Watershed Survey Report,* and summarized in Appendix C).

Current Water Quality Trends - HORN POND

Water Quality Information

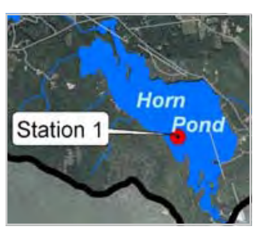
Water quality monitoring data for Horn Pond has been collected since 1982. This includes 11 years of secchi disk transparencies (SDT), 7 years of total phosphorus data (including 2 years of epicore samples), 2 years of chlorophyll-a, (Chl-a) data, 7 years of color data, and 5 years of dissolved oxygen profiles. The Maine Department of Environmental Protection (Maine DEP), the Maine Volunteer Lake Monitoring Program (VLMP), the UNH Lay Lakes Monitoring Program (LLMP) and Center for Freshwater Biology (CFB), and NH Department of Environmental Services (NHDES) have collaborated in the collection of lake data to collect water quality data for Horn Pond in order to evaluate present water quality, track algae blooms, and determine water quality trends.

The water quality of Horn Pond is considered to be good by Maine standards, based on measures of SDT, TP, and Chl-a, and potentially non-supporting by NH standards based on the median TP concentration. The potential for nuisance algal blooms on Horn Pond is low. Water flushes through the Horn Pond 8.2 times/year, much more frequently than the average Maine or New Hampshire lake which flushes 1 to 1.5 times per year.

The ultimate goal for Horn Pond is to maintain the current in-lake TP concentration of 8.0 ppb to prevent future water quality declines in Horn Pond. This can be accomplished by preventing soil erosion and stormwater runoff from existing development, and restricting phosphorus loading from new development.

Sampling Locations

Horn Pond has one regular sampling location, Station 1, located in the deepest area of the lake near the western shore. Station 1 is located on the Wakefield, NH side of Horn Pond.

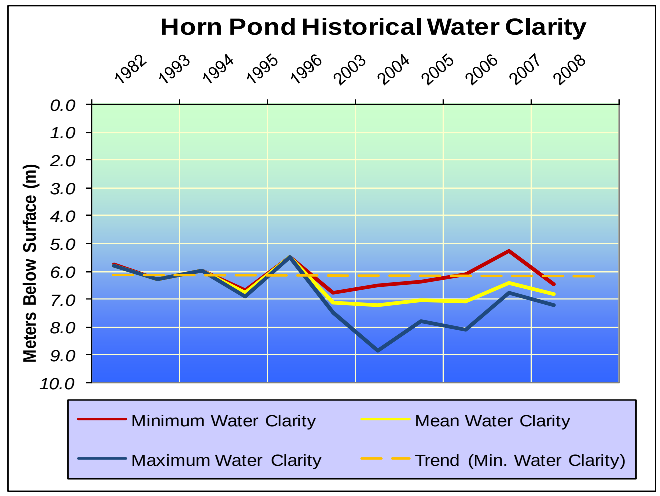


Water Clarity

Secchi Disk Transparency (SDT) is a quick, simple, inexpensive, and accurate method for determining the clarity of a lake. Factors that limit the depth of clarity include algae, zooplankton, water color, and silt. Generally, as algal populations increase, SDT readings decrease. SDT readings have been conducted in Horn Pond for over 29 years at Station 1, with an average annual SDT of 6.6 m (21.7 ft).

Sampling Results for Station 1 (1982-2008)

Sampling Parameter	Station 1
Mean Color (SPU)	16
Median EpiCore P (ppb)	8.0
Mean Secchi (m)	6.6
Mean Chl a (ppb)	2.8



Dissolved Oxygen (DO)

Dissolved oxygen (DO) in the lake is critical to the survival of all plants and animal. DO levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species. Low DO at the bottom of the lake is of particular concern because it can result in the release of phosphorus from bottom sediments- leading to increased algal production. Recent profiles show low to moderate DO depletion in deep areas of Horn Pond. Therefore, the potential for TP to leave the bottom sediments and become available to algae in the water column (internal loading) is low.

Total Phosphorus (TP)

Phosphorus is an essential element for plant growth, yet is found in limited amounts in lake systems. Therefore, small increases in phosphorus in Horn Pond can lead to substantial increases in algal growth. The range of water column total phosphorus for Horn Pond over the period from 1982 to 2008 for Station 1 is 4 – 11 parts per billion (ppb) with a median of 8.0 ppb. More sampling is needed to clearly define TP trends, and to determine whether this lake is truly non-supporting based on NH standards.

Lake Fact Sheet

Wilson Lake

LAKE FACTS

Watershed: Acton, ME

Counties: York

Midas Number: 3920

Mean Depth: 17 feet (5.2 m)

Max Depth: 44 feet (13.4 m)

Surface Area: 308 acres (0.48 mi^2)

Volume: 6,756,766 m^3

Perimeter: 19,419 feet

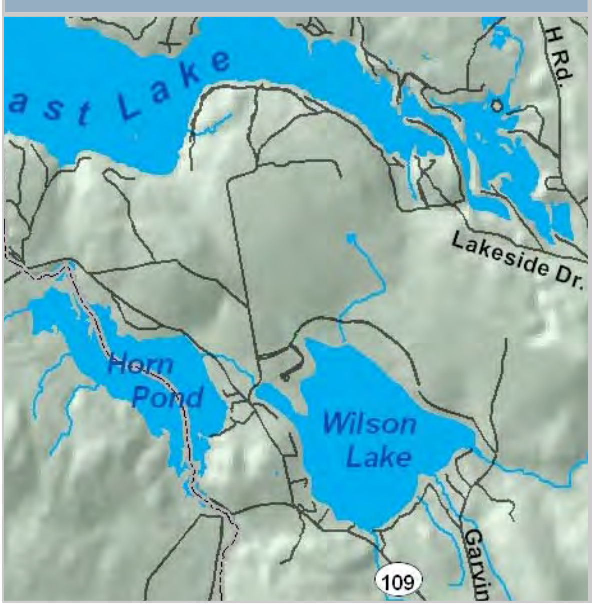
Flushing Rate: 0.85 flushes/year

Avg. Transparency: 5.8 meters (19 ft)

Watershed Area: 2,479 acres (3.9 mi^2)

Drains to: Horn Pond

Major Drainage Basin: Salmon Falls River



Wilson Lake is located on Route 109 in Acton, Maine - north of Gerrish Mountain and approximately 2 miles from the New Hampshire Border. The 308-acre waterbody drains to Horn Pond to the northwest, which flows into the Salmon Falls River and eventually empties into the tidal waters of the Piscataqua River in Portsmouth, New Hampshire. Boat access for Wilson Lake is located on the northwest side of the lake, off Young's Ridge Road.

The water quality of Wilson Lake is classified as "good", based on measured water quality parameters. Water quality classifications are assigned by Maine DEP based on measures of Secchi disk transparency (SDT), chlorophyll-a (Chl-a), and total phosphorus (TP). Lakes in this category are clear with an average SDT of 6.1 to 9.1 meters (20 to 30 feet) with relatively low algae levels (chlorophyll-a of 2 to 4 ppb) and phosphorus concentrations ranging from 5 to 10 ppb. This water quality type is common, and lakes in this category are considered to have average water quality.

The Wilson Lake direct watershed covers 3.9 square miles (2,479 acres) and is surrounded by houses on all shores. Although Wilson Lake's water quality is above average, the lake is threatened by polluted runoff from development in the surrounding watershed and along it's well developed shoreline. Additionally, low dissolved oxygen levels in deep areas of the lake indicate that it is threatened by polluted runoff. Soil erosion, in particular, is the single greatest source of pollution to Wilson Lake. Soil contains the nutrient phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen, affecting fish and animals who depend on the lake water.

In the spring of 2009, in an effort to address this concern, a team of 32 local volunteers and technical staff from the Wilson Lake Association, Acton Wakefield Watersheds Alliance, York County SWCD, NHDES, and Maine DEP conducted a survey of the watershed and identified 71 sites that are contributing polluted runoff to Wilson Lake. Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Survey results and remediation recommendations were compiled in the *Wilson Lake Watershed Survey Report* (summarized in Appendix C).

Current Water Quality Trends - WILSON LAKE

Water Quality Information

Water quality monitoring data for Wilson Lake has been collected since 1977. This includes 29 years of secchi disk transparencies, 9 years of phosphorus data (including 7 epicore samples), 5 years of chlorophyll-a, data 7 years of color data, and 17 years of dissolved oxygen profiles. The Maine Department of Environmental Protection (Maine DEP) and the Volunteer Lake Monitoring Program (VLMP) have collaborated in the collection of lake data to evaluate present water quality, track algae blooms, and determine water quality trends.

The water quality of Wilson Lake is considered to be good, based on measures of SDT, total phosphorus (TP), and Chlorophyll-a (Chl-a), and the potential for nuisance algal blooms on Wilson Lake is low to moderate. As such, stringent protection loading recommendations have been recommended for Wilson Lake.

The ultimate goal for Wilson Lake is to protect existing water quality by limiting future phosphorus increases to less than 1.0 ppb from current levels. This can be accomplished by limiting non-point source pollution (e.g. soil erosion, stormwater runoff) from existing development and restricting phosphorus loading from new development through watershed-wide planning efforts.

Sampling Location

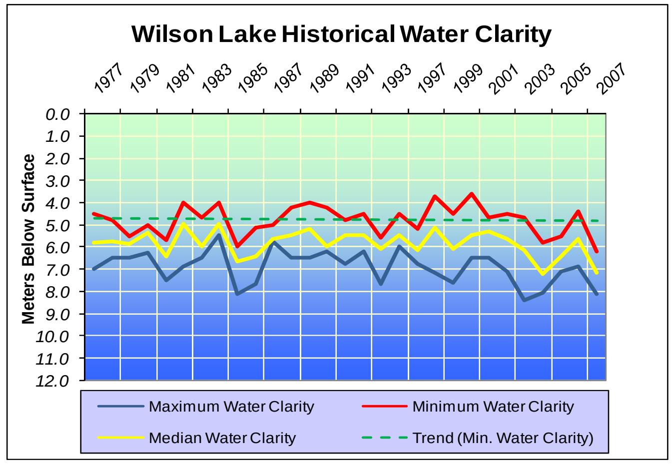
Wilson Lake has one regular sampling location, Station 1, located in the deepest area (44 ft.) in the lake's center.

Water Clarity

Secchi Disk Transparency (SDT) is a quick, simple, inexpensive, and accurate method for determining the clarity of a lake. Factors that limit the depth of clarity include algae, zooplankton, water color, and silt. Generally, as algal populations increase, SDT readings decrease. SDT readings have been conducted in Wilson for over 29 years at Station 1. Historical transparency readings range from 3.6 to 8.4 meters, with an average annual SDT of 5.9 m (19.4 ft). According to standards in Maine, Horn Pond has above average water clarity.

Sampling Results for Station 1 (1977-2007)

Sampling Parameter	Station 1
Mean Color (SPU)	16
Median EpiCore P (ppb)	6.5
Mean Secchi (m)	5.9
Mean Chl-a (ppb)	3.5



Dissolved Oxygen (DO)

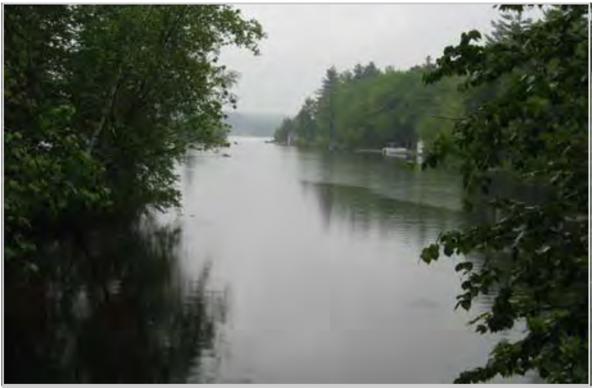
Dissolved oxygen (DO) in the lake is critical to the survival of all plants and animals. DO levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species. Low DO at the bottom of the lake is of particular concern because it can result in the release of phosphorus from bottom sediments- leading to increased algal production. Recent profiles show high DO depletion in deep areas of Wilson Lake Therefore, the potential for TP to leave the bottom sediments and become available to algae in the water column (internal loading) is high.

Total Phosphorus (TP)

Phosphorus is an essential element for plant growth, yet is found in limited amounts in lake systems. Therefore, small increases in phosphorus in Wilson Lake can lead to substantial increases in algal growth. The range of water column total phosphorus for Wilson Lake over the period from 1979 to 2004 for Station 1 is 4 – 13 parts per billion (ppb) with a median of 6.5 ppb. Wilson Lake may be particularly sensitive to small increases in phosphorus, making management measures to limit phosphorus inputs from the watershed particularly important.

Lake Fact Sheet

Lovell Lake



Lovell Lake is located in Wakefield, New Hampshire just north of Route 109. The 538-acre lake is both spring-fed and fed by small streams, including Horse Brook to the northwest. Lovell Lake outlets into the Branch River in the village of Sanbornville to the west. From here, the Branch River flows in a southeasterly direction to Milton, NH where it joins the Salmon Falls River on the Maine-New Hampshire border. The Salmon Falls River eventually empties into the tidal waters of the Piscataqua River in Portsmouth, New Hampshire.

Lovell Lake is a "Tier 1" waterbody and is "Fully Supporting" its designated uses according to NH water quality standards. Water quality classifications are assigned by New Hampshire DES based on measures of total phosphorus (TP) and chlorophyll-a (Chl-a). Lakes in this category are generally clear with relatively low algae levels of phosphorus (< 8 ppb) and Chl-a (< 3.3 ppb).

Lovell Lake is an oligotrophic lake, which means that it is generally nutrient-poor, with a rocky substrate and shoreline, limited algae and aquatic plant growth, and an abundance of dissolved oxygen, except in the deepest waters. This profusion of dissolved oxygen is crucial for productive warm water fish habitat, while low dissolved oxygen near the lake bottom prevents the establishment of a cold water fishery.

The Lovell Lake direct watershed covers 4.8 square miles (3,076 acres) in the Village of Sanbornville in the Town of Wakefield. Although Lovell Lake's water quality is average, the lake is threatened by polluted runoff from development in the surrounding watershed. Soil erosion, in particular, is the single greatest source of pollution to Lovell Lake. Soil contains the nutrient phosphorus, which has the potential to promote algae blooms when it enters a lake in large quantities. As the algae die off, the water becomes depleted of oxygen, affecting fish and animals who depend on the lake water.

In September 2008, in an effort to address this concern, a team of 32 local volunteers and technical staff from the Lovell Lake Association, Acton Wakefield Watersheds Alliance, York County SWCD, NH DES, and Maine DEP conducted a survey of the watershed and identified 161 sites that are contributing polluted runoff to Lovell Lake. Teams documented polluted runoff sources from roads, properties, driveways, and shorelines using cameras and standardized field data sheets. Survey results and remediation recommendations were compiled in the *Lovell Lake Watershed Survey Report* (summarized in Appendix C).

LAKE FACTS

Watershed: Wakefield, NH

Counties: Carroll

Midas Number: N/A

Mean Depth: 13 feet (3.9 m)

Max Depth: 41 feet (12.5 m)

Surface Area: 538 acres (0.84 mi^2)

Volume: 8,623,000 m^3

Perimeter: 34,777 feet

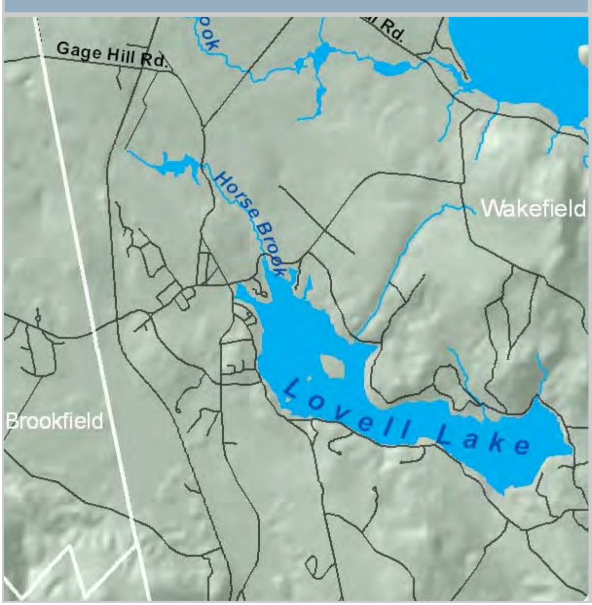
Flushing Rate: 0.70 flushes/year

Avg. Transparency: 5.9 meters (19 ft)

Watershed Area: 3,076 acres (4.81 mi^2)

Drains to: Branch River

Major Drainage Basin: Salmon Falls River



Current Water Quality Trends - LOVELL LAKE

Water Quality Information

Water quality monitoring data for Lovell Lake has been collected at Station 1 since 1979, and Station 2 since 1989. This includes 19 years of secchi disk transparencies, 19 years of phosphorus data, 16 years of chlorophyll-a (Chl-a) and color data, and 3 years of dissolved oxygen profiles. The UNH Lay Lakes Monitoring Program (LLMP) and Center for Freshwater Biology (CFB), and NH Department of Environmental Services (NHDES) have collaborated in the collection of lake data for Lovell Lake in order to evaluate present water quality, track algae blooms, and determine water quality trends.

Based on measures total phosphorus (TP), and Chl-a, Lovell Lake does not meet standards for High Quality Waters in New Hampshire. Lovell Lake has a relatively low flushing rate which can make it sensitive to pollution. It takes 1.4 years for water to flush through the Lovell Lake system. The average Maine and NH lake flushes 1– 1.5 times/year.

Based on a slight decrease in water clarity, and a median phosphorus concentration of 7.5 ppb (which indicates that Lovell Lake has limited capacity to treat additional phosphorus from the land), phosphorus reduction strategies are needed for Lovell Lake. Lowering current in-lake phosphorus levels by 0.3 ppb will help establish Lovell Lake as a high quality waterbody in NH. This can be accomplished by limiting non-point source pollution (e.g. erosion and stormwater runoff) from existing development and restricting phosphorus loading from new development through watershed-wide planning efforts.

Sampling Locations

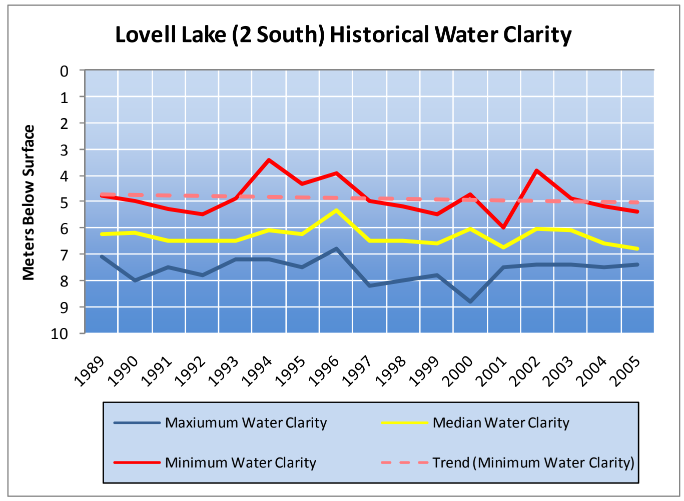
Lovell Lake has three sampling locations: Station 1 (north), Station 2 (south), and Station 3 (middle). Station 2 is located in the deepest part of the lake (41 ft.).

Water Clarity

Secchi Disk Transparency (SDT) is a quick, simple, inexpensive, and accurate method for determining the clarity of a lake. Factors that limit the depth of clarity include algae, zooplankton, water color, and silt. Generally, as algal populations increase, SDT readings decrease. SDT readings have been conducted in Lovell Lake for over 19 years at Station 2, with an average a mean annual SDT of 6.3 m (20.7 ft).

Sampling Results for Station 2 (1989-2007)

Sampling Parameter	Station 2
Mean Color (SPU)	11.7
Median EpiCore P (ppb)	7.5
Mean Secchi (m)	6.3
Mean Chl-a (ppb)	2.7



Dissolved Oxygen (DO)

Dissolved oxygen (DO) in the lake is critical to the survival of all plants and animals. DO levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species. Low DO at the bottom of the lake is of particular concern because it can result in the release of phosphorus from bottom sediments- leading to increased algal production. Recent DO profiles have not been collected in Lovell Lake, though profiles from previous decades indicate high DO depletion in deep areas of the lake. Therefore, the potential for TP to be released from bottom sediments and become available to algae in the water column (internal loading) is high.

Total Phosphorus (TP)

Phosphorus is an essential element for plant growth, yet is found in limited amounts in lake systems. Therefore, small increases in phosphorus in Lovell Lake can lead to substantial increases in algal growth. The range of water column total phosphorus for Lovell Lake over the period from 1989 to 2007 for Station 2 is 1.3 – 16.4 parts per billion (ppb) with a median of 7.5 ppb.