

The Broads

Watershed-Based Management Plan

December 2025 - **FINAL**

Prepared by
FB Environmental Associates

THE BROADS

WATERSHED-BASED MANAGEMENT PLAN

Prepared by **FB ENVIRONMENTAL ASSOCIATES**
in collaboration with the Lake Winnipesaukee Alliance

DECEMBER 2025 | **FINAL**

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TABLE OF CONTENTS

Acknowledgements iii

Table of Contents iv

List of Abbreviations x

Definitions xii

Executive Summary 14

1 Introduction 1

1.1 Waterbody Description and Location 1

1.2 Watershed Protection Groups 2

1.3 Purpose and Scope 3

1.4 Community Involvement and Planning 3

1.4.1 Plan Development Meetings 3

1.4.2 Final Public Presentation 3

1.5 Incorporating EPA's Nine Elements 3

2 Assessment of Water Quality 5

2.1 Water Quality Summary 5

2.1.1 Water Quality Standards & Impairment Status 5

2.1.2 Water Quality Data Collection 6

2.1.3 Trophic State Indicator Parameters 8

2.1.4 Dissolved Oxygen & Water Temperature 9

2.1.5 Chloride & Specific Conductivity 12

2.1.6 Phytoplankton (Cyanobacteria) and Zooplankton 14

2.1.7 Fish 17

2.1.8 Invasive Species 18

2.2 Assimilative Capacity 20

2.3 2024 Data Summary 21

2.4 Watershed Modeling 21

2.4.1 Lake Loading Response Model (LLRM) 21

2.4.2 Build-out Analysis 27

2.5 Water Quality Goal & Objectives 30

3 Pollutant Source Identification 33

3.1 Watershed Development 33

3.1.1 Historical Development 33

3.1.2 Watershed Survey 35

3.1.3 Shoreline Survey 43

3.1.4 Soil & Shoreline Erosion 44
3.1.5 Wastewater and Septic Systems 46
3.1.6 Fertilizers 47
3.1.7 Pets 47
3.1.8 Agriculture 47
3.1.9 Future Development 48
3.2 Internal Phosphorus Load 48
3.3 Potential Contamination Sources 48
3.3.1 Hazardous Waste Sites 48
3.3.2 Above and Underground Storage Tanks 48
3.3.3 Local Potential Contamination Sources 49
3.3.4 NPDES Outfalls 49
3.3.5 Remediation Sites 49
3.4 Wildlife 49
3.5 Environmental Variability 49
4 Management Strategies 51
4.1 Structural Nonpoint Source (NPS) Restoration 51
4.1.1 Watershed & Shoreline BMPs 51
4.2 Non-Structural Nonpoint Source (NPS) Restoration 51
4.2.1 Pollutant Reduction Best Practices 51
4.2.2 Zoning and Ordinance Updates 52
4.2.3 Land Conservation 57
4.2.4 Septic System Regulation 57
4.2.5 Sanitary Sewer System Inspections 58
4.2.6 Boats & Marinas 58
4.2.7 Fertilizer Use Prohibition 58
4.2.8 Pet Waste Management 59
4.2.9 Agricultural Practices 59
4.2.10 Nuisance Wildlife Controls 59
4.3 Outreach & Education 60
4.4 Adaptive Management Approach 62
5 Action Plan 63
5.1 Action Plan 63
5.2 Pollutant Load Reductions 71
6 Plan Implementation & Evaluation 72
6.1 Plan Oversight 72

6.2 Estimated Costs 72
6.3 Funding Strategy 73
6.4 Monitoring Plan 75
6.5 Indicators to Measure Progress 75
Additional Resources 78
References 79
Appendix A: Supporting Maps 82
Appendix B: BMP Matrix 92

LIST OF TABLES

Table 1. NHDES assessment units covering lakes/ponds within the Broads watershed and their associated water quality rating as reported on the NHDES 2024 303(d) list. 6

Table 2. Summary of recent (2014–2023) sampling data for total phosphorus (TP), chlorophyll-a (Chl-a), Secchi Disk transparency (SDT), and dissolved oxygen (DO) and temperature (T) profiles, chloride, and specific conductivity at monitoring sites in the Broads. Sample size (*n*) refers to the number of unique sampling dates for each parameter. 6

Table 3. Aquatic life integrity (ALI) nutrient criteria ranges by trophic class in New Hampshire. 20

Table 4. Decision matrix for aquatic life integrity (ALI) assessment in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae concentration. 20

Table 5. Assimilative capacity (AC) analysis results for the Broads section of Lake Winnipesaukee using oligtrophic standards, for deep stations with data from at least five independent dates within the most recent 10 years, as of 2024. Chlorophyll-a dictates the assessment results. 20

Table 6. Summary of trophic state indicator parameters collected by the UNH LLMP within the Broads in 2024. 21

Table 7. In-lake water quality predictions the Broads. TP = total phosphorus. Chl-a = chlorophyll-a. SDT = Secchi disk transparency. Bloom Days represent average annual probability of chlorophyll-a exceeding 8 µg/L. 26

Table 8. Total phosphorus (TP) and water loading summary by model and source for the Broads, with all modeled bays shown as point sources. Italicized sources sum to the watershed load. 26

Table 9. Amount of buildable land and projected buildings within the Broads watershed, in Alton, Gilford, Moultonborough, New Durham, Tuftonboro, and Wolfeboro, NH. 28

Table 10. US Census Bureau population growth rates for the towns of Alton, Gilford, Moultonborough, New Durham, Tuftonboro, and Wolfeboro, NH, 1970-2020. Population estimates obtained from the NH Office of Strategic Initiatives. 29

Table 11. Summary of Winnipesaukee WMP Goals from existing WMPs. 31

Table 12. Water quality objectives for the Broads. Objective 2 is represented only for the Broads watershed (excluding the other Lake Winnipesaukee sub watersheds). Interim goals/benchmarks are cumulative. TP refers to total phosphorus. 32

Table 13. Average Shoreline Disturbance and Vulnerability Scores for the Broads. Higher values represent poorer or more vulnerable conditions. 43

Table 14. Ordinance review summary of regulatory and non-regulatory tools for natural resource protection in Gilford, Alton and Tuftonboro, which comprise 97% of the Broads watershed. 53

Table 15. Outreach events hosted by the Lake Winnipesaukee Alliance in 2024 and 2025. 60

Table 16. Action Plan for the Broads watershed. Lake Winnipesaukee Alliance; BCCD: Belknap County Conservation District; CCCD: Caroll County Conservation District; LRPC: Lakes Region Planning Commission; CWSRF: Clean Water State Revolving Fund; NH ARM: NH Aquatic Resource Mitigation Fund; NFWF: National Fish & Wildlife Foundation; NFRF: Northeast Forests and Rivers Fund; NAWCA: North American Wetlands Conservation Act; LCHIP: Land and Community Heritage Investment Program; RCCP: Regional Conservation Partnership Program; LWCF: Land and Water Conservation Fund; ACEP: Agricultural Conservation Easement Program, CSP: Conservation Stewardship Program; EQIP: Environmental Quality Incentives Program. 63

Table 17. Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal (Objective 1) and that reflect all field identified reduction opportunities in the watershed. 71

Table 18. Estimated total phosphorus (TP) reductions and costs for implementation of the Action Plan. 73

Table 19. Environmental, programmatic, and social indicators for the Broads Watershed-Based Management Plan. Milestones are cumulative, starting in Year 1 (2026). ** indicators particularly relevant to assessing progress toward achieving the water quality goal and objectives. 76

LIST OF FIGURES

Figure 1. Location of the Broads watershed in relation to the rest of Lake Winnipesaukee's watersheds. xvii

Figure 2. Precipitation and average, maximum, and minimum air temperature for the Broads watershed from 1994–2023. Data retrieved from Daymet (2024). The dashed line and grey shaded area for precipitation represents the Locally Estimated Scatterplot Smoothing (LOESS) regression and 95% confidence intervals, respectively. The dashed lines for air temperature indicate a statistically significant increasing trend ($p < 0.05$). 1

Figure 3. Map of the five water quality monitoring sites analyzed in the Water Quality Analysis (shown in blue, WINBGILD, WIN26DL, WINBLKPNT, WINALTMARINA, and WWH0BBL) with the locations of cyanobacteria advisories/warnings (green). .. 7

Figure 4. Boxplots showing median total phosphorus concentration in the epilimnion, metalimnion, and hypolimnion of the Broads deep spot of Lake Winnipesaukee (WINBGILD). Data are shown for all available years (1979-2023) as well as the most recent 10 years only (2014-2023). Sample sizes for the 2014-2023 period are 65, 1 and 2 for the epilimnion, metalimnion and hypolimnion, respectively. For the 1979-2023 period, n = 98, 7 and 12 for the epilimnion, metalimnion and hypolimnion, respectively. 8

Figure 5. Median epilimnion total phosphorus, median epilimnion chlorophyll-a, and median water clarity (Secchi Disk transparency for scope and no scope methods) measured at the Broads deep spot of Lake Winnipesaukee (WINBGILD) between May 24th and September 15th from 1984-2023. A statistically significant decreasing trend in chlorophyll-a was detected from the Mann-Kendall nonparametric trend test using *rkt* package in R Studio. 9

Figure 6. Dissolved oxygen (black) and water temperature (blue) depth profiles for the Broads deep spot of Lake Winnipesaukee (WINBGILD). Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation. Semitransparent dots are the medians from profile data collected between May and September in 1990, 2001, 2008, twice in 2015, and 2016 (n=6), with three additional dissolved oxygen measurements taken in 1979 and 1984. Non-transparent dots represent the values from the most recent profile (2016). There are only two profiles at the deep spot that have been collected in the last 10 years, one in 2015 and one in 2016. 10

Figure 7. Dissolved oxygen (black) and water temperature (blue) depth profiles for the 26 Alton Deep Spot of Lake Winnipesaukee (WIN26DL). Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation. Profiles were collected on 6th and 19th July 2023 (n=2). 11

Figure 8. Yearly median of monthly medians for specific conductivity (top) and chloride (bottom) in the deep spot of the Broads, Lake Winnipesaukee (WINBGILD). Dashed lines indicate a statistically significant increasing (degrading) trend. There were insufficient data points (n=9) for trend analysis of specific conductivity in the metalimnion layer and for epilimnetic chloride. 13

Figure 9. Relative abundance (% of total community) of plankton groups collected by NHDES using an 80 µm mesh net at the Broads deep spot (WINBGILD), 2017–2024. The top graph shows phytoplankton results; the bottom graph shows zooplankton results. Data provided by Kirsten Hugger, NHDES. 15

Figure 10. Relative abundance (% of total community) of cyanobacteria taxa sampled by NHDES using an 80 µm mesh net at the Broads deep spot (WINBGILD), 2017–2024. Data provided by Kirsten Hugger, NHDES. 17

Figure 11. A representation of the impacts of increasing spiny water flea (*Bythotrephes longimanus*) populations in North American lakes. 19

Figure 12. Conceptual diagram of point source and sub-watershed routing for the Lake Winnipesaukee model, using the Broads as the calibration point. Red arrows indicate a point source (other modeled bay). Gray arrows indicate sub-watersheds and black arrows indicate the model outlet point. 22

Figure 13. The Broads watershed (not including the other bays of Lake Winnipesaukee) land cover area by general category (agriculture, developed, forest, and water/wetlands) and total phosphorus (TP) watershed load by general land cover type. This shows that developed areas cover 9% of the watershed and contribute 70% of the TP direct watershed load to the Broads (not accounting for other bays of Lake Winnipesaukee). The water/wetlands category does not include the lake area. 23

Figure 14. Map of current total phosphorus load per unit area (kg/ha/yr) for each sub-watershed in the Broads direct watershed. Higher phosphorus loads per unit area are concentrated in shoreline areas..... 27

Figure 15. Full build-out time projections of the Broads Watershed (based on compound annual growth rates)..... 29

Figure 16. Conceptual diagram of the flow of water through Lake Winnipesaukee. Despite a general east to west movement of water, there may be substantial exchange between bays due to wind, weather, time of year, flushing, and other dynamics, especially in bays with relatively open concept with the Broads, such as Sanders Bay..... 30

Figure 17. Location of identified nonpoint source sites in the Broads watershed. 37

LIST OF ABBREVIATIONS

ACRONYM	DEFINITION
AC	Assimilative Capacity
AIPC	Aquatic Invasive Plant Control, Prevention and Research Grants
ACEP	Agricultural Conservation Easement Program
ALI	Aquatic Life Integrity
ARM	Aquatic Resource Mitigation Fund
BCCD	Belknap County Conservation District
BMP	Best Management Practice
BRCC	Belknap Range Conservation Coalition
CAGR	Compound Annual Growth Rate
CCCD	Carroll County Conservation District
CHL-A	Chlorophyll-a
CNMP	Comprehensive Nutrient Management Plan
CSP	Conservation Stewardship Program
CUM	Cubic Meters
CWA	Clean Water Act
CWP	Center for Watershed Protection
CWSRF	Clean Water State Revolving Fund
DO	Dissolved Oxygen
DPW	Department of Public Works
EMD	Environmental Monitoring Database
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
FBE	FB Environmental Associates
FT	Feet
HA	Hectare
HAB	Harmful Algal Bloom
ILF	In-Lieu Fee
KG	Kilogram
LCHIP	Land and Community Heritage Investment Program
LID	Low Impact Development
LLMP	Lay Lakes Monitoring Program
LLRM	Lake Loading Response Model
LRCT	Lakes Region Conservation Trust
RPC	Lakes Region Planning Commission
LWCF	Land and Water Conservation Fund
M	Meter
NAWCA	North American Wetlands Conservation Act
NFRF	Northeast Forest and River Fund
NFWF	National Fish and Wildlife Foundation
NH GRANIT	New Hampshire Geographically Referenced Analysis and Information Transfer System
NHACC	New Hampshire Association of Conservation Commissions
NHD	National Hydrography Dataset
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
NHLCD	New Hampshire Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System

ACRONYM	DEFINITION
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
NRI	Natural Resources Inventory
NWI	National Wetlands Inventory
PAS	Potentially Attaining Standards
PCR	Primary Contact Recreation
PCS	Potential Contamination Source
PFAS	Per- and polyfluoroalkyl substances
PNS	Potentially Not Supporting
ppb, ppm	parts per billion, parts per million
RCCP	Regional Conservation Partnership Program
RCRA	Resource Conservation and Recovery Act
ROW	Right-of-Way
SCC	State Conservation Committee
SCCD	Strafford County Conservation District
SDT	Secchi Disk Transparency
SPNHF	Society for the Protection of New Hampshire Forests
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
UNH	University of New Hampshire
USLE	Universal Soil Loss Equation
WMP	Watershed-Based Management Plan
YR	Year

DEFINITIONS

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

Anoxia is a condition of low dissolved oxygen.

Areal water load (m/yr) is the total annual volume of water (m^3) entering a waterbody from all sources (rain, runoff, groundwater, and streams) normalized to (or divided by) the lake's surface area (m^2). It represents the depth of water added to the lake surface annually if all inflow were evenly distributed over that surface.

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

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

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

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

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

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

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

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

Eutrophication is the process by which lakes become more productive over time (oligotrophic to mesotrophic to eutrophic). Lakes naturally become more productive or "age" over thousands of years. In recent geologic times, however, humans have enhanced the rate of enrichment and lake productivity, speeding up this natural process to tens or hundreds of years.

Fall turnover is the process of complete lake mixing when cooling surface waters become denser and sink, especially during high winds, forcing warmer, less-dense water to the surface. This process is critical for the natural exchange of oxygen and nutrients between surface and bottom layers in the lake.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

EXECUTIVE SUMMARY

With a 33,797-acre watershed, the Broads comprises 17,188 acres of surface water forming the open, central section of Lake Winnipesaukee in New Hampshire's economically vital Lakes Region. The watershed draining to the Broads is divided into four primary sub-watersheds: the Broads Direct (23,738 acres), Poorfarm Brook (4,393 acres), West Alton Brook (3,427 acres), and Hurd Brook (2,239 acres) watersheds. The Broads section of Lake Winnipesaukee is located within the towns of Alton, Gilford, Tuftonboro, Wolfeboro, Moultonborough, and Meredith, and its watershed extends slightly into New Durham. The Broads mixes its waters with surrounding bays of Lake Winnipesaukee, including Alton Bay, Wolfeboro Bay, Center Harbor Bay, Sanders Bay, Meredith Bay, Winter Harbor, and Moultonborough Bay. It is also fed by upstream waterbodies such as Mirror Lake.

The Problem

Because of its size and complexity, maintaining the health of Lake Winnipesaukee depends on developing and implementing watershed-based management plans (WMPs) for all contributing watersheds, in collaboration with the many towns they span. The Broads is one of the last major watersheds still in need of a comprehensive WMP.

Historically, the Broads has experienced generally excellent water quality. Protecting this high water quality is critical given Lake Winnipesaukee's importance to New Hampshire's economy and natural heritage. However, Lake Winnipesaukee is formally listed as impaired for aquatic life integrity (ALI) on the 303(d) New Hampshire List of Impaired Waters for the 2024 cycle. The impairment (4A-M) is due to low pH and the presence of non-native aquatic plants. NHDES also assessed alkalinity and non-native fish, shellfish, or zooplankton as ALI parameters potentially not supporting (3-PNS). Although Lake Winnipesaukee is not listed as impaired for primary contact recreation (e.g., swimming), cyanobacteria hepatotoxic microcystins are potentially not supporting (3-PNS) state thresholds.

Recently, cyanobacteria blooms have emerged as a significant concern in Lake Winnipesaukee, including within the Broads. NHDES issued three cyanobacteria advisories for the Broads between June and September 2024, one for *Dolichospermum* and two for *Gloeotrichia.* One of the *Gloeotrichia* advisories was issued during a bloom event that affected much of Lake Winnipesaukee. Both *Gloeotrichia* and *Dolichospermum* produce toxins harmful to humans, pets, and wildlife.

These blooms are occurring despite generally low in-lake nutrient levels, highlighting the sensitivity of the lake to additional stressors. Cyanobacteria blooms are typically spurred by a combination of warming waters and elevated nutrient inputs. In The Broads watershed, key phosphorus sources include stormwater runoff from impervious surfaces, shoreline erosion, road and ditch erosion, disturbed soils from construction, excessive fertilizer application, failed or improperly functioning septic systems, leaking sewer infrastructure, unmitigated agricultural activities, and waste from pets, livestock, and wildlife. Twenty (20) problem sites were identified in the watershed during a field survey, and the main issues found were road shoulder and ditch erosion, inadequate buffers along watercourses and waterbodies, and untreated stormwater runoff from impervious surfaces.

Anthropogenic inputs such as stormwater runoff, shoreline erosion from increased boat traffic and wave action, and other land use impacts can affect the health of the lake, especially as environmental variability drives more frequent extreme precipitation events and extends the ice-free period on lakes.

Additionally, 334 shorefront properties were identified as having some impact on water quality due to evidence of erosion and lack of vegetated buffer, while approximately 742 properties in the shoreland zone have septic systems older than 25 years. Lake model results revealed changes in phosphorus loading and in-lake phosphorus concentrations over time from pre-development through future conditions, showing that the water quality of the Broads is threatened by current development activities in the watershed and will degrade further with continued development in the future, especially when compounded by the effects of environmental variability. The largest phosphorus sources to Lake Winnipesaukee (with the Broads as the calibration point) come from the watershed load, including watershed loads to other bays around the lake (87%). Most of that watershed load originates from surrounding bays (80% of the total phosphorus load), indicating the impact of watershed development throughout the greater Lake Winnipesaukee watershed on open water areas such as the Broads. The other bays contributing phosphorus to the Broads include Alton Bay, Center Harbor Bay, Wolfeboro Bay, Moultonborough Bay, Winter Harbor, Sanders Bay, and Meredith Bay. The success of this WMP therefore depends in large part on the successful implementation of goals in those bays' watersheds.

The Goal

The goal of the Broads WMP is to improve the water quality of the Broads, and the greater Lake Winnipesaukee, such that they continue to meet state water quality standards for oligotrophic waterbodies and support the designated uses for aquatic life integrity, Potential Drinking Water Supply, and Primary/Secondary Contact Recreation, while substantially reducing the likelihood of harmful cyanobacteria blooms. This goal will be achieved by accomplishing the following objectives:

OBJECTIVE 1: Reduce phosphorus loading from existing development by 1,244 kg/yr to the Broads to improve the average in-lake summer total phosphorus concentration to 4.0 ppb.

OBJECTIVE 2: Mitigate (prevent or offset) phosphorus loading from future development to the Broads by 151 kg/yr to maintain average summer in-lake total phosphorus concentration for the Broads in the next 10 years (2035). This objective only focuses on future development within the direct watershed of the Broads.

The Solution

In collaboration with the Lake Winnipesaukee Alliance (LWA), FB Environmental Associates (FBE) was contracted to develop a WMP to better understand and protect the water quality of the Broads section of Lake Winnipesaukee. As part of the development of the WMP and according to the Site-Specific Project Plan (SSPP), a build-out analysis, land-use model, water quality and assimilative capacity analysis, septic system database, shoreline survey, and watershed survey were completed to identify and quantify the sources of phosphorus and other pollutants to the lake. Results from these analyses were used to determine recommended management strategies for the identified pollutant sources in the watershed. An Action Plan (Section 5) was developed in collaboration with the Steering Committee comprised of key watershed stakeholders (see Acknowledgements). The following actions were recommended to meet the established water quality goal and objectives for the Broads:

WATERSHED STRUCTURAL BEST MANAGEMENT PRACTICES (BMPs): Sources of phosphorus from watershed development should be addressed through installation of stormwater controls, stabilization techniques, buffer plantings, etc., as recommended for the high priority sites (and the medium and low priority sites as opportunities arise) identified during the watershed survey, the high and medium impact shoreline properties identified during the shoreline survey, and any new or redevelopment projects in the watershed with high potential for soil erosion.

MONITORING: A long-term water quality monitoring plan is critical to evaluate the effectiveness of implementation efforts over time. LWA, in concert with the University of New Hampshire Extension's Lakes Lay Monitoring Program (LLMP), should continue the annual monitoring program and consider incorporating additional monitoring recommendations laid out in this plan. The LLMP should remain the primary lab for processing water quality samples from Lake Winnipesaukee due to their lower method detection limits for total phosphorus.

EDUCATION AND OUTREACH: LWA and other key watershed stakeholders should continue all aspects of their education and outreach strategies and consider developing new ones or improving existing ones to reach more watershed residents. Examples include providing educational materials to existing and new property owners, as well as renters, by distributing them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Educational campaigns should include raising awareness of water quality concerns, septic system maintenance, fertilizer and pesticide use, pet waste disposal, waterfowl feeding, invasive aquatic species, boat pollution, shoreline buffer improvements, gravel road maintenance, and stormwater runoff controls.

OTHER ACTIONS: Additional strategies for reducing phosphorus loading to the lake include: revising local ordinances such as setting low impact development (LID) requirements on new construction; identifying and replacing malfunctioning septic systems; inspecting and remediating leaky sewer lines; using best practices for road maintenance and other activities including municipal operations such as street and stormwater infrastructure cleaning; conserving large or connective habitat corridor parcels; and improving agricultural practices. Future development should also be considered as a pollutant source and potential threat to water quality. The Broads is at risk for greater water quality degradation because of new development in the watershed unless environmental variability resiliency and LID strategies are incorporated into existing zoning standards.

The recommendations of this plan will be carried out largely by the Lake Winnipesaukee Alliance with assistance from a diverse stakeholder group, including representatives from municipalities (e.g., select boards, planning boards), conservation commissions, state and federal agencies (e.g., NH State Parks) or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners. The cost of successfully implementing the plan is estimated at $1.5-$2.4 million over the next 10 or more years in addition to the dedication and commitment of volunteer time and support to manage plan implementation. However, many costs are still unknown or were roughly estimated and should be updated as information becomes available. This financial investment can be accomplished through a variety of funding mechanisms via both state and federal grants, as well as commitments from municipalities or donations from private residents. Of significant note, this plan meets the nine planning elements required by the EPA, and the Broads is now eligible for federal watershed assistance grants.

Important Notes

The success of this plan is dependent on the continued effort of volunteers and a strong and diverse stakeholder group that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim milestones. A reduction in nutrient loading is no easy task, and because there are many diffuse sources of phosphorus reaching surface waters in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful. The recommendations in this plan are idealized and, in some cases, may be difficult to achieve given the physical and political realities of the community dealing with old infrastructure, lack of access to key lakefront areas, and limited funding and volunteer or staff capacity.

Finally, we all have a common responsibility to protect our lakes for future generations to enjoy. Private landowners arguably hold the most power in making significant impact to restoring and maintaining excellent water quality in our lakes; however, engaging private landowners as a single stakeholder group can be difficult and outreach efforts often have limited reach, especially to those individuals who may require the most education and awareness of important water quality protection actions. The joint committee will continue to engage the public as much as possible so that private individuals can help review and implement the recommendations of this plan and protect the water quality of the Broads long into the future.

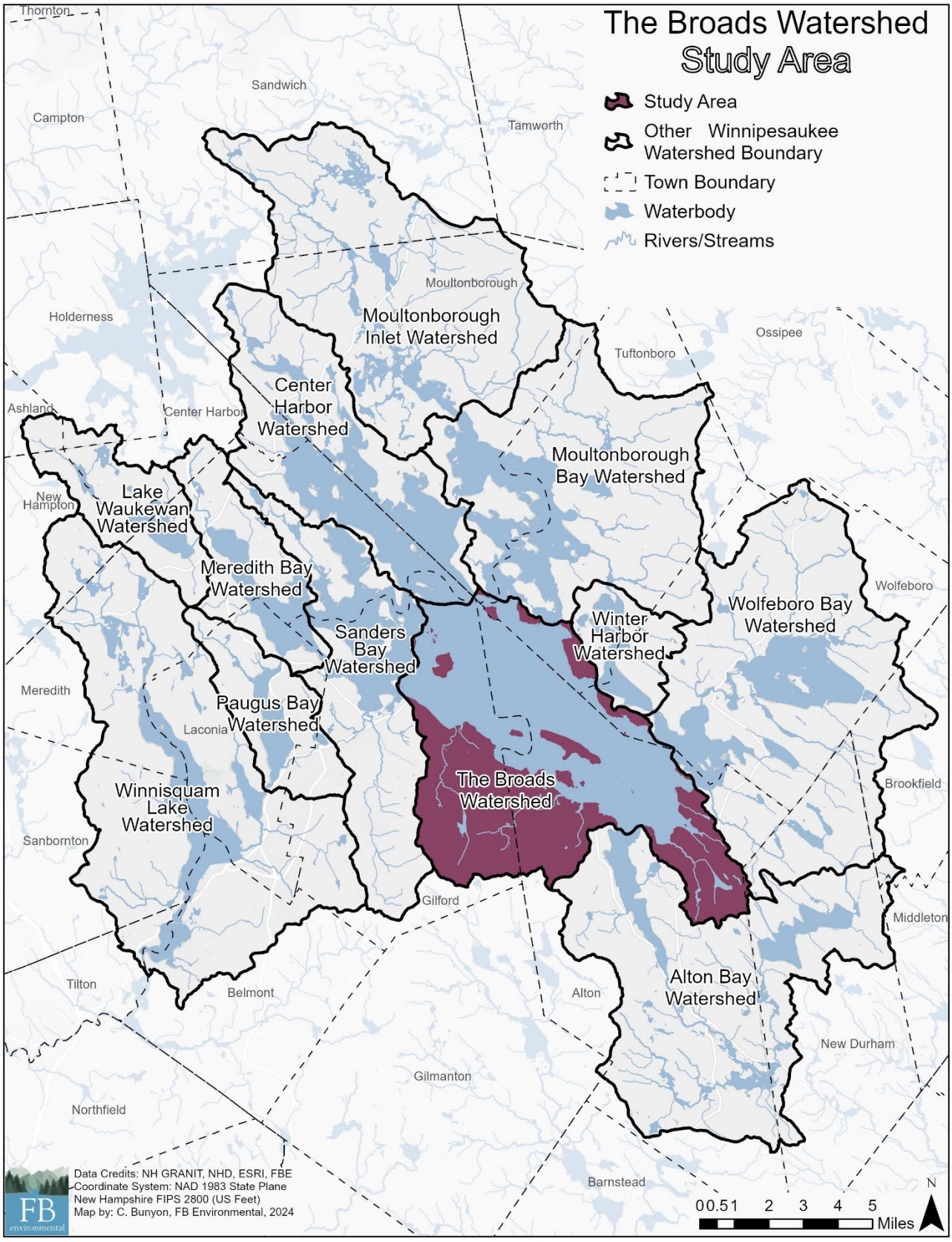


Figure 1. Location of the Broads watershed in relation to the rest of Lake Winnipesaukee's watersheds.

1 INTRODUCTION

1.1 WATERBODY DESCRIPTION AND LOCATION

The Broads is a 17,188-acre (6,956-hectare) section of Lake Winnipesaukee around its center (Figure 1). The watershed spans 33,797 acres (13,677 hectares) into the towns of Alton (53%), Gilford (37%), Tuftonboro (6.5%), Wolfeboro (2.6%), Moultonborough (0.3%), New Durham (0.2%), and Meredith (<0.1%). The primary streams draining into the Broads include Poor Farm Brook and West Alton Brook on the lake's western side, along with Hurd Brook in the southeastern portion of the watershed. Minge Brook and several unnamed streams also flow directly into The Broads. Due to its central location within Lake Winnipesaukee, the Broads receives inflow from and discharges to multiple bays, including Alton Bay, Center Harbor Bay, Wolfeboro Bay, Moultonborough Bay, Winter Harbor, Sanders Bay, and Meredith Bay. This makes the Broads unique among the Lake Winnipesaukee watersheds, with diverse inputs and significant in-lake mixing. Water from the Broads ultimately exits the lake via the Winnipesaukee River, joining the Pemigewasset River before reaching the Merrimack River.

The Broads watershed lies in a temperate zone influenced by converging weather patterns—warm, moisture-laden air from the south and cooler, drier air from the north. These interactions give rise to a range of weather events, including heavy snowfall, nor'easters, severe thunderstorms, and the occasional hurricane. The area experiences moderate to high rainfall and snowfall, averaging 49.3 inches of precipitation annually between 1994 and 2023. Data were collected for this period from Daymet which interpolates weather data at a specific location from nearby weather stations. Annual precipitation has varied over the 30-year period, showing no significant increasing or decreasing trend (tested using the *rkt* package in R Studio) (Figure 2). Average and minimum annual temperature values have increased during the same time frame ($p < 0.05$), while maximum temperature has not displayed a significant trend (Figure 2).

The highest elevation in the watershed, approximately 2,375 ft above sea level, is in its westernmost section, near the peaks of Belknap Mountain and Gunstock Mountain in Gilford. Lake Winnipesaukee's shoreline in the Broads sits at approximately 505 feet above sea level (NH GRANIT).

The watershed is characterized primarily by mixed forest that includes both conifers (e.g., white pine and eastern hemlock) and deciduous (e.g., beech, oak, maple, ash, birch, and aspen) tree species. Animals that rely on these forested resources include land mammals (deer, moose, black bear, coyote, bobcat, fisher, fox, raccoon, weasel, porcupine, mink, chipmunks, squirrels, and bats), water mammals (muskrat, otter, and beaver), land and water reptiles and amphibians (turtles, snakes, frogs, and salamanders), various insects, birds (herons, loons, gulls, geese, multiple species of ducks[1], wild turkeys, ruffed grouse, cormorants, bald eagles, and song birds), and fish. The Towns of Alton, Gilford and Tuftonboro are home to a variety of state-listed threatened (T) and endangered (E) wildlife species, including the common loon (T), purple martin (T), cliff swallow (T), pied-billed grebe (T), spotted turtle (T), northern black racer (T), bridle shiner (T), and the Canada lynx (E) (NH NHB, 2020).

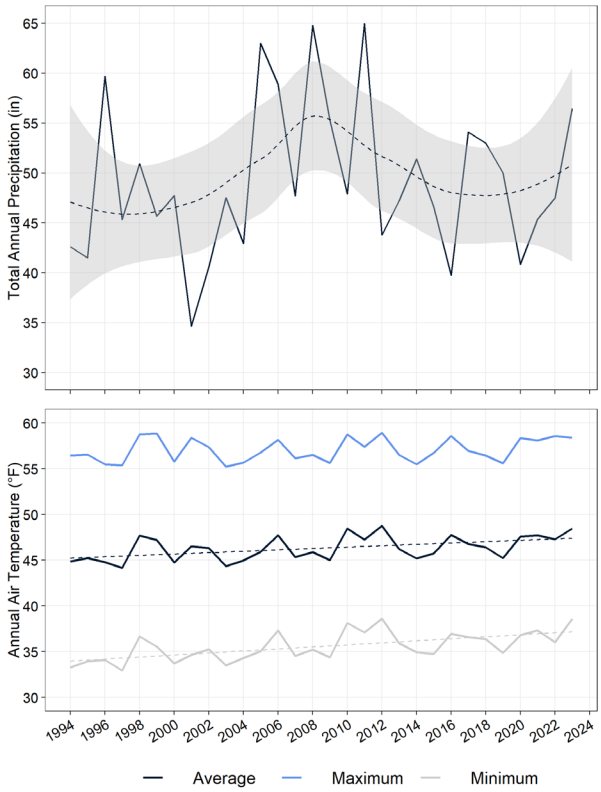


Figure 2. Precipitation and average, maximum, and minimum air temperature for the Broads watershed from 1994–2023. Data retrieved from Daymet (2024). The dashed line and grey shaded area for precipitation represents the Locally Estimated Scatterplot Smoothing (LOESS) regression and 95% confidence intervals, respectively. The dashed lines for air temperature indicate a statistically significant increasing trend ($p < 0.05$).

[1] American black duck, black scoter, canvasback, common goldeneye, common loon, common merganser, hooded merganser, long tailed duck, mallard, red-breasted merganser, and wood duck.

1.2 WATERSHED PROTECTION GROUPS

The Lake Winnipesaukee Alliance (LWA) is a non-profit organization with a mission "*dedicated to protecting the water quality and natural resources of Lake Winnipesaukee and its watershed now and for the future. Using education and science, we're relentless in our pursuit of the best policies and practices to ensure a healthy, vibrant Lake for residents, business owners, and visitors, today and for generations to come.*" LWA serves the 14 communities located in Belknap and Carroll counties. LWA is led by several paid staff and a volunteer Board of Directors.

The Carroll County Conservation District (CCCD) and the Belknap County Conservation District (BCCD) are two of 10 county conservation districts in New Hampshire that operate as resource management agencies and a subdivision of local governments. CCCD focuses on "*water quality, erosion & sedimentation, wildlife habitats, health of forests & wetlands, non-point source pollution, and storm water & flooding.*" BCCD's mission is to "*help landowners and communities conserve the natural resources of Belknap County.*" Both organizations work with farmers, forest owners, landowners, schools, and municipalities to help protect and conserve the area's natural resources through projects such as stream bed restoration, invasive species management, and pollinator plantings. Wolfeboro, Tuftonboro and Moultonborough are in the CCCD service area; Alton and Gilford are in the BCCD service area.

Covering 31 communities, the Lakes Region Planning Commission (LRPC) is a valuable resource to the region. The LRPC aids communities with their local planning services in a targeted approach to protect the environment, while supporting local economies and cultural values.

Lakes Region Conservation Trust (LRCT) is a non-profit organization "*dedicated to the permanent conservation, stewardship, and respectful use of lands that define the character of the Lakes Region and its quality of life.*" Their vision is a "*future where conserved lands support thriving biodiversity, healthy watersheds, and vibrant human communities.*" LRCT has conserved 174 properties totaling over 29,000 acres in the Lakes Region.

The Belknap Range Conservation Coalition (BRCC) is a non-profit organization whose mission is to "*promote the conservation of open space, responsible stewardship, and low-impact public enjoyment of the scenic, natural, recreational, and historical resources of the Belknap Mountain Range*". Significant portions of this mountain range are within the Broads watershed.

The Society for the Protection of New Hampshire Forests (SPNHF, or Forest Society) has the mission to conserve forests in NH. They accomplish this mission through "*land conservation, forest management and stewardship, engagement through recreation and education, and advocacy leadership*".

The New Hampshire Association of Conservation Commissions (NHACC) works to provide educational assistance to conservation commissions throughout New Hampshire (217 in total). As a non-profit organization, the NHACC's mission is to instill responsible use of the available natural resources by promoting conservation and serving as the communication link between conservation commissions, while providing technical support on the logistics of conservation commission meetings and document language. Conservation commissions in the Broads watershed include those of Alton, Gilford, Moultonborough, and Tuftonboro.

NH LAKES has the mission to "*restore and preserve the health of New Hampshire's lakes. Our vision is a New Hampshire where all our lakes are clean and healthy, and caring for them is a way of living, doing business, and governing.*"

The University of New Hampshire Lakes Lay Monitoring Program engages volunteers and local groups in collecting and analyzing water quality data for lakes across New Hampshire, including Lake Winnipesaukee. The data support informed decision-making for lake management and protection strategies.

The New Hampshire Department of Environmental Services (NHDES) works with local organizations to improve water quality in New Hampshire at the watershed level. NHDES works with communities to identify water resource goals and to develop and implement watershed-based management plans. This work is achieved by providing financial and technical assistance to local watershed management organizations and by investigating actual and potential water contamination problems, among other activities.

1.3 PURPOSE AND SCOPE

The purpose and overarching goal of the Broads Watershed-Based Management Plan (WMP) is to guide implementation efforts over the next 10 years (2026-2035) to improve the water quality of the Broads section of Lake Winnipesaukee such that it meets state water quality standards for the protection of aquatic life integrity (ALI) and substantially reduces the likelihood of harmful cyanobacteria blooms in the lake.

As part of the development of this plan, a **build-out analysis**, land-use model, water quality and **assimilative capacity** analysis, and shoreline and watershed surveys were conducted to better understand the sources of phosphorus and other pollutants to the lake (Sections 2 and 3). Results from these analyses were used to establish the water quality goal and objectives (Section 2.4), determine recommended management strategies for the identified pollutant sources (Section 4), and estimate pollutant load reductions and costs needed for remediation (Sections 5 and 6). Recommended management strategies involve using a combination of **structural and non-structural Best Management Practices** (BMPs), as well as an **adaptive management approach** that allows for regular updates to the plan (Section 4). An Action Plan (Section 5) with associated timeframes, responsible parties, and estimated costs was developed in collaboration with the Steering Committee (Section 1.4). This plan meets the nine elements required by the United States Environmental Protection Agency (EPA) so that communities become eligible for federal watershed assistance grants (Section 1.5).

1.4 COMMUNITY INVOLVEMENT AND PLANNING

The plan was developed through the collaborative efforts of numerous meetings, public presentations, and conference calls between FB Environmental Associates (FBE), LWA, representatives from the towns of Gilford and Alton, and private landowners (see Acknowledgments).

1.4.1 Plan Development Meetings

Several meetings were held over the duration of the plan development. The following list does not include routine annual meetings conducted separately by stakeholders, except as they relate to the watershed plan development.

- **May 22, 2024:** Kick-off meeting with the public to introduce the watershed planning process at the Gilford Public Library.
- **June 18, 2025:** Steering Committee meeting facilitated by LWA to review the shoreline survey and watershed survey.
- **October 20, 2025:** FBE presented the water quality analysis, build-out analysis, modelling results and water quality goal to the Advisory Committee at the Gilford Town Hall.
- **November 20, 2025:** FBE presented the draft action plan to the Advisory Committee via Zoom.

1.4.2 Final Public Presentation

A final public presentation was held virtually on December 17, 2025, to summarize the analyses and recommendations detailed in the plan. An opportunity for public feedback on the plan was offered.

1.5 INCORPORATING EPA'S NINE ELEMENTS

EPA guidance lists nine components that are required within a WMP to restore waters impaired or likely to be impaired by **nonpoint source (NPS) pollution**. These guidelines highlight important steps in restoring and protecting water quality for any waterbody affected by human activities. The nine required elements found within this plan are as follows:

A. **IDENTIFY CAUSES AND SOURCES: Section 3** highlights known sources of NPS pollution to the Broads and describes the results of the watershed survey and other assessments conducted in the watershed. These sources of pollutants must be controlled to achieve load reductions estimated in this plan, as discussed in item (B) below.
B. **ESTIMATE PHOSPHORUS LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES: Sections 2, 3, and 5** quantify the sources of phosphorus load to the Broads, calculate the pollutant load reductions that could be achieved by

identified management measures, and determine the amount of reduction needed to meet the water quality goal, respectively.

C. **DESCRIPTION OF MANAGEMENT MEASURES: Sections 4 and 5** identify ways to achieve the estimated phosphorus load reduction and reach water quality targets. The Action Plan focuses on several major topic areas that address NPS pollution. Management options in the Action Plan focus on non-structural BMPs integral to the implementation of structural BMPs.

D. **ESTIMATE OF TECHNICAL AND FINANCIAL ASSISTANCE: Sections 5 and 6** include descriptions of the associated costs, sources of funding, and primary authorities responsible for implementation. Sources of funding need to be diverse and should include local, state, and federal granting agencies, local groups, private donations, and landowner contributions for implementation of the Action Plan.

E. **EDUCATION & OUTREACH: Sections 4 and 5** describe how the educational component of the plan is already being or will be implemented to enhance public understanding of the project.

F. **SCHEDULE FOR ADDRESSING PHOSPHORUS REDUCTIONS: Section 5** provides a list of action items and recommendations to reduce the phosphorus load to the Broads. Each item has a set schedule that defines when the action should begin and/or end or run through (if an ongoing activity). The schedule should be adjusted by the committee on an annual basis (see Section 4 on Adaptive Management).

G. **DESCRIPTION OF INTERIM MEASURABLE MILESTONES: Section 6** outlines indicators along with milestones of implementation success that should be tracked annually.

H. **SET OF CRITERIA: Sections 2 and 6** can be used to determine whether loading reductions are being achieved over time, substantial progress is being made towards water quality objectives, and if not, criteria for determining whether this plan needs to be revised.

I. **MONITORING COMPONENT: Section 6** describes the long-term water quality monitoring strategy for the Broads, the results of which can be used to evaluate the effectiveness of implementation efforts over time as measured against the criteria in (H) above. The success of this plan cannot be evaluated without ongoing monitoring and assessment and careful tracking of load reductions following successful BMP implementation projects.



Lake Winnipesaukee shoreline. Photo taken by Harrison Flagg, 2024. Used with permission.

2 ASSESSMENT OF WATER QUALITY

This section provides an overview of the past, current, and future state of water quality based on the water quality assessment and watershed modeling, which identified pollutants of concern and informed the established water quality goal and objectives for the Broads.

2.1 WATER QUALITY SUMMARY

2.1.1 Water Quality Standards & Impairment Status

2.1.1.1 Designated Uses & Water Quality Criteria

The **Clean Water Act** (CWA) requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support and include uses for ALI, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife. Surface waters can have multiple designated uses. **Primary contact recreation (PCR) and aquatic life integrity (ALI) are the two major uses for lakes – ALI being the focus of this plan.** In New Hampshire, all surface waters are also legislatively classified as Class A or Class B, most of which are Class B (Env-Wq 1700). **Lake Winnipesaukee is classified as Class B in the State of New Hampshire**. Additionally, from 1976 to 2009, NHDES conducted surveys of lakes to determine **trophic state** (**oligotrophic**, **mesotrophic**, or **eutrophic**). The trophic surveys evaluated physical lake features, as well as chemical and biological indicators. For the Broads, the NHDES Lake Trophic Survey Reports (1979, 1984, 1990, 2001) classify this portion of the lake as oligotrophic, with low phytoplankton abundance and few aquatic plants.

Water quality criteria are then developed to protect designated uses, serving as a "yardstick" for identifying water quality exceedances and for determining the effectiveness of state regulatory pollution control and prevention programs. Depending on the designated use and type of waterbody, water quality criteria can become more or less strict if the waterbody is classified as either Class A or B or as oligotrophic, mesotrophic, or eutrophic. To determine if a waterbody is meeting its designated uses, water quality criteria for various parameters (e.g., **chlorophyll-a**, **total phosphorus**, **dissolved oxygen**, **pH**, and toxins) are applied to the water quality data. If a waterbody meets or is better than the water quality criteria, the designated use is supported. The waterbody is considered impaired for the designated use if it does not meet water quality criteria. Water quality criteria for each classification and designated use in New Hampshire can be found in RSA 485 A:8, IV and in the state's surface water quality regulations.

2.1.1.2 Antidegradation Provisions

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

2.1.1.3 Waterbody Impairment Status

The Broads watershed contains one primary lake/pond assessment unit: Lake Winnipesaukee (Table 1). The unit is formally listed as impaired for ALI on the 303(d) New Hampshire List of Impaired Waters for the 2024 cycle (NHDES, 2024). Two smaller units with insufficient data for assessment also fall within the watershed: Gunstock Recreational Area Snow-Making Pond, and Poorfarm Brook – Cobble Mountain Dam. The NH Statewide Mercury Advisory to limit consumption of fish applies to all three assessment units (NHDES, 2021). Although Lake Winnipesaukee is not listed as impaired for PCR, cyanobacteria hepatotoxic microcystins are potentially not supporting state thresholds, and cyanobacteria blooms have recently emerged as a significant concern, as described in Section 0.

Table 1. NHDES assessment units covering lakes/ponds within the Broads watershed and their associated water quality rating as reported on the NHDES 2024 303(d) list.

Assessment Unit Name	AUID	Impaired Designated Use	Parameter
LAKE WINNIPESAUKEE	NHLAK700020110-02-19	ALI	pH, non-native aquatic plants*
GUNSTOCK REC. AREA-SNOW-MAKING POND	NHLAK700020106-03	N/A	Insufficient data
POORFARM BROOK - COBBLE MOUNTAIN DAM	NHIMP700020106-01	N/A	Insufficient data

* Lake Winnipesaukee potentially not supporting for alkalinity and non-native fish, shellfish, or zooplankton for ALI, as well as for cyanobacteria hepatotoxic microcystins for PCR.

2.1.2 Water Quality Data Collection

Data were acquired from NHDES's Environmental Monitoring Database in February 2024 and reflect data collected through 2023. Additional data collected by the UNH Center for Freshwater Biology field team and Lakes Lay Monitoring Program (LLMP) volunteers in the Broads watershed were provided by Bob Craycraft in April 2024. Data for "26 Alton Deep Station" and "Winter Harbor Broads" summarized below are taken solely from the latter dataset, whereas both datasets include data for the other sites. A data summary for 2024 is provided in Section 2.3.

The Broads deep spot has continuous data for epilimnetic total phosphorus, chlorophyll-a and Secchi Disk transparency for the most recent 10 years of data (2014–2023). Dissolved oxygen-temperature profile, chloride and specific conductivity data are sparser (Table 2). The four LLMP stations have shorter data time series, although sample frequency at 26 Alton Deep, Black Point Deep, and West Alton Marina has increased in recent years. Because of the sparse nature of these sites' datasets, this analysis focuses primarily on the Broads deep spot. Locations of monitoring stations are shown in Figure 3.

Table 2. Summary of recent (2014–2023) sampling data for total phosphorus (TP), chlorophyll-a (Chl-a), Secchi Disk transparency (SDT), and dissolved oxygen (DO) and temperature (T) profiles, chloride, and specific conductivity at monitoring sites in the Broads. Sample size (*n*) refers to the number of unique sampling dates for each parameter.

Site Name	Lake Winnipesaukee - Broads Deep Spot	Lake Winnipesaukee - LLMP 26 Alton Deep	Lake Winnipesaukee - LLMP West Alton Marina	Lake Winnipesaukee - LLMP Black Point Deep	Lake Winnipesaukee - LLMP Winter Harbor Broads
Site ID	WINBGILD	WIN26DL	WINALTMARINA	WINBLKPNT	WWH0BBL
Years Sampled TP *(n)*	2014-2023 (65)	2022, 2023 (7)	2023 (5)	2022, 2023 (7)	2019 (4)
Years Sampled Chl-a *(n)*	2014-2023 (69)	2022, 2023 (7)	2023 (5)	2022, 2023 (7)	2019 (4)
Years Sampled SDT *(n)*	2014-2023 (77)	2022, 2023 (7)	2023 (5)	2022, 2023 (7)	2019 (4)
Years Sampled DO/Temperature Profile *(n)*	2015, 2016 (3)	2023 (2)	2023 (2)	2023 (2)	N/A
Years Sampled Chloride *(n)*	2016, 2021-2023 (4)	2022, 2023 (7)	2023 (5)	2022, 2023 (7)	N/A
Years Sampled Specific Conductivity (*n*)	2015, 2016, 2021-2023 (6)	2022, 2023 (7)	2023 (5)	2022, 2023 (7)	N/A

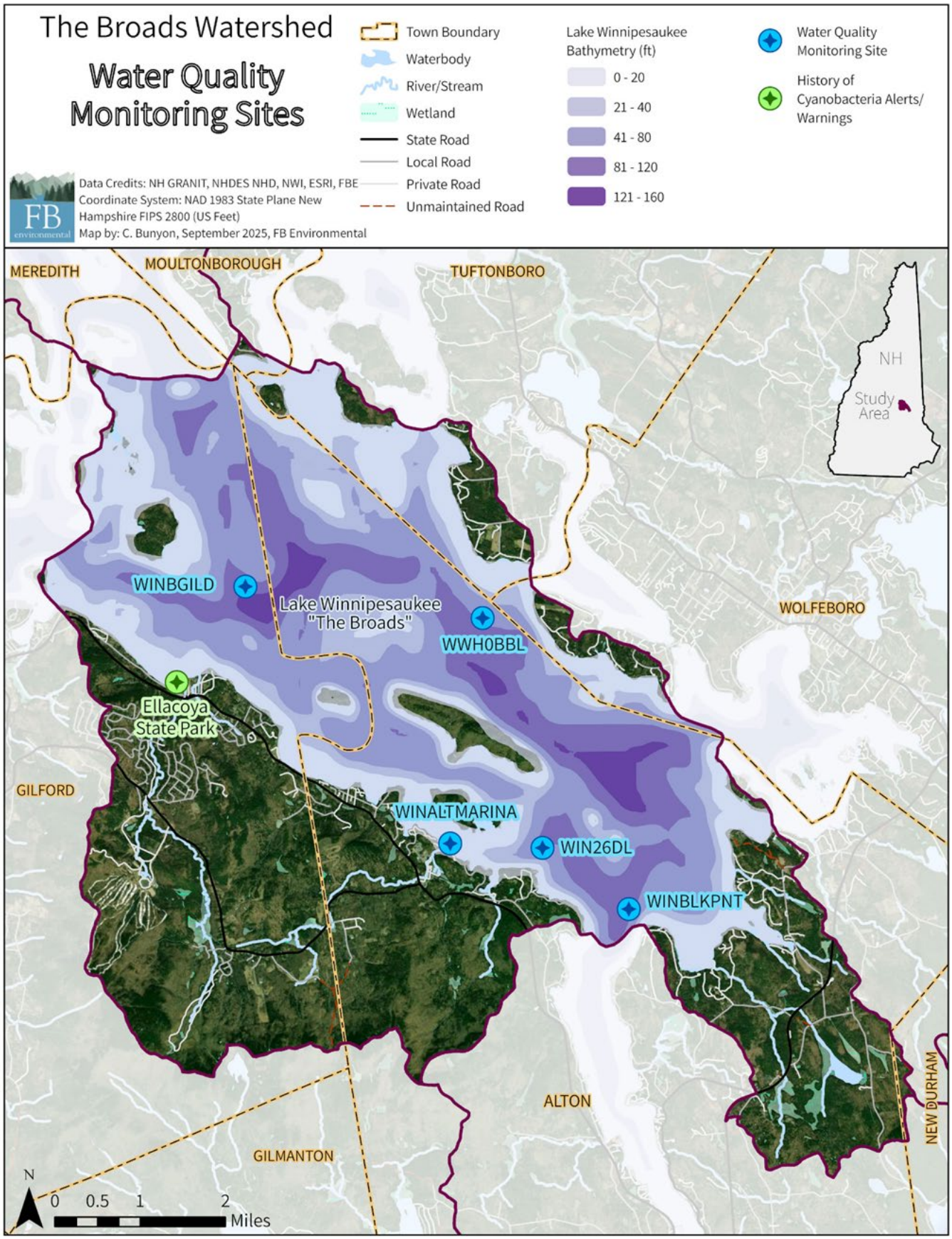


Figure 3. Map of the five water quality monitoring sites analyzed in the Water Quality Analysis (shown in blue, WINBGILD, WIN26DL, WINBLKPNT, WINALTMARINA, and WWH0BBL) with the locations of cyanobacteria advisories/warnings (green).

2.1.3 Trophic State Indicator Parameters

Total phosphorus, chlorophyll-a, and Secchi Disk transparency are trophic state indicators, or indicators of biological productivity in lake ecosystems. The combination of these parameters helps determine the extent and effect of **eutrophication** in lakes and helps signal changes in lake water quality over time. For example, changes in Secchi Disk transparency may be due to a change in the amount and composition of algae communities (typically because of greater total phosphorus availability) or the amount of dissolved or particulate materials in a lake. Such changes are often the result of human disturbance or other impacts to the lake's watershed.

For the primary deep spot in the Broads (WINBGILD), median total phosphorus concentrations in the metalimnion and hypolimnion within the last 10 years (2014-2023) are slightly elevated compared to the long-term average (Figure 4). This indicates that internal loading may be occurring in this part of the lake within recent years, although only two hypolimnetic TP data points in this period limit the conclusiveness of this trend. No statistically significant trends were found for epilimnetic total phosphorus or Secchi Disk transparency between 1984-2023 at the same deep spot, although a statistically significant decreasing trend was detected for chlorophyll-a (Figure 5). There are, however, significant data gaps earlier in the time series for all three water quality metrics.

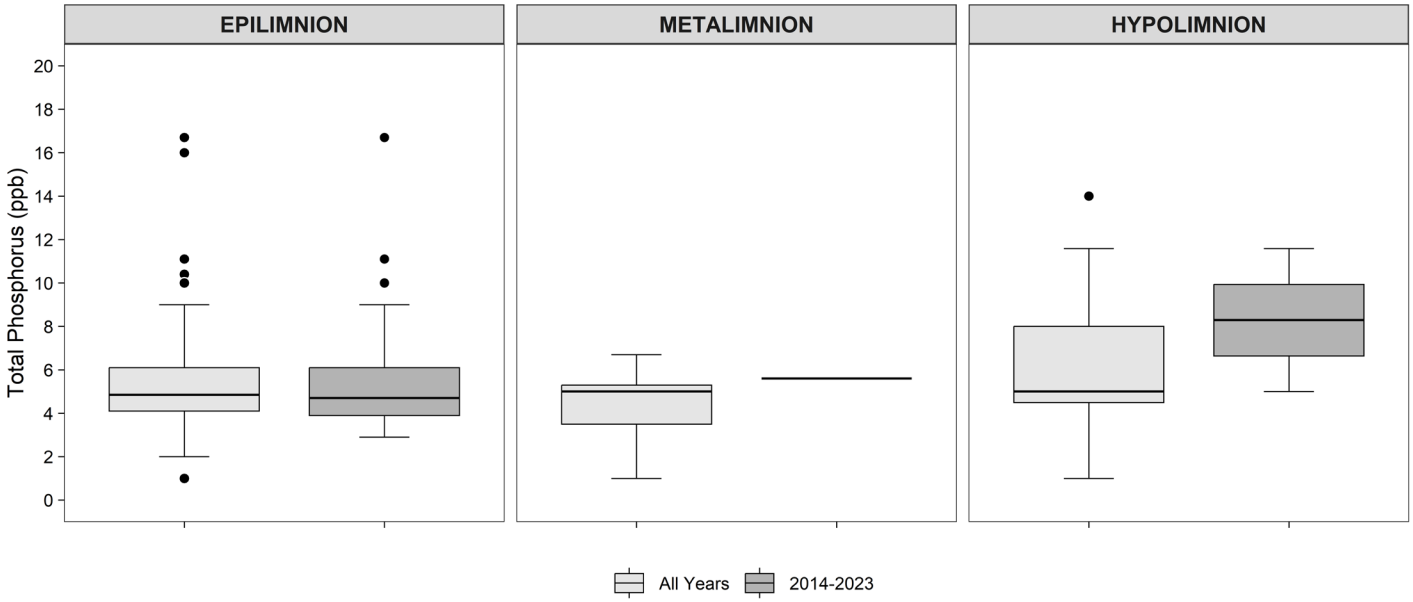


Figure 4. Boxplots showing median total phosphorus concentration in the epilimnion, metalimnion, and hypolimnion of the Broads deep spot of Lake Winnipesaukee (WINBGILD). Data are shown for all available years (1979-2023) as well as the most recent 10 years only (2014-2023). Sample sizes for the 2014-2023 period are 65, 1 and 2 for the epilimnion, metalimnion and hypolimnion, respectively. For the 1979-2023 period, n = 98, 7 and 12 for the epilimnion, metalimnion and hypolimnion, respectively.

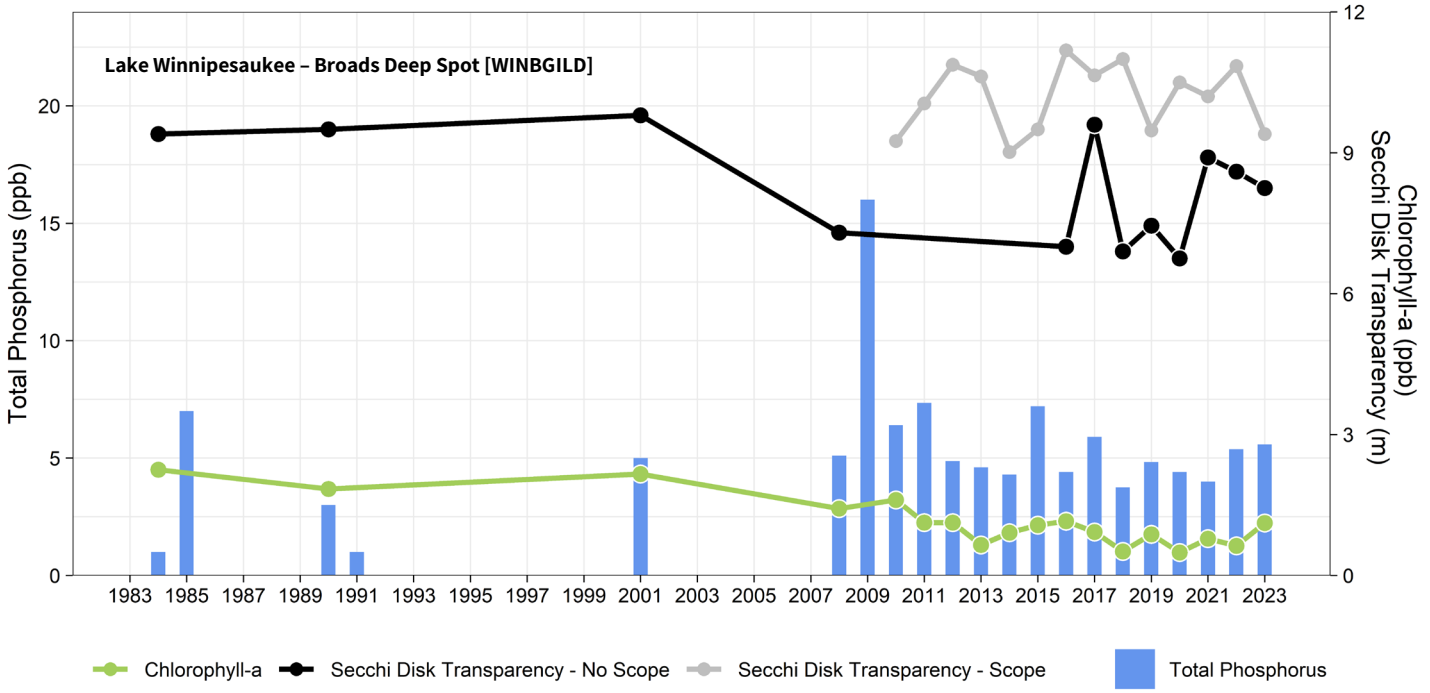


Figure 5. Median epilimnion total phosphorus, median epilimnion chlorophyll-a, and median water clarity (Secchi Disk transparency for scope and no scope methods) measured at the Broads deep spot of Lake Winnipesaukee (WINBGILD) between May 24th and September 15th from 1984-2023. A statistically significant decreasing trend in chlorophyll-a was detected from the Mann-Kendall nonparametric trend test using *rkt* package in R Studio.

2.1.4 Dissolved Oxygen & Water Temperature

Depletion of dissolved oxygen in the deepest part of New Hampshire lakes is a common occurrence throughout the summer months. This is triggered when **thermal stratification** prevents warmer (less dense), oxygenated surface waters from mixing with cooler (denser), oxygen-depleted bottom waters in the lake. Chemical and biological processes occurring in bottom waters deplete the available oxygen throughout the summer, and because these waters are colder and denser, the oxygen cannot be replenished through mixing with surface waters. Dissolved oxygen levels below 5 ppm (and water temperature above 24°C) can stress and reduce habitat for coldwater fish and other sensitive aquatic organisms. In addition, **anoxia** (low dissolved oxygen) at lake bottoms can result in the release of sediment-bound phosphorus (called **internal phosphorus loading**), which can become a readily available nutrient source for algae and cyanobacteria. While thermal stratification and depletion of oxygen in bottom waters is a natural phenomenon in dimictic lakes (lakes that mix twice per year) such as Lake Winnipesaukee, it is important to track these parameters to make sure the extent and duration of low oxygen does not change drastically because of human disturbance in the watershed resulting in excess phosphorus loading.

Figure 6, below, shows temperature and dissolved oxygen profiles averaged across sampling dates (1979-2016) during thermal stratification largely in summer (between spring and fall turnover) at the Lake Winnipesaukee Broads deep spot. A profile taken over two dates in July 2023 for the 26 Alton Deep Spot shows similar results to the WINBGILD profile (Figure 7). The change in temperature, seen most dramatically between 8 and 10 m, indicates thermal stratification in the water column. A slight increase in dissolved oxygen around this depth (near or at the top of the thermocline where microorganisms can be neutrally buoyant) indicates photosynthetic activity by phytoplankton. Dissolved oxygen levels were not identified below 2 ppm at any depth, which is the limit after which internal loading is likely to occur. Historic recording of temperature and dissolved oxygen profiles included only one water column profile per sampling season. While these data are useful in tracking major trends over time, the more recent monitoring consisting of several profiles per sampling season can provide better insight to seasonal changes in the lake.

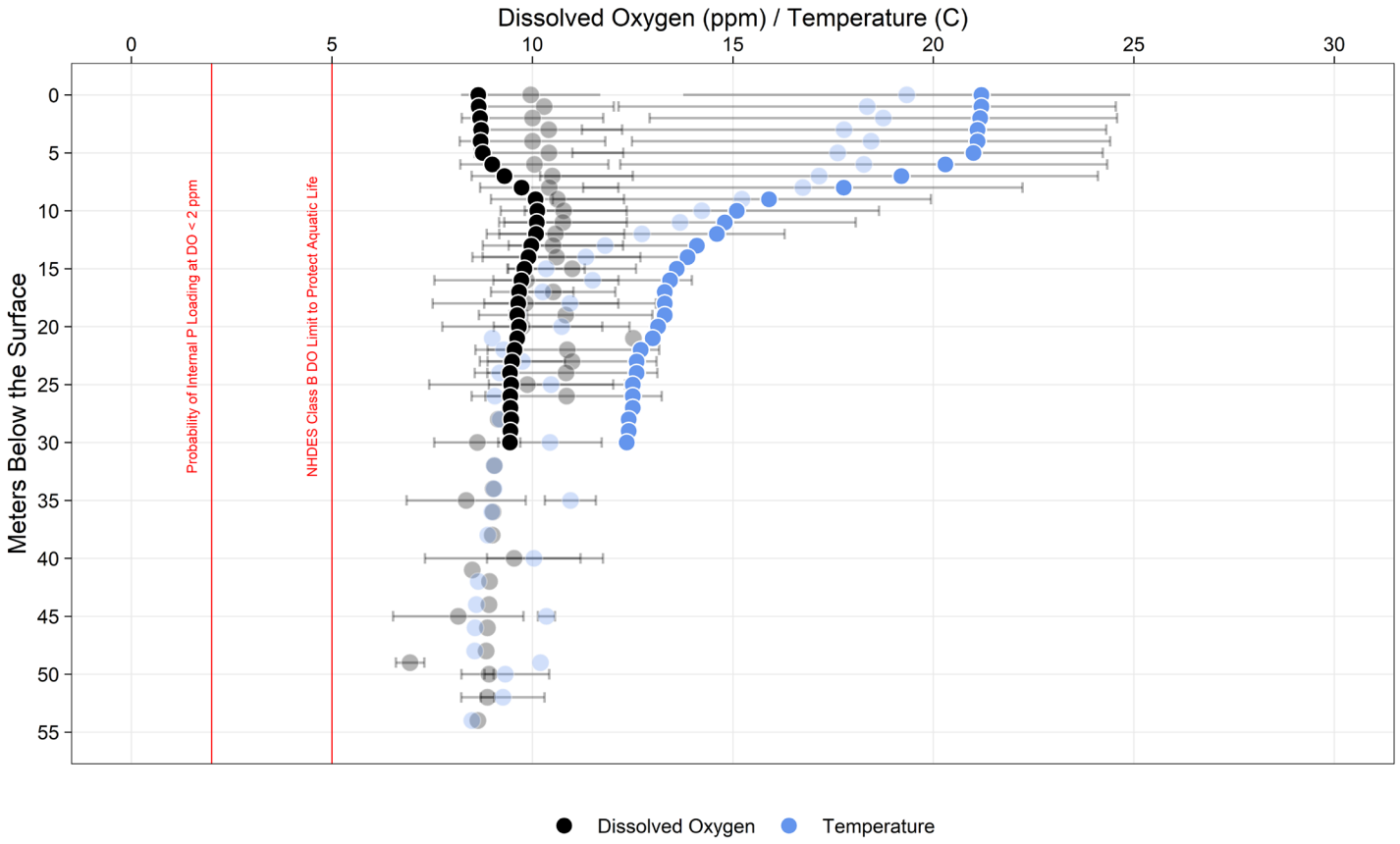


Figure 6. Dissolved oxygen (black) and water temperature (blue) depth profiles for the Broads deep spot of Lake Winnipesaukee (WINBGILD). Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation. Semitransparent dots are the medians from profile data collected between May and September in 1990, 2001, 2008, twice in 2015, and 2016 (n=6), with three additional dissolved oxygen measurements taken in 1979 and 1984. Non-transparent dots represent the values from the most recent profile (2016). There are only two profiles at the deep spot that have been collected in the last 10 years, one in 2015 and one in 2016.

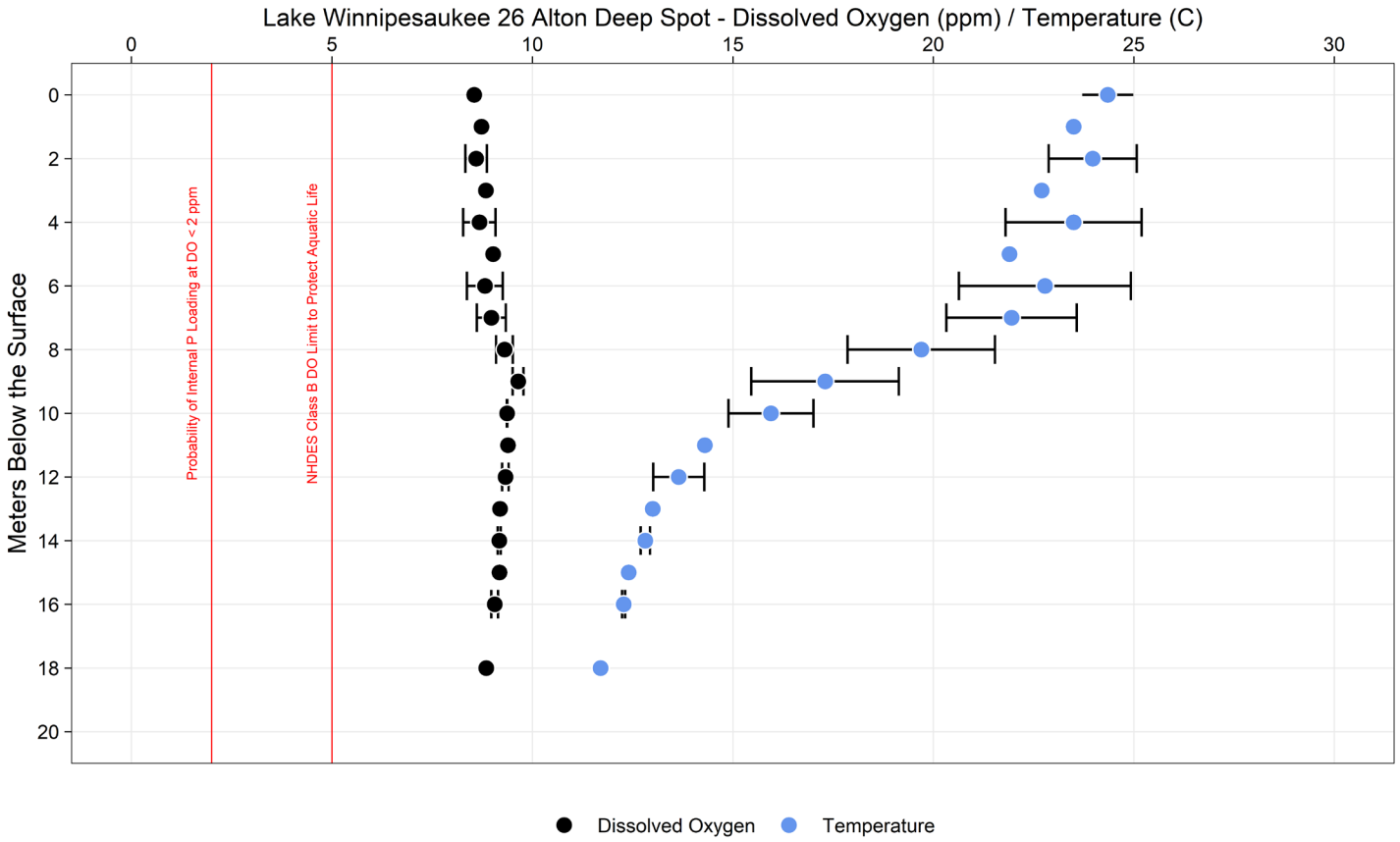


Figure 7. Dissolved oxygen (black) and water temperature (blue) depth profiles for the 26 Alton Deep Spot of Lake Winnipesaukee (WIN26DL). Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation. Profiles were collected on 6th and 19th July 2023 (n=2).

2.1.5 Chloride & Specific Conductivity

Chloride pollution can cause harm to aquatic organisms and disrupt internal mixing processes when concentrations reach toxic levels. Because chloride requires physical grab samples and analysis at a local laboratory, lake managers often use specific conductivity as a rough measure of potential chloride toxicity. Specific conductivity measures the water's ability to conduct an electrical current and gives lake managers a sense of the amount of dissolved material in the water. In the Northeast, chloride from winter salting practices often accounts for the increased conductivity of waters. The State of New Hampshire sets a chronic threshold of 230 ppm for chloride (which roughly equates to 835 µS/cm for specific conductivity). Concentrations of chloride (mean of 17.9 ppm) and specific conductance (mean of 81.1, 72.4 and 72.5 for epilimnion, metalimnion and hypolimnion, respectively) in 2014-2023 in the Broads deep spot of Lake Winnipesaukee are well below the chronic threshold, which is typical for a high-quality lake (most New Hampshire lakes are around 4 ppm or 40 µS/cm). However, specific conductivity in the epilimnion and hypolimnion layers show statistically significant increasing trends over the period from 1979-2023, particularly in the years 2016-2023 (Figure 8). The increasing trends indicate that chloride from winter salting practices for deicing roads and other surfaces in the watershed may be contaminating the lake. While not an immediate concern for the health of the lake, chronic chloride toxicity will likely become an issue in the future without a proactive reduction in salt use in the watershed. No chloride data have been collected for the 26 Alton deep station, but the mean values of specific conductivity collected in 2023 were 87.00, 89.14, and 89.77 in the epilimnion, metalimnion and hypolimnion zones, respectively.

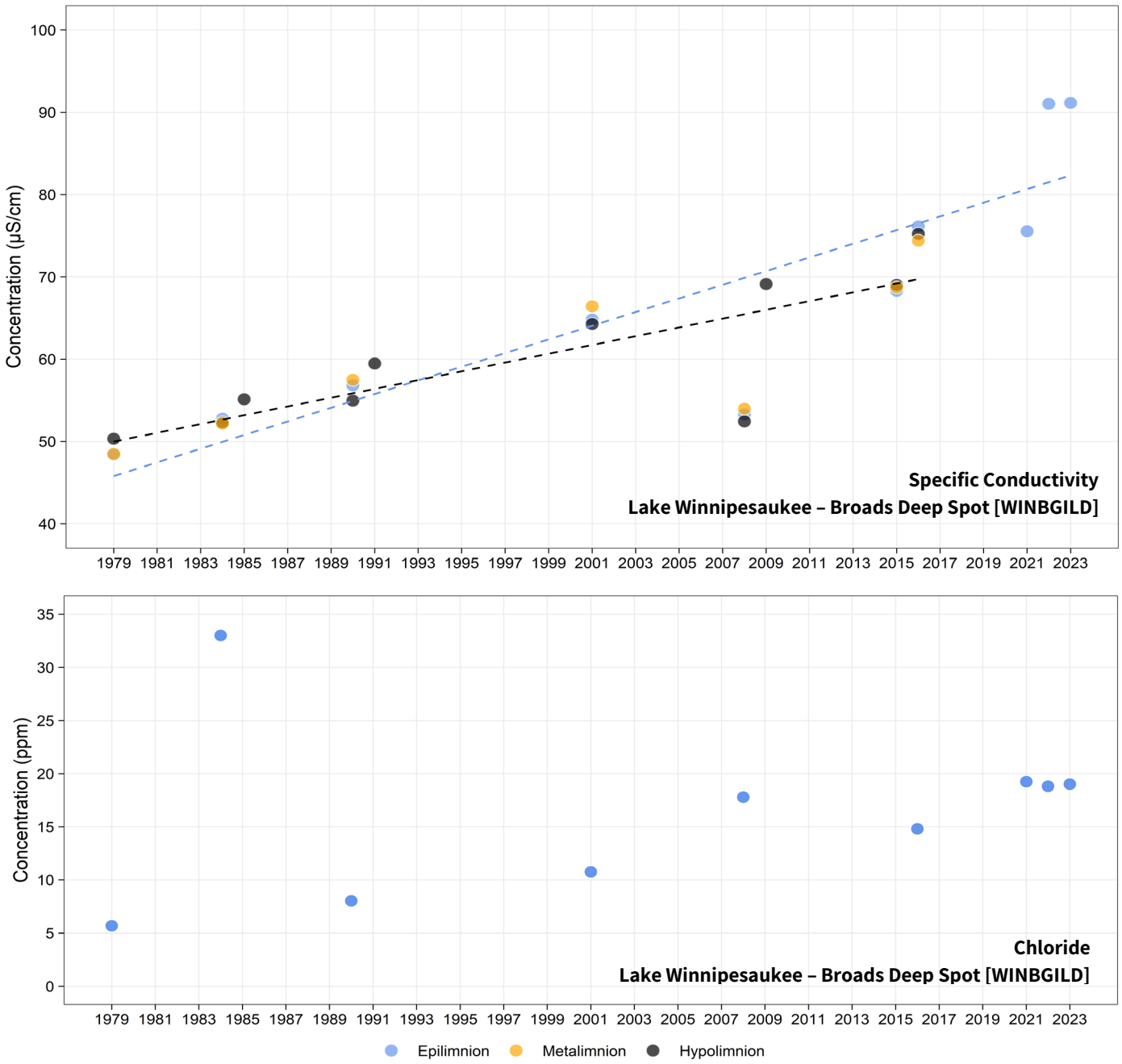


Figure 8. Yearly median of monthly medians for specific conductivity (top) and chloride (bottom) in the deep spot of the Broads, Lake Winnipesaukee (WINBGILD). Dashed lines indicate a statistically significant increasing (degrading) trend. There were insufficient data points (n=9) for trend analysis of specific conductivity in the metalimnion layer and for epilimnetic chloride.

2.1.6 Phytoplankton (Cyanobacteria) and Zooplankton

2.1.6.1 Historical Phytoplankton/Zooplankton Surveys

Phytoplankton and zooplankton samples were collected and analyzed during the 1979, 1984, 1990, and 2001 NHDES Trophic Surveys of the Broads. The dominant phytoplankton species were *Tabellaria* (diatom), *Dinobryon* (golden-brown), *Rhizosolenia* (diatom), *Chrysosphaerella* (golden-brown) and *Asterionella* (diatom). The dominant zooplankton taxa were *Keratella* (rotifer), *Collotheca* (rotifer), *Nauplius* larvae (copepod), *Kellicotia* (rotifer), and *Polyarthra* (rotifer). Copepods are small crustaceans that eat phytoplankton and provide an important food source to fish. Daphnia are among the most efficient grazers of phytoplankton but were not shown to be a dominant zooplankter in the Broads.

2.1.6.2 Recent Phytoplankton/Zooplankton Surveys

In recent years, NHDES has conducted annual phytoplankton and zooplankton surveys throughout Lake Winnipesaukee as part of efforts to monitor for the invasive spiny water flea (see Section 2.1.8). The relative densities of various phytoplankton and zooplankton groups recorded at the WINBGILD water quality monitoring station are summarized in Figure 9 below. Although it may be too early to identify clear trends in abundance over time, the introduction of the spiny water flea—first detected in the lake in September 2023—is expected to cause cascading impacts on plankton communities within the Broads. Both phytoplankton and zooplankton samples were filtered using an 80 µm mesh net. This small mesh size allows for a representative snapshot of the plankton community.

In most years from 2017 to 2024, cyanobacteria, diatoms and golden-brown algae dominated the phytoplankton community in the Broads. While the relative abundance of these groups varies from year to year, no consistent trend over time is evident. Among zooplankton, rotifers were the most abundant group from 2016 to 2024. Cladocerans were observed in relatively low proportions at the Broads deep spot throughout this period, but notably, none were detected in 2024—just one year after the initial detection of the spiny water flea.

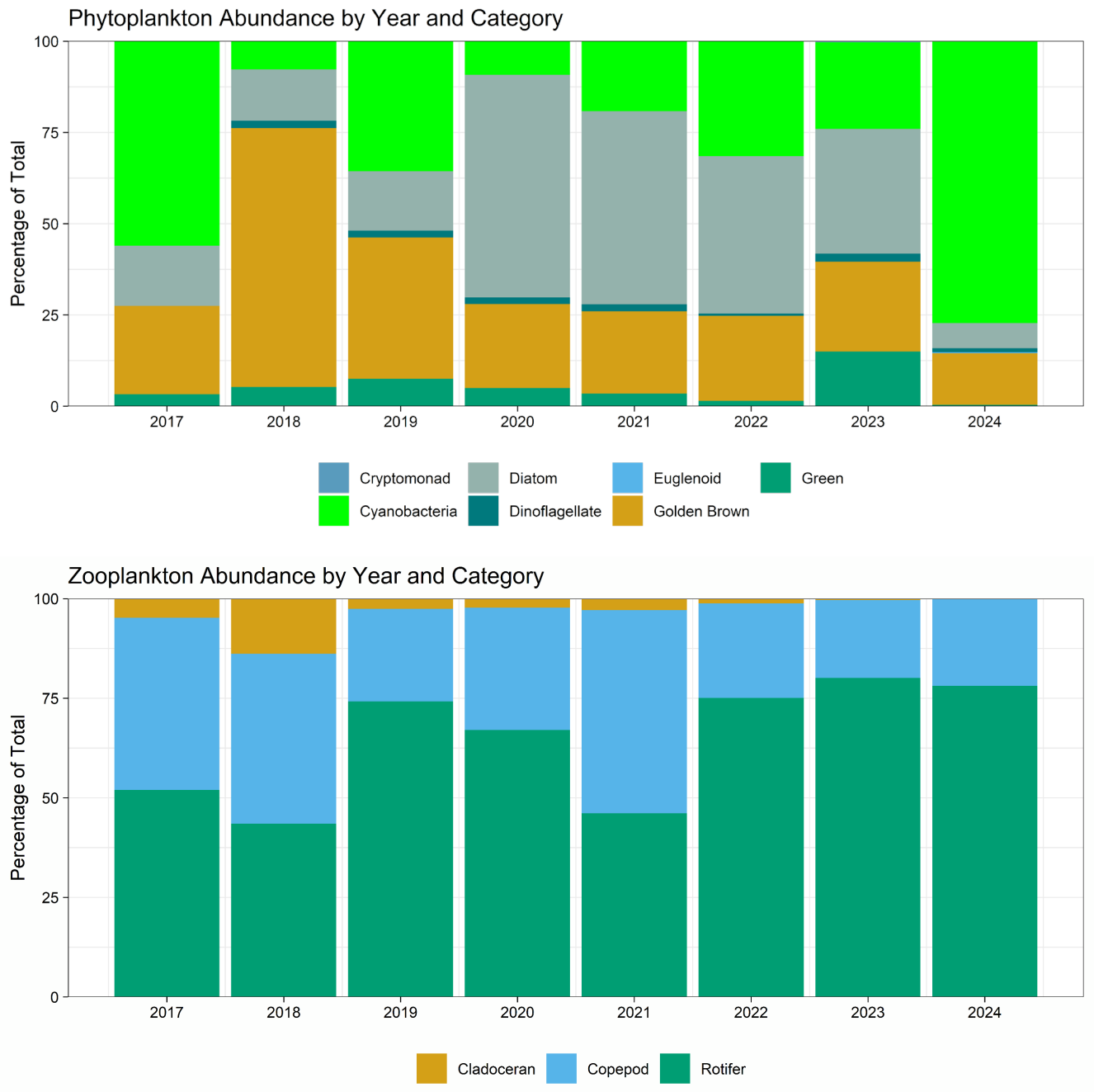


Figure 9. Relative abundance (% of total community) of plankton groups collected by NHDES using an 80 µm mesh net at the Broads deep spot (WINBGILD), 2017–2024. The top graph shows phytoplankton results; the bottom graph shows zooplankton results. Data provided by Kirsten Hugger, NHDES.

2.1.6.3 Cyanobacteria Bloom History

Nutrients such as phosphorus and nitrogen, as well as algae and cyanobacteria, naturally occur in the environment, including lakes and tributaries and their contributing watersheds, and are essential to lake health. Under natural conditions, algae and cyanobacteria concentrations are regulated by limited nutrient inputs and lake mixing processes that keep them from growing too rapidly. However, human related disturbances, such as erosion, overapplied fertilizers, polluted stormwater runoff, excessive domesticated animal waste, and inadequately treated wastewater, can dramatically increase the amount of nutrients entering lakes and their tributaries. Excess nutrient loading to human-disturbed lake systems, in combination with a warming climate, has fueled the increasing prevalence of Harmful Algal Blooms (HABs) or the rapid growth of algae and cyanobacteria in lakes across the United States.

Cyanobacteria are small photosynthesizing, sometimes nitrogen-fixing, single-celled bacteria that grow in colonies in freshwater systems. Cyanobacteria blooms can (but not always) produce microcystins and other toxins that pose a serious health risk to humans, pets, livestock, and wildlife, such as neurological, liver, kidney, and reproductive organ damage, gastrointestinal pain or illness, vomiting, eye, ear, and skin irritation, mouth blistering, tumor growth, seizure, or death. Blooms can form dense mats or surface scum that can occur within the water column or along the shoreline. Dried scum along the shoreline can harbor high concentrations of microcystins that can re-enter a waterbody months later. There are several different species of cyanobacteria, such as:

- ***Gloeotrichia*:** typically observed as large, round colonies of filaments, associated with microcystins.
- ***Dolichospermum* (formerly *Anabaena*):** typically observed as filaments, associated with microcystins, anatoxins, saxitoxins, and cylindrospermopsin, documented at Ellacoya State Park in 2022.
- ***Microcystis*:** typically observed as variations of small-celled colonies, associated with microcystins and anatoxins.
- ***Aphanizomenon*:** typically forms rafts of filaments, associated with anatoxin-a, anatoxin-a (S), saxitoxins, and possibly microcystins.
- ***Woronichinia*:** typically forms dense colonies, associated with microcystins.
- ***Planktothrix* (formerly *Oscillatoria*):** typically observed as filaments, associated with microcystins and cylindrospermopsin, can maintain high growth rate at relatively low light intensities when it forms metalimnetic blooms (NHDES, 2020).
- ***Pseudanabaena:*** typically observed as filaments, documented in the Broads in 2019 and 2022–2024.

Cyanobacteria are becoming more prevalent in low-nutrient lake systems likely due to environmental variability warming effects (e.g., warmer water temperatures, prolonged thermal stratification, increased stability, reduced mixing, and lower flushing rates at critical low-flow periods that allow for longer residence times) that allow cyanobacteria to thrive and outcompete other phytoplankton species (Przytulska, Bartosiewicz, & Vincent, 2017; Paerl, 2018; Favot, et al., 2019). Many cyanobacteria can regulate their buoyancy and travel vertically in the water column to maximize their capture of both sunlight and sediment phosphorus (even during stratification and/or under anoxic conditions) for growth. In addition, some cyanobacteria can also fix atmospheric nitrogen, if enough light, phosphorus, iron, and molybdenum are available for the energy-taxing process. Some taxa are also able to store excess nitrogen and phosphorus intra-cellularly for later use under more favorable conditions. Because of these traits and as climate warming increases the prevalence and dominance of cyanobacteria, cyanobacteria are one of the major factors driving positive feedbacks with lake eutrophication and may be both accelerating eutrophication in low-nutrient lakes and preventing complete recovery of lakes from eutrophic states (Dolman, et al., 2012; Cottingham, Ewing, Greer, Carey, & Weathers, 2015). A better understanding of cyanobacteria's role in nutrient feedbacks will be needed for better and more effective lake restoration strategies.

Through 2024, there have been five NHDES-issued cyanobacteria bloom advisories for Lake Winnipesaukee within the Broads watershed. An alert was posted for Welch Island based on a photo in July 2020, and a two-day advisory was in place at Ellacoya State Park in Gilford in June 2022. The latter bloom had a cell count of 199,733 cells/mL, primarily composed of *Dolichospermum*. An eight-day warning was issued in June 2024 for *Dolichospermum* (80,500 cells/mL), and a nine-day warning in August-September 2024 for *Gloeotrichia* (525,000 cells/mL) was downgraded to a Watch for 13 additional days (200 cells/mL *Gloeotrichia*).

Cyanobacteria taxa were identified and enumerated as part of the annual NHDES phytoplankton surveys discussed in Section 2.1.6.2. Figure 10 illustrates the diversity of cyanobacteria present at the Broads deep spot (WINBGILD). In recent years, *Pseudanabaena* has dominated the cyanobacteria community, but at least 15 other species have been identified at this location since 2017.

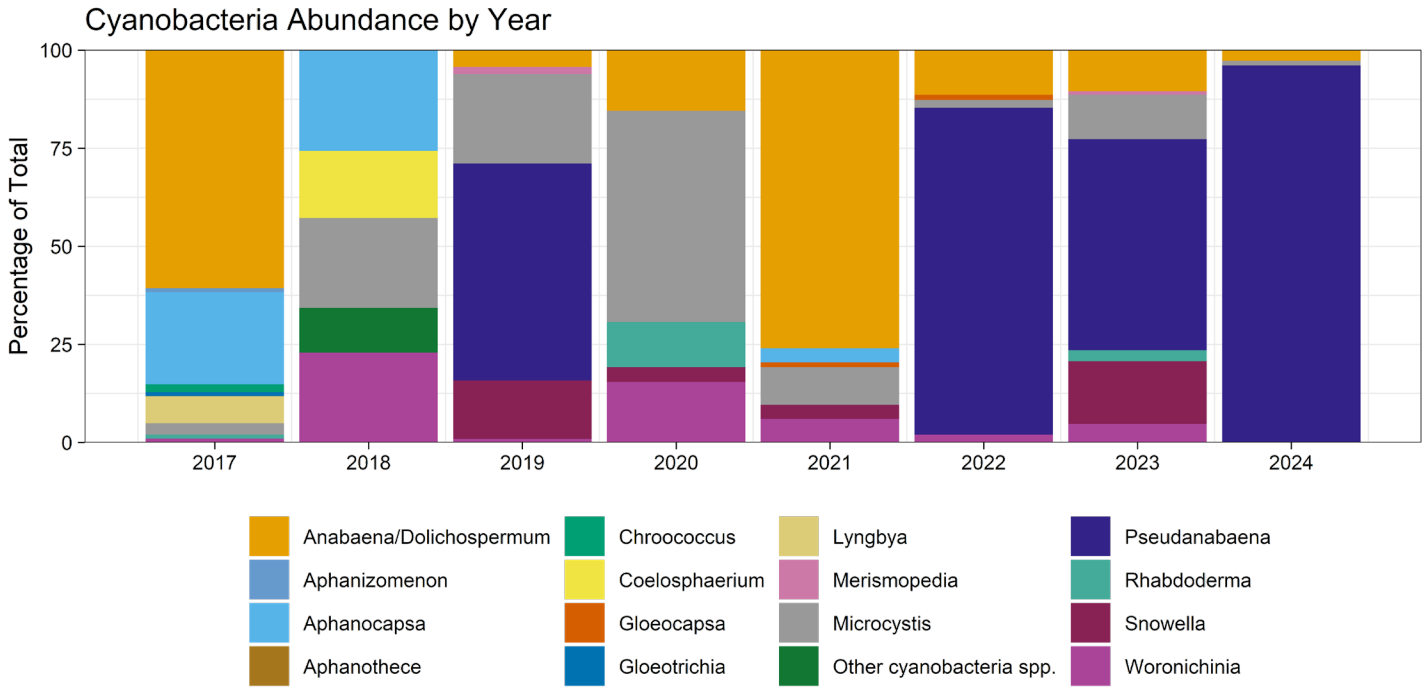


Figure 10. Relative abundance (% of total community) of cyanobacteria taxa sampled by NHDES using an 80 µm mesh net at the Broads deep spot (WINBGILD), 2017–2024. Data provided by Kirsten Hugger, NHDES.

2.1.7 Fish

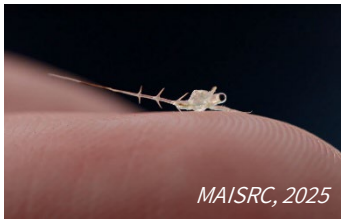
Fish are an important natural resource for sustainable ecosystem food webs and provide recreational opportunities. Fish surveys conducted by NH Fish & Game in the Broads section of Lake Winnipesaukee have recorded landlocked Atlantic salmon, smallmouth bass, largemouth bass, brown bullhead, black crappie, bluegill, burbot, lake trout, lake whitefish, rock bass, rainbow trout, and white perch. The NH Fish & Game Wildlife Action Plan (NHFG, 2015) additionally identified American eel within the Broads (Appendix A, Map A-10).

NHFG surveys in West Alton Brook, Poorfarm Brook and Hurd Brook conducted in 2010 identified the presence of blacknose dace, landlocked Atlantic salmon, brown bullhead, common white sucker, eastern brook trout, rainbow trout, and golden shiner. The presence of eastern brook trout is an indicator of high-quality coldwater stream habitat.

2.1.8 Invasive Species


NHDES

Variable milfoil (*Myriophyllum heterophyllum*) was first discovered in Lake Winnipesaukee in 1965, marking the state's earliest recorded infestation of an aquatic invasive species (NHDES, 2019). Since then, more than 90 waterbodies across New Hampshire have become infested with one or more types of aquatic invasive species (NHDES, 2022a). Although the rate of spread has slowed thanks to statewide prevention and early detection efforts, managing and removing established populations continues to pose significant challenges. disrupt natural habitats, displace native plant and animal communities, lower property values, impair fishing, degrade recreational experiences, and incur high removal costs. There are multiple programs that help prevent the introduction and spread of invasive species in lakes, including the Lake Host Program and the Weed Watcher Program.


MAISRC, 2025

A more recent introduction to Lake Winnipesaukee is the spiny water flea (*Bythotrephes longimanus*), a large, predatory zooplankton first detected in Lake Winnipesaukee in 2023 and again in 2024. This invasive species can disrupt lake food webs by competing with native carnivorous and omnivorous zooplankton, such as large-bodied *Leptodora* and cyclopoid copepods, which feed on smaller zooplankton like rotifers. Additionally, the spiny water flea preys directly on native herbivorous, filter-feeding zooplankton, including *Daphnia* and bosminids (both types of cladocerans), and rotifers (Cutter et al., 2023). These groups are essential grazers in lake ecosystems. Declines in *Daphnia* populations resulting from spiny water flea invasion have been linked to increased diatom abundance in two Wisconsin lakes (Walsh et al., 2018). The spiny water flea has fewer predators than native zooplankton because small or juvenile fish are unable to consume their sharp, barbed spine (MAIRSC, 2025). They reproduce rapidly, reaching maturity and producing offspring within a week, and are capable of reproducing asexually. The lack of native predators and fast reproduction cycle enables the species to spread rapidly once introduced to a lake. See Figure 11 for a visual representation of these impacts.

The full impact of the spiny water flea on Lake Winnipesaukee is still being assessed. However, preliminary data collected annually by NHDES suggest a decline in the density of cladoceran taxa (e.g., *Daphnia,* bosminids) across the lake between 2017 and 2024 (Hugger, 2025). Possible impacts could include an increase in diatom densities, a decrease in food sources for native fish (cladocerans), and the clogging of fishing rod eyelets. Continued annual monitoring of phytoplankton and zooplankton communities will help lake managers detect potential impacts, anticipate cascading effects, and implement strategies to prevent issues such as phytoplankton blooms or reduced water clarity.

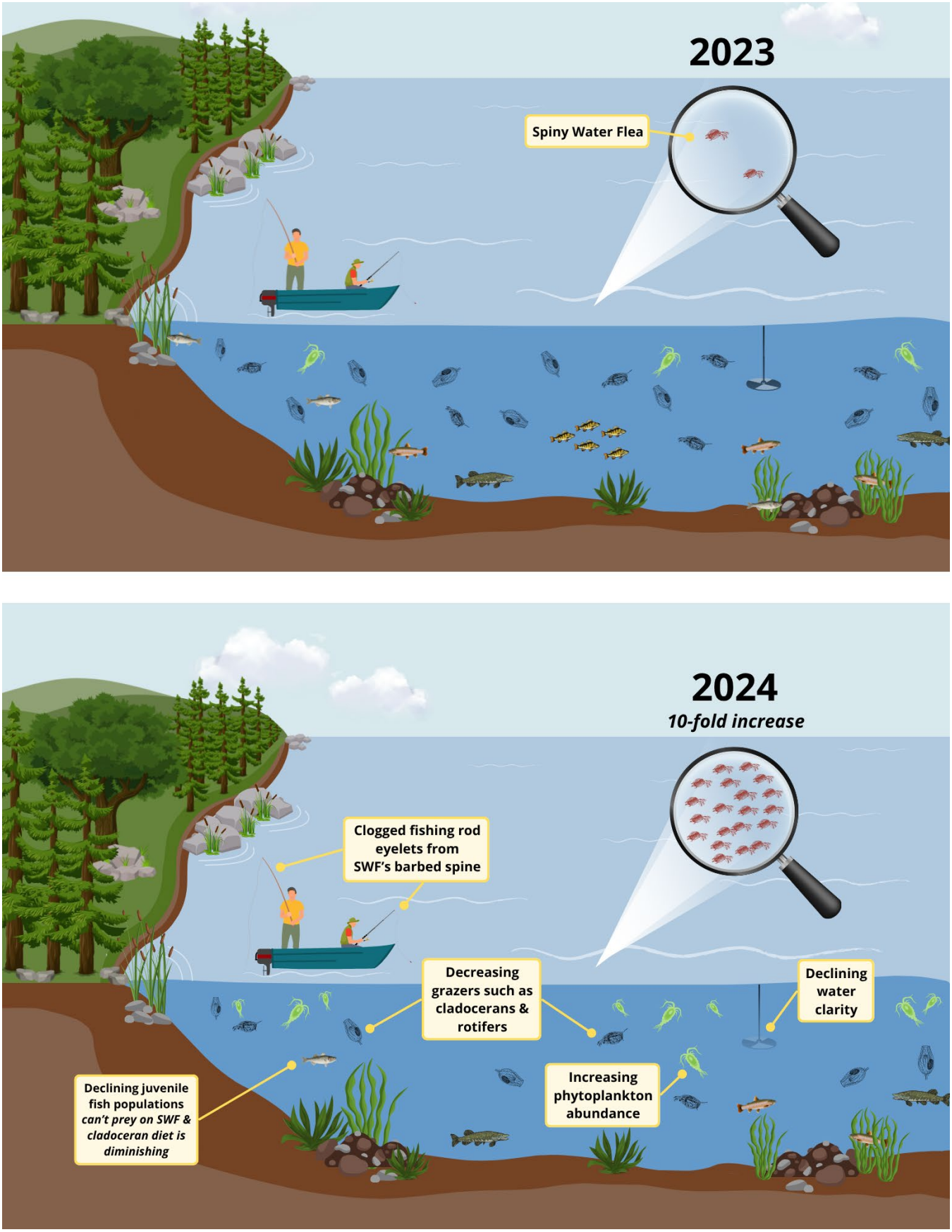


Figure 11. A representation of the impacts of increasing spiny water flea (*Bythotrephes longimanus*) populations in North American lakes.

2.2 ASSIMILATIVE CAPACITY

The assimilative capacity of a waterbody describes the amount of pollutant that can be added without causing a violation of the water quality criteria. The assimilative capacity is based on lake trophic designation. Lake Winnipesaukee is an oligotrophic waterbody, and this designation was selected for running the assimilative capacity analysis for the Broads section of Lake Winnipesaukee. For oligotrophic waterbodies, the water quality criteria are set at 8 ppb for total phosphorus and 3.3 ppb for chlorophyll-a, above which the waterbody is considered impaired (**Table 3.** Aquatic life integrity (ALI) nutrient criteria ranges by trophic class in New Hampshire.Table 3). According to Table 3-17 in the 2024 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM), NHDES requires 10% of the difference between the best possible water quality and the water quality standard be kept in reserve. Therefore, total phosphorus and chlorophyll-a must be at or below 7.2 ppb and 3.0 ppb, respectively, to achieve Tier 2 High Quality Water status. Support determinations are based on the nutrient stressor (phosphorus) and response indicator (chlorophyll-a), with chlorophyll-a dictating the assessment if both chlorophyll-a and total phosphorus data are available and the assessments differ (Table 4). Results of the assimilative capacity analysis for all deep spots within the Broads with sufficient data (five or more independent dates within the last 10 years) show that this portion of Lake Winnipesaukee meets Tier 2 (High Water Quality) for its trophic class designation (Table 5). The existing median total phosphorus and chlorophyll-a concentrations both meet the assimilative capacity threshold.

Table 3. Aquatic life integrity (ALI) nutrient criteria ranges by trophic class in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae.

Trophic State	TP (ppb)	Chl-a (ppb)
Oligotrophic	< 8.0	< 3.3
Mesotrophic	> 8.0 - 12.0	> 3.3 - 5.0
Eutrophic	> 12.0 - 28.0	> 5.0 - 11.0

Table 4. Decision matrix for aquatic life integrity (ALI) assessment in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae concentration.

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

Table 5. Assimilative capacity (AC) analysis results for the Broads section of Lake Winnipesaukee using oligtrophic standards, for deep stations with data from at least five independent dates within the most recent 10 years, as of 2024. Chlorophyll-a dictates the assessment results.

Parameter	AC Threshold (ppb)	Existing Median WQ (ppb)*	Remaining AC (ppb)	Assessment Results
LAKE WINNIPESAUKEE – BROADS DEEP SPOT [WINBGILD]				
Total Phosphorus	7.2	4.7	2.3	Tier 2 (High Water Quality)
Chlorophyll-a	3.0	0.8	2.2	
LAKE WINNIPESAUKEE – 26 ALTON DEEP [WIN26DL]				
Total Phosphorus	7.2	4.6	2.6	Tier 2 (High Water Quality)
Chlorophyll-a	3.0	1.6	1.4	
LAKE WINNIPESAUKEE – BLACK POINT DEEP [WINBLKPNT]				
Total Phosphorus	7.2	5.3	1.9	Tier 2 (High Water Quality)
Chlorophyll-a	3.0	1.7	1.3	
LAKE WINNIPESAUKEE – WEST ALTON MARINA [WINALTMARINA]				
Total Phosphorus	7.2	4.7	2.5	Tier 2 (High Water Quality)
Chlorophyll-a	3.0	1.6	1.4	

2.3 2024 DATA SUMMARY

Water quality data for the Broads were collected between July 2nd and September 12th, 2024 by UNH Extension LLMP volunteers at the Broads deep spot station (WINBGILD). Their results are summarized in the 2024 sampling highlights report (UNH LLMP, 2024). Mean epilimnion total phosphorus was 5.3 ppb and mean composite chlorophyll-a concentration was 1.8 ppb (n = 8 for both). The mean total phosphorus value is 0.6 ppb higher than the 2014-2023 median, and the mean chlorophyll-a value is 1.0 ppb higher than the median for the same period. Additionally, one of the total phosphorus measurements was 9.1 ppb, which falls within the mesotrophic range. All other total phosphorus and chlorophyll-a values were within oligotrophic thresholds. Mean Secchi disk transparency was 9.2 m (n=7). LLMP results for sites within the Broads monitored in 2024 are summarized in Table 6. Dissolved oxygen levels measured in bottom waters (12.5 to 45 m deep) on July 30th, 2024 averaged 9.4 ppm, which are ideal conditions for aquatic life and meet oligotrophic criteria.

Table 6. Summary of trophic state indicator parameters collected by the UNH LLMP within the Broads in 2024.

Site Name and ID	Mean Total Phosphorus in ppb (*n*)	Mean Chlorophyll-a in ppb (*n*)	Mean Secchi Disk Transparency in m (*n*)
Broads Deep Spot (WINBGILD)	5.3 (n=8)	1.8 (n=8)	9.2 (n=7)
26 Alton Deep (WIN26DL)	4.6 (n=6)	1.9 (n=5)	10 (n=8)
Black Point Deep (WINBLKPNT)	4.8 (n=5)	1.7 (n=5)	10.1 (n=6)

In addition, NHDES collected one chlorophyll-a sample at 15 m depth on September 27th, 2024 as part of the Biological Special Project, and recorded a concentration of 2.22 ppb. This is within the oligotrophic range. NHDES also collected specific conductivity and chloride data at WINBGILD on two occasions in 2024. The first sample was taken at 1 m depth on September 4th, as part of its plankton research project with specific focus on detecting the spiny water flea. Specific conductance measured 88.6 µs/cm, in line with measurements taken in 2022 and 2023 and significantly higher than older measurements. Chloride measured 26.2 mg/L, elevated compared to the values recorded in the previous three years, which averaged 20 mg/L.

The second NHDES sample event at WINBGILD was on September 27th, at 6 m, 25 m and 56 m depths, through the Lake Winnipesaukee Biology Special Study project. Specific conductance measured 93.7 µs/cm, 91.9 µs/cm, and 95.5 µs/cm at these respective depths – similarly high to what was collected earlier in the month and in the previous two years. Chloride at 6 m, 25 m and 56 m measured 24.1 mg/L, 26.3 mg/L, and 24.1 mg/L respectively – all slightly elevated relative to previous years. A declining trend in water quality in relation to chloride is therefore emerging for the period 1979-2024 (p= 0.049, n=10, Mann-Kendall trend test). NHDES data were accessed in September 2025 via the Environmental Monitoring Database maintained by NHDES.

2.4 WATERSHED MODELING

2.4.1 Lake Loading Response Model (LLRM)

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

The LLRM is an Excel-based model that uses environmental data to develop a water and phosphorus loading budget for lakes and their tributaries (AECOM, 2009). Water and phosphorus loads (in the form of mass and concentration) are traced from various sources in the watershed through tributary basins and into the lake. The model incorporates data about watershed and sub-watershed boundaries, land cover, point sources (if applicable), septic systems, waterfowl, rainfall, volume and surface area, and internal phosphorus loading. These data are combined with coefficients, attenuation factors, and equations from scientific literature on lakes, rivers, and nutrient cycles to generate annual average predictions[2] of total phosphorus, chlorophyll-a, Secchi

[2] The model cannot simulate short-term weather or loading events.

disk transparency, and algal bloom probability. The model can be used to identify current and future pollutant sources, estimate pollutant limits and water quality goals, and guide watershed improvement projects. A complete detailing of the methodology employed for the Broads LLRM is provided in *The Broads Lake Loading Response Model Report* (FBE, 2025a).

2.4.1.1 Lake Morphology & Flow Characteristics

The morphology (shape) and bathymetry (depth) of lakes and ponds are considered reliable predictors of water clarity and lake ecology. Large, deep lakes are typically clearer than small, shallow lakes as the differences in lake area, number and volume of upstream lakes, and **flushing rate** affect lake function and health.

The surface area of the Broads is 17,231 acres (44.6 miles of shoreline, including islands) with a maximum depth of 178 feet (54.3 meters) and volume of 1,183,539,529 m^3 (Appendix A, Map A-1). The **areal water load** is 11 ft/yr (3.3 m/yr), and the flushing rate is 0.32 times per year. The flushing rate of 0.32 means that the entire volume of the Broads is replaced roughly every three years. The Broads has a different flushing rate than Lake Winnipesaukee in aggregate due to the influence of the other bays and their watersheds; the flushing rate of Lake Winnipesaukee is about 0.2, meaning it takes 5 years for the entire volume of Lake Winnipesauke to be replaced. Figure 12 illustrates the net direction of flow of water throughout Lake Winnipesaukee's sub-basins.

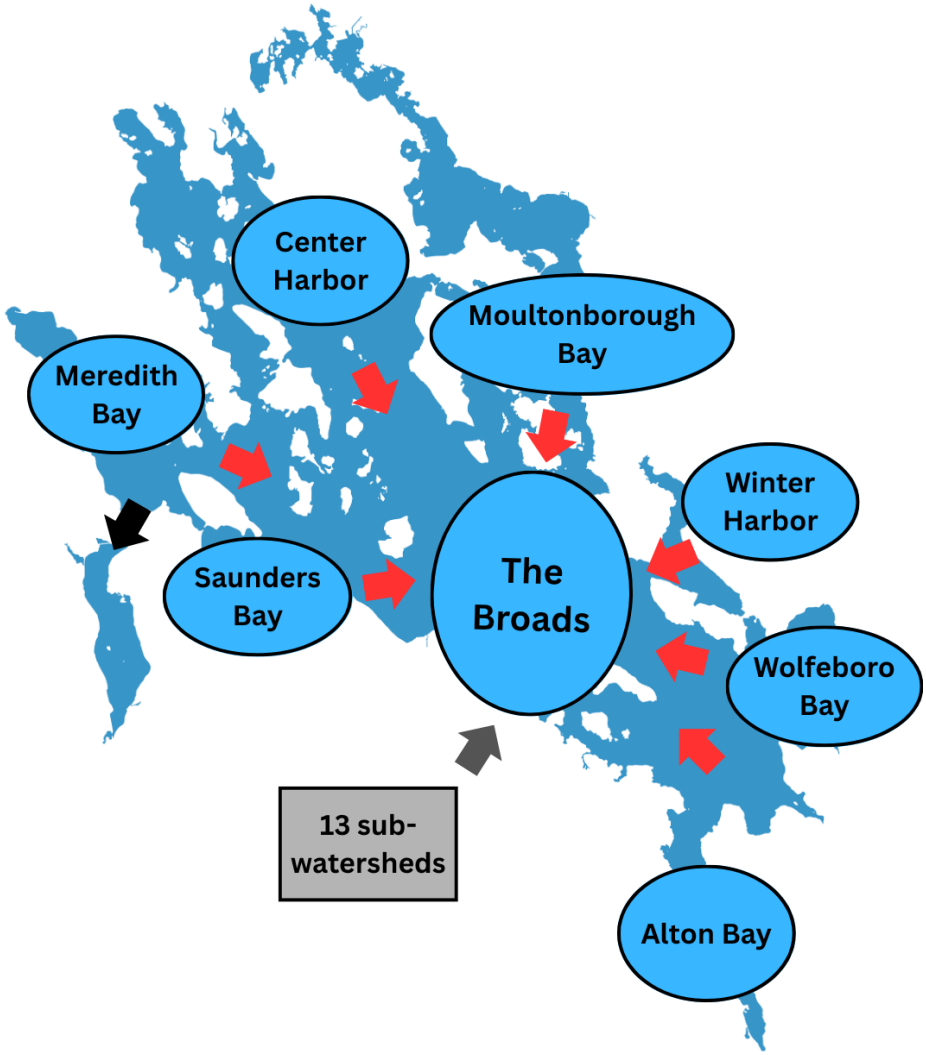


Figure 12. Conceptual diagram of point source and sub-watershed routing for the Lake Winnipesaukee model, using the Broads as the calibration point. Red arrows indicate a point source (other modeled bay). Gray arrows indicate sub-watersheds and black arrows indicate the model outlet point.

2.4.1.2 Land Cover

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

Current land cover in the Broads watershed was determined by FBE using a combination of published datasets on NH GRANIT and ESRI World Imagery from May 26, 2023, and Google Earth satellite imagery from October 10, 2020. For more details on methodology, see *The Broads Lake Loading Response Model Report* (FBE, 2025a). Refer also to Appendix A, Map A-2.

As of the 2023/2020 aerial imagery, development accounts for 9% (618 acres) of the direct drainage area to the Broads, while forested and meadow areas account for 88% (5,867 acres; Figure 13). Wetlands and open water represent 1% (92 acres) of the watershed, not including the surface area of Lake Winnipesaukee. Agriculture represents 1% (59 acres).

Developed areas within the Broads watershed are characterized by **impervious surfaces**, including areas with asphalt, concrete, compact gravel, and rooftops that force rain and snow that would otherwise soak into the ground to run off as stormwater. Stormwater runoff carries pollutants to waterbodies that may be harmful to aquatic life, including sediments, nutrients, pathogens, pesticides, hydrocarbons, and metals. There are documented correlations between the percentage of effective impervious cover in a drainage area and the water quality of the receiving waterbody, with higher percent impervious cover, often greater than 10% as per the NHDES "1065 Rule", causing degradation of water quality and aquatic habitat. While an impervious cover analysis was not completed for this plan, impervious cover in the direct watershed to the Broads is less than 10% since developed land cover (at 9%) reflects all human-impacted areas and includes such non-impervious areas as lawns. However, localized development along the Lake Winnipesaukee shoreline contains dense impervious cover that would exceed the 10% threshold within the shoreland zone and contribute contaminated runoff in short, first-flush flow paths to the Broads, posing a substantial risk to water quality.

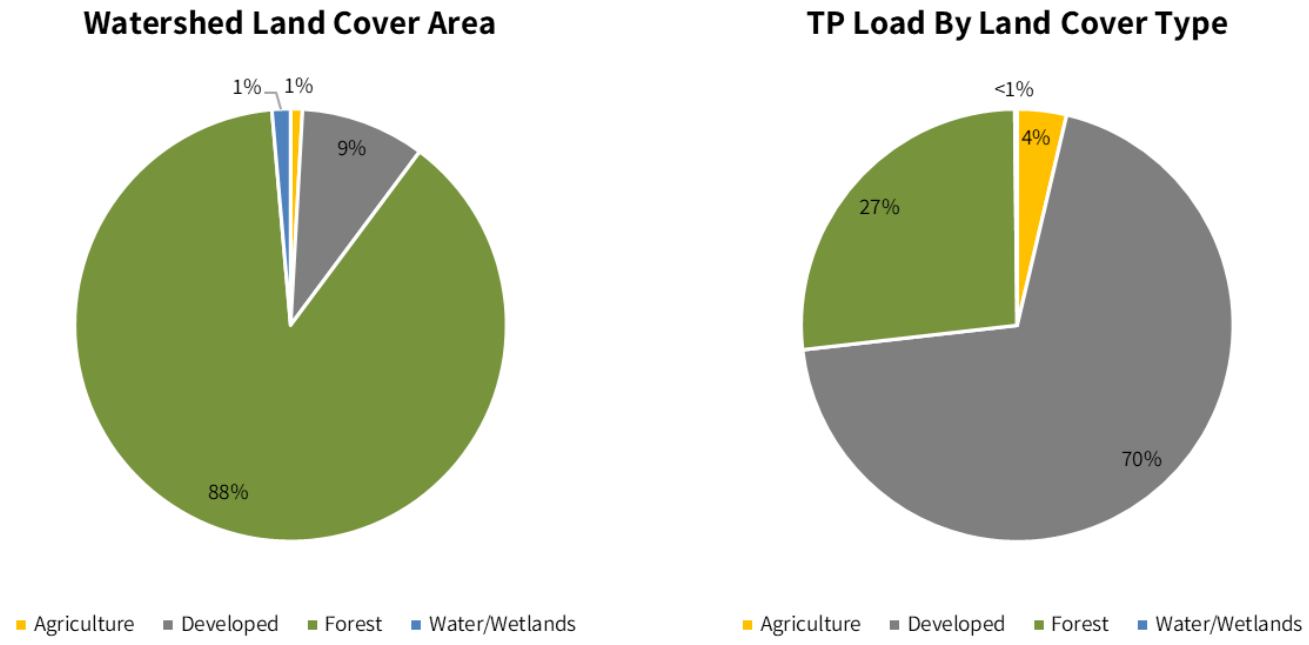


Figure 13. The Broads watershed (not including the other bays of Lake Winnipesaukee) land cover area by general category (agriculture, developed, forest, and water/wetlands) and total phosphorus (TP) watershed load by general land cover type. This shows that developed areas cover 9% of the watershed and contribute 70% of the TP direct watershed load to the Broads (not accounting for other bays of Lake Winnipesaukee). The water/wetlands category does not include the lake area.

2.4.1.3 Internal Phosphorus Loading

Phosphorus that enters the lake and settles to the bottom can be re-released from sediment under anoxic conditions, providing a nutrient source for algae, cyanobacteria, and plants. Internal phosphorus loading can also result from wind-driven wave action or physical disturbance of the sediment (boat props, aquatic macrophyte management activities). Internal loading estimates were based on default values from the literature. Only two dissolved oxygen and temperature profiles that reached deep into the hypolimnion of the Broads deep spot exist, with one profile reaching 54 meters in 2008 and one reaching 45.5 meters in 2024 (the total depth of the Broads deep spot is ~54 meters). Full dissolved oxygen and temperature profiles are essential for determining the average annual duration and depth of anoxia (defined as <2 mg/L dissolved oxygen), which impact the severity and extent of internal loading. There is also a lack of paired epilimnion/hypolimnion total phosphorus data taken at the deep spot, especially in recent years which is the most useful for estimating phosphorus accumulation in the deep water. Despite the lack of data, it is assumed that there is minimal internal loading in the Broads due to the lack of documented dissolved oxygen depletion as deep as 45.5 meters, the historically excellent water quality, and the lack of internal loading in the other bays. Because of this, internal loading was assumed to be occurring at background levels, with an assumed P rate of release of 0.50 mg/m^2/day over a 60-day release period.

WHAT IS INTERNAL LOADING?

Over time, as phosphorus enters the lake from the landscape, this phosphorus either stays in the lake (i.e., settles to the bottom or is taken up by plants/algae for growth) or leaves the lake (i.e., get flushed out). The phosphorus that settles on the lake bottom will generally bind with one of two naturally occurring elements that also get flushed into the lake each year from the watershed: aluminum or iron. If phosphorus binds with aluminum, then the bond is permanent, and the phosphorus is sedimented in the lake bottom. If the phosphorus binds with iron, then the bond is non-permanent and in summer when the lake bottom is deprived of oxygen (anoxic), it triggers a chemical reaction that releases phosphorus from iron. This phosphorus is now free to be mixed up into the water column and serve as a nutrient source for plants and algae. Looking at the ratios between aluminum, iron, and phosphorus indicates whether the lake is vulnerable to internal loading or cycling of phosphorus.

2.4.1.4 LLRM Results

Overall, model predictions for the Broads were in good agreement with observed data for total phosphorus (2%) and Secchi disk transparency (41%) and poor agreement with chlorophyll-a (88%) (Table 7). It is important to note that the LLRM does not explicitly account for all the biogeochemical processes occurring within a waterbody that contribute to overall water quality and is less accurate at predicting chlorophyll-a and Secchi disk transparency. For example, chlorophyll-a is estimated strictly from nutrient concentrations, but other factors strongly affect algae growth, including transport of phosphorus from the sediment-water interface to the water column by cyanobacteria (especially *Gloeotrichia*, which have been observed in large quantities in recent years in Lake Winnipesaukee), low light from suspended sediment, grazing by zooplankton, presence of heterotrophic algae, and flushing effects from high flows. There were insufficient data available to evaluate the influence of these other factors on observed chlorophyll-a concentrations and Secchi disk transparency readings.

The largest phosphorus sources to the Lake Winnipesaukee (with the Broads as the calibration point) come from the watershed load, including the influence of the other bays (87%). Most of the watershed load to the lake originates from surrounding bays (80% of the total phosphorus load), emphasizing the impact of watershed development throughout the greater Lake Winnipesaukee watershed on open water areas such as the Broads. It should be noted that the watershed phosphorus load related to each of the other bays includes other phosphorus sources such as atmospheric deposition, waterfowl, internal loading, and septic systems. Of the watershed load, the LLRM predicts that Moultonborough Bay has the largest impact on the Broads (25%), followed by Meredith & Sanders Bay, Center Harbor Bay, Alton Bay, and Wolfeboro Bay (each contributing 11-15% of the total phosphorus load), which contribute similar phosphorus loads to the Broads (without consideration for currents or other hydrodynamics). The direct watershed load to the Broads (7%) and Winter Harbor had the smallest total phosphorus load (2%) (Table 8; Figure 13). It's important to note that exchange between Meredith Bay and the Broads is highly unlikely due to its downstream position, and there is likely substantial (but not 100%) exchange between the Broads and Sanders Bay due to their openness to each other. The model was run considering phosphorus loading to all of Lake Winnipesaukee; it is highly likely that the phosphorus load of Meredith & Sanders Bay to the lake as a whole (15%) is higher than their contribution to the Broads alone, meaning these bays have a lesser impact on the Broads than is implied in the LLRM results.

Other sources of phosphorus such as atmospheric deposition (7%), internal loading (1%), waterfowl (4%), and septic systems (1%) were relatively minor sources, though additional phosphorus loading from each of these sources in the other bays are included in their respective watershed loads. Development in the Broads direct watershed is most concentrated in the densely developed shoreline, neighborhoods of medium density single-family homes, and on the islands. Development is also dense around the shoreline where septic systems or holding tanks are located within a short distance to the water, leaving little horizontal (and sometimes vertical) space for proper filtration of wastewater effluent. Improper maintenance or siting of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent to the lake. The most densely developed area of the Broads shoreline (Lake Shore Park) is serviced by sewer systems, which also represent a potential vulnerability if the sewer systems are old or damaged and leaking wastewater into groundwater near the lake. Note that septic systems are a relatively minor load to the Broads because 1) the estimate is only for those systems directly along the shoreline and potentially short-circuiting minimally treated effluent to the lake, 2) some of the shoreline area is serviced by sewer which is not accounted for in the model since the assumption is that the sewer lines are not leaking, and 3) shoreline septic systems for the other bays of Lake Winnipesaukee watershed are included in their respective watershed loads (see Table 8 for a breakdown). The load from septic systems throughout the rest of the watershed is inherent to the coefficients used to generate the watershed load. Phosphorus loading from wastewater sources, such as sewage lagoons (i.e. Sandy Island), was not quantified.

Internal loading is currently a relatively minor source of phosphorus to the Broads (and all other bays). Although the model predicts zero or few bloom days (Table 7), numerous bloom warnings and alerts were issued by NHDES in 2022 and 2024. Bloom warnings/alerts spanned 2 days (*Dolichospermum*) in 2022 and 30 days in 2024 (*Dolichospermum* & *Gloeotrichia*).

Normalizing for the size of a sub-watershed (i.e., accounting for its annual discharge and direct drainage area) better highlights sub-watersheds with elevated pollutant exports relative to their drainage area. Sub-watersheds with moderate-to-high phosphorus mass exported by area (>0.20 kg/ha/yr) generally had more development (i.e., Marina Road Inlet and Wolfeboro Neck; Figure 14). Drainage areas directly adjacent to waterbodies have direct connection to the lakes and are usually targeted for development, thus increasing the possibility for phosphorus export.

Once the model is calibrated for current in-lake phosphorus concentration, we can then manipulate land cover and other factor loadings to estimate pre-development loading scenarios (e.g., what in-lake phosphorus concentration was prior to human development or the best possible water quality for the lake). Refer to FBE (2025a) for details on methodology. Pre-development loading estimation showed that total phosphorus loading to Lake Winnipesaukee increased by 177%, from 3,849 kg/yr prior to European settlement to 10,653 kg/yr under current conditions; the direct land use load for the Broads increased by 264%, from 198 kg/yr to 720 kg/yr (Table 8). These additional phosphorus sources are coming from development in the watershed (especially from the direct shoreline of the Broads), septic systems, atmospheric dust, and the other bays to Lake Winnipesaukee (Table 8). Water quality prior to settlement was predicted to be excellent with extremely low phosphorus and chlorophyll-a concentrations and high water clarity (Table 7).

We can also manipulate land cover and other factors to estimate future loading scenarios (e.g., what in-lake phosphorus concentration might be at full build-out or the worst possible water quality for the lake under current zoning). Refer to FBE (2025a) and *The Broads Watershed Build-out Analysis Report* (FBE, 2025b) for details on methodology. Note: the future scenario did not assume a 10% increase in precipitation over the next century (NOAA Technical Report NESDIS 142-1, 2013), which would have resulted in a lower predicted in-lake phosphorus concentration; this is because the model does not consider the rate and distribution of the projected increase in precipitation. However, environmental variability models also predict more intense and less frequent rain events that may exacerbate erosion of phosphorus-laden sediment to surface waters and therefore could increase in-lake phosphorus concentration (despite dilution and flushing impacts that the model assumes).

Future loading estimation showed that total phosphorus loading to the Broads may increase by 100%, from 10,653 kg/yr under current conditions to 20,315 kg/yr at full build-out (2092) under current zoning (Table 8). This approximation included future load estimations from all other bays estimated in their respective watershed plans (LWWA, 2010; FBE, 2020; FBE, 2024). The direct watershed load to the Broads was predicted to increase by 98% from 720 kg/yr to 1,424 kg/yr by 2092. This additional phosphorus will be generated from more development in the watershed (especially in undeveloped headwater areas with the exception of the Poorfarm Brook sub-watershed which is mostly conserved), greater atmospheric dust, more septic systems, and potentially enhanced internal loading (Table 8). The projected increased loading to each bay led to worsening predicted water quality in the Broads as well. The Lake Winnipesaukee model (using the Broads as the calibration point) predicted higher (worse) phosphorus (10.8 µg/L), higher (worse) chlorophyll-a (3.5 µg/L), and lower (worse) water clarity (3.7 m) compared to current conditions for the Broads (Table 7). Predicted future water quality was similarly poor for the other bays.

Table 7. In-lake water quality predictions the Broads. TP = total phosphorus. Chl-a = chlorophyll-a. SDT = Secchi disk transparency. Bloom Days represent average annual probability of chlorophyll-a exceeding 8 µg/L.

Model Scenario	Median TP (µg/L)	Predicted Median TP (µg/L)	Mean Chl-a (µg/L)	Predicted Mean Chl-a (µg/L)	Mean SDT (m)	Predicted Mean SDT (m)	Bloom Days
The Broads							
Pre-Development	--	2.0	--	0.2	--	13.3	0
Current (2023)	4.8 (5.8)*	5.7	0.8	1.5	10.4	6.1	0
Future (2092)	--	10.8	--	3.5	--	3.7	10

*Mean TP concentration (first value) represents current in-lake epilimnion TP from observed data. Median TP concentration (second value in parentheses) represents 20% greater than the observed mean value as the value used to calibrate the model. Most lake data are collected in summer when TP concentrations are typically lower than annual average concentrations for which the model predicts.

Table 8. Total phosphorus (TP) and water loading summary by model and source for the Broads, with all modeled bays shown as point sources. Italicized sources sum to the watershed load.

SOURCE	PRE-DEVELOPMENT			CURRENT (2024)			FUTURE (2092)		
	TP (KG/YR)	%	WATER (CU.M/YR)	TP (KG/YR)	%	WATER (CU.M/YR)	TP (KG/YR)	%	WATER (CU.M/YR)
THE BROADS									
ATMOSPHERIC	488.1	13%	88,114,797	767.0	7%	88,114,797	1,743.2	9%	88,114,797
INTERNAL	0.0	0%	0	64.4	1%	0	122.8	1%	0
WATERFOWL	418.4	11%	0	418.4	4%	0	418.4	2%	0
SEPTIC SYSTEM	0.0	0%	0	142.5	1%	151,429	181.3	1%	151,429
WATERSHED LOAD	2,942.6	76%	553,458,786	9,2460.8	87%	551,465,189	17,849.4	88%	551,669,224
Direct Land Use Load	*197.6*	*5%*	*46,272,408*	*719.5*	*7%*	*45,980,889*	*1,743.2*	*7%*	*45,569,998*
Wolfeboro Bay	*589.3*	*15%*	*100,323,496*	*1,204.7*	*11%*	*99,145,801*	*2,646.3*	*13%*	*100,398,137*
Moultonborough Bay	*777.0*	*20%*	*156,526,840*	*2,659.0*	*25%*	*156,936,405*	*4,511.0*	*22%*	*157,546,717*
Winter Harbor	*93.0*	*2%*	*12,572,264*	*255.0*	*2%*	*12,600,892*	*493.0*	*2%*	*12,611,729*
Center Harbor Bay	*537.9*	*14%*	*68,987,016*	*1425.8*	*13%*	*68,682,276*	*2,449.1*	*12%*	*68,285,404*
Meredith & Sanders Bay	*375.7*	*10%*	*83,047,557*	*1,648.3*	*16%*	*82,592,123*	*3,512.5*	*17%*	*82,516,192*
Alton Bay	*372.0*	*10%*	*85,729,204*	*1,348.5*	*13%*	*65,526,803*	*2,813.3*	*14%*	*84,771,048*
TOTAL LOAD TO LAKE	**3,849.1**	**100%**	**641,573,583**	**10,653.1**	**100%**	**639,682,870**	**20,315.1**	**100%**	**639,965,450**

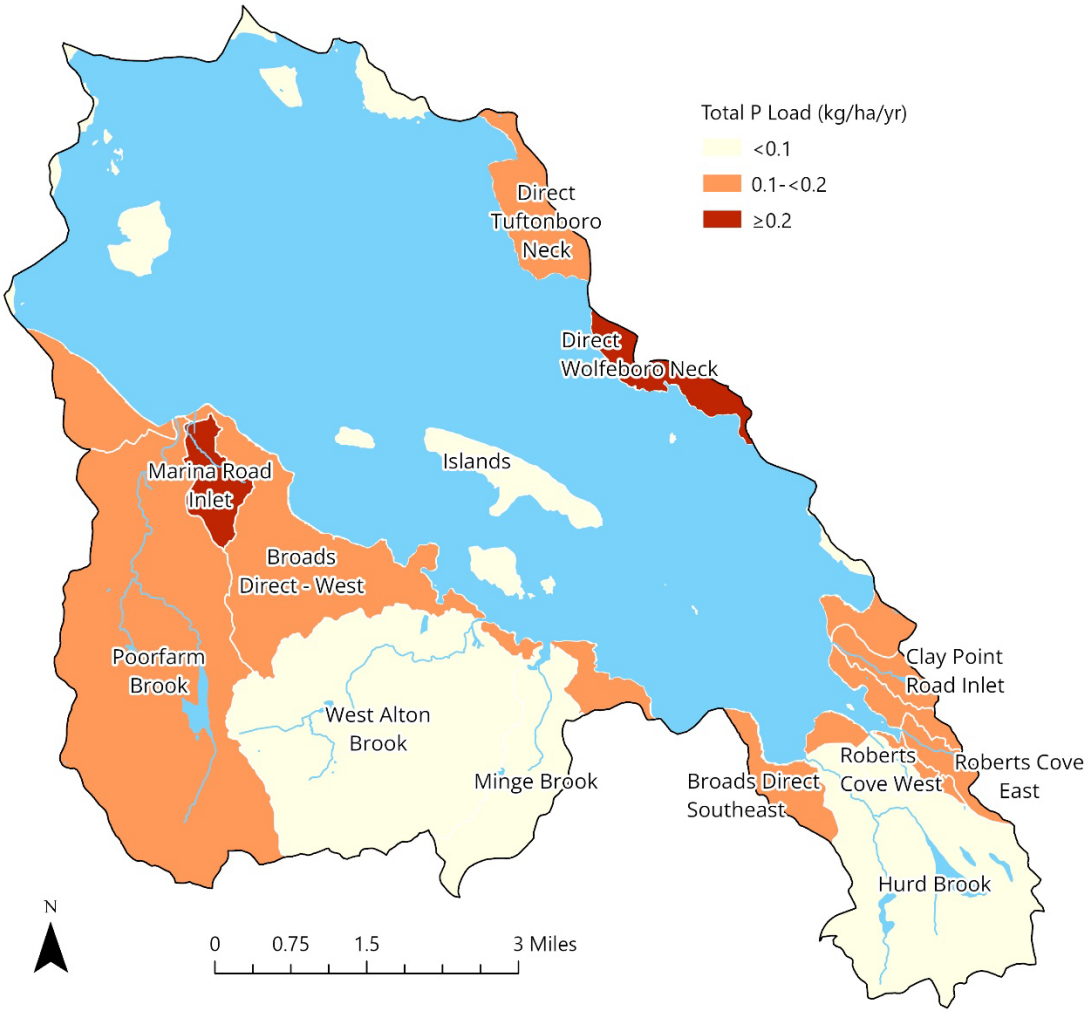


Figure 14. Map of current total phosphorus load per unit area (kg/ha/yr) for each sub-watershed in the Broads direct watershed. Higher phosphorus loads per unit area are concentrated in shoreline areas. Total phosphorus loads were estimated using a land use–based model. While the model accounts for human disturbance through land use changes, it may not fully represent site-specific erosion conditions.

2.4.2 Build-out Analysis

A full build-out analysis was completed for the Broads watershed for the municipalities of Alton, Gilford, Tuftonboro, Wolfeboro, Moultonborough, and New Durham (FBE, 2025b). A build-out analysis identifies areas with development potential and projects future development based on a set of conditions (e.g., zoning regulations, environmental constraints) and assumptions (e.g., population growth rate). A build-out analysis shows what land is available for development, how much development can occur, and at what densities. “Full Build-out” is a theoretical condition representing the moment in time when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum capacity permitted by local ordinances and zoning standards. Local ordinances and zoning standards are subject to change, and the analysis requires simplifying assumptions; therefore, the results of the build-out analysis should be viewed as planning-level estimates only for potential future outcomes from development trends.

FULL BUILD-OUT is a theoretical condition representing the moment in time when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum capacity permitted by current local ordinances and current zoning standards.

To determine where development may occur within the study area, the build-out analysis first subtracts land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands, conserved lands, hydric soils), zoning restrictions (e.g., shoreland zoning, street Right-of-Ways (ROWs), and building setbacks), and practical design considerations (e.g., lot layout inefficiencies) (Appendix A, Map A-3). Existing buildings also reduce the capacity for new development.

The build-out analysis showed that 53% (8,443 acres) of the study area is buildable under current zoning regulations (Appendix A, Map A-4). As most of the watershed lies within the Towns of Alton and Gilford, most of the buildable area can be found there as well (Table 9). FBE identified 2,723 existing principal buildings within the watershed, and the build-out analysis projected that an additional 3,923 buildings could be constructed in the future resulting in a total of 6,646 buildings in the watershed (Appendix A, Map A-5). Much of the Lake Winnipesaukee shoreline parcels are already developed, so many of the projected buildings fall outside the direct shoreline area in expansive forested areas of Alton and Gilford. Additional roadways would need to be built throughout the watershed for these projected buildings to be accessible.

Table 9. Amount of buildable land and projected buildings within the Broads watershed, in Alton, Gilford, Moultonborough, New Durham, Tuftonboro, and Wolfeboro, NH.

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area	No. Existing Buildings	No. Projected Buildings	Total No. Buildings	Percent Increase
Alton	*7,593*	*4,702*	*62%*	*1,034*	*2,359*	*3,393*	*288%*
Lakeshore Residential (LR)	2,251	1,331	59%	770	1,278	2,048	166%
Recreation Service (RS)	79	58	74%	7	31	38	443%
Residential Rural (RR)	41	21	50%	9	10	19	111%
Right of Way	19	0	0%	0	0	0	0
Rural (RU)	5,203	3,292	63%	248	1,040	1,288	419%
Gilford	*7,263*	*3,036*	*42%*	*1,481*	*1,201*	*2,682*	*81%*
Island Residential (IR)	294	165	56%	94	58	152	62%
Limited Residential (LR)	1,479	844	57%	178	256	434	144%
Natural Resource Residential (NRR)	3,439	1,382	40%	19	440	459	2316%
Resort Commercial (RC)	854	385	45%	219	228	447	104%
Single Family Residential (SFR)	1,197	260	22%	971	219	1,190	23%
Moultonborough	*35*	*10*	*29%*	*18*	*9*	*27*	*50%*
Residential/Agricultural	35	10	29%	18	9	27	50%
New Durham	*83*	*83*	*100%*	*1*	*38*	*39*	*3800%*
Rural Residential/Recreational/Agricultural	83	83	100%	1	38	39	3800%
Tuftonboro	*712*	*431*	*61%*	*92*	*222*	*314*	*241%*
Island Conservation	205	188	92%	20	100	120	500%
Lakefront	155	50	32%	58	37	95	64%
Low Density Residential	353	193	55%	14	85	99	607%
Wolfeboro	*332*	*181*	*55%*	*97*	*94*	*191*	*97%*
General Residential District (GR)	116	70	60%	19	37	56	195%
Residential District (R)	21	7	35%	9	3	12	33%
Rural Residential District (RR)	99	89	90%	4	37	41	925%
Shorefront Residential District (SFR)	96	15	16%	65	17	82	26%
Total	*16,018*	*8,443*	*53%*	*2,723*	*3,923*	*6,646*	*144%*

Three iterations of the TimeScope Analysis were run using compound annual growth rates (CAGR) for 10-, 20- and 50-year periods from 2010-2020 (0.79%), 2000-2020 (1.34%), and 1970-2020 (2.01%), respectively, to project the rate of new development into the future (Table 10). Full build-out is projected to occur in 2138 at the 10-year CAGR, 2092 at the 20-year CAGR, and 2070 for the 50-year CAGR (Figure 15).

Note that the growth rates used in the TimeScope Analysis are based on town-wide census statistics but have been applied here to a portion of the municipalities. If areas closer to the lake within each municipality develop faster than more inland areas, watershed full build-out conditions may occur sooner. Also note that the population growth rate in these municipalities is decreasing, so the 10 or 20-year estimate is likely more accurate than the 50-year estimate. Using census data to project population increase and/or development has inherent limitations. For instance, the building rate may increase at a different rate than population, due to factors such as commercial versus residential development and number of people per household. Many projected buildings would also require the development of new roadways, which is a factor that would affect the rate of development. As such, the TimeScope Analysis might over or underestimate the time required for the study area to reach full build-out. Numerous social and economic factors influence population change and development rates, including policies adopted by federal, state, and local governments. The relationships among the various factors may be complex and therefore difficult to model.

Table 10. US Census Bureau population growth rates for the towns of Alton, Gilford, Moultonborough, New Durham, Tuftonboro, and Wolfeboro, NH, 1970-2020. Population estimates obtained from the NH Office of Strategic Initiatives.

	Compound Annual Growth Rate (CAGR)		
Town	**50 Year Avg. (1970-2020)**	**20 Year Avg. (2000-2020)**	**10 Year Avg. (2010-2020)**
Alton	2.58%	1.36%	1.16%
Gilford	1.76%	0.62%	0.78%
Tuftonboro	2.01%	0.69%	0.33%
Wolfeboro	1.51%	0.27%	0.23%
Moultonborough	2.68%	0.46%	1.98%
New Durham	3.11%	0.97%	0.21%
Combined	**2.01%**	**1.34%**	**0.79%**

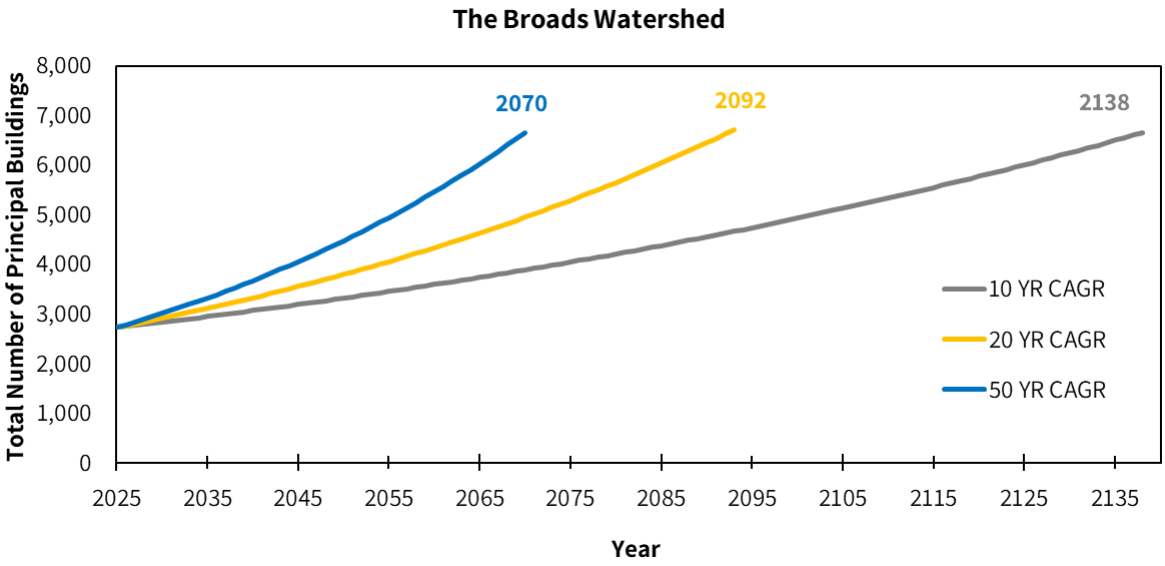


Figure 15. Full build-out time projections of the Broads Watershed (based on compound annual growth rates).

2.5 WATER QUALITY GOAL & OBJECTIVES

The model results estimated changes in total phosphorus loading and in-lake total phosphorus concentrations over time from pre-development through future conditions, showing that the water quality of the Broads is threatened by current development activities in the watershed and will degrade further with continued development in the future. We can use these results to make informed management decisions and set an appropriate water quality goal for the Broads. In-lake total phosphorus and chlorophyll-a concentrations indicate that there is enough reserve capacity for the lake to assimilate additional nutrients under a "business as usual" scenario for the time being. Therefore, the water quality goal for the Broads is the result of obtaining the necessary load reductions to obtain the water quality goals for the other sub watersheds of Lake Winnipesaukee.

From south to north along the eastern shoreline, Alton Bay, Wolfeboro Bay, Winter Harbor, Moultonborough Bay, and Center Harbor Bay all flow into the Broads. Sanders Bay and Meredith Bay to the northwest likely have some exchange with the Broads, though not 100% as they are positioned mostly downflow (Figure 16). Paugus Bay was excluded in determining the water quality goal for the Broads as it is entirely down flow of the broads. A WMP has been, or is being, written for each of these other sub watersheds, and their identified phosphorus load reductions needed to obtain their water quality goals are presented in Table 11.

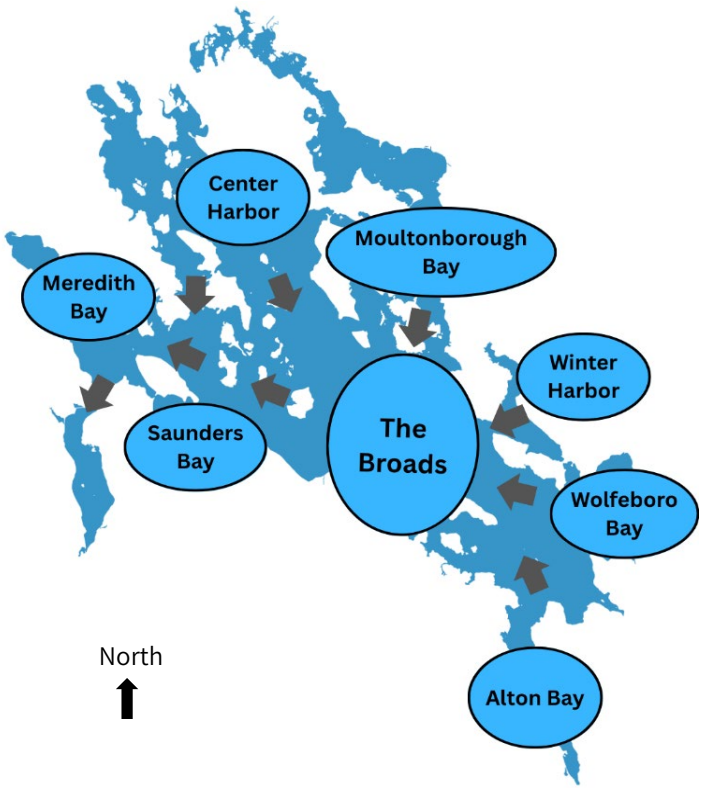


Figure 16. Conceptual diagram of the flow of water through Lake Winnipesaukee. Despite a general east to west movement of water, there may be substantial exchange between bays due to wind, weather, time of year, flushing, and other dynamics, especially in bays with relatively open concept with the Broads, such as Sanders Bay.

Given the connectivity of the sub watersheds of Lake Winnipesaukee to the Broads, we recommend the goal of reducing the annual average total phosphorus load by 12% (1,244 kg/yr) to the Broads. This includes a reduction of 141 kg/yr (7% of the total goal) of phosphorus load within the direct watershed of the Broads and reductions within all other sub watersheds of Lake Winnipesaukee that flow to the Broads (92% of the goal; Table 11). The resulting effect would reduce the current average summertime concentration in the Broads to 4.0 ppb.

Table 11. Summary of Winnipesaukee WMP Goals from existing WMPs.

Watershed	Load Reduction Needed to Meet the WMP Goal (kg/yr)	% of Total Load	Reference
Alton Bay	492*	30%*	FBE, 2025c
Center Harbor Bay	179*	11%*	FBE, 2025d
Meredith Bay[1]	*Unknown*	*NA*	(LWA, 2010)
Moultonborough Bay	187	5%	(FBE, 2020)
Sanders Bay[2]	59.4	*NA*	(LWA, 2010)
Winter Harbor	18.7	5%	(FBE, 2020)
Wolfeboro Bay	149	9.4%	(FBE, 2024)
The Broads	141*	7%*[3]	-
Total	**1,244**	**12%**	-

* Assuming all identified sources of external load are met (watershed survey sites, shoreline survey sites, old shoreline septic systems, identified point sources.

[1] Load reductions and quantitative goals are not presented for Meredith Bay.

[2] Load reductions for Sanders Bay represent addressing the seven sites along Gunstock Brook as stated in the Executive Summary. A quantitative goal was not established for Sanders Bay.

[3] Percent of load reduction to the direct watershed load of the Broads.

The goal of the Broads WMP is to improve the water quality of the Broads, and the greater Lake Winnipesaukee, such that they continue to meet state water quality standards for oligotrophic waterbodies and support the designated uses for aquatic life integrity, Potential Drinking Water Supply, and Primary/Secondary Contact Recreation, while substantially reducing the likelihood of harmful cyanobacteria blooms. This goal will be achieved by accomplishing the following objectives. More detailed action items to achieve these objectives will be provided in the Action Plan of the Broads WMP as well as the other sub watersheds' WMPs.

> **Objective 1:** Reduce phosphorus loading from existing development by 1,244 kg/yr to the Broads to improve the average in-lake summer total phosphorus concentration to 4.0 ppb.
>
> **Objective 2:** Mitigate (prevent or offset) phosphorus loading from future development to the Broads by 151 kg/yr to maintain average summer in-lake total phosphorus concentration for the Broads in the next 10 years (2035). *Note: this only focuses on future development within the direct watershed of the Broads.*

Non-structural best management practices (BMPs) throughout the watershed, such as educating homeowners about septic system maintenance, fertilizer use, and residential stormwater management, may be effective at reducing phosphorus loading to the Broads beyond what had been identified in Table 11 to meet and exceed the water quality goals. Preventing septic system failures, reducing residential lawn fertilizer use, and improved stormwater management at the property-scale were not relied on in the goal attainment calculations above but would also contribute to reducing phosphorus load to the Broads.

Objective 2 can be met through ordinance revisions that implement low impact development strategies and encourage cluster development with open space protection and/or through conservation of key parcels of forested and/or open land.

The interim goals for each objective allow flexibility in reassessing water quality objectives following more data collection and expected increases in phosphorus loading from new development in the watershed over the next 10 or more years (Table 12). Understanding predicted water quality following watershed improvements compared to likely water quality following no action will help guide adaptive changes to interim goals (e.g., goals are on track or goals are falling short). If the goals are not being met due to lack of funding or other resources for implementation projects versus due to increases in phosphorus loading from new development outpacing reductions in phosphorus loading from improvements to existing development, then this creates much different conditions from which to adjust interim goals. For each interim goal year, stakeholders should update the water quality data and model and assess why goals are or are not being met. Stakeholders will then decide on how to adjust the next interim goals to better reflect water quality conditions and practical limitations to implementation.

Measures of success for achieving the goal and objectives should be based on a reduction in phosphorus loading from the major tributaries to the Broads and/or from shorefront BMPs and septic system upgrades, as well as a reduction in the frequency and

severity of cyanobacteria blooms in the bay and Lake Winnipesaukee. It is unlikely that reduction efforts in the watershed will result in a measurable improvement in the average summer in-lake total phosphorus concentration due to the large influence of mixing with the Broads, unless large-scale reductions are completed around Lake Winnipesaukee. While any amount of phosphorus load reduction to the lake will be helpful for controlling cyanobacteria blooms, it is important to understand that the dominant cyanobacteria taxa in the lake can uptake phosphorus from phosphorus-rich sediments and store phosphorus for later use under more optimal growth conditions. Thus, the management implications for minimizing the risk of cyanobacteria blooms is not straightforward and depends on a number of factors out of our direct control. The physiological characteristics of these cyanobacteria taxa also means that the typical application of the state's water quality standards for lakes in the form of the assimilative capacity analysis are less relevant for Lake Winnipesaukee.

Table 12. Water quality objectives for the Broads. Objective 2 is represented only for the Broads watershed (excluding the other Lake Winnipesaukee sub watersheds). Interim goals/benchmarks are cumulative. TP refers to total phosphorus.

Water Quality Objective	**Interim Goals/Benchmarks**		
	2027	**2030**	**2035**
Objective 1. Reduce phosphorus loading from existing development to the Broads by 1,244 kg/yr to improve average in-lake summer or annual total phosphorus concentration to 4.0 ppb.	Achieve 3% reduction (311 kg/yr) in TP loading to the Broads.	Achieve 6% reduction (622 kg/yr) in TP loading to the Broads: re-evaluate water quality and track progress.	Achieve 12% reduction (1,244 kg/yr) in TP loading to the Broads: re-evaluate water quality and track progress.
Objective 2. Mitigate (prevent or offset) phosphorus loading from future development by 151 kg/yr to the Broads to maintain average summer in-lake total phosphorus concentration in the next 10 years (2035).	Prevent or offset 37.75 kg/yr in TP loading from new development to the Broads.	Prevent or offset 75.5 kg/yr in TP loading from new development to the Broads; re-evaluate water quality and track progress.	Prevent or offset 151 kg/yr in TP loading from new development to the Broads; re-evaluate water quality and track progress.

3 POLLUTANT SOURCE IDENTIFICATION

This section describes sources of excess phosphorus to the Broads. Sources of phosphorus to lakes include stormwater runoff, shoreline erosion, construction activities, illicit connections, failed or improperly functioning septic systems, leaky sewer lines, fabric softeners and detergents in greywater, fertilizers, and pet, livestock, and wildlife waste. These external sources of phosphorus to lakes can then circulate within lakes and settle on lake bottoms, contributing to internal phosphorus loads over time. Additional phosphorus sources can enter the lake from atmospheric deposition but are not addressed here because of limited local management options. Wildlife is mentioned as a potential source but largely for nuisance waterfowl such as geese or ducks that may be congregating in large groups because of human-related actions such as feeding or having easy and expansive shoreline access (i.e., lawns). Environmental variability is also not a direct source but can exacerbate the impact of the other phosphorus sources identified in this section and should be considered when striving to achieve the water quality objectives.

Nonpoint source (NPS) pollution, which contributes a large proportion of the excess phosphorus to the Broads, comes from many diffuse sources on the landscape and is more difficult to identify and control than point source pollution. NPS pollution can result from contaminants transported by overland runoff (e.g., agricultural runoff or runoff from suburban and rural areas), groundwater flow, or direct deposition of pollutants to receiving waters. Examples of NPS pollution that can contribute nutrients to surface waters via runoff, groundwater, and direct deposition include erosion from disturbed ground or along roads, stormwater runoff from developed areas, malfunctioning septic systems, excessive fertilizer application, unmitigated agricultural activities, pet waste, and wildlife waste. Each of these is described in more detail below.

3.1 WATERSHED DEVELOPMENT

3.1.1 Historical Development

The Broads region of Lake Winnipesaukee has a long history of human use. The area has likely been occupied since approximately 8,000 BCE. Groups of the Indigenous Western Abenaki tribe, such the Winnipesaukee, occupied the Lakes region of New Hampshire when early English settlers arrived there in the mid-1600s (Brames, Inc., n.d.). The Native Americans' impact on the Broads environment would have been minimal. Their livelihoods were based on a mix of hunting, fishing, gathering and subsistence farming of corn, beans, squash, potato, and tobacco.

The Indigenous people developed an extensive network of trails around Lake Winnipesaukee and to villages outside of the region, as recorded by historian Chester B. Price of New Durham and recently digitized in an online StoryMap (Indigenous New Hampshire Collaborative Collective, 2024). The largest Native American village in the Northeast, Aquedoctan, was located on the shores of Lake Paugus and Weirs Beach, just outside of the Broads watershed (LWHS, n.d.). The Aguadak'gan Trail ran along the south-western shore of Lake Winnipesaukee (where NH Route 11 is today) and connected Aquedoctan to Quannippi, the village in Alton Bay. The Native Americans were primarily based in these two villages, setting up weirs in the Weirs Channel to catch migrating shad and mining clay for pottery near Brickyard Mountain, but their trails allowed them to utilize the land around the entire shoreline of Lake Winnipesaukee.

The first major shift in land use within the Broads watershed occurred in the early colonial period, during the decades following the establishment of the Province of New Hampshire in the 1620s. European settlers that arrived in the area gradually displaced Native Americans and established larger farms and logging operations. These initial farms were for subsistence agriculture. One of the more significant impacts on the Lake in the early colonial period was the construction of the Lakeport dam in Paugus Bay in 1766. Prior to the building of the dam, Lake Winnipesaukee's water level was approximately 5–12 feet lower than it is today (Brames, Inc., n.d.).

By the 1770s, small towns were being chartered in the vicinity of the Broads watershed, and by 1820, Gilford and Wolfeboro had 1,816 and 1,794 residents, respectively. These towns continued to grow slowly, except during the years from 1880–1900, when many small towns across New England saw their populations decrease. Large industrial mills in towns like Dover were built during these decades, and rural to urban migration was at a peak. Many smaller towns would not reach the same population until the second half of the twentieth century.

The "Great Sheep Boom" between 1810 and 1840 led to significant deforestation and building of stone walls in woodlands across New England. By 1840, there were an average of 65 sheep per square mile in New England – more than two sheep for every person. Around this time, approximately 50% of the area of Tuftonboro was farmland (Laconia Daily Sun, 2022). The clearing of forested

land for farming, as well as high sheep density, during this period increased the rates of sedimentation and nutrient runoff into Lake Winnipesaukee and other waterbodies within the Broads. The sheep boom collapsed rapidly after 1840 and many farms were abandoned.

Industrialization in the 1800s led to increased development and changing land use patterns around Lake Winnipesaukee. Lumber became the region's most important commodity. Dams and canals associated with sawmills and gristmills were established along streams and rivers draining into the Lake. These mills contributed to water pollution through the discharge of untreated waste, while logging and expanding infrastructure with impervious surfaces increased runoff throughout the watershed. Although much of the Broads is more rural in character than other parts of Lake Winnipesaukee's shoreline, the combined impacts of damming and declining water quality throughout the region affected the entire Lake. For example, dams in the Merrimack River system led to the extirpation of shad in Lake Winnipesaukee by the end of the 19th century. Around 830,000 shad were estimated to be caught in the Merrimack River in 1789, while in 1888, not a single shad was caught (Brames, Inc., n.d.).

Another major export of the Lake Winnipesaukee area in this period was lake ice. Boats were used to transport ice from the Lake in winter, to be sold to other parts of the region. Ice from Lake Winnipesaukee was sought after because of its lack of bubbles and debris compared to other New England lakes, and the demand for ice was also the main reason a train stop was added at Lake Shore Park later in the 19th century (Thompson-Ames Historical Society, n.d.).



The Lakeshore Railway in West Alton, sometime between the 1890s and 1930s. Source: Winnipesaukee Forum.

Urbanization of towns surrounding the Broads during the industrial period led to further clearing of land along Lake Winnipesaukee, as residential and agricultural areas expanded to accommodate the growing town populations. The opening of the Lakeshore Railroad in 1890 connected Alton to Lakeport, running along the south-western shore of the Lake (for the most part following the Native American Aguadak'gan Trail). Before this, agricultural and industrial products were transported across the Lake by steamboats, and beyond Alton by the Cocheco railroad.

Advances in farming techniques and machinery in the late 19th century increased agricultural productivity, and farmland began to expand again after the earlier collapse of the wool industry. Dairy farming became prominent, facilitated by the railway and steamboat networks, allowing access to outside markets.

Tourism also emerged as an important economic factor around the Broads during the late 19th century, especially after the Lakeshore railroad opened in 1890. Another railroad traveled from Alton to Wolfeboro. Both lines were accessible to visitors from Boston, and during this time Lake Winnipesaukee was established as a popular vacation spot for tourists from all around the Northeast. Increasing tourism led to the development of summer cottages, hotels, inns, and recreational facilities, especially concentrated around the shores of Lake Winnipesaukee. It also contributed to further construction of roads, parking lots and other impervious surfaces, in turn increasing stormwater runoff and pollution into waterbodies. Stops along the Lakeshore railroad within the Broads included West Alton, Mount Major, Ames and Lake Shore Park, the same areas that are now connected by NH Route 11. Several marinas were also established within the Broads as boating became a popular recreational activity, with one of the larger ones being the West Alton Marina. Development on several of the islands in the Broads also began in this period.





Some large estates and buildings were constructed on the shores of the Broads in the late 19th and early 20th century, such as the Lincoln Cottage (top) and Kimball Castle (bottom), both near Belknap Point. Source: Winnipesaukee Forum.

Residential, commercial, and recreational development along the Lake shore continued to increase throughout the 20th century. This Broads became more accessible as tarred roads were established and personal vehicles became more common. Gilford's population grew by over 25% in each decade between 1950 and 1990, and in 2020 its census recorded 7,699 residents. Properties grew in size and

often included expansive lawns, tennis courts, and private marinas. Some properties, such as the Broadview Condominiums, built in the 1980s near Gilford, contained densely spaced townhouses. Others were spacious with only a few large structures separated by large lawns, such as the Lincoln Cottage and Kimball Castle near Belknap Point, Glendale.

The 20th century also brought a new type of tourism to the Broads. Popular winter sport resorts were developed in the mountainous regions of the watershed. Gunstock Mountain Resort near Gilford was established in the 1930s as part of a national job-creation drive by President Franklin D. Roosevelt following the Great Depression (Gunstock, n.d.). It became an important winter tourist attraction for its skiing, continued to develop throughout the century, and remains a popular ski destination in New Hampshire. Trees were logged to create the slopes, and lodges were built using lumber cut and milled in the area.



Ski jump at Gunstock Mountain Resort in the 1940s. Source: Gunstock.

Another significant development along the shores of Lake Winnipesaukee, which remains an important cultural landmark in the Broads, was the establishment of Ellacoya State Park in Gilford in 1959 (Mausolf, 2019). Spanning 107 acres, the park serves both day visitors and campers, offering facilities for RVs. The RV lot is largely open, aside from a small cluster of trees near the entrance. The park also features a 600-foot beach on Lake Winnipesaukee.

Agriculture, especially dairy farming, became more commercialized in the 20th century as better transportation infrastructure allowed access to larger regional markets. This resulted in further conversion of forested lands to hayfields (to provide livestock feed for winter months) and pastures. Other farm types, such as orchards, were also established. Farms are still present in parts of the Broads watershed. Along with stormwater runoff from urban development, agricultural runoff is often an important contributor to water quality changes in lakes. There have been efforts to implement better stormwater management practices, land conservation initiatives, and regulations aimed at reducing nutrient loading and protecting water quality. This began with the establishment of the Winnipesaukee River Basin Study Commission in the 1960s, which focused on pollution from wastewater discharges (Winnipesaukee Gateway, n.d.). This study led to the creation of the Winnipesaukee River Basin Program and the construction of public sewer pipelines in parts of the Broads (the treatment plant is outside the watershed). Most of the properties in the watershed, including all those on the islands, use septic systems or other on-site wastewater disposal systems, whose maintenance is the responsibility of the homeowner.

Numerous islands of significant size fall within the Broads watershed. These include Rattlesnake, Sleepers, Welch, Round, Camp, Fish, Sandy, Diamond and Treasure Islands, and parts of Long, Barndoor and Cow Islands. Some of the larger islands have houses built along most of their shoreline, while the interiors remain undeveloped. Rattlesnake Island, for example, has 191 houses (Alton Planning Board, 2023). Compared to the mainland, many of these homes remain seasonally occupied, though they have also grown in size over time. Interior lots on Rattlesnake Island were at one time planned to be sold for development, but this did not occur. The area is now owned by the Lakes Region Conservation Trust and Rattlesnake Island Association, who maintain hiking trails in this mountainous area. Most of the islands are only accessible by boat, and homeowners utilize docking facilities at West Alton, Gilford, and Wolfeboro marinas.

3.1.2 Watershed Survey

A watershed survey of the Broads watershed was completed by technical staff from FBE and LWA. The objective of the watershed survey was to identify and characterize sites contributing NPS pollution and/or providing opportunities to mitigate NPS pollution in the watershed. Prior to fieldwork, FBE analyzed aerial images and GIS data for land use/land cover, roads, public properties, waterbodies, and other features. This information enabled FBE to better plan for the survey (e.g., to target known or likely high-polluting sites, such as unpaved roads, beaches, highly impervious areas, etc.) and to inform recommended solutions.

FBE and LWA staff conducted the watershed survey on August 29 and September 4, 2024. On October 3, LWA staff identified an additional NPS site. Islands were not assessed during the watershed survey. Documentation at each site included describing the problem, making recommendations for addressing the issue, rating the site's impact on water quality (Low, Medium or High), logging the site's geoposition, and taking photographs. Field staff accessed sites from public and private roads and waterfront access points. In total, 20 problem sites were documented (Figure 17). The main issues found were water access point erosion and road and ditch erosion, and camp and beach runoff.

FBE estimated the potential pollutant removal that could be achieved by implementing recommendations, amounting to **10.9 kg** of phosphorus prevented per year. Appendix B summarizes the recommendations, load reduction estimates, and estimated costs for each site. The top five high priority sites (based on lowest impact-weighted cost per mass of phosphorus removed) are shown below. In addition to these specific sites, managers of both private and public roads should use best practices for road installation and maintenance for water quality protection.

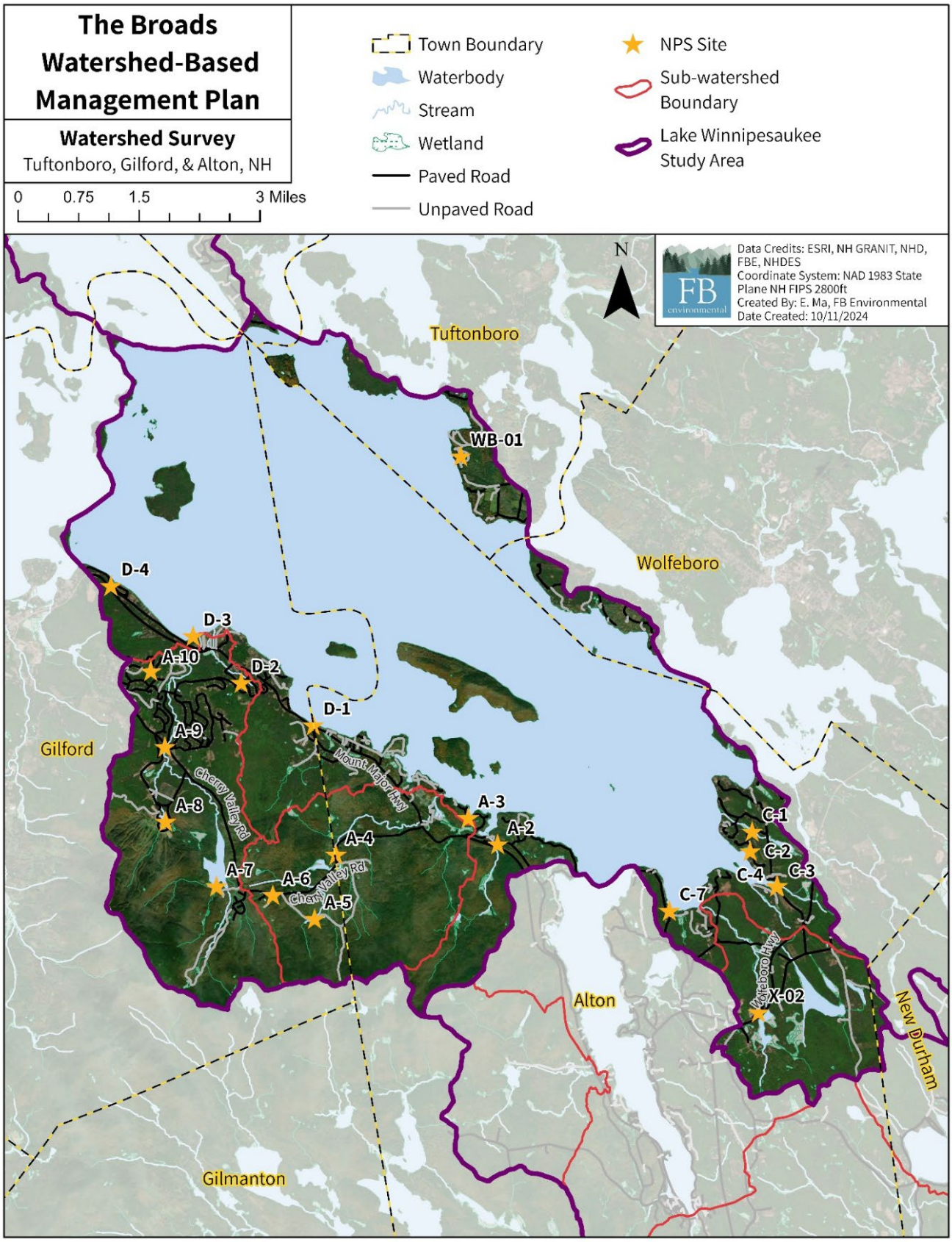


Figure 17. Location of identified nonpoint source sites in the Broads watershed.

Site A-3: Echo Shores Road Opposite House 122

Location (latitude, longitude): 43.54224, -71.28929

Impact: High

Observations: A property opposite (uphill of) 122 Echo Shores Road is under construction, with a large area of bare ground present on the site. A long ditch drains along this road and leads to a cross-road culvert which conveys water along the boundary of House 122 and to the lake. A large volume of sediment has been deposited at the culvert inlet, and the outlet appears unstable with significant bank erosion. An existing filter sock that crosses the ditch is being overtopped by sediment.

Recommendations: We recommend installing check dams along the ditch, as well as a turnout before the ditch reaches the cross culvert. The bank around the outlet should also be stabilized with rip rap and native vegetation to limit further bank erosion.



(Top Left) Sediment is washing out from the construction site onto the road shoulder. (Top Right) The unvegetated ditch downslope of the construction site is eroding. (Bottom Left) An existing filter sock in the ditch is overtopped by sediment. (Bottom Right) A view from Echo Shores Road, looking north towards the culvert outlet next to House 122.

Site C-3: Robert's Cove Road Ditch

Location (latitude, longitude): 43.52980, -71.21299

Impact: Medium

Observations: A ditch on the western shoulder of Robert's Cove Road, as well as the catch basin it leads to, has accumulated sediment and debris. The sides of the ditch are also unstable. The ditch is approximately 139 feet long. This site is very close to Lake Winnipesaukee, with runoff entering the lake at Roberts Cove.

Recommendations: We recommend cleaning out the catch basin and stabilizing the ditch with riprap and native vegetation. We also recommend adding at least two check dams within the ditch to slow stormwater and filter out sediment.





(Left & Right) Photos of the ditch showing accumulated sediment. (Middle) Accumulated debris around the catch basin.

Site A-07: Bickford Road Crossing Near House 66

Location (latitude, longitude): 43.53019, -71.35152

Impact: Low

Observations: The end of Bickford Road, west of its intersection with Wood Road, is steeply sloped and is eroding into the wetland complex north of the road. This wetland complex is associated with Poorfarm Brook which drains to the lake at Ellacoya State Park. A stream crossing conveys water from a small pond to the wetland just east of House 66 at the end of Bickford Road. An approximately 25-foot-long gully has formed on the northeast side of the stream crossing, caused by stormwater runoff in the road ditch on the north side of the road that leads to the stream.

Recommendations: We recommend stabilizing the gully with rip rap or crushed stone as well as revegetating it with native plants to reduce the sediment load entering Poorfarm Brook.




(Left) A view looking upslope at the road ditch on the northern side of Bickford Road. (Right) A view downslope of the same ditch, facing the stream crossing.

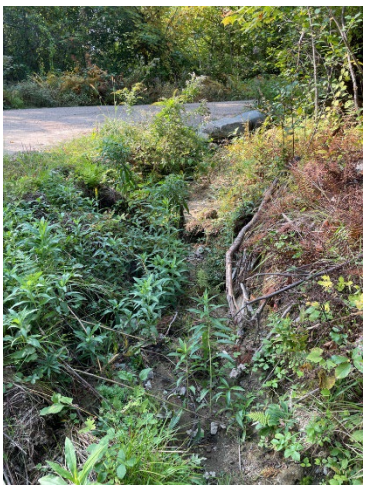
Site WB-01: Eaglemere Road South

Location (latitude, longitude): 43.607181, -71.290717

Impact: Medium

Observations: The culvert beneath Eaglemere Road South is undersized and is leading to sedimentation in the roadside ditch. The small stream drains to the east side of Lake Winnipesaukee at Tuftonboro Neck.

Recommendations: We recommend cleaning out the culvert and road ditch and upsizing the culvert. We also recommend restoring the road crown to prevent stormwater from accumulating on only one side of the road.


(Left) A view of the sand accumulated in the ditch near the culvert. (Middle) Another view of the roadside ditch. (Right) A view from the culvert looking up the ditch.

Site A-4: Cherry Valley Road Stream Crossing

Location (latitude, longitude): 43.53578, -71.32198

Impact: Medium



Observations: There is significant bank erosion along West Alton Brook on the northern, upstream bank. A large, natural-bottom concrete box culvert conveys streamflow beneath the road and is fairly well aligned with the channel. Despite an existing coir log placed on both sides of the bank at the inlet, water in the stream below the crossing is turbid. There is also some minor erosion on the downstream side of the culvert. Species observed growing on the bank slopes include fox grape (*Vitis labrusca*), poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*) and interrupted fern (*Osmunda claytoniana*). West Alton Brook ultimately flows into Lake Winnipesaukee at the West Alton Marina.

Recommendations: We recommend stabilizing the bank with rip rap where there is exposed soil and revegetating the whole slope with native plant species. The coir logs should be stabilized with wooden stakes.







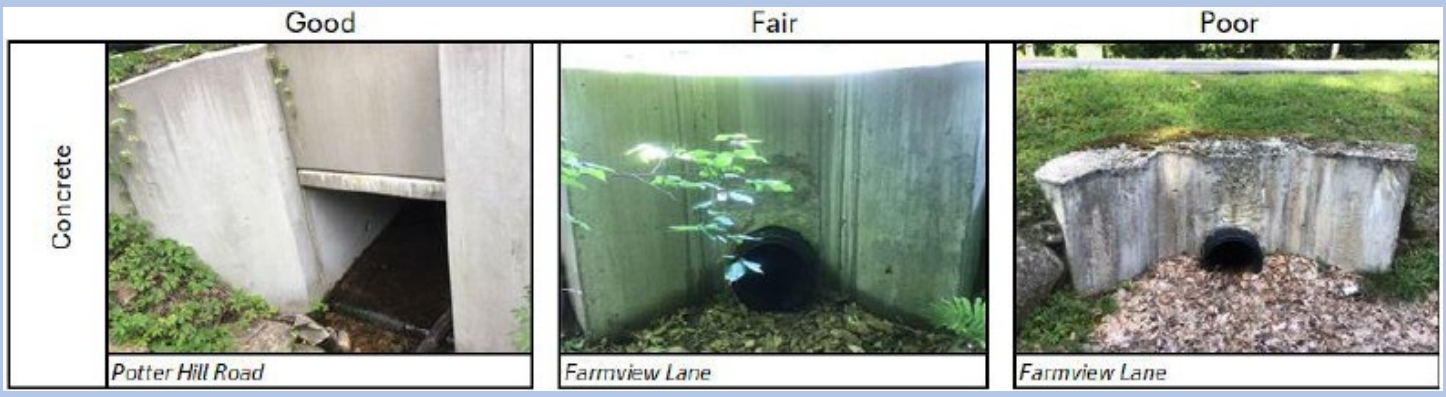
(Left) Bank erosion on the south side of the West Alton Brook inlet below Cherry Valley Road sends sediment into the stream. (Middle) Bank erosion was observed on the north side of the inlet. (Right) Water in the brook is turbid near the culvert. (Top) A coir log (circled) on the northern bank of the brook near the culvert inlet acts to prevent sediment loading to the stream.

Drainage Infrastructure Assessment – Gilford, NH (2024)

Between June and August 2024, the Lakes Region Planning Commission completed a town-wide inventory of 2,504 culverts and closed drainage system (CCDS) features on municipal roads in Gilford. This effort, guided by the NH SADES protocol, provides critical data on pipe materials, drainage structures, and end treatments. The majority of pipes assessed were plastic, with 84% in "Good" condition—supporting the Town's ongoing transition away from aging metal infrastructure, which showed high rates of deterioration. Key findings also include the dominance of masonry headwalls without wingwalls, and a need to monitor precast concrete structures for early signs of degradation.

This assessment represents a 209% increase in surveyed features since the last CCDS survey in 2016, offering Gilford an expanded, GIS-ready dataset to guide stormwater infrastructure maintenance and planning. The report recommends continued investment in plastic replacements, targeted inspection of concrete components, and adoption of GIS tools to streamline field verification. A follow-up assessment is advised within five years to track changes and ensure system resilience in the face of growing environmental and development pressures.

The 2024 assessment comes at a critical time as the region faces more frequent and intense storms, increasing the volume and impact of stormwater runoff. The significantly improved inventory—documenting 2,504 existing features—provides a much clearer understanding of where vulnerabilities lie. This comprehensive dataset equips the town to prioritize repairs and upgrades that reduce flooding, road damage, and pollutant-laden runoff. Well-maintained drainage infrastructure also helps protect downstream water quality in areas like Center Harbor Bay by minimizing erosion and controlling the flow of stormwater into sensitive waterbodies.



A visual description of headwalls and wing walls from the LRPC 2024 CCDS Report (LRPC, 2024).

3.1.3 Shoreline Survey

LWA staff member John Flaherty conducted a shoreline survey of Lake Winnipesaukee in the Broads between July and August 2024, with boating assistance for surveying lakefront parcels provided by Broads residents Timothy Wanzer, Maureen Casey, Larry Greeley, Rich Cram, Thomas Davis, Dick Fleming, and Dana Huff. The shoreline survey uses a simple scoring method to highlight shoreline properties around the lake that exhibit significant erosion. This method of shoreline survey is a rapid technique to assess the overall condition of properties within the shoreland zone and prioritize properties for technical assistance or outreach.

Technical staff documented the condition of the shoreline for each parcel using a scoring system that evaluates vegetated buffer, presence of bare soil, extent of shoreline erosion, distance of structures to the lake, and slope. The scores were summed to produce two metrics: the "Shoreline Disturbance Score" (ranging from 3 to 12) and the "Shoreline Vulnerability Score" (ranging from 1 to 6). Higher scores reflect poorer or more vulnerable shoreline conditions. Photos were taken at each parcel and were cataloged by tax map-lot number. These photos will provide stakeholders with a valuable tool for assessing shoreline conditions over time. It is recommended that a shoreline survey be conducted in mid-summer every five years to evaluate changing conditions.

A total of 1,135 parcels were evaluated along the shoreline of the Broads. The average Shoreline Disturbance Score, which evaluates buffer, bare soil, and shoreline erosion, was 5.5 (Table 13). About 30% of the shoreline, or 334 parcels, scored 7 or greater. A disturbance score of 7 or above indicates shoreline conditions that may be detrimental to lake water quality. These shoreline properties tend to have inadequate buffers, evidence of bare soil or use of lawn fertilizer, and shoreline erosion.

The average Shoreline Vulnerability Score, which evaluates distance and slope, was 4.4 (Table 13). About 86%, or 977 parcels, scored 4 or greater. A vulnerability score of 4 or greater indicates that the parcel may have its residence within 150 feet of the shoreline with a moderate or steep slope to the shoreline. Parcels with a vulnerability score of 4 or greater are more prone to erosion issues, whether or not adequate buffers and soil coverage are present. The majority of shoreline parcels in the Broads (75%, or 846 parcels) are particularly prone to erosion for having homes within 75 feet of the shoreline, receiving the maximum score for distance to shore of 3.

Table 13. Average Shoreline Disturbance and Vulnerability Scores for the Broads. Higher values represent poorer or more vulnerable conditions.

Evaluated Condition	Average Condition Score	Average Score
Buffer (1-5)	2.8	Shoreline Disturbance Score (3-12) **5.5**
Bare Soil (1-4)	1.4	
Shoreline Erosion (1-3)	1.3	
Distance (0-3)	2.5	Shoreline Vulnerability Score (1-6) **4.4**
Slope (1-3)	1.8	

The pollutant loading estimates are based on the Shoreline Disturbance Scores. The 334 parcels with scores 7-12 are contributing approximately 113 kg of phosphorus annually[3]. If shoreline landowners were to create adequate buffers and install other shoreline Best Management Practices (BMPs) on these properties (at a 50% BMP efficiency rate), the annual reduction would be 56.5 kg of phosphorus.

Certain site characteristics, such as slope, can cause shorelines to be naturally more vulnerable to erosion. Other site characteristics such as structure distance to the lake, are often a direct consequence of the historic development on that parcel and cannot be easily changed. Shoreline buffers and amount of exposed soil are more easily changed to strengthen the resiliency of the shoreline to disturbance in the watershed. In summary, the overall average shoreline condition of the Broads is moderate for erosion issues (average disturbance score of 5.5). The Broads is also generally more prone to erosion issues because many homes are located close to shore (average distance score is 2.5 out of 3).

Scores should be used to prioritize areas of the shoreline for remediation. Recommendations largely include improving shoreline vegetated buffers. Encouraging landowners to plant and/or maintain vegetated buffers as a BMP along their shoreline, particularly in areas of bare soil, will help mitigate erosion and reduce sediment and nutrient loading to the lake. In 2025, LWA sent postcard mailings to property owners of the 57% of parcels that received scores between 7 and 12 on the Shoreline Disturbance Score with a report of the results for their property and recommendations for getting technical assistance help. Property owners will be invited to participate in the free and voluntary Be Winni Blue/LakeSmart program.

3.1.4 Soil & Shoreline Erosion

Erosion can occur when ground is disturbed by digging, construction, plowing, foot or vehicle traffic, or wildlife. Rain and associated runoff are the primary pathways by which eroded soil reaches lakes and streams. Once in surface waters, nutrients are released from the soil particles into the water column, causing excess nutrient loading to surface waters or cultural eutrophication. Since development demand near lakes is high, construction activities in lake watersheds can be a large source of nutrients. Unpaved roads and trails used by motorized vehicles near lakes and streams are especially vulnerable to erosion. Stream bank erosion can also have a rapid and severe effect on lake water quality and can be triggered or worsened by upstream impervious surfaces like buildings, parking lots, and roads which send large amounts of high velocity runoff to surface waters. Maintaining natural vegetative buffers around lakes and streams and employing strict erosion and sedimentation controls for construction can minimize these effects.

3.1.4.1 Surficial Geology

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

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

The unique geological formation in this area formed the Winnipesaukee River Basin Stratified Drift Aquifers, comprising seventeen of the cleanest and most productive aquifers in the region. Several of these aquifers, mapped by the US Geological Survey (Ayotte, 1997), surround Lake Winnipesaukee in the Broads watershed, where they contain coarse-grained deposits. They appear in patches along the shore between Belknap Point and West Alton, including beneath

[3] Based on Region 5 model bank stabilization estimate for fine sandy loams, using 50 ft or 100 ft or 200 ft (length) by 3 ft (height) and moderate lateral recession rate of 0.1 ft/yr.

Ellacoya State Park. Saturated thickness is generally between 0 and 20 feet, though it extends to 60 feet at Ellacoya State Park; and the aquifers have a maximum transmissivity of 1,000 ft^2/day.

Lake Winnipesaukee serves as a discharge point for these aquifers, receiving groundwater from the stratified drift deposits. Due to the high transmissivity of the material, contaminants can spread rapidly through the aquifer and into the lake and other surface waters. Therefore, safeguarding the aquifer is essential for protecting the water quality of Lake Winnipesaukee.

3.1.4.2 Soils and Erosion Hazard

The soils in the Broads watershed (Appendix A, Map A-6) are a direct result of geologic processes. Of the 50 different soil series present within the watershed (excluding soils beneath waterbodies), the most prevalent is Tunbridge-Lyman-Becket complex (7,474 acres, 37% of the watershed area; a well-drained soil series), followed by Skerry fine sandy loam (1,614 acres, 8%; moderately well drained), Canterbury fine sandy loam (1,497 acres, 7%; well drained), Becket fine sandy loam (1,482 acres, 7%; well drained), and Lyman-Tunbridge-Rock outcrop complex (1,029 acres, 5%; somewhat excessively drained). The remaining 35% of the watershed (excluding areas identified with soil as "water") is a combination of 45 additional soil series ranging from 5% to 0.0002% of the watershed.

Soil erosion hazard is dependent on a combination of factors, including land contours, climate conditions, soil texture, soil composition, permeability, and soil structure (O'Geen et al., 2006). Soil erosion hazard should be a primary factor in determining the rate and placement of development within a watershed. Soils with negligible soil erosion hazard are primarily low-lying wetland areas near abutting streams. The soil erosion hazard is determined from the associated slope and soil erosion factor K_w[4] used in the Universal Soil Loss Equation (USLE). The USLE predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year. A rating of "slight" specifies erosion is unlikely to occur under standard conditions. A rating of "moderate" specifies some erosion is likely and erosion-control measures may be required. A rating of "severe" specifies erosion is very likely and erosion-control measures and revegetation efforts are crucial. A rating of "very severe" specifies significant erosion is likely and control measures may be costly. These ratings are derived as part of the Soil Erosion Hazard Off-Road/Off-Trail for each soil series. Excluding soils under waterbodies, "very severe" erosion hazard areas account for 17% (3,347 acres) of the Broads watershed, and "severe" hazard areas account for 19% (3,789 acres). These areas are mostly concentrated in the western portions of the watershed, associated with the Belknap Mountain Range (Appendix A, Map A-7). Moderate erosion hazard areas account for 51% of the watershed land area (10,363 acres) and slight erosion hazard areas account for 13% (2,552 acres). An additional 1% (226 acres) is not rated. Development should be restricted in areas with very severe and severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have greater negative impact on water quality, more effort and investment are required to maintain its stability and function within the landscape, particularly from BMPs that protect steep slopes from development and/or prevent stormwater runoff from reaching water resources. Other areas prone to erosion include steeply sloped areas on Rattlesnake and Sleepers Island (Appendix A; Map A-7; Map A-8).

3.1.4.3 Shoreline Erosion

Water level fluctuations in lakes and ponds can occur on long- and short-term timescales due to naturally changing environmental conditions or as a response to human activity. The effect of lake level fluctuation on physical and environmental conditions depends on several factors including the degree of change in water level, the rate of change, seasonality, and the size and depth of the waterbody (Leira & Cantonati, 2008; Zohary & Ostrovsky, 2011). Changes in lake level can impact flora and fauna mainly by altering available habitat, impacting nesting locations, and altering available food sources. In addition to impacts to the biological communities, lakes can experience physical impacts on water quality from changes in lake level. Frequent lake level fluctuations can impact the shoreline, leading to erosion and increased sedimentation in near-shore habitats, inhibiting light penetration and altering water clarity. Exposed shoreline sediment that is inundated at high water levels can release phosphorus, leading to alterations in nutrient accumulation and algae populations. High and low water levels can have detrimental effects on water systems, so finding a balance in managing water level at appropriate times throughout the year is critical to maintaining a healthy waterbody for both recreational enjoyment and aquatic life use. Management strategies become even more challenging when considering the impact of

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

increased wake boating and extreme weather events (droughts and storms) on water level. Residents within the Broads have expressed concern about enhanced shoreline erosion caused by boat wakes (see, for example, the approved petition for a No Wake Zone between Pig and Lockes Islands, just beyond the watershed boundary, from 2021). Water level management in Lake Winnipesaukee is complex, requiring a balance between the various environmental and recreational needs of users of both the lake and the downstream Winnipesaukee River. The lake level is controlled at the Lakeport Dam in Laconia.

3.1.5 Wastewater and Septic Systems

Untreated discharges of sewage (domestic wastewater) are prohibited regardless of source. An example of an NPS discharge of untreated wastewater is from insufficient or malfunctioning subsurface sewage treatment and disposal systems, commonly referred to as septic systems, but which also include holding tanks and cesspools. When properly designed, installed, operated, and maintained, septic systems can reduce phosphorus concentrations in sewage within a zone close to the system (depending on the development and maintenance of an effective biomat, the adsorption capacity of the underlying native soils, and proximity to a restrictive layer or groundwater). Age, overloading, or poor maintenance can result in system failure and the release of nutrients and other pollutants into surface waters (EPA, 2016). Nutrients from insufficient septic systems can enter surface waters through surface overflow or breakout, stormwater runoff, or groundwater. Cesspools are buried concrete structures that allow solid sludge to sink to the bottom and surface scum to rise to the top and eventually leak out into surrounding soils through holes at the top of the structure. Holding tanks are completely enclosed structures that must be pumped regularly to prevent effluent back-up into the home.

How Old is Your Septic System?

Unsure of the age or status of your septic system? Don't worry! You can investigate the age of your septic system by searching your street address on the NHDES Subsurface Application Status OneStop. We recommend entering the town and street name into the query to pull up your property. The approval date associated with your property should reflect how old the system is. Sometimes there is no data on the State's database. This might mean there was a clerical error, or your system is older than the database itself. In this case, call a licensed septic inspector, who can identify the location and status of your septic system. Inspections should be routinely performed every few years, to inform you of the status of your system and to ensure it is not failing or underperforming. Pumping the septic tank every 1-3 years can also ensure proper function.

Septic systems along the shoreline pose a great risk to water quality due to the proximity of the septic drainfield to the waterbody compared to others in the watershed. In a conventional septic system, household waste is held in a septic tank, which separates liquids, solids, and oils. Wastewater then flows to the drainfield, where it is dispersed into the soil for treatment through natural filtration. Although the primary public health concern in siting and designing septic systems is pathogen treatment, nutrients such as nitrogen and phosphorus are also present in wastewater and pose a risk to water quality if there is inadequate nutrient removal. Since septic systems rely on the soil to treat nutrients, the characteristics of the surrounding soil are incredibly important to the transport of nutrients from septic systems to waterbodies. For example, septic systems in coarse-textured soils, soils with shallow water table, or bedrock tend to have a lower capacity to treat nutrients. Septic systems can also fail as they age, which leads to wastewater ponding at the drainfield surface. This is largely a public health issue, due to the pathogens in the wastewater, but failing septic systems near the shore can also pose significant nutrient loading issues especially if there is a downslope path where the water can be easily transported to a waterbody.

LWA completed an initial review of available data on septic systems within 250 feet of the Broads shoreline in 2024. The objective of this survey was to determine the number of septic systems along the shoreline and the proportion of older septic systems. Using GIS and parcel data from the towns of Alton, Gilford, Moultonborough, Tuftonboro, and Wolfeboro, it was determined that 1,227 parcels of land fall within the 250-foot boundary of the lake. Deductions were made for vacant land, commercial lots, conservation land, sub-parcels, etc. resulting in 985 parcels with buildings. Further analysis of the 985 parcels indicates that 734 parcels contain buildings built before 1999; the date we are using to determine the number of systems older than 25 years (the average life span of a septic system). Town tax records were reviewed to gather information on property ownership and the NHDES Subsurface OneStop online database was searched to provide information on the construction or operational approval dates of the septic system. A review of the 233 parcels with lot sizes

equal to or under 0.5 acres determined that 174 parcels had buildings built before 1999. The NHDES Subsurface OneStop database indicated that only 20 systems had been replaced. Refer to the *Septic System Risk Analysis The Broads Watershed* Technical Memorandum (LWA, 2024) for further details on assessment methodology.

LWA then estimated nutrient loading using the LLRM Septic System Nutrient Model, an Excel-based model that uses the following inputs and assumptions to estimate phosphorus loading. Due to the high seasonal use of properties on Lake Winnipesaukee, the number of people per dwelling has been increased to 3.5, rather than the 2.5 value normally used in the LLRM.

As detailed in *The Broads Lake Loading Response Model Report* (FBE, 2025a), shoreline septic systems contribute **142.5 kg/yr** of total phosphorus loading to the Broads, comprising **1%** of the total phosphorus load from all sources to the lake. Some septic systems, cesspools, or holding tanks are located within a short distance to the water, leaving little horizontal (and sometimes vertical) distance through soil for proper filtration of wastewater effluent. Improper siting, installation, or maintenance of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent directly to the lake. This effluent contains not only nutrients and bacteria but also microplastics, pharmaceuticals, and other pollutants harmful to public health.

3.1.6 Fertilizers

When lawn and garden fertilizers are applied in excessive amounts, in the wrong season, or just before heavy precipitation, they can be transported by rain or snowmelt runoff to lakes and other surface waters where they can promote cultural eutrophication and impair the recreational and aquatic life uses of the waterbody. Many states and local communities are beginning to set restrictions on the use of fertilizers by prohibiting their use altogether or requiring soil tests to demonstrate a need for any phosphate application to lawns. The New Hampshire Shoreland Water Quality Protection Act (SWQPA) prohibits all fertilizer use within 25 feet of the reference line of public waters, as well as quick-release fertilizers (those containing more than 2% phosphorus and a nitrogen component that is less than 50% slow-release) within 25 to 250 feet of the reference line.

3.1.7 Pets

In residential areas, fecal matter from pets can be a significant contributor of nutrients to surface waters. Each dog is estimated to produce 200 grams of feces per day, which contain concentrated amounts of phosphorus (CWP, 1999). If pet feces are not properly disposed, these nutrients can be washed off the land and transported to surface waters by stormwater runoff. Pet feces can also enter by direct deposition of fecal matter from pets standing or swimming in surface waters. Dogs are not allowed at Ellacoya State Park, a recreation area along the shoreline in the Broads.

3.1.8 Agriculture

Agriculture in the Broads watershed is minimal (<0.5%) and includes some cropland, orchards, grazing areas, and hayfields. Agricultural activities, including dairy farming, raising livestock and poultry, growing crops, and keeping horses and other animals for pleasure or profit, involve managing nutrients.

Agricultural activities and facilities with the potential to contribute to nutrient impairment include:

- Plowing and earth moving;
- Fertilizer and manure storage and application;
- Livestock grazing;
- Animal feeding operations and barnyards;
- Paddock and exercise areas for horses and other animals; and
- Leachate from haylage/silage storage bunkers.

Diffuse runoff of farm animal waste from land surfaces (whether from manure stockpiles or cropland where manure is spread), as well as direct deposition of fecal matter from farm animals standing or swimming in surface waters, are significant sources of agricultural nutrient pollution in surface waters. Farm activities like plowing, livestock grazing, vegetation clearing, and vehicle traffic can also result in soil erosion which can contribute to nutrient pollution.

Excessive or poorly timed fertilizer application, as well as improper storage that allows nutrients to wash away with precipitation, not only threatens lakes and other water bodies but also prevents nutrients from reaching the intended crops. The key to nutrient application is to apply the right amount of nutrients at the right time. When appropriately applied

to soil, synthetic fertilizers or animal manure can fertilize crops and restore nutrients to the land. When improperly managed, pollutants in manure can enter surface waters through several pathways, including surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, and leaching into soil and groundwater.

3.1.9 Future Development

Understanding population growth, and ultimately development patterns, provides critical insight to watershed management, particularly as it pertains to lake water quality. According to the US Census Bureau, towns in the watershed (Alton, Gilford, Tuftonboro, Wolfeboro, Moultonborough, and New Durham) have experienced steady population growth over the last 50 years (see Section 2.4.2). The watershed has experienced consistently higher population growth rates than the statewide average. The Broads has long been treasured as a recreational haven for both summer vacationers, young campers, and year-round residents. The area offers fishing, hiking, boating, sailing, canoeing, kayaking, and swimming in the summer, and ice fishing, cross-country skiing, snowshoeing, and snowmobiling in the winter. The desirability of the Broads and the greater New Hampshire Lakes Region as recreational destinations and full-time residence will likely stimulate continued population growth in the future. Growth figures and estimates suggest that towns should continue to 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.

3.2 INTERNAL PHOSPHORUS LOAD

Phosphorus that enters the lake and settles to the bottom can be re-released from sediment under anoxic conditions, providing a nutrient source for algae, cyanobacteria, and plants, otherwise known as internal phosphorus loading. The watershed modeling in Section 2.4.1 identified internal phosphorus load as a relatively minor source of phosphorus to the Broads and all other bays in Lake Winnipesaukee, contributing approximately 1% to the total phosphorus load.

3.3 POTENTIAL CONTAMINATION SOURCES

Point source (PS) pollution can be traced back to a specific source such as a discharge pipe from an industrial facility, municipal treatment plant, permitted stormwater outfall, or a regulated animal feeding operation, making this type of pollution relatively easy to identify. Section 402 of the CWA requires all such discharges to be regulated under the National Pollutant Discharge Elimination System (NPDES) program to control the type and quantity of pollutants discharged. NPDES is the national program for regulating point sources through issuance of permit limitations specifying monitoring, reporting, and other requirements under Sections 307, 318, 402, and 405 of the CWA.

NHDES operates and maintains the OneStop database and data mapper, which houses data on Potential Contamination Sources (PCS) within the State of New Hampshire. Identifying the types and locations of PCS within the watershed may help identify sources of pollution and areas to target for restoration efforts.

On January 28, 2025, FBE downloaded datasets for aboveground storage tanks, underground storage tanks, automobile salvage yards, solid waste facilities, hazardous waste sites, local potential contamination sources, NPDES outfalls, and remediation sites in the Kingston Lake watershed. Out of the eight possible categories, five occur in the watershed: hazardous waste sites, underground storage tanks, aboveground storage tanks, local potential contamination sources, NPDES outfalls, and remediation sites (Appendix A, Map A-9).

3.3.1 Hazardous Waste Sites

Hazardous waste generating facilities are identified through the EPA's Resource Conservation and Recovery Act (RCRA) and require either federal or state regulation. Of the three hazardous waste generating facilities within the Broads watershed, two listed as active – the Gunstock Mountain Resort, and the West Alton Marina LLC. The third is listed as inactive.

3.3.2 Above and Underground Storage Tanks

Above and underground storage tanks include permitted containers with oil and hazardous substances such as motor fuels, heating oils, lubricating oils, and other petroleum and petroleum-contaminated liquids. There are nine aboveground storage tanks within the Broads watershed. Four are located near the tips of Tuftonboro and Wolfeboro Necks, three are at Camp Brookwoods, and the other two are at Robert's Cove and Gunstock Mountain Resort. There are an additional 14 underground storage tanks within the watershed. Most are located on the west side of Lake Winnipesaukee, in the towns of

Gilford and Alton. Ownership of these tanks can range from commercial industries, gas stations, hospitals, marinas, schools, local government, residential or farms, and utilities.

3.3.3 Local Potential Contamination Sources

Local potential contamination sources are sites that may represent a hazard to drinking water quality supplies due to the use, handling, or storage of hazardous substances. There may be overlap between local potential contamination sources and other PCS identified in this section. There are two local potential contamination sources within the Broads watershed, both associated with the Gunstock Mountain Resort.

3.3.4 NPDES Outfalls

The Gunstock Recreation Area Wastewater Treatment Facility discharges pollutants to Poor Farm Brook via a NPDES outfall (Permit # NH0100994). This is the only NPDES outfall within the Broads watershed.

3.3.5 Remediation Sites

The 65 remediation sites present within the Broads watershed consist of underground injection control sites, leaking storage facilities that contain fuel or oil, initial spill response sites, failing septic systems, non-domestic wastewater, and submerged vehicles, among others.

3.4 WILDLIFE

Fecal matter from wildlife such as geese, gulls, other birds, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (CWP, 1999). Congregations of geese, gulls, and ducks are of concern because they often deposit their fecal matter next to or directly into surface waters. Examples include large, mowed fields adjacent to lakes and streams where geese and other waterfowl gather, as well as the underside of bridges with pipes or joists directly over the water that attract large numbers of pigeons or other birds. Studies show that geese inhabiting **riparian** areas increase soil nitrogen availability (Choi et al., 2020), and gulls along shorelines increase phosphorus concentration in beach sand pore water that then enters surface waters through groundwater transport and wave action (Staley et al., 2018). When submerged in water, the droppings from geese and gulls quickly release nitrogen and phosphorus into the water column, contributing to eutrophication in freshwater ecosystems (Mariash et al., 2019). On a global scale, fluxes of nitrogen and phosphorus from seabird populations have been estimated at 591 Gg N per year and 99 Gg P per year, respectively (with the highest values derived from arctic and southern shorelines) (Otero et al., 2018). Additionally, other studies show greater concentrations of nitrogen, ammonia, and dissolved organic carbon downstream of beaver impoundments when compared to similar streams with no beaver activity in New England (Bledzki et al., 2010). The model estimated that waterfowl are likely contributing 418.4 kg/yr (4%) of the total phosphorus load to the Broads.

3.5 ENVIRONMENTAL VARIABILITY

Environmental variability has important implications for water quality that should be incorporated into WMPs. In the last century, New England has already experienced significant changes in stream flow and air temperature. Out of 28 stream flow stations throughout New England, 25 showed increased flows over the record, likely due to the increase in frequency of extreme precipitation and total annual precipitation in the region. In 79 years of recorded flooding in the Oyster River in Durham, NH, three of the four highest floods occurred in the past 10 years (Ballestero et al., 2017). Average annual air temperature in New England has risen by 1°C to 2.3 °C since 1895 with greater increases in winter air temperature (IPCC, 2013). Lake ice-out dates are occurring earlier as warmer winter air temperature melts the snowpack and lake ice; earlier ice-out allows a longer growing season and increases the duration of anoxia in bottom waters. Increasing storm frequencies flush more nutrients to surface waters for algae to feed on and flourish under warmer air temperatures. These trends will likely continue to impact both water quality and quantity. Models predict a 10-40% increase in stormwater runoff by 2050, particularly in winter and spring and an increase in both flood and drought periods as seasonal precipitation patterns shift. Adding to this stress is population growth and corresponding development in New Hampshire. The build-out analysis for the watershed showed up to 3,923 new buildings could be added to the watershed at full build-out based on current zoning standards. The Broads is at serious risk for sustained water quality degradation with the possibility for new development in the watershed unless environmental resiliency and **low impact development** (LID) strategies are incorporated to existing zoning standards.



Lake Winnipesaukee shoreline. Photo taken by Harrison Flagg, 2024. Printed with permission.

4 MANAGEMENT STRATEGIES

The following section details management strategies for achieving the water quality goal and objectives using a combination of structural and non-structural restoration techniques, as well as outreach and education and an adaptive management approach. A key component of these strategies is the idea that existing and future development can be remediated or conducted in a manner that sustains environmental values. All stakeholder groups have the capacity to be responsible watershed stewards, including citizens, businesses, the government, and others. Specific action items are provided in the Action Plan (Section 5).

4.1 STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Structural NPS restoration techniques are engineered infrastructure designed to intercept stormwater runoff, often allowing it to soak into the ground, be taken up by plants, harvested for reuse, or released slowly over time to minimize flooding and downstream erosion. These BMPs often incorporate some mechanism for pollutant removal, such as sediment settling basins, oil separators, filtration, or microbial breakdown. They can also consist of removing or disconnecting impervious surfaces, which in turn reduces the volume of polluted runoff generated, minimizing adverse impacts to receiving waters.

4.1.1 Watershed & Shoreline BMPs

Twenty (20) NPS sites identified during the 2024 watershed survey and 334 prioritized shoreline properties from the 2024 shoreline survey were documented to have some impact to water quality through the delivery of phosphorus-laden sediment (refer to Section 3.1.1-3.1.2). As such, structural BMPs to reduce the external watershed phosphorus load are a necessary and important component for the protection of water quality in the watershed.

The following series of BMP implementation action items are recommended for achieving Objective 1:

- Address the top five ranked sites (and the remaining 15 sites as opportunities arise) identified during the 2024 watershed survey. The sites were ranked based on phosphorus load reduction, waterbody proximity, and estimated cost. The full prioritization matrix with recommended improvements is provided in Appendix B.
- Provide technical assistance and/or implementation cost sharing to the 334 prioritized shoreline properties identified during the 2024 shoreline survey. Workshops and tours of demonstration sites can help encourage landowners to utilize BMPs on their own property. Conduct regular shoreline surveys to continue prioritizing properties for technical follow-up.

For the proper installation of structural BMPs in the watershed, the committee should work with experienced professionals on sites that require a high level of technical knowledge (engineering). Whenever possible, pollutant load reductions should be estimated for each BMP installed. More specific and additional recommendations are included in Section 5. For helpful tips on implementing BMPs, see Additional Resources.

4.2 NON-STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Non-structural NPS restoration techniques refer to a broad range of behavioral practices, activities, and operational measures that contribute to pollutant prevention and reduction. The following section highlights important restoration techniques for several key areas, including pollutant reduction best practices, zoning and ordinance updates, land conservation, septic system regulation, sanitary sewer system inspections, fertilizer use prohibition, pet waste management, agricultural practices, and nuisance wildlife controls.

4.2.1 Pollutant Reduction Best Practices

Pollutant reduction best practices include recommendations and strategies for improving road management and municipal operations for the protection of water quality. Following standard best practices for road maintenance and drainage management protects both infrastructure and water quality through the reduction of sediment and other pollutant transport. Refer to the *New Hampshire Stormwater Manual* (UNH Stormwater Center, CEI & NHDES, 2025) for standard road design and maintenance best practices.

Even though none of the watershed towns are required to comply with the six minimum control measures under the New Hampshire Small MS4 General Permit, each town could consider instituting the permit's key measures, such as street sweeping, catch basin cleaning, and road/ditch maintenance, if not already in place. The MS4 permit also covers illicit discharge detection and elimination plans (and ordinance inclusion), source control and pollution/spill prevention protocols, and education/outreach and/or training for residents, municipal staff, and stormwater operators, all of which are aimed at minimizing polluted runoff to surface waters. Alton completes street sweeping once per year in the spring and again in the fall if necessary. Alton contracts with a company that cleans catch basins. Alton maintains municipal gravel roads, none of which are within 500 feet of Lake Winnipesaukee.

4.2.2 Zoning and Ordinance Updates

Regulations through municipal zoning and ordinances such as LID strategies that prevent polluted runoff from new and re-development projects in the watershed are equally important as implementing structural BMPs on existing development. In fact, local land use planning and zoning ordinances can be the most critical components of watershed protection. LWA completed a preliminary ordinance review of natural resource protections for the towns surrounding Lake Winnipesaukee, including Gilford, Alton, and Tuftonboro (Table 14). These towns have already incorporated several important regulations into their ordinances. A more robust review of these ordinances is encouraged for more specific recommendations on improving ordinances and regulations related to natural resource protection. The towns should also consider their staffing capacity to enforce existing and proposed regulations. Refer to the Alton Bay and Center Harbor Bay WMPs (FBE, 2025c; 2025d) for ordinance reviews of towns with small areas in the Broads (Moultonborough, New Durham, and Meredith) and Wolfeboro Bay WMP (FBE, 2024) for Wolfeboro.

Example Town Ordinances

1. **Shoreland Protection District:** Kingston, NH
2. **Septic pump-out regulations:** Sunapee, NH
3. **Zoning overlay districts for environmental protection:** Kingston, NH; Portsmouth, NH
4. **Wetland protection zoning:** Hampton, NH
5. **Zoning for groundwater protection:** Rollinsford, NH
6. **Protection of steep slopes for water quality:** Holderness, NH
7. **Low impact design:** Bedford, NH
8. **Fertilizer and pesticide use:** Portsmouth, NH

Local land use planning and zoning ordinances should consider incorporating environmental variability resiliency strategies for protecting water quality and improving infrastructure based on temperature, precipitation, water levels, wind loads, storm surges, wave heights, soil moisture, and groundwater levels (Ballestero et al., 2017). There are nine strategies which can aid in minimizing the adverse effects associated with environmental variability and include the following (McCormick and Dorworth, 2019).

- **Installing Green Infrastructure and Nature-Based Solutions:** Planning for greener infrastructure requires that we think about creating a network of interconnected natural areas and open spaces needed for groundwater recharge, pollution mitigation, reduced runoff and erosion, and improved air quality. Examples of green infrastructure include forest, wetlands, natural areas, riparian (banks of a water course) buffers, and floodplains; all of which already exist to various extents in the watershed and have minimized the damage created by intense storms. As future development occurs, these natural barriers must be maintained or even increased to reduce runoff of pollutants into freshwater. See also Section 4.2.3: Land Conservation.
- **Using LID Strategies:** Use of LID strategies requires replacing traditional approaches to stormwater management using curbs, pipes, storm drains, gutters, and retention ponds with innovative approaches such as bioretention, vegetated swales, and permeable paving.
- **Minimizing Impervious Surfaces:** Impervious surfaces such as roads, buildings, and parking lots should be minimized by creating new ordinances and building construction design requirements which reduce the imperviousness of new development. Property owners can increase the permeability for their lots by incorporating permeable driveways and walkways.
- **Encouraging Riparian Buffers and Maintaining Floodplains:** Municipal ordinances should forbid construction in floodplains, and in some instances, floodplain protections should be expanded. Riparian (vegetated) buffers and filter strips along waterways should be preserved and/or created to slow runoff and filter pollutants.

- **Protecting and Re-establishing Wetlands:** Wetlands are increasingly important for preservation because wetlands hold water, recharge groundwater, and mitigate water pollution.
- **Encouraging Tree Planting and Conservation:** Trees help manage stormwater by reducing runoff and mitigating erosion along surface waters. Trees also provide critical shading and cooling to streams and land surfaces.
- **Promoting Landscaping Using Native Vegetation:** Landowners should promote the use of native vegetation in landscaping, and landscapers should become familiar with techniques which minimize runoff and the discharge of nutrients into waterbodies (Chase-Rowell et al., 2012).
- **Slowing Down the Flow of Stormwater:** To slow and infiltrate stormwater runoff, roadside ditches can be armored or vegetated and equipped with turnouts, settling basins, check dams, or infiltration catch basins. Rain gardens can retain stormwater, while waterbars can divert water into vegetated areas for infiltration. Water running off roofs can be channeled into infiltration fields and drainage trenches.
- **Coordinating Infrastructure, Housing, and Transportation Planning:** Coordinate planning for infrastructure, housing, and transportation to minimize impacts on natural resources. Critical resources including groundwater must be conserved and remain free of pollutants especially as future droughts may deplete groundwater supplies.

Table 14. Ordinance review summary of regulatory and non-regulatory tools for natural resource protection in Gilford, Alton and Tuftonboro, which comprise 97% of the Broads watershed. (Table produced by staff at LWA.)

Strategy	Gilford	Alton	Tuftonboro
Aquifer Protection Overlay District	Yes, a boundary of 50 ft outward from the area.	Yes, Adequate areas of pervious surfaces and open areas are needed for groundwater infiltration methods. On-site disposal of solid wastes other than brush and stumps is prohibited.	None, the Tuftonboro master plan for 2022 talks about adopting the ordinance in the future.
Comprehensive Shoreland Protection	Yes, follows NH RSA 483-B, Shoreland Water Quality Protection Act.	Shoreland Protection overlay district was Rescinded on 12 March 2024. Follows NH state regulations.	Does not have a shoreland protection ordinance. Has lakefront residential and island conservation district imposing a 50 ft set back from front property line. Tuftonboro master plan 2022 talks about adopting for the future.
Conservation Focus Area Overlay District	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.	Has open space/ forestry district.
Erosion and Sedimentation Control Ordinance	None, but mentioned in the Island & Shorefrontage district. Also necessary when creating a site plan to make a sedimentation and erosion control plan.	No ordinances but regulations for sedimentation and erosion control during site planning and incorporated in the storm management plan.	None were mentioned so it must follow state regulations.
LID reference	No reference	Yes, are preferred and will be used to the maximum extent possible.	No reference

Strategy	Gilford	Alton	Tuftonboro
Groundwater Protection Ordinance	Mentioned in Aquifer protection district, no ordinance of its own.	No, considered part of the aquifer protection overlay district.	None, but incorporated in the wetlands ordinance. The Tuftonboro mater plan for 2022 mentions adopting a groundwater protection ordinance.
Phosphorus Ordinance	None. Prohibited the use of phosphorus-containing fertilizers within wetland buffer zones. As well as an ordinance on the sale of phosphorus soaps and detergents.	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.
Shorefront Conservation Overlay District	Yes, merged with island frontage district	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.
Site Plan Review Regulations	Yes, the director of planning and land use or his designee shall inspect all site construction subject to the authority of the planning board for compliance with approved site plan designs. The director may allow minor deviations if they don't exceed the dimensional requirements allowed in zoning ordinances and are consistent with the intent of the planning board.	Yes, last revised in December 2012.	Yes, last revised April 2019.
Steep Slope Watershed Overlay	Yes, Has steep slopes and critical elevation conservation area regulations. Slope>15% and elevations higher than 1,300ft.	None mentioned so it must follow state regulations.	None, Tuftonboro master plan for 2022 talks about the implementation of the plan in the future.

Strategy	Gilford	Alton	Tuftonboro
Sewer Ordinance	Yes, 7-26-2023 updated last.	None, but is talked about in the floodplain development ordinance in which if the sewer is placed in a special flood hazard area assurance has to be given to the codes enforcement officer that the design will limit or eliminate infiltration of flood water from the system.	None, but is talked about in the floodplain development ordinance in which if the sewer is placed in a special flood hazard area assurance has to be given to the codes enforcement officer that the design will limit or eliminate infiltration of flood water from the system.
Stormwater Management	Follows NH regulations, if a site plan will render more than 15% or 2,500 square feet of any lot, whichever is greater, within the aquifer protection district impervious a stormwater management plan is needed.	The purpose of Alton's stormwater management ordinance is to protect public health, safety, and welfare by reducing pollution, enhancing groundwater recharge, managing runoff velocity, and preserving water quality and infrastructure. The ordinance applies to developments with slopes of 15% or more or areas near steep slopes, requiring landowners to implement temporary erosion controls and permanent stormwater measures, while obtaining necessary permits and maintaining systems. Applicants must submit detailed site plans, erosion control strategies, and inspection schedules, ensuring compliance with design standards that control runoff and preserve natural drainage. The Code Official and Board of Selectmen oversee administration, including plan reviews, inspections, bonding requirements, and consultation with the Conservation Commission.	stormwater management plans are required for any development that involves more than one acre of site distance, is located on a steep slope (15+%), or otherwise adversely affect water quality.

Strategy	Gilford	Alton	Tuftonboro
Subdivision Regulations	Yes, subdivision plans must be prepared and stamped by a licensed land surveyor or professional engineer. All subdivisions are reviewed by the planning board in which the person may explain the application.	Yes, last amended April 2017.	Yes, last amended May 2023.
Washing/Public Waters	Ordinance on the sale of soaps and detergents with phosphorus so as to cut down on pollution in the lakes.	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.
Water Quality Protection Overlay District	None, follows NH RSA 483-B, Shoreland water quality protection act.	Follows NHDES regulations	Mentioned in the Tuftonboro watershed management plan for Lake Wentworth and Crescent Lake.
Water Resources Conservation Overlay District	None, follows NH RSA 483-B, Shoreland Water Quality Protection Act.	None, considering adding an overlay district in the master plan in 2022.	None were mentioned so it must follow state regulations.
Conservation Subdivision Design Ordinance	No, but the Conservation Commission must review sedimentation plans for site projects.	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.
Watershed Overlay District	None were mentioned so it must follow state regulations.	None were mentioned so it must follow state regulations.	None, The Tuftonboro master plan for 2022 talks about the implementation of a watershed management plan in the future.
Wastewater/Septics	Follows NH regulations	None were mentioned so it must follow state regulations.	Septics are not permitted on slopes of 15% or greater, otherwise, follow NH state regulations.

Strategy	Gilford	Alton	Tuftonboro
Wetland Resources Conservation Overlay District	Has a wetland district that requires a 25ft buffer around wetlands over an acre. Buildings can be placed on wetlands as long as no digging occurs. Use of phosphorus-containing fertilizer is prohibited in wetland buffer(25ft). But no wetlands resources conservation overlay district	25ft wetland buffer otherwise follows NHDES.	Requires wetland delineation be completed for any lot less than 5 acres submitted for subdivision or site plan approval. Doesn't include a do-not-disturb buffer around the wetlands.

4.2.3 Land Conservation

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Land conservation is one of many tools for protecting water quality for future generations. For the Broads, 26% (4,329 acres) of the watershed's land area has been classified as conservation land (refer to Appendix A, Map A-10). Major conserved areas include the Belknap Mountain State Forest, Belknap County Recreation Area, parts of Rattlesnake Island, Cotton-Hurd Preserve, and several smaller conservation areas and easements that form larger units of conserved land. While only a few of these border Lake Winnipesaukee, several protect land on the shores of Hurd Brook and Poorfarm Brook.

Local groups should continue to pursue opportunities for land conservation in the Broads watershed based on the highest valued habitat identified by the New Hampshire Fish & Game (NHFG). NHFG ranks habitat based on value to the State, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape. These habitat rankings are published in the State's 2015 Wildlife Action Plan (with updated statistics and data layers released in January 2020), which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire. The Broads watershed is part of the Sebago-Ossipee Hills and Plains ecoregion (NHFG, 2015). Approximately 29,083 acres (86%) of the Broads watershed (including the lake area) are considered Highest Ranked Habitat in New Hampshire. Many of the conserved areas overlap with the Highest Ranked Habitat in the State and in the bioregion. A map of priority habitats for conservation based on the NH Wildlife Action Plan can be found in Appendix A, Map A-10.

4.2.4 Septic System Regulation

When properly designed, installed, operated, and maintained, septic systems can treat residential wastewater and reduce the impact of excess pollutants in ground and surface waters. It is important to note, however, that traditional septic systems are designed to remove pathogens from wastewater and not specifically other pollutants such as nutrients. The phosphorus in wastewater is "removed" only by binding with soil particles or recycled in plant growth but is not removed entirely from the watershed system. Nutrient removal can only be achieved through more expensive, alternative septic systems, though available systems remove nitrogen and not phosphorus. Proper design, installation, operation, maintenance, and replacement considerations include the following:

- Proper design includes adequate evaluation of soil conditions, seasonal high groundwater or impermeable materials, proximity of sensitive resources (e.g., drinking water wells, surface waters, wetlands, etc.).
- Proper siting and installation mean that the system is installed in conformance with the approved design and siting requirements (e.g., setbacks from waterways).
- Proper operation includes how the property owner uses the system. While most systems excel at treating normal domestic sewage, disposing of some materials, such as toxic chemicals, paints, personal hygiene products, oils and grease in large volumes, and garbage, can adversely affect the function and design life of the system, resulting in treatment failure and potential health threats. Proper operation also includes how the property owner protects the

system. Allowing vegetation with extensive roots to grow above the system will clog the system. Driving large vehicles over the system may crush or compact piping or leaching structures;

- Proper maintenance means having the septic tank pumped at regular intervals to eliminate accumulations of solids and grease in the tank. It may also mean regular cleaning of effluent filters, if installed. The frequency of septic pumping is dependent on the use and total volume entering the system. A typical 3-bedroom, 1,000 gallon tank should be pumped every 3 years or more frequently if within the shoreland zone.
- Proper replacement of failed systems, which may include programs or regulations to encourage upgrades of conventional systems (or cesspools and holding tanks) to more innovative alternative technologies.

Management strategies for reducing water quality impacts from septic systems (as well as cesspools and holding tanks) start with education and outreach to property owners so that they are better informed to properly operate and maintain their systems. Other management strategies include setting local regulations for enforcing proper maintenance and inspection of septic systems and establishing funding mechanisms to support replacement of failing systems (with priority for cesspools and holding tanks). For instance, the Town of New Durham adopted a subsurface ordinance that regulates septic systems within 250 feet of the shoreline of Merrymeeting Lake and ponds within the Town. Regulations include the requirement of homeowners without a valid subsurface system design approval on file and/or who seek a proposed building expansion to submit proof of proper system functioning by a certified septic system inspector within one year of notification. New Hampshire state law requires buyers to obtain a state-licensed septic system evaluator for any part of a septic system within 250 feet of the shoreline (see Statutes § 485-A:39).

4.2.5 Sanitary Sewer System Inspections

Portions of the Broads watershed are served by the Winnipesaukee River Basin Program (WRBP) sewer system, operated by the NHDES Water Division. The main sewer line runs along Paugus Bay in Laconia and generally follows the Winnipesaukee River until it reaches a treatment facility in Franklin (NHDES, 2022b). Within the Broads watershed, the sewer main runs northwest along Lake Winnipesaukee's shoreline in Gilford as well as in the vicinity of Poorfarm Brook, and joins the main interceptor at the Weirs. It is important for municipalities with sewer infrastructure to develop a program (if not already in place) to inspect and evaluate their sanitary sewer system and address identified leaks and overflows, especially in areas near waterbodies.

4.2.6 Boats & Marinas

NHDES provides an interactive map of boat pump-out locations, including both public and private boat pump-outs, dump stations for portable toilets, and mobile pump-out vessels. Within the Broads, there are two active public boat pump-out facilities, both in the town of Alton: West Alton Marina off West Alton Marina Rd, and Roberts Cove Basin in Robert's Cove, along Basin Rd. In addition to these pump-out facilities, boaters can access the lake at other locations, such as the Ellacoya State Park boat ramp. The following best practices apply to marinas, boat access points and pump-out facilities:

- Target outreach to marina owners, boat dealers, and their consumers regarding State and EPA requirements;
- Encourage marina owners to provide clean and safe onshore restrooms and pump-out facilities;
- Provide an appropriate location for boat washing. This should include a wash pad with runoff directed away from the lake. Signage should direct users to CLEAN, DRAIN, and DRY their boats. See recommendations from NH Lakes;
- Do not allow waste from the pump-out stations to drain directly into receiving waters;
- Consider alternatives to asphalt for parking lots and vessel storage areas such as permeable pavement;
- Install infiltration trenches at the leading edge of a boat ramp to catch pollutants in an oil absorbent barrier or crushed stone before discharge;
- Install vegetated buffers between surface waters and upland areas; and
- Protect storm drains with filters or oil-grit separators. Stencil words (such as "Drains to the Lake") on storm drains to alert customers and visitors that storm drains lead directly to waterbodies without treatment. Contact the appropriate municipal public works department before stenciling any drain.

4.2.7 Fertilizer Use Prohibition

Management strategies for reducing water quality impacts from residential, commercial, and municipal fertilizer application start with education and outreach to property owners. New Hampshire law prohibits the use of fertilizers within 25 ft of a surface water. Outside of 25 ft, property owners can get their soil tested before considering application of fertilizers

to their lawns and gardens to determine whether nutrients are needed and if so in what quantity or ratio. A soil test kit can be obtained through the UNH Cooperative Extension. Many New England communities are starting to adopt local regulations prohibiting the use of both fertilizers and pesticides, especially near critical waterbodies. The watershed towns could consider a similar prohibition, at the very least for a watershed zoning overlay of major lakes and ponds. Gilford's ordinances explicitly prohibit phosphorus-containing fertilizers within 25 feet of wetlands (see Section 4.2.2).

4.2.8 Pet Waste Management

Pet waste collection as a pollutant source control involves a combination of educational outreach and enforcement to encourage residents to clean up after their pets. Public education programs for pet waste management are often incorporated into a larger message of reducing pollutants to improve water quality. Signs, posters, brochures, and newsletters describing the proper techniques to dispose of pet waste can be used to educate the public and create a cause-and-effect link between pet waste and water quality (EPA, 2005). Adopting simple habits, such as carrying a plastic bag on walks and properly disposing of pet waste in dumpsters or other refuse containers, can make a difference. It is recommended that pet owners do not put dog and cat feces in a compost pile because it may contain parasites, bacteria, pathogens, and viruses that are harmful to humans and may or may not be destroyed by composting. "Pooper-scooper" ordinances are often used to regulate pet waste disposal. These ordinances generally require the removal of pet waste from public areas, other people's properties, and occasionally from personal property, before leaving the area. Fines are typically the enforcement method used to encourage compliance with these ordinances.

4.2.9 Agricultural Practices

Manure and fertilizer management and planning are the primary tools for controlling nutrient runoff from agricultural areas. Direct outreach and education should be conducted for small hobby farms and any larger-scale operations in the watershed. NRCS is a great resource for such outreach and education to farmers. Larger-scale agricultural operations can work with the NRCS to complete a Comprehensive Nutrient Management Plan (CNMP). These plans address soil erosion and water quality concerns of agricultural operations through setting proper nutrient budgets, identifying the types and amount of nutrients necessary for crop production (by conducting soil tests and determining proper calibration of nutrient application equipment), and ensuring the proper storage and handling of manure. Manure should be stored or applied to fields properly to limit runoff of solids containing high concentrations of nutrients. Manure and fertilizer management involve managing the source, rate, form, timing, and placement of nutrients. Writing a plan is an ongoing process because it is a working document that changes over time.

4.2.10 Nuisance Wildlife Controls

Human development has altered the natural habitat of many wildlife species, restricting wildlife access to surface waters in some areas and promoting access in others. Minimizing the impact of wildlife on water quality generally requires either reducing the concentration of wildlife in an area or reducing their proximity to a waterbody. In areas where wildlife is observed to be a large source of nutrient contamination, such as large and regular congregations of waterfowl, a program of repelling wildlife from surface waters (also called harassment programs) may be implemented. These programs often involve the use of scarecrows, kites, a daily human presence, or modification of habitat to reduce attractiveness of an at-risk area. Providing closed trash cans near waterbodies, as well as discouraging wildlife from entering surface waters by installing fences, pruning trees, or making other changes to landscaping, can reduce impacts to water quality. Public education and outreach on prohibiting waterfowl or other wildlife feeding is an important step to reducing the impact of nuisance wildlife on the lake.

Beaver dam management may also be necessary in the watershed. Beavers repair their dams if they detect the noise or sensation of flowing water through the dam. If the beaver senses the water level is too low upstream of the dam after constructing a dam, they will abandon the dam and find another suitable site to build a dam. In the context of beaver dam management, this could pose additional issues if beavers relocate to another site along the same stream to build a new dam thus creating additional impoundments and greater flooding potential. Investigating the status of beaver dams in the watershed may be useful to determining if beaver dam management is needed. Options for dam management include installing culverts with beaver exclusion fencing (i.e., the Beaver Deceiver design) and/or other beaver deterrents to maintain a lower water level in the lower dam's pooling area. If the dam is present and active, a more advanced design such as the Clemson Pond Leveler may be necessary to regulate the water level above and below the dam to prevent washouts. The Clemson Pond leveler deceives beavers by releasing water inconspicuously such that beavers are not triggered to repair

the dam (thus impounding more water). Physically maintaining the dams to ensure they are not built too high is also a viable option.

4.3 OUTREACH & EDUCATION

Awareness through education and outreach is a critical tool to protecting and restoring water quality. Most people want to be responsible watershed stewards and not cause harm to water quality, but many are unaware of best practices to reduce or eliminate contaminants from entering surface waters. LWA is the primary entity for education and outreach campaigns in the watershed and for development and implementation of the plan. LWA should continue all aspects of their education and outreach strategies and consider developing new ones or improving existing ones and/or forming new collaborations with other organizations (conservation commissions, neighboring watershed associations, etc.) to reach more watershed residents. Refer to Section 5: Action Plan. Examples include providing educational materials to existing and new property owners, as well as renters, by distributing them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Additionally, LWA should continue to engage with local stakeholders such as conservation commissions, land trusts, municipalities, businesses, and landowners. Educational campaigns should include raising awareness of water quality, septic system maintenance, fertilizer and pesticide use, pet waste disposal, waterfowl feeding, invasive aquatic species, boat pollution, shoreline buffer improvements, gravel road maintenance, and stormwater runoff controls.

Throughout the development of this WMP (2024–2025), LWA has conducted multiple outreach events to the Lake Winnipesaukee community (Table 15). These include presentations on water quality issues to communities and organizations, and the promotion of the Winni Blue Initiative to businesses and individuals in the lake watershed. LWA conducted and produced reports for 52 LakeSmart visits in 2024–2025. Weekly articles on lake issues are written by LWA and published in the local paper beginning in May and running through Columbus/Indigenous Peoples Day in October—43 articles were published in 2024–2025. A sign campaign promoting support and awareness of the Lake Winnipesaukee Alliance was run through the summer into the fall of 2025, radio spots were run on LAKES 101.5, and public service announcements were run throughout the summer 2025. Additionally, LWA produced printed newsletters, annual reports, social media posts, and electronic newsletters and distributed these to donors and residents throughout the watershed detailing the work of the organization, including updates on the watershed-based management plans.

Table 15. Outreach events hosted by the Lake Winnipesaukee Alliance in 2024 and 2025.

Date	Outreach activity
Presentations on Water Quality Issues	
1/17/24	Fire & Ice at Lake Life Realty
3/7/24	GSRWA Presentation
3/9/24	GIA Presentation
4/12/24	Delta Gamma Kappa Presentation
4/20/24	Water Dance in Meredith
4/25/24	Meredith Democrats Presentation
5/16/24	Source Water Protection Conference
6/1/24	Open House at Cyr Lumber
6/8/24	Water Summit
6/21/24	Radio Spot at Shep Browns with The Pulse of NH
6/29/24	Black Cat Island Presentation
7/6/24	Woodlands Association Meeting
7/13/24	Krainewood Association Meeting
7/17/24	Governor's Island Presentation
7/31/24	Moultonborough Cyano Presentation
8/1/24	Meredith Cyano Presentation
8/2/24	LRCT Paddle and Talk
8/10/24	Twin Barns Release Party
8/11/24	Lake Winni Day
8/25/24	Bald Peak Event

8/28/24	Meredith Rotary Presentation
9/12/24	Alton Bay Business Association Meeting
10/12/24	Winni Clean Up Days
10/24/24	Cyano Talk at LPC
11/7/24	Tuftonboro Womens Service Organization
12/12/24	Lakes Region Conservation Trust Board of Directors
12/18/24	Presentation of the Wolfeboro Bay Watershed Management Plan
1/6/25	Taylor Community Presentation
1/22/25	Lakes Region Community College meeting with the President
1/30/25	Meredith Community Center tabling event
2/25/25	Meeting with Moultonborough Town Administrator and Town Planner to discuss septic system regulations
2/26/25	Meredith Rotary Club to solicit assistance with ice-out sampling
3/6/25	Belknap County Natural Resource Assessment Workgroup
3/15/25	Gilford Island Association's meeting
3/26/25	Meeting with UNH and NH Department of Environmental Services to discuss issues on Lake Winnipesaukee and monitoring needs
4/3/25	Cherry Valley Road site walk on proposed development project
4/10/25	Radio interview with Lakes 101.5 on ice out story
4/22/25	Meeting with Gilford DPW director to discuss road projects in Gilford
5/8/25	Presentation to the Lakes Region Sail & Power Squadron
Promotion of the Lake Winni Blue Initiative	
5/10/25	Table event at Love Our Earth Day, Laconia
5/15/25	Presentation to the Meredith Garden Club
5/29/25	Presentation on updates to the NH Stormwater Manual, Moultonborough Town Library
6/14/25	Septic System talk held at Moultonborough Public Library
6/18/25	Septic Regulations webinar held for Realtors
6/18/25	Meredith Local Lakes Associations meeting and presentation
6/19/25	Tabling event at Four Your Eyes Only, Moultonborough
6/21/25	Presentation to the Black Point Assn, Alton
6/23/25	Presentation at the annual meeting of Lakes Region Planning Commission
7/12/25	Presentation to Krainewood Association's Annual meeting, Moultonborough
7/12/25	Lake Kanasatka Watershed Assn annual meeting, Moultonborough
7/17/25	Presentation to the members of the Winnipesaukee Golf Club
7/19/25	Varney Point Assn annual meeting, Gilford
7/19/25	Barber Pole Assn. annual meeting, Tuftonboro
7/20/25	Twin Barns public promotion of Keep Winni Blue beer
7/22/25	Podcast with Andy Opel on water quality
7/24/25	Presentation on cyanobacteria at the Loon Preservation Committee, Moultonborough
8/8/25	Tabling event at Lake Winnipesaukee Day, Wolfeboro
8/9/25	Party with a Purpose, Governors Island, Gilford – 100+ in attendance
8/13/25	Landscaping by the Water's Edge Presentation, Moultonborough
8/15/25	Presentation to the Wolfeboro Corinthian Yacht Club
8/30/25	Presentation to the Langdon Cove Assn., Moultonborough
9/10/25	Geology webinar
9/11/25	Presentation to NEPA, Laconia
9/23/25	Laconia High School talk
9/23/25	Gathering at Olcott's home in Wolfeboro to discuss water quality issues – 50 in attendance
10/6/25	Moultonborough's Womens Club

4.4 ADAPTIVE MANAGEMENT APPROACH

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

- **Maintaining an Organizational Structure for Implementation.** Communication and a centralized organizational structure are imperative to successfully implementing the actions outlined in this plan. A diverse group of stakeholders through LWA should be assembled to coordinate watershed management actions. This group can include representatives from state and federal agencies or organizations, municipalities, local businesses, and other interested groups or private landowners. Refer to Section 6.1: Plan Oversight.
- **Establishing a Funding Mechanism**. A long-term funding mechanism should be established to provide financial resources for management actions. In addition to initial implementation costs, consideration should also be given to the type and extent of technical assistance needed to inspect and maintain structural BMPs. Funding is a key element of sustaining the management process, and, once it is established, the plan can be fully vetted and restoration actions can move forward. A combination of grant funding, private donations, and municipal funding should be used to ensure implementation of the plan. Refer to Section 6.3 for a list of potential funding sources.
- **Determining Management Actions.** This plan provides a unified watershed management strategy with prioritized recommendations for restoration using a variety of methods. The proposed actions in this plan should be used as a starting point for grant proposals. Once a funding mechanism is established, designs for priority restoration actions on a project-area basis can be completed and their implementation scheduled. Refer to Section 5: Action Plan.
- **Continuing and Expanding the Community Participation Process.** Plan development has included active involvement of a diversity of watershed stakeholders. Plan implementation will require continued and ongoing participation of stakeholders, as well as additional outreach efforts to expand the circle of participation. Long-term community support and engagement is vital to successfully implementing this plan. Continued public awareness and outreach campaigns will aid in securing this engagement. Refer to Section 4.3: Outreach & Education.
- **Continuing and/or Establishing Long-Term Monitoring Programs.** A water quality monitoring program is necessary to track the health of surface waters in the watershed. Information from the monitoring programs will provide feedback on the effectiveness of management practices. Refer to Section 6.4: Monitoring Plan.
- **Establishing Measurable Milestones.** A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critical to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure plan progress. Refer to Section 6.5: Indicators to Measure Progress and Section 2.5: Establishment of Water Quality Goal for interim milestones.

5 ACTION PLAN

5.1 ACTION PLAN

The Action Plan (Table 16) outlines responsible parties, approximate costs[5], an implementation schedule, and potential funding sources for each recommendation within the following major categories: (1) Watershed & Shoreline BMPs; (2) Road Management; (3) Municipal Operations; (4) Municipal Land Use Planning & Zoning; (5) Land Conservation; (6) Septic System Management; (7) Agricultural Practices; and (8) Education and Outreach. The plan is designed to be implemented from 2026–2035 and is flexible to allow for new priorities throughout the 10-year implementation period as additional data are acquired.

Table 16. Action Plan for the Broads watershed. Lake Winnipesaukee Alliance; BCCD: Belknap County Conservation District; CCCD: Caroll County Conservation District; LRPC: Lakes Region Planning Commission; CWSRF: Clean Water State Revolving Fund; NH ARM: NH Aquatic Resource Mitigation Fund; NFWF: National Fish & Wildlife Foundation; NFRF: Northeast Forests and Rivers Fund; NAWCA: North American Wetlands Conservation Act; LCHIP: Land and Community Heritage Investment Program; RCCP: Regional Conservation Partnership Program; LWCF: Land and Water Conservation Fund; ACEP: Agricultural Conservation Easement Program, CSP: Conservation Stewardship Program; EQIP: Environmental Quality Incentives Program.

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
1. Watershed & Shoreline BMPs			
1.a. Complete design and construction of mitigation measures at the four high priority sites identified in the watershed survey. **Achieves a total reduction of 2.4 kg/yr P.**	LWA, CCCD, BCCD, LRPC, Municipalities, private landowners	$100K-$300K 2026–35	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
1.b. Complete design and construction of mitigation measures at nine medium priority sites identified in the watershed survey as opportunities arise. **Achieves a total reduction of 5.9 kg/yr P.**	LWA, CCCD, BCCD, LRPC, Municipalities, private landowners	$200K-$425K 2026–35	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
1.c. Complete design and construction of mitigation measures at six low priority sites identified in the watershed survey as opportunities arise. **Achieves a total reduction of 2.5 kg/yr P.**	LWA, CCCD, BCCD, LRPC, Municipalities, private landowners	$60K-$120K 2026–35	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners

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

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
1.d. Continue promoting the Be Winni Blue/LakeSmart program evaluations and certifications through NH Lakes to educate property owners about lake-friendly practices such as revegetating shoreline buffers with native plants, avoiding large grassy areas, and increasing mower blade heights to 4 inches. Coordinate with NHDES Soak Up the Rain NH program for workshops and trainings. Cost assumes coordination and materials for up to 10 workshops.	LWA, CCCD, BCCD, LRPC, NH Lakes, NHDES Soak Up the Rain NH, Municipalities	$20K-$30K 2026–35	NH Lakes, NHDES Soak Up the Rain NH, Grants (319, Moose plate), CWSRF, Municipalities
1.e. Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install stormwater and/or erosion controls such as rain gardens and buffer plantings. Prioritize high impact properties identified during the shoreline survey. Cost assumes technical assistance and implementation cost sharing provided to the 334 prioritized shoreline properties. With a 50% BMP removal efficiency rate this would amount to **a reduction of 57 kg/yr P (achieves 4.6% of Objective 1).**	LWA, CCCD, BCCD, LRPC, Municipalities, private landowners	$1M-$1.25M 2026–35	Grants (319, Moose plate), CWSRF, private landowners
1.f. Repeat the shoreline survey in 5–10 years when updating the WMP. Use the results to target education and technical assistance for high impact sites. Cost assumes hired consultant for survey and summation of shoreline survey results.	LWA, Municipalities	$25K 2030, 2035	Municipalities, Grants (Moose plate), CWSRF
1.g. Provide technical support to local marinas like the West Alton Marina to ensure proper pump-out facilities and washing stations are preventing contamination of the lake.	LWA	TBD 2026–35	CWSRF, Grants (Moose Plate), Municipalities
1.h. Address the external load reduction opportunities identified in WMPs for Alton Bay, Center Harbor Bay, Meredith Bay, Sanders Bay, Moultonborough Bay, Winter Harbor, and Wolfeboro Bay, which all mix with the Broads and impact its water quality. Addressing all impacts outside of those identified within the Broads itself would **achieve 89% (1,085 kg/yr P reduction) of Objective 1**.	LWA, Cyanobacteria Mitigation Steering Committee of New Durham/Alton, Municipalities, NHDES (Powder Mill State Fish Hatchery)	$15M-$20M 2026-2035	Grants (319, Moose Plate), CWSRF, Municipalities
1.i. Address recommendations for culverts and closed drainage systems assessed as having 'Poor' condition or identified as needing maintenance within the Broads watershed on the NH Statewide Asset Data Exchange	Municipalities, NHDOT	TBD 2026-2035	Municipalities, CWSRF

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
System (SADES). The Lakes Regional Planning Commission recently completed an in-depth assessment of these structures within Gilford (LRPC, 2024).			
2. Road Management			
2.a. Review practices for road and drainage maintenance currently used by public and private entities/groups and determine areas for improvement.	Municipalities, LWA, CCCD, BCCD, LRPC	$10K 2026	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
2.b. Provide education and training to contractors and municipal staff on protocols for road maintenance best practices. Assumes one workshop. Consider holding joint workshop with other Lake Winnipesaukee region municipalities (or other wider service area) for cost sharing savings.	Municipalities, LWA, CCCD, BCCD, LRPC	$15K 2026	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
2.c. Develop and/or update a written protocol for road maintenance best practices.	Municipalities, LWA, CCCD, BCCD, LRPC	$20K 2026	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
2.d. Incorporate water quality considerations and strategies into roadway evaluations and action plans.	Municipalities, LWA, CCCD, BCCD, LRPC	N/A 2026–35	Municipalities
2.e. Establish inspection and maintenance agreements for private unpaved roads. Cost does not include the implementation of proper road maintenance by private landowners and assumes that municipalities can accommodate this additional effort in current budgets.	Municipalities, private landowners	N/A 2026–35	Municipalities, private landowners
2.f. Hold informational workshops on proper road management and winter maintenance and provide educational materials for homeowners about winter maintenance and sand/salt application for driveways and walkways. Cost assumes up to five workshops.	LWA, CCCD, BCCD, Municipalities, private landowners	$10K 2026–35	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star), private landowners
3. Municipal Operations			

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
3.a. Review and optimize MS4 compliance for towns (regardless of MS4 designation), including infrastructure mapping, erosion and sediment controls, illicit discharge programs, and good housekeeping practices. Sweep municipal paved roads and parking lots two times per year (spring and fall).	Municipalities (Public Works/Highway)	TBD 2026–35	Municipalities
3.b. Participate in the Municipal Green SnowPro Program. Complete training to become Green SnowPro Certified.	Municipalities (Public Works/Highway)	Est. $150-$250/person 2026–35	Municipalities
3.c. Review and update winter operations procedures to be consistent with Green SnowPro best management practices for winter road, parking lot, and sidewalk maintenance.	Municipalities (Public Works/Highway)	N/A 2026	Municipalities
3.d. In Alton, Gilford and Tuftonboro, adopt policies to either eliminate fertilizer applications on town properties or implement best practices for fertilizer management (to minimize application and transport of phosphorus). Consider extending these regulations to private properties as well.	Municipalities (Public Works/Highway)	N/A 2026-35	Municipalities
3.e. Develop best practice design standards for stormwater control measures, including deep sump catch basins.	Municipalities (Public Works/Highway)	N/A 2026	Municipalities
4. Municipal Land Use Planning & Zoning			
4.a. Present WMP recommendations to Select Boards and Planning Boards in Alton, Gilford, and Tuftonboro. Cost assumes presentations conducted by LWA or volunteers.	LWA	N/A 2026	LWA
4.b. Meet with municipal staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, low impact development, and open space. Cost assumes meetings conducted by LWA.	LWA, Municipalities	N/A 2026-29	LWA, Municipalities

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
4.c. Incorporate WMP recommendations into municipal master plans and encourage regular review of the WMP action plan.	Municipalities	N/A 2026–35	Municipalities
4.d. Adopt/strengthen zoning ordinance provisions and enforcement mechanisms (refer to NHDES, 2008): 1) to promote low impact development practices, particularly impervious cover limits that incorporate Effective Impervious Cover regulations per UNH Stormwater Center, CEI & NHDES (2025); 2) to require stormwater regulations that align with MS4 Permit requirements; 3) to promote or require vegetative buffers around lake shore and tributary streams; 4) to require shorefront “tear down and replace” home construction to be no more non-conforming than existing structures; 5) to require shorefront seasonal to year-round conversions of homes to demonstrate no additional negative impacts to lake water quality; 6) to establish a lake protection overlay zoning ordinance that prohibits erosion from sites in sensitive areas (e.g., lake shorefront, along lake tributaries, steep slopes); and 7) to enhance performance standards for unpaved roads to prevent erosion and protect lake water quality.	Municipalities	N/A 2026–35	Municipalities
4.e. Increase municipal staff capacity for inspections and enforcement of stormwater regulations on public and private lands.	Municipalities	TBD 2026–35	Municipalities
5. Land Conservation			
5.a. Develop a Natural Resources Inventory (NRI) for Tuftonboro (Alton completed an NRI in 2022 and Gilford in 2021). This was also identified as a high priority in Tuftonboro's 2022 Master Plan.	Municipalities, Conservation Commissions	$20K-$30K per municipality 2026-28	Municipalities, Grants (NFWF NFRF), CWSRF

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
5.b. Create a priority list of watershed areas that need protection based on NRIs. Refer to Section 4.2.3 to understand current conservation lands and valuable habitats and wildlife in the watershed that can be used to help identify potential areas to target for conservation.	LWA, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts	$4K-$8K 2026-28	Grants (NFWF NFRF, NAWCA), CWSRF, Municipalities
5.c. Identify potential conservation buyers and property owners interested in easements within the watershed. Use available funding mechanisms, such as the Regional Conservation Partnership Program (RCPP) and the Land and Community Heritage Investment Program (LCHIP), to provide conservation assistance to landowners.	LWA, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts	N/A 2026-28	Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP)
5.d. Maximize conservation of intact forest and other ecologically important properties through education, zoning, and public or private conservation.	LWA, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts, private landowners	TBD 2026–35	Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NFRF), Municipalities, private landowners
6. Septic System Management			
6.a. Distribute educational materials to property owners about septic system function and maintenance. Ensure wide distribution while targeting the 742 Broads shoreline parcels with septic systems older than 25 years. Reducing external load from old septic systems would **achieve 74.2 kg/yr P reduction (achieves 6.0% of Objective 1).**	Municipalities, LWA	$20K 2026, 2029, 2034	Municipalities, Grant (319), CWSRF
6.b. Look into whether any septic pumping companies would give a quantity discount or a member's discount to incentivize septic system pumping.	LWA	N/A 2026–35	LWA

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
6.c. Evaluate locations of older and/or noncompliant septic systems (including cesspools or holding tanks) to identify clusters where conversion to community septic systems might be desirable.	LWA, Municipalities	TBD 2026	CWSRF, Municipalities
6.d. Enforce inspection for all home conversions (from seasonal to permanent residences) and property sales to ensure systems are sized and designed properly. Require upgrades if needed. Prioritize shorefront properties around Lake Winnipesaukee.	Municipalities	N/A 2026-35	Municipalities
6.e. Develop and maintain a septic system database for the watershed to facilitate code enforcement of any septic system ordinances.	Municipalities	$5K-$10K 2026-35	Municipalities, CWSRF
6.f. Institute a minimum pump-out/inspection interval for shorefront septic systems (e.g., once every 3–5 years). Pump-outs (~$250 per system) are the responsibility of the owner.	Municipalities	N/A 2026-28	Municipalities, private landowners
6.g. Inspect and evaluate sanitary sewer system and address identified leaks and overflows, especially in areas near Lake Winnipesaukee and its tributary streams.	Municipalities	TBD 2026-35	Municipalities
7. Agricultural Practices			
7.a. Work with NRCS to implement soil conservation practices such as cover crops, no-till methods, and others which reduce erosion and nutrient pollution to surface waters from agricultural fields.	NRCS, farm owners	TBD 2026–35	Grants, NRCS
8. Education & Outreach			
8.a. Share additional/dynamic information on the Lake Winnipesaukee Alliance website, such as water quality data, loon activity, weather conditions, and webcam, to generate more traffic to the website.	LWA	TBD 2026-27	Grants
8.b. Educate managers of private boat launches about invasive species management, in addition to the existing lake host program that operates at public boat launches.	LWA	$10K 2026, 2030, 2035	Grants (NHDES AIPC)

Action Item	Responsible Party	Estimated Cost & Schedule	Potential Funding Sources
8.c. Offer workshops for landowners with 10 acres or more for NRCS assistance with land conservation. Cost assumes up to two workshops.	LWA	$5K 2026-30	Grants (RCCP, ACEP, CSP, EQIP)
8.d. Encourage private property owners to hire Green SnowPro certified commercial salt applicators.	LWA, CCCD, BCCD, LRPC, Municipalities	N/A 2026–35	LWA, CCCD, Municipalities
8.e. Educate contractors and municipal staff about erosion and sediment control (ESC) practices required on plans. Work with municipalities to ensure that there are sufficient resources to enforce permitting conditions.	Municipalities, LWA, CCCD, BCCD, LRPC	$6K 2026-28	Municipalities, Grants (319), CWSRF
8.f. Create flyers/brochures or other educational materials through printed or online mediums, regarding topics such as stormwater controls, road maintenance, buffer improvements, fertilizer and pesticide use, pet waste disposal, boat pollution, invasive aquatic species, waterfowl feeding, and septic system maintenance. Consider creating a "watershed homeowner" packet that covers these topics and is distributed (mailed separately or in tax bills or posted at community gathering locations or events) to existing and new property owners, as well as renters. Hold 1–2 informational workshops per year to update the public on restoration progress and ways that individuals can help. Cost is highly variable.	Municipalities, LWA, CCCD, BCCD, LRPC	$20K-$60K 2026-35	Municipalities, Grants (319), CWSRF
8.g. Collaborate with NH Lakes on legislative or advocacy issues such as boat speed limits.	LWA, NH Lakes	N/A 2026–35	Grants
8.h. Establish a Weed Watchers team for Lake Winnipesaukee.	LWA, NH Lakes, Municipalities	N/A 2026–35	LWA, NH Lakes, Municipalities
8.i. Secure Lake Host participation at the West Alton Marina. Lake Host volunteers can provide boat inspections and education on invasive plant species.	LWA, Private Landowners, Volunteers	N/A 2026-35	LWA, Municipalities, Private Landowners

5.2 POLLUTANT LOAD REDUCTIONS

To meet the water quality goal, Objective 1 set a target phosphorus load reduction of **1,244 kg/yr** to achieve a summertime in-lake total phosphorus concentration of 4.0 ppb, which meets state water quality standards for oligotrophic waterbodies and is anticipated to reduce the likelihood of cyanobacteria blooms within the Broads. The following opportunities for phosphorus load reductions to achieve Objective 1 were identified in the watershed based on field and desktop analyses:

- Remediating the 20 watershed survey sites could prevent up to **10.9 kg/yr** of phosphorus load from entering Lake Winnipesaukee within the Broads sub-watershed.
- Treating the 334 prioritized shoreline survey sites could reduce the phosphorus load to the Broads by **56.5 kg/yr**.
- Upgrading the approximately 734 shorefront septic systems older than 25 years is estimated to reduce the phosphorus load to the Broads by **73.4 kg/yr**.

Addressing these field-identified phosphorus load reduction opportunities coming from the external watershed load could reduce the phosphorus load to the Broads by **141 kg/yr**, meeting 12% of the needed reductions to achieve Objective 1 (Table 17). Achieving the load reductions needed to meet the water quality goals identified in the WMPs for Alton Bay, Center Harbor Bay, Wolfeboro Bay, Sanders Bay, Moultonborough Bay, and Winter Harbor will result in a reduction of an **additional 1,085 kg/yr** phosphorus to the Broads. Altogether, achieving the goals for these watersheds and for the Broads would meet **100%** of Objective 1 for the Broads.

Objective 2 (preventing or offsetting additional phosphorus loading from anticipated new development) can be met through ordinance revisions that implement LID strategies, limit impervious cover, and encourage cluster development with open space protection and/or through conservation of key parcels of forested and/or open land.

While the objectives focus on phosphorus, the treatment of stormwater and sediment will also reduce many other water pollutants. These include other nutrients (e.g., nitrogen), petroleum products, bacteria, road salt/sand, excessive organic material (raking/blowing leaves and grass cuttings, erosion from boat wakes), and heavy metals (cadmium, nickel, zinc, etc.). Without a monitoring program in place to measure these other pollutants, it will be difficult to track the success of efforts that reduce these other pollutants. However, various spreadsheet models are available to estimate reductions in these pollutants based on BMPs installed which can help track and assess long-term response.

Table 17. Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal (Objective 1) and that reflect all field identified reduction opportunities in the watershed. Reduction percentages are based on the current condition value for each parameter.

Parameter	**Unit**	**Current Condition**	**Target Condition**	**Reduction** (Amount, % change)
Total P Load (All Sources)[1]	kg/yr	10,642	9,416	-1,226 (11%)
(A) Background P Load[2]	kg/yr	4,128	4,128	0 (0%)
(B) Disturbed (Human) P Load[3]	kg/yr	6,514	5,288	-1,226 (19%)
(C) Developed Land Use and Shorefront Septic System P Load[4]	kg/yr	6,450	5,224	-1,226 (19%)
(D) Internal P Load (Broads)	kg/yr	64	64	0 (0%)
In-Lake TP (summer)*	ppb	5.7	4.9	-0.8 (14%)
In-Lake Chl-a*	ppb	1.5	1.2	-0.3 (20%)
In-Lake SDT*	meters	10.4	10.4	0 (0%)
In-Lake Bloom Probability*	days	0	0	0 (0%)

[1] Total P Load (All Sources) = A + B.
[2] Sum of forested/water/natural land use load, waterfowl load, and atmospheric load.
[3] Sum of developed land use load and shorefront septic system load, and internal load (B = C + D).
[4] Sum of developed land use and shorefront septic system P load from the Broads Direct Drainage, Wolfeboro Bay, Moultonborough Bay, Winter Harbor, Center Harbor Bay, Meredith & Sanders Bay, and Alton Bay.
* Water quality parameters were sourced from the model except for SDT, which has a higher observed value than the model predicts.

6 PLAN IMPLEMENTATION & EVALUATION

The following section details the oversight and estimated costs (with funding strategy) needed to implement the action items recommended in the Action Plan (Section 5), as well as the monitoring plan and indicators to measure progress of plan implementation over time.

6.1 PLAN OVERSIGHT

The recommendations of this plan will be carried out largely by LWA with assistance from a diverse stakeholder group, including representatives from the municipalities (e.g., select boards, planning boards), conservation commissions, state and federal agencies or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners. LWA and an established committee will need to meet regularly and work hard to coordinate resources across stakeholder groups to fund and implement the management actions. The Action Plan (Section 5) will need to be updated periodically (typically every 2, 5, and 10 years) to ensure progress and to incorporate any changes in watershed activities. Measurable milestones (e.g., number of BMP sites, volunteers, funding received, etc.) should be tracked by the committee.

The Action Plan (Section 5) identifies the stakeholder groups responsible for each action item. Generally, the following responsibilities are noted for each key stakeholder:

- **LWA** will be responsible for plan oversight and implementation. LWA will assist with water quality monitoring, facilitate outreach activities and watershed stewardship, and raise funds for stewardship work.
- **Municipalities** will work to address NPS problems identified in the watershed, including conducting regular best practices maintenance on roads, adopting ordinances for water quality protection, and addressing other recommended actions specified in the Action Plan. LWA can work with each municipality to provide support in reviewing and tailoring the recommendations to fit the specific needs of each community.
- **Conservation Commissions** will work with municipal staff and boards to facilitate the implementation of the recommended actions specified in the Action Plan.
- **BCCD and CCCD** can provide administrative capacity and help acquire grant funding for BMP implementation projects and education/outreach to watershed residents and municipalities.
- **NHDES** can provide technical assistance, permit approval, and the opportunity for financial assistance through the 319 Watershed Assistance Grant Program and other funding programs.
- **Private Landowners** will seek opportunities for increased awareness of water quality protection issues and initiatives and conduct activities in a manner that minimizes pollutant impact to surface waters.

The success of this plan is dependent on the continued effort of volunteers and a strong and diverse committee that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim milestones. A reduction in nutrient loading is no easy task, and because there are many diffuse sources of phosphorus reaching the rivers, lakes, and ponds from existing development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.

6.2 ESTIMATED COSTS

The strategy for reducing pollutant loading to the Broads to meet the water quality goal and objectives set in Section 2.5 will be dependent on available funding and labor resources but will include approaches that address sources of phosphorus loading, as well as water quality monitoring and education and outreach. Additional significant but difficult to quantify strategies for reducing phosphorus loading to the lake are revising local ordinances such as setting LID requirements on new construction, identifying and replacing malfunctioning septic systems, performing proper road maintenance, and improving agricultural practices (refer to Section 5: Action Plan for more details). With a dedicated stakeholder group in place and with the help of grant or local funding, it is possible to achieve the target phosphorus reductions and meet the established water quality goal for the Broads in the next 10 years. **The cost of successfully implementing the plan is estimated to be at least $1.5-$2.4 million over the next 10 or more years** (Table 18), excluding recommended actions for surrounding watersheds (Action Item 1.h. in the Action Plan). However, many costs are still unknown or were roughly

estimated and should be updated as information becomes available. In addition, costs to private landowners (e.g., septic system upgrades, private road maintenance, etc.) are not reflected in the estimate.

Table 18. Estimated total phosphorus (TP) reductions and costs for implementation of the Action Plan. The light gray shaded planning actions are necessary to achieve the water quality goal. Other planning actions are important but difficult to quantify for TP reduction and costs, the latter of which were roughly estimated here as general placeholders.

Planning Action	TP Reduction (kg/yr)	Estimated Total Cost	Estimated Annual Cost
Watershed & Shoreline BMPs[1]	68	$1,405,000–$2,150,000	$140,500–$215,000
Road Management	TBD	$55,000	$5,500
Municipal Operations[2]	TBD	$1,250–$2,500 +	$125–$250 +
Municipal Land Use Planning & Zoning	TBD	TBD	TBD
Land Conservation	TBD	$24,000–$38,000	$2,400–$3,800
Septic System Management[3]	74	$25,000–$30,000	$2,500–$3,000
Agricultural Practices	TBD	TBD	TBD
Education & Outreach	TBD	$41,000–$81,000	$4,100–$8,100
Total	**142**	**$1,551,250–$2,354,000**	**$155,125–$235,400**

[1] The TP reduction and estimated costs excludes Item 1.h. in the Action Plan, i.e. watershed and shoreline BMPs identified in Lake Winnipesaukee watersheds surrounding the Broads. The costs and TP reductions are included in those WMPs.

[2] The cost of municipal operations as a planning action only reflects the cost of the Green SnowPro Program course for employees, not other items shown in the Action Plan.

[3] Septic system management only reflects shoreline septic systems, and does not include the cost of inspecting, repairing, or replacing private septic systems.

6.3 FUNDING STRATEGY

It is important that the committee develop a strategy to collect the funds necessary to implement the recommendations listed in the Action Plan (Section 5). Funding to cover ordinance revisions and third-party review could be supported by municipalities through tax collection (as approved by majority vote by town residents). Monitoring and assessment funding could come from a variety of sources, including state and federal grants, municipalities, or donations. Funding to improve septic systems, roads, and shoreland zone buffers would likely come from property owners. As the plan evolves into the future, the establishment of a funding subcommittee will be a key part in how funds are raised, tracked, and spent to implement and support the plan. Listed below are state and federal funding sources that could assist the committee with future water quality and watershed work in the Broads.

Funding Options:

- **EPA/NHDES 319 Grants (Watershed Assistance Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management Program Plan, updated 2024) and protect high quality waters. 319 grants are available for the implementation of watershed-based plans and typically fund $50,000 to $150,000 projects over the course of two years.
- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. The total SCC grant request per application cannot exceed $40,000.
- **Land and Community Heritage Investment Program (LCHIP)** – This grant provides matching funds to help municipalities and nonprofits protect the state's natural, historical, and cultural resources.

- **Aquatic Resource Mitigation Fund (ARM)** – This grant provides funds for projects that protect, restore, or enhance wetlands and streams to compensate for impacted aquatic resources. The fund is managed by the NHDES Wetlands Bureau that oversees the state In-Lieu Fee (ILF) compensatory mitigation program. A permittee can make a payment to NHDES to mitigate or offset losses to natural resources because of a project's impact to the environment.
- **Northeast Forests and Rivers Fund (NFWF NFRF)** – This National Fish and Wildlife Foundation grant awards $75,000 to $300,000 to projects that restore and sustain healthy forests and rivers through habitat restoration, fish barrier removal, and stream connectivity such as culvert upgrades.
- **Aquatic Invasive Plant Control, Prevention and Research Grants (NHDES AIPC)** – Funds are available each year for projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities.
- **Clean Water State Revolving Fund (NHDES CWSRF)** – This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund NPS pollution prevention, watershed protection and restoration, and estuary management projects that help improve and protect water quality in NH.
- **Drinking Water & Groundwater Trust Fund Source Water Protection Program (NHDES DWGTF SWP)** – The SWP program provides grants to permanently protect drinking water supply lands in New Hampshire, including land that falls within wellhead protection areas, hydrologic areas of concern, high-yield stratified drift aquifers classified as GA2, and/or land that the Advisory Commission has determined will likely benefit a future public or community public water system.
- **Regional Conservation Partnership Program (RCCP)** – This NRCS grant provides conservation assistance to producers and landowners for projects carried out on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges. Eligible activities include land management restoration practices, entity-held easements, and public works/watershed conservation activities.
- **Agricultural Conservation Easement Program (ACEP)** – This NRCS grant protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting, restoring, and enhancing wetlands on eligible land. Eligible applicants include private landowners of agricultural land, cropland, rangeland, grassland, pastureland, and non-industrial private forestland.
- **Conservation Stewardship Program (CSP)** – This NRCS grant helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Eligible lands include private agricultural lands, non-industrial private forestland, farmstead, and associated agricultural lands, and public land that is under control of the applicant.
- **Environmental Quality Incentives Program (EQIP)** – This NRCS grant provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits. Eligible applicants include agricultural producers, owners of non-industrial private forestland, water management entities, etc.
- **National Fish and Wildlife Federation Five Star and Urban Waters Restoration Grants (NFWF 5-Star)** –Grants seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Eligible projects include wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure BMPs; water quality monitoring/assessment; outreach and education.
- **North American Wetlands Conservation Act (NAWCA) U.S. Standard Grants** – The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the North American Wetlands Conservation Act (NAWCA). These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds.
- **National Park Service – Land and Water Conservation Fund Grant Program (LWCF)** – Eligible projects include acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and

development of trails. Municipalities must have an up-to-date Open Space and Recreation Plan. Trails constructed using grant funds must be ADA-compliant.

6.4 MONITORING PLAN

A long-term water quality monitoring plan is critical to evaluate the effectiveness of implementation efforts over time. The UNH LLMP has been monitoring the Lakes Region's waterbodies for decades, providing valuable water quality data to communities that would otherwise not exist. LWA, in concert with the LLMP, should continue and consider expanding upon the following annual monitoring:



NHDES requires **dissolved oxygen** samples to meet stringent requirements to be included in State assessment. These requirements are intended to ensure that dissolved oxygen data is consistent and represents the highest stress periods of the year and time of day (June 1 to September 30 and between 10am and 2pm). Samples also must be collected from the epilimnion (defined as the surface to the first 1 or more ˚C change in temperature). To meet Class B standards, no more than two or 10% of samples (whichever is greater) that meet these requirements can have a dissolved oxygen concentration less than 5 mg/L.

- Continue to monitor the active sites within the Broads, including the Broads deep spot (WINBGILD), 26 Alton Deep (WIN26DL), and Black Point Deep (WINBLKPNT), for all parameters included in the UNH LLMP protocol. This includes sampling three to five times each summer (June-September or October) for at least total phosphorus (epilimnion, metalimnion, and hypolimnion), chlorophyll-a (composite or epilimnion), Secchi disk transparency, and dissolved oxygen-temperature profiles to the lake bottom.
    - Ensure that dissolved oxygen-temperature profiles are being collected concurrently with sampling of lake deep spot stations and consider collecting profiles at a higher frequency (e.g., every two weeks from May-October).
    - Consider purchasing a ~70-meter cord handheld meter for LWA to reach the bottom of the deepest area of Lake Winnipesaukee.
    - Consider adding total nitrogen and the nitrogen species (total dissolved nitrogen, nitrate-nitrite, and ammonium) to routine lake sampling.
- Continue to monitor the lake for cyanobacteria blooms and alert NHDES immediately when suspected. Coordinate with NHDES to collect samples for analysis.
- Monitor total phosphorus and flow (as well as specific conductance, chloride, temperature, and/or turbidity, if able) at major tributary inflows to the Broads (Poorfarm Brook, West Alton Brook, and Hurd Brook), at least two to five times per year each summer, specifically targeting wet and dry weather conditions.
- Continue monthly samples for speciation and enumeration of phytoplankton and zooplankton in the water column at WINBGILD.
- Continue collaboration with NHDES to monitor spiny water flea populations.
- Consider expanding cyanotoxin testing, fluorometry, and picocyanobacteria analysis via e-DNA (through the Bigelow Laboratory for Ocean Sciences) to include the Broads.

6.5 INDICATORS TO MEASURE PROGRESS

The following environmental, programmatic, and social indicators and associated numeric targets (milestones) will help to quantitatively measure the progress of this plan in meeting the established goal and objectives for the Broads watershed (Table 19). These benchmarks represent short-term (2026), mid-term (2030), and long-term (2035) targets derived directly from actions identified in the Action Plan (Section 5). Setting milestones allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. The committee should review the milestones for each indicator on an ongoing basis to determine if progress is being made, and then determine if the plan needs to be revised because the targets are not being met.

Environmental Indicators are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They assume that recommendations outlined in the Action Plan (Section 5) will be implemented accordingly and will result in the improvement of water quality. **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. **Social Indicators** measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement.

Table 19. Environmental, programmatic, and social indicators for the Broads Watershed-Based Management Plan. Milestones are cumulative, starting in Year 1 (2026). ** indicators particularly relevant to assessing progress toward achieving the water quality goal and objectives.

Indicators	Milestones		
	2026	2030	2035
ENVIRONMENTAL INDICATORS			
Achieve an average summer deep spot epilimnion total phosphorus concentration of 4.0 ppb at the deep spot station in the Broads	<4.6 ppb	<4.3 ppb	<4.0 ppb
Achieve an average summer deep spot epilimnion chlorophyll-a concentration of 1.2 ppb at the deep spot station in the Broads	<1.5 ppb	<1.3 ppb	<1.2 ppb
Eliminate the occurrence of cyanobacteria or algal blooms in the Broads (milestones based on observed data from 2024)**	<17 days/yr	<7 days/yr	0 days/yr
Maintain an average summer water clarity of 10 m or deeper at the deep spot station in the Broads	10+ m	10.5+ m	11+ m
Control the proliferation of spiny water flea and variable milfoil in the Broads	Invasives Controlled	Invasives Controlled	Invasives Controlled
Prevent the introduction of new invasive aquatic species in the Broads	No New Invasives	No New Invasives	No New Invasives
PROGRAMMATIC INDICATORS			
Amount of funding secured from municipal/private work, fundraisers, donations, and grants	$200,000	$1,000,000	$2,000,000
Number of NPS sites remediated (20 identified)**	5	10	20
Linear feet of buffers improved in the shoreland zone**	5,000	25,000	50,000
Percentage of shorefront properties with LakeSmart certification	20%	30%	50%
Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing	30	150	300
Number of workshops and trainings for stormwater improvements to residential properties (e.g., NHDES Soak Up the Rain NH program)	2	5	10
Number of updated or new ordinances that target water quality protection	1	2	5
Number of new municipal staff for inspections and enforcement of regulations	1	1	2
Number of voluntary or required septic system inspections (seasonal conversion and property transfer)	5	10	25
Number of septic system upgrades	15	75	150
Number of informational workshops and/or trainings for landowners, municipal staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best practices for road management and winter maintenance	2	5	10
Number of parcels with new conservation easements or number of parcels put into permanent conservation	3	10	20
Number of copies of watershed-based educational materials distributed or articles published	200	500	1,000
Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities	2	5	10
Number of municipalities fully implementing key aspects of the MS4 program	2	3	6
Number of meetings and/or presentations to municipal staff and/or boards related to the WMP	2	10	20

Indicators	Milestones		
	2026	2030	2035
Number of CNMPs completed or NRCS technical assistance provided for farms in the watershed	1	2	4
SOCIAL INDICATORS			
Number of new LWA supporters (mailing list additions, volunteers, etc.)	5	10	15
Number of volunteers participating in educational campaigns	5	10	25
Number of people participating in informational meetings, workshops, trainings, BMP demonstrations, or group septic system pumping	25	50	100
Number of watershed residents installing conservation practices on their property and/or participating in LakeSmart	30	150	300
Number of municipal DPW staff receiving Green SnowPro training	1	3	5
Number of groups or individuals contributing funds for plan implementation	25	50	100
Number of newly trained water quality and invasive species monitors	2	10	15
Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance	10%	25%	50%
Number of farmers working with NRCS, BCCD, or CCCD	1	2	4
Number of daily visitors to the LWA website	10	25	50



Photo credit: Harrison Flagg, One If By Land Productions

ADDITIONAL RESOURCES

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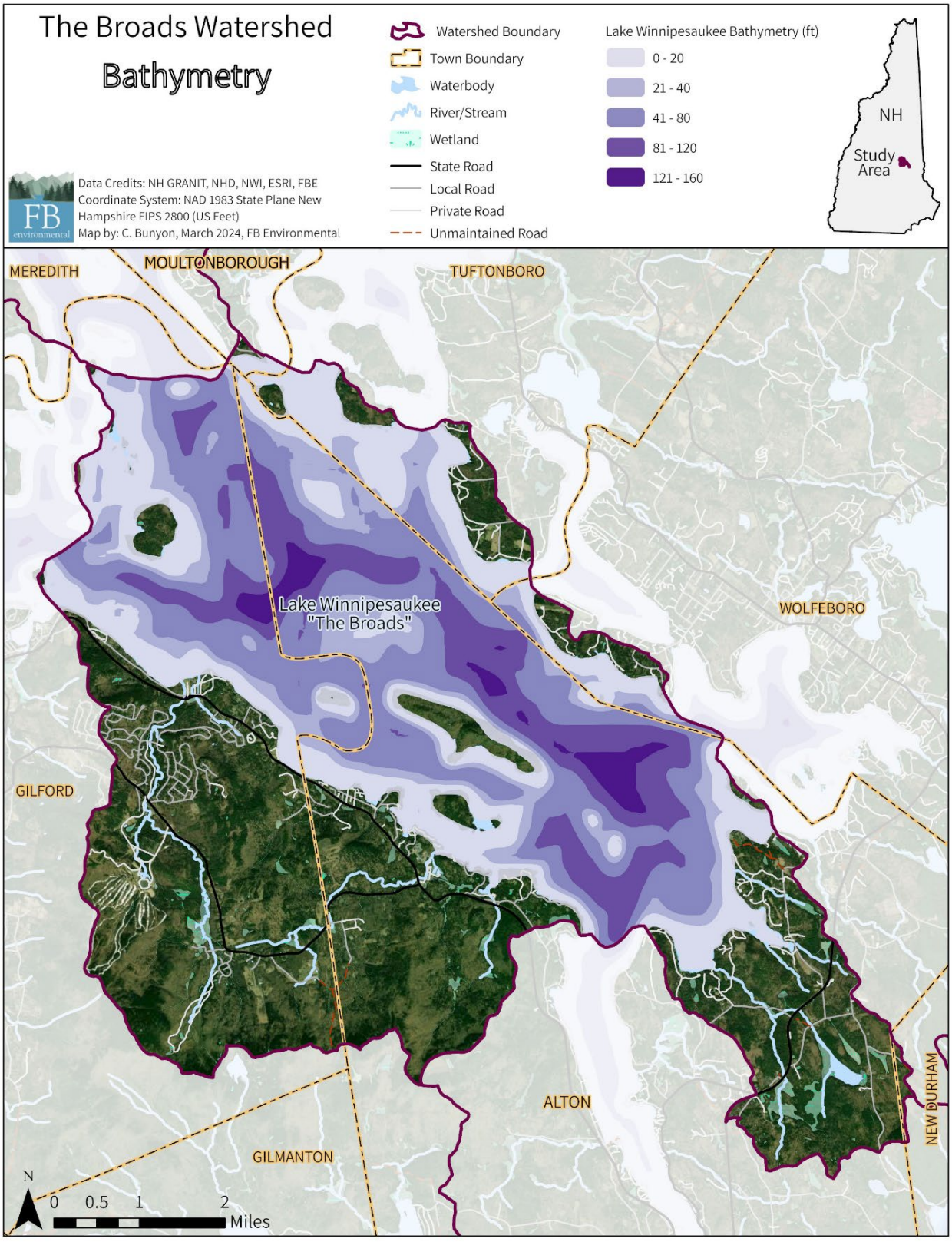
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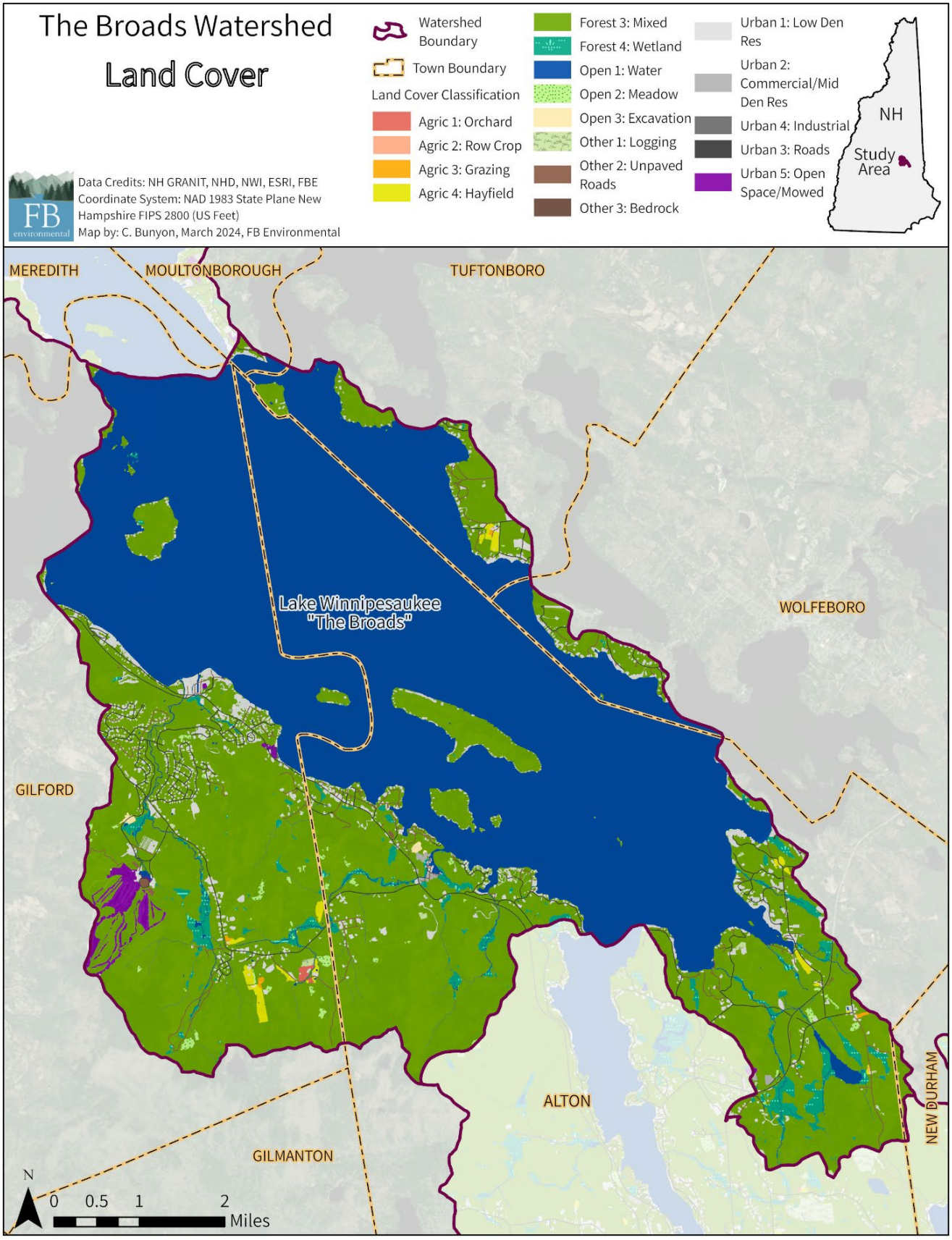
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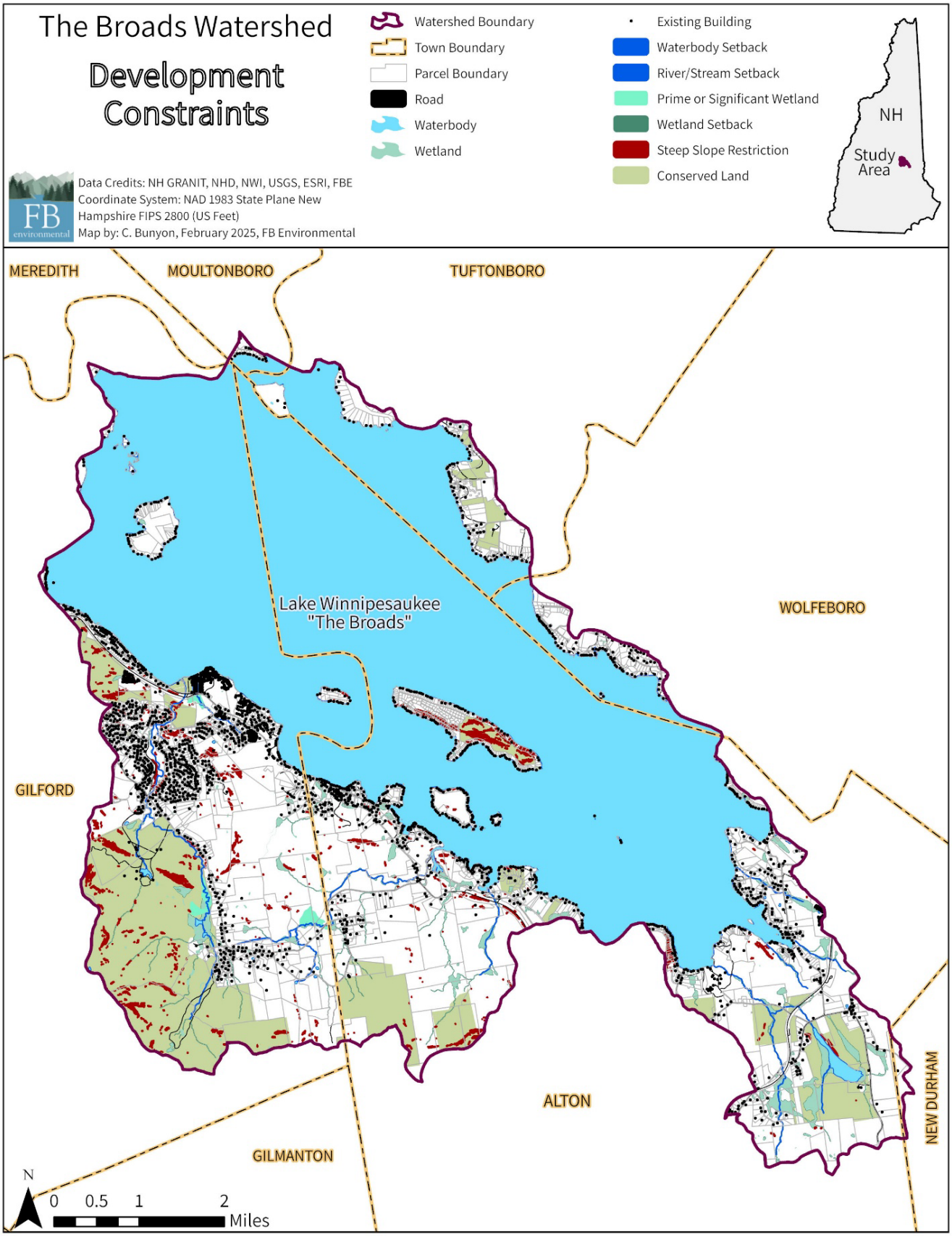
APPENDIX A: SUPPORTING MAPS



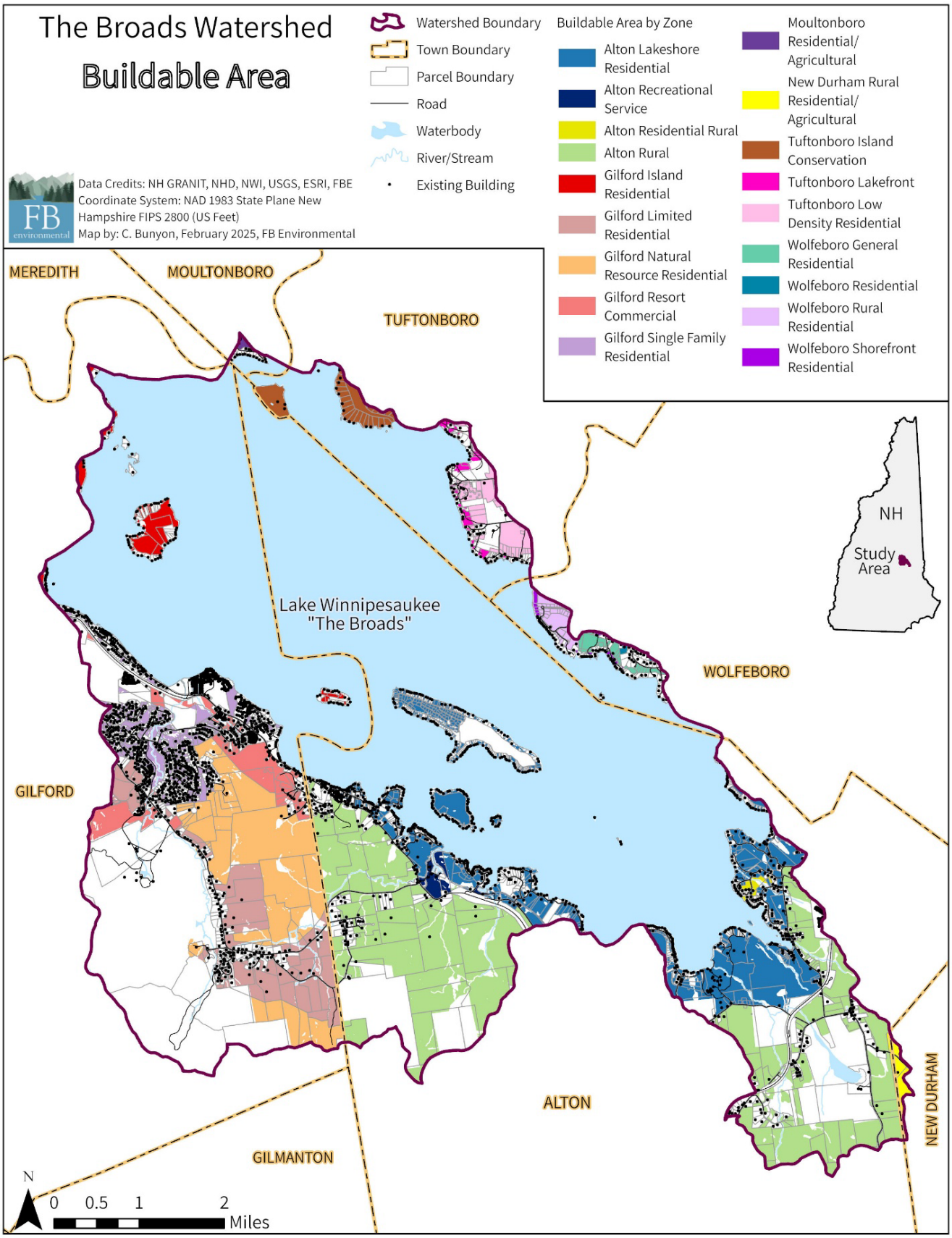
Map A-1. Bathymetry as 20-foot depth contours for the Broads (Lake Winnipesaukee).



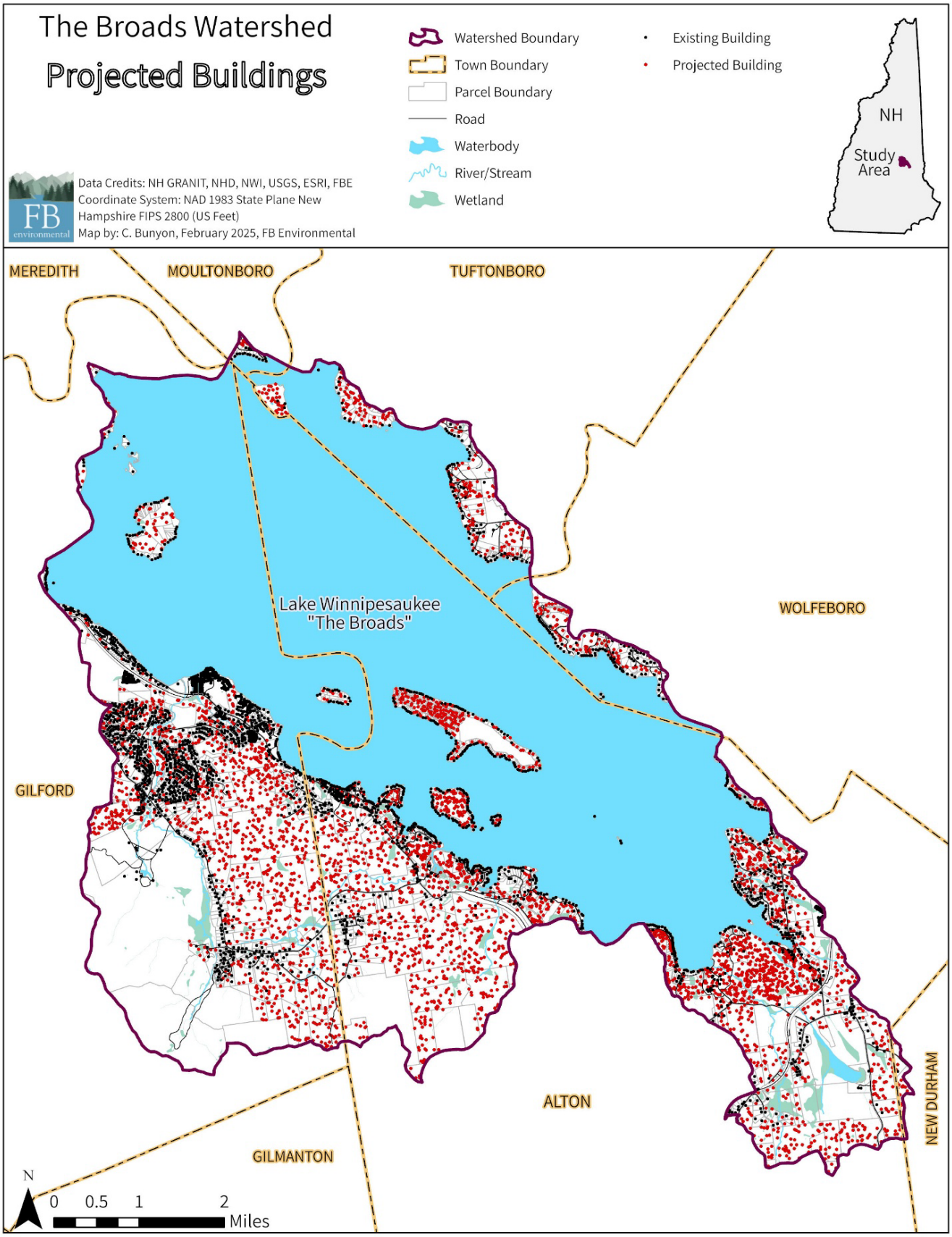
Map A-2. Land cover for the Broads watershed.



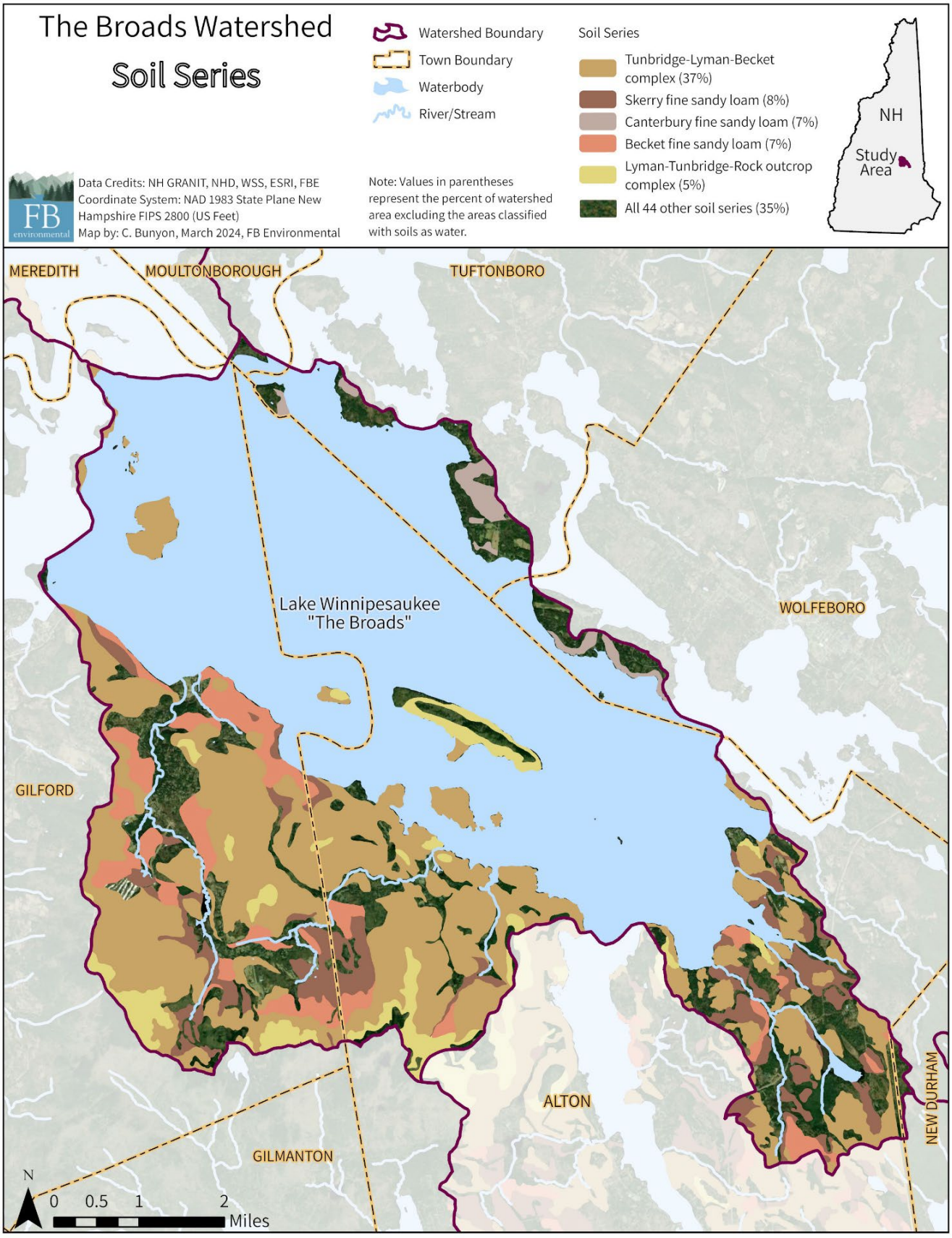
Map A-3. Development constraints (including existing buildings) in the Broads watershed in Alton, Gilford, Moultonborough, Tuftonboro, Wolfeboro, and New Durham, New Hampshire.



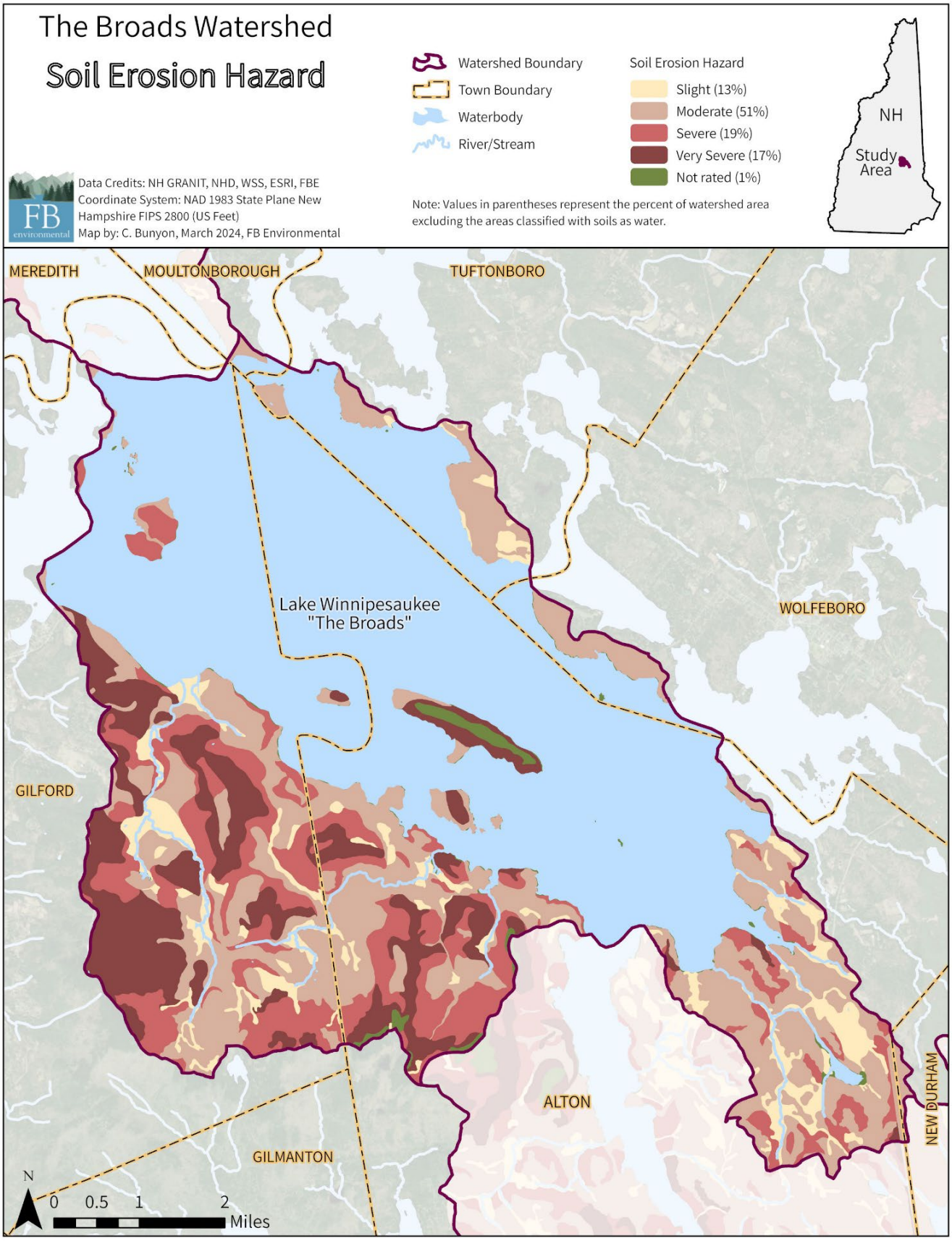
Map A-4. Buildable area by municipal zone in the Broads watershed in Alton, Gilford, Moultonborough, Tuftonboro, Wolfeboro, and New Durham, New Hampshire.



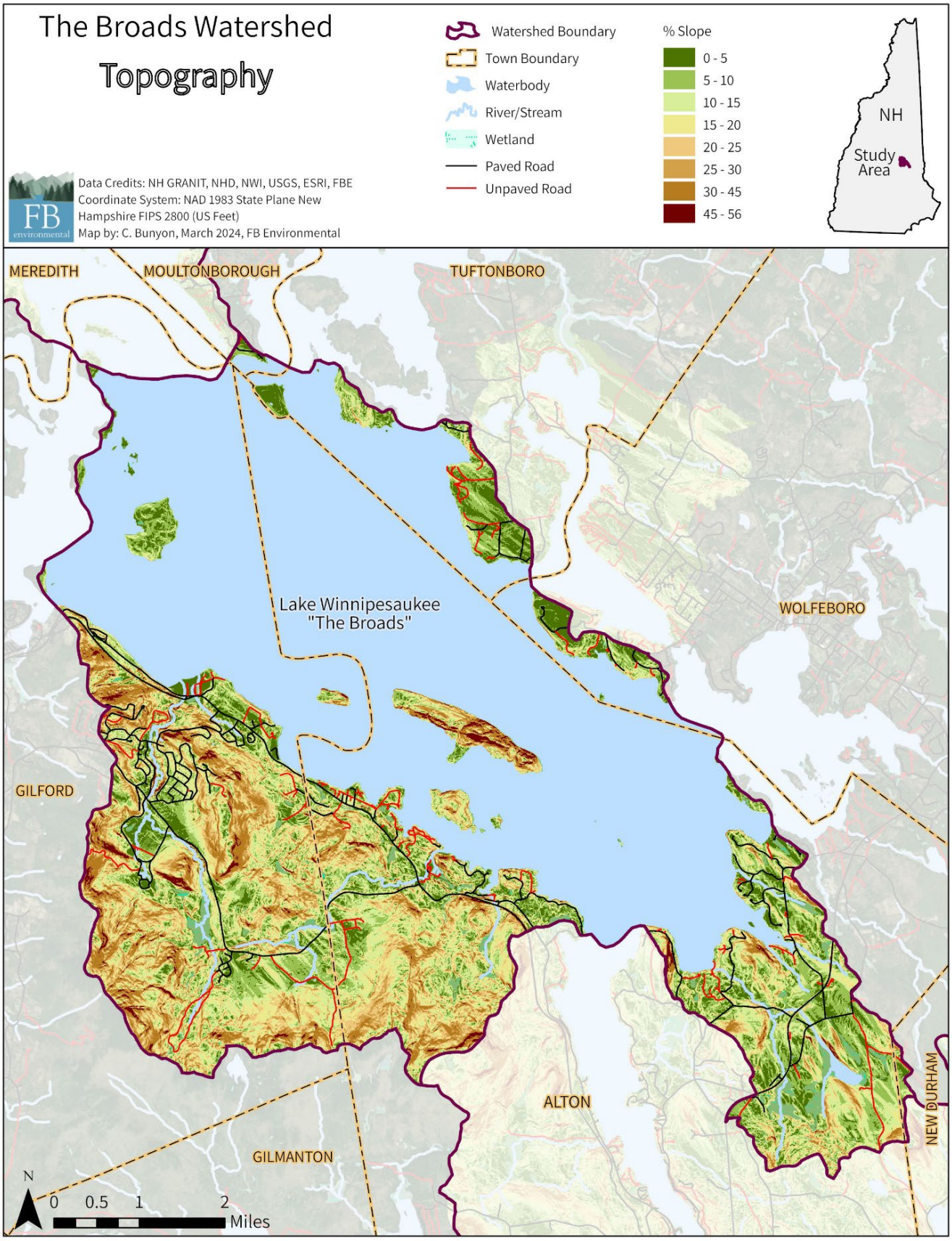
Map A-5. Projected buildings in the Broads watershed in Alton, Gilford, Moultonborough, Tuftonboro, Wolfeboro, and New Durham, New Hampshire.



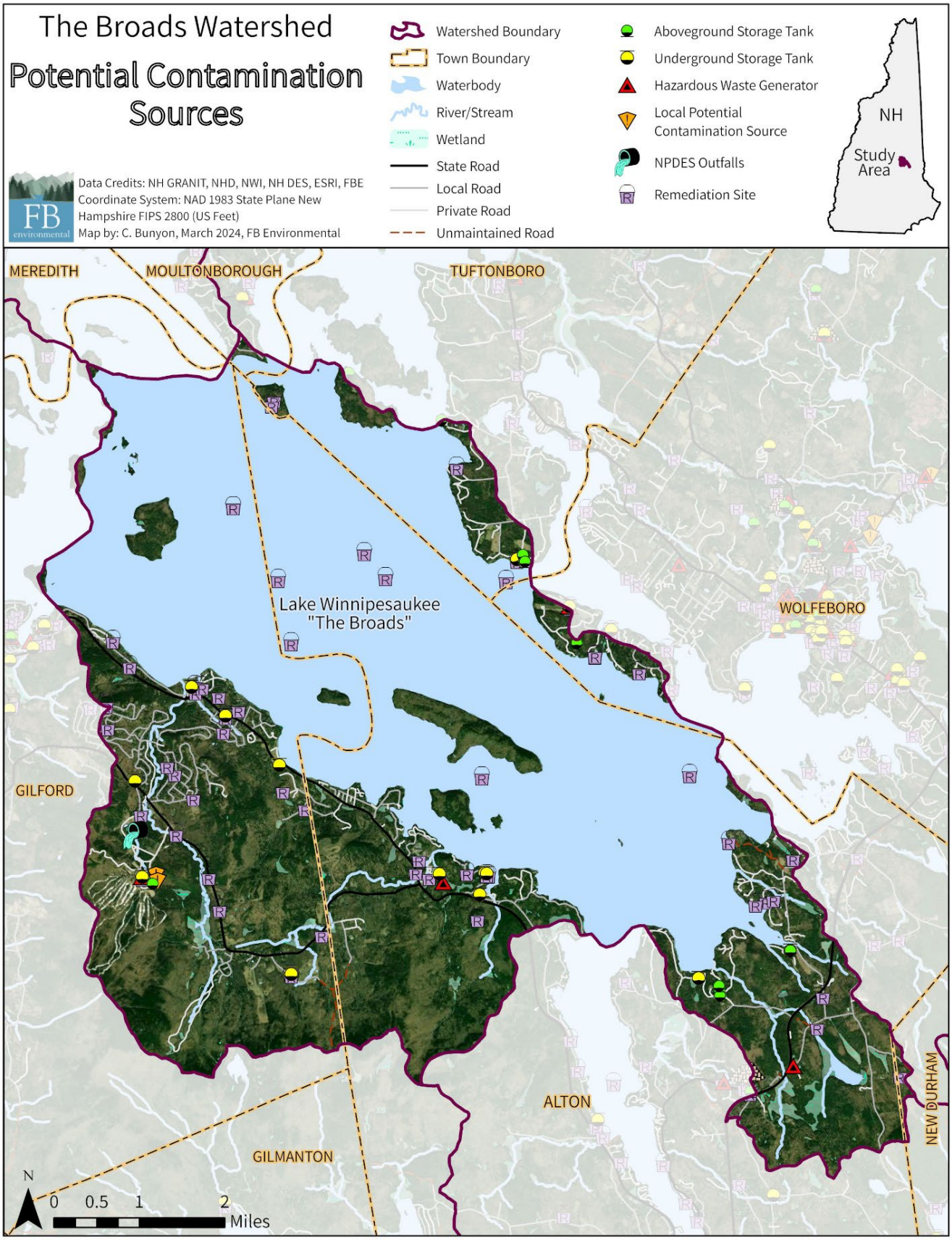
Map A-6. Soil series in the Broads watershed.



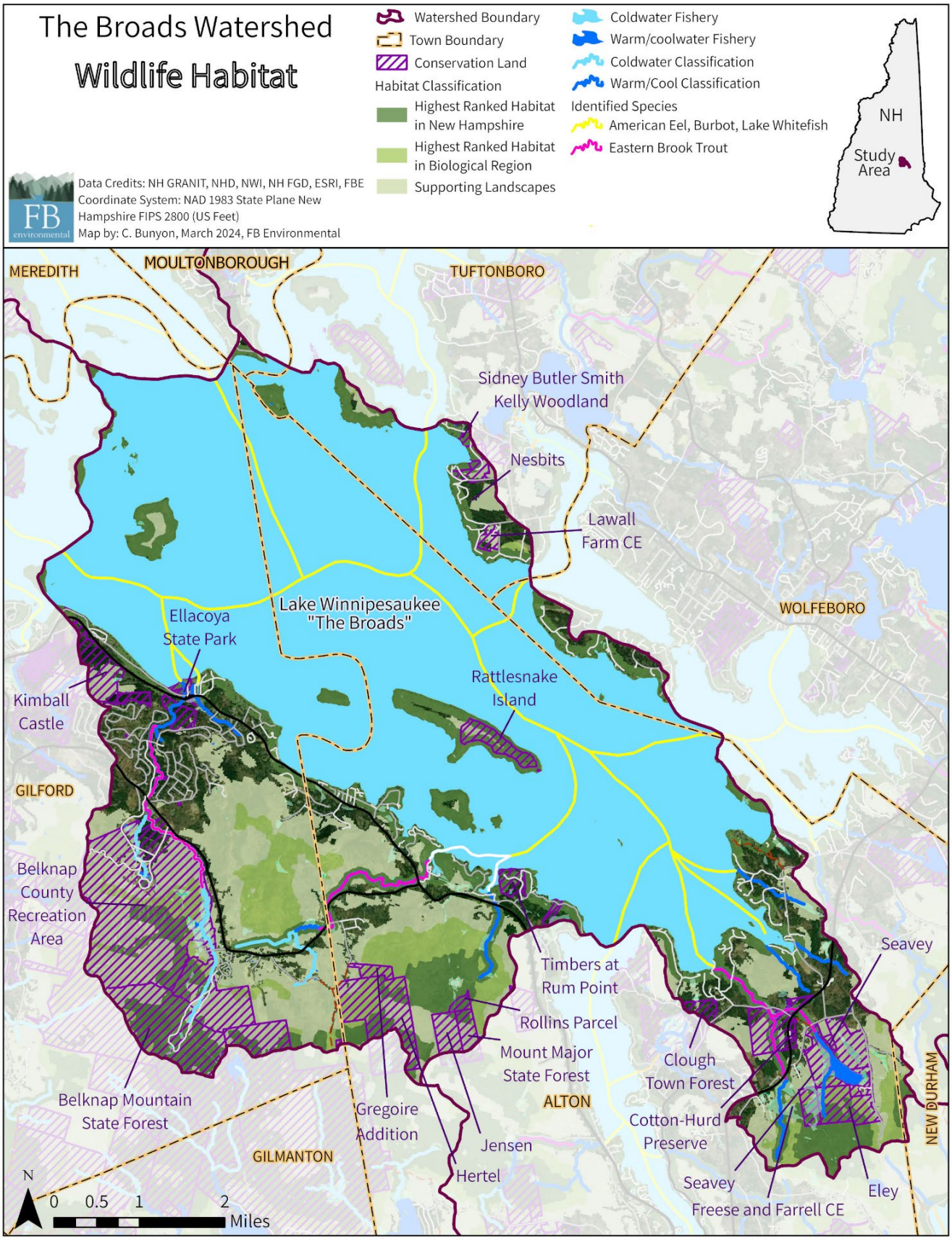
Map A-7. Soil Erosion Hazard in the Broads watershed.



Map A-8. Topography of the Broads watershed.



Map A-9. Potential sources of contamination in the Broads watershed.



Map A-10. Conservation land and high-value habitat according to the 2020 New Hampshire Wildlife Action Plan within the Broads watershed.

APPENDIX B: BMP MATRIX

Table B-1. Site ID, location description, water quality impact, estimated load reduction, and implementation costs for the 20 nonpoint source sites identified in the Broads watershed. **Pollutant load reduction and cost estimates are preliminary and are for planning purposes only**. Some cost estimates are based on pre-COVID19 ranges (adjusted for 2024 inflation), and thus actual construction costs could be highly variable at this time. Sites are priority ranked from 1-20 for lowest to highest cost per kilogram of phosphorus load reduced with remediation.

SITE	LOCATION	IMPACT	LOAD REDUCTION			ESTIMATED COST			RANK
			TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Low Cost	Est. High Cost	Est. Avg. Cost	
A-3	Echo Shores Road Opposite House 122	High	3.4	0.9	2.3	$12,000	$25,000	$18,500	1
C-3	Robert's Cove Road Ditch	Medium	3.2	0.8	2.2	$8,000	$15,000	$11,500	2
A-7	Bickford Road Crossing Near House 66	Low	2.7	0.7	1.9	$10,000	$15,000	$12,500	3
WB-01	Eaglemere Road South	Medium	2.4	0.6	1.6	$5,000	$30,000	$17,500	4
A-4	Cherry Valley Road Stream Crossing	Medium	4.7	1.2	3.2	$30,000	$60,000	$45,000	5
C-2	Cedar Cove Association Beach Culvert	Medium	1.5	0.5	1.6	$15,000	$25,000	$20,000	6
D-4	Belknap Point Road	High	3.2	1.1	2.9	$25,000	$150,000	$87,500	7
A-9	Cherry Valley Road at Gunstock ½ Mile Sign	Low	0.5	1.0	0.0	$20,000	$30,000	$25,000	8
A-6	Grant Road and Cherry Valley Road Intersection	Medium	1.8	0.5	1.2	$12,500	$25,000	$18,750	9
C-4	Robert's Cove Road Public Access Area	High	0.2	0.2	0.8	$10,000	$20,000	$15,000	10
A-8	Gunstock Pond	Medium	0.6	1.2	7.9	$20,000	$100,000	$60,000	11
D-2	Highland Drive	Medium	0.2	0.2	0.5	$10,000	$15,000	$12,500	12
A-2	Route 11-D and Wallsten Road Intersection	Low	1.5	0.4	1.0	$10,000	$20,000	$15,000	13
C-1	Dewitt Drive Crossing	Low	0.6	0.3	0.7	$5,000	$25,000	$15,000	14
A-10	Sagamore Road and Barefoot Place Culvert	Low	0.6	0.1	0.4	$10,000	$15,000	$12,500	15
D-1	Scenic Island Viewing Area	Medium	1.2	0.6	2.5	$60,000	$100,000	$80,000	16
A-5	Glidden Road Stream Crossing	Low	0.2	0.1	0.1	$5,000	$10,000	$7,500	17
D-3	Ellacoya State Park Beach Inlet	High	0.6	0.2	0.4	$50,000	$100,000	$150,000	18
X-02	Hidden Springs Road	Low	0.4	0.1	0.2	$10,000	$20,000	$15,000	19
C-7	Black Point Road Beach	Medium	0.1	0.1	0.6	$30,000	$50,000	$40,000	20
		TOTAL	**29.5**	**10.9**	**32.1**	**$357,500**	**$850,000**	**$603,750**	