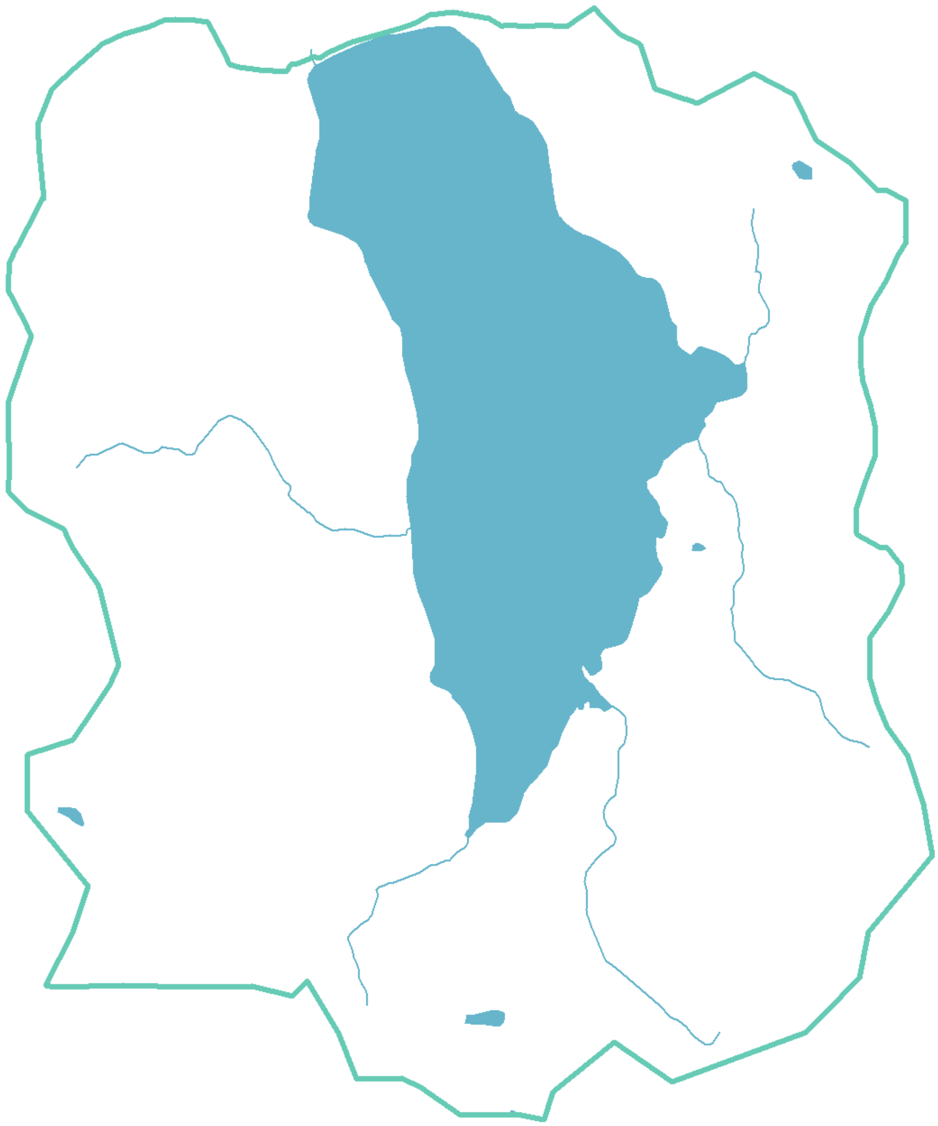
PLEASANT LAKE

WATERSHED RESTORATION PLAN



FINAL **JANUARY 2017**

PREPARED FOR

SOUTHERN NH PLANNING COMMISSION
438 Dubuque St
Manchester, NH 03102

PREPARED BY

FB ENVIRONMENTAL ASSOCIATES
170 West Rd, Suite 6
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Pleasant Lake Watershed
Rockingham County, New Hampshire
Watershed Area = 2,315 acres (3.6 sq.mi.)
Pleasant Lake
479 acres (0.75 sq.mi.)
Voydatch Pond
Mud Pond
Deerfield
Northwood
Wilsons Brook
Clark Brook
Philbrick Brook
Loon Cove Brook
Rt 107 Inlet
Nicholls Brook
Ambrose Ln
Oakwood Dr
Lynn Grove Rd
Old Woods Rd
Circle St
Cole Rd
Knox Ln
Gulf Rd
Rita's Cir
R E A Rd
Frost Rd
Broad Cove Rd
Pierce Dr
Jack St
Burke Rd
Pleasant Hill Rd
No Name
Scott Ln
Cedar Ln
Pond View Ln
107
North Rd
Willow Ln
Sunset Ln
Driveway A321
Swett Rd
Whittier Rd
Griffin Rd
Old Centre Rd
0
0.25
0.5
1
Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Wetland
Lake/Pond
Stream
Road
Data Source: NH GRANIT, FBE
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
FB environmental

PLEASANT LAKE

WATERSHED RESTORATION PLAN

Prepared by **FB ENVIRONMENTAL ASSOCIATES**

in cooperation with Southern New Hampshire Planning Commission, Pleasant Lake Preservation Association, and the New Hampshire Department of Environmental Services

JANUARY 2017 | FINAL

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 604(b) funds from the U.S. Environmental Protection Agency.

EXECUTIVE SUMMARY

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

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

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

LAKE QUICK FACTS

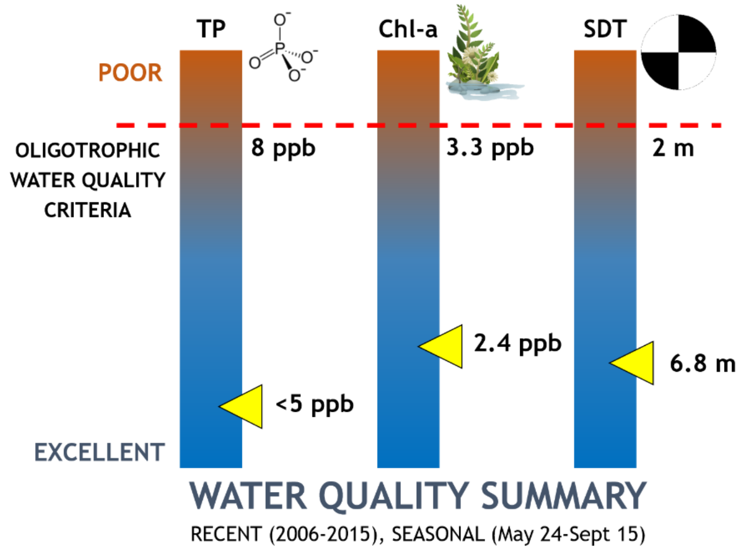
Town/State:	Deerfield, NH (82%) Northwood, NH (18%)
Total Watershed Area:	3.6 sq. mi. (2,315 ac.)
Lake Area:	0.75 sq. mi. (479 ac.)
Shore Length:	4.5 miles
Max Depth:	69 ft.
Mean Depth:	23.6 ft.
Lake Volume:	3.7 billion gallons
Flushing Rate:	0.48 times per year
Lake Elevation:	578 ft.
Trophic Classification:	Oligotrophic
Impairments:	Dissolved Oxygen

Invasives: No milfoil has been discovered in the lake, but Chinese mystery snails have been spotted in the lake since 2013.

Tributaries: The Rt. 107 Inlet drainage area discharges to the southern end of the lake and accounts for 25% of the total water load to the lake. The Direct Shoreline drainage area accounts for 24%. Other tributaries include Wilsons, Clark, Philbrick, Loon Cove, Branch, Farrelly, and Veasey Brooks, as well as an unnamed drainage that flows south from the Northwood side of the lake to the outlet area of Clark Brook.

Other Notes: Pleasant Lake is a naturally occurring lake that has been raised by a dam at the northern end (lake outlet). The low flushing rate of 0.48 means that the entire volume of the lake is replaced every 2 years, which allows pollutants more time to settle in lake bottom sediments and/or be taken up by biota.

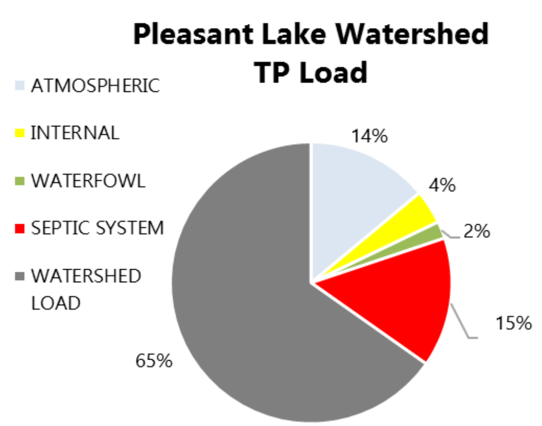
WATER QUALITY ASSESSMENT & MODELING



Visual summary of existing water quality in Pleasant Lake. Data represent recent (2006-2015) and seasonal (May 24-Sept 15) median or average calculations. TP = total phosphorus; Chl-a = chlorophyll-a; SDT = Secchi Disk Transparency. SDT is based on data collected with a scope.

Overall, the water quality of Pleasant Lake is excellent. Yet, the lake is currently listed by NHDES as impaired for Aquatic Life Use for insufficient levels of dissolved oxygen (DO) (NHDES, 2014b). Low DO in violation of the Class A criterion of 6 ppm in bottom waters of Pleasant Lake is common and generally persistent year to year, impacting about 42% of lake volume in mid to late summer. Low DO is typically attributed to excess nutrient inputs (e.g., phosphorus), which stimulate algal blooms and excessive plant growth that are decomposed at lake bottom. However, current phosphorus concentrations in Pleasant Lake are low and well within oligotrophic criteria set by NHDES, indicating that other factors, such as historical land use, may have contributed to the DO impairment observed today. It is difficult to discern the true extent and duration of low DO in Pleasant Lake due to the lack of profile data for every year and during critical low-oxygen months (August-September). Most profile data were collected every other year and in June or July. It will be important to continue monitoring DO and phosphorus in the upper and lower water column on a yearly basis in late summer.

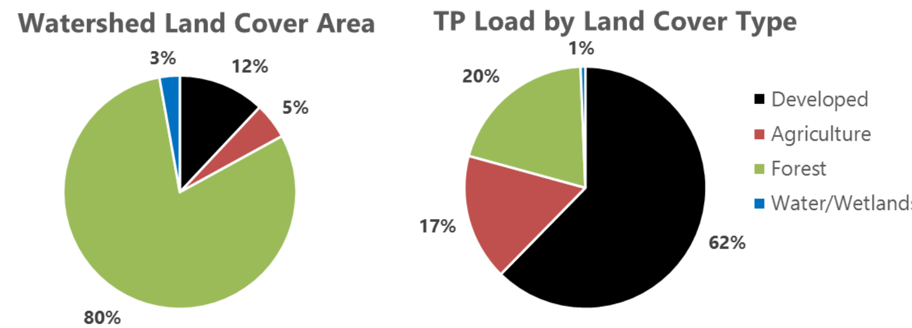
A water quality analysis of the tributaries showed that Farrelly, Veasey, and Loon Cove Brooks should be prioritized for future monitoring and land use investigations of potential NPS pollution. Farrelly and Veasey Brooks showed elevated turbidity, indicating potential soil erosion issues, while Loon Cove Brook had the highest median phosphorus concentration at 53 ppb. Since much of the upstream drainage area of Loon Cove Brook is forested, phosphorus is likely coming from development near the outlet.



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

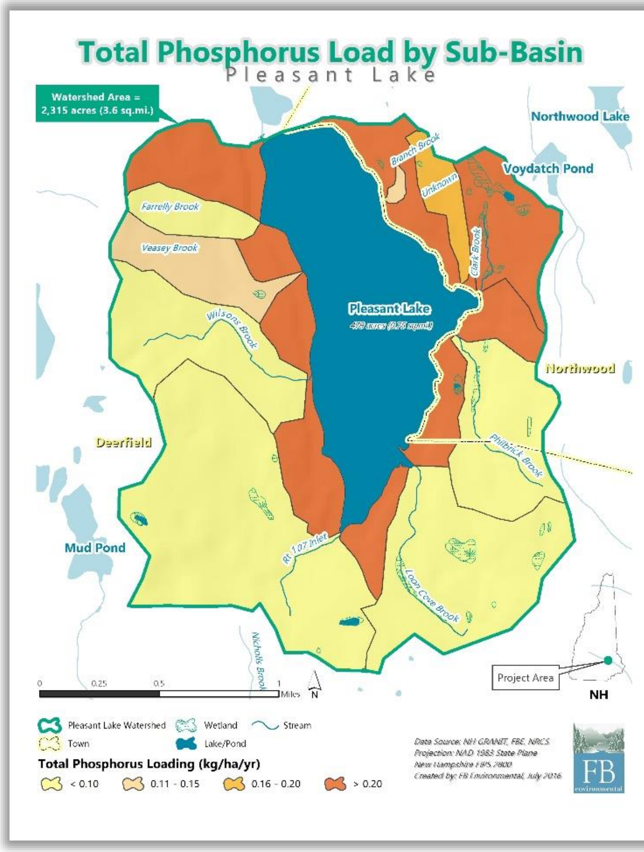
The land use model results indicate that the greatest phosphorus load comes from watershed runoff, which accounts for 65% of the current total phosphorus loading to Pleasant Lake. Septic systems contribute the second largest source of phosphorus to Pleasant Lake, providing 15% (23 kg/yr) of the total phosphorus load to the lake. Old systems (> 25 years old) made up 25% of shorefront resident respondents, and year-round residents comprised 43% of respondents (SNHPC, 2015).

Although developed areas cover only 12% of the watershed (see Section 2.1.3), developed areas are contributing 62% of the phosphorus load to Pleasant Lake; agriculture covers 5% of the watershed, but contributes 17% of the phosphorus load to Pleasant Lake (FBE, 2016a).



Watershed land cover area (does not include lake surface area) by general category (developed, agriculture, forest, and water/wetlands) and total phosphorus (TP) load by general land cover type.

The Direct Shoreline sub-basin contributes the highest phosphorus load per unit area (0.26 kg/ha/yr) to Pleasant Lake (Appendix A, Map 10), as well as the largest phosphorus load in total mass (46.1 kg/yr). Direct shoreline areas are usually high phosphorus contributors because of their proximity to lakes and high-density development. Given this, the direct shoreline of a lake deserves special attention in any lake protection plan. Also of note, Clark Brook, draining the northeastern corner of the watershed in Northwood, contributes the second highest phosphorus load per unit area (0.24 kg/ha/yr) to Pleasant Lake.



The direct shoreline area of the lake contributes the most phosphorus per hectare per year. Refer to Appendix A, Map 10 for a larger map.

The build-out analysis identified an estimated 863 acres (48%) of the entire 1,794-acre study area as developable (Appendix A, Map 11). Up to 238 new buildings (a 70% increase from 2016) could be added at full build-out by the year 2052, using a conservative growth rate of 1.56%. This predicted increase in development was then input to the model; the future phosphorus load was estimated at 245 kg/yr, with an in-lake phosphorus concentration of 9.9 ppb.

Pleasant Lake may experience a 60% increase (from 153 to 245 kg/yr) in phosphorus loading at full build-out by 2052. The Direct Shoreline and Rt. 107 Inlet sub-basins are most at risk for increases in phosphorus loading because of anticipated development.

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

WATER QUALITY GOAL & OBJECTIVES

Although excess phosphorus loading from current land use may not be the cause of the low-oxygen impairment in Pleasant Lake, unmitigated sources of pollution (e.g., phosphorus, hydrocarbons, etc.) are expected to increase as development and other human activities in the Pleasant Lake watershed increase (e.g., conversion of small, seasonal properties to large, year-round homes). The anticipated increase in phosphorus loading and associated algal growth could further exacerbate DO depletion beyond what historic land use activities have caused. For this reason, phosphorus was used to set the water quality goal for Pleasant Lake.

> **The goal of the Pleasant Lake Watershed Restoration Plan is to improve the water quality of Pleasant Lake and prevent a future decline in lake water quality as a direct result of anticipated new development.**

This goal will be achieved by accomplishing three major objectives.

OBJECTIVE 1: Investigate cause of the low-oxygen impairment in Pleasant Lake.

The low-oxygen impairment in Pleasant Lake is likely caused by legacy organic matter loading from historical land use activities (e.g., logging, land clearing, farming, etc.). Sediment core analyses and better characterization of the current extent and duration of low oxygen in Pleasant Lake should be conducted to confirm this theory. Understanding the cause of the low-oxygen impairment will better inform management measures for improving and/or preventing further exacerbation of low oxygen conditions.

OBJECTIVE 2: Gather more consistent water quality data for Pleasant Lake.

Recent phosphorus data typically fell below the laboratory detection limit of 5 ppb. Thus, a "true" summer median total phosphorus concentration could not be discerned and used as a baseline metric from which to set a target reduction goal. More data using a lower method detection limit for phosphorus are needed to update the model and determine specific benchmark reductions in in-lake phosphorus concentrations. Until then, the third water quality objective focuses on reducing phosphorus loading to Pleasant Lake.

OBJECTIVE 3: Reduce current phosphorus loading by 10% (15 kg/yr) and prevent future phosphorus loading of 26 kg/yr to Pleasant Lake over the next 10 years (2017-2026) to improve in-lake median total phosphorus concentration by 0.6 ppb.

The Steering Committee agreed that an aggressive reduction in phosphorus loading is needed to protect the excellent water quality of Pleasant Lake, particularly due to the uncertain disconnect between the currently-low in-lake phosphorus concentration and the low-oxygen impairment. Achieving this objective through the implementation of Best Management Practices (BMPs) and low impact development (LID) techniques will help reduce current in-lake phosphorus concentrations and prevent further DO depletion in the lake. Refer to Sections 5.2.2-5.2.6 for specific action items and recommendations.

POLLUTANT SOURCE IDENTIFICATION

During the 2015 watershed survey, fifteen NPS sites were identified and rated for impact level based on location, slope, amount of soil eroded, and proximity to water. Recommendations ranged from installing buffer plantings and infiltration swales to replacing culverts and reconstructing concrete aprons.

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

NH Fish and Game Department (NHFGD) Boat Access Parking (Site ID #1)

This gravel and pavement parking lot in the northwest corner of the watershed was identified as one of the primary sites contributing sediment to Pleasant Lake due to gully erosion and sediment/gravel transport across Gulf Road to Pleasant Lake. Recommendations for this site and adjacent Gulf Road sites includes the reconstruction of two bituminous concrete aprons directing runoff from the base of the parking area towards the vegetated woods between the parking area and the outlet tributary. Additionally, the width of the entrance should be evaluated for appropriate size to possibly remove excess pavement (see photo at left).

Gulf Road (Site ID #2, 3, 5, 6, 7, 8, 9, 10, 11, 12)

Due to its proximity to the lake, the runoff and sediment erosion from Gulf Road is a great concern for the integrity of Pleasant Lake, as there are large gullies along the road shoulder and a moderate slope near the NHFGD Boat Access Parking. Additionally, many small nonpoint source pollution sites (often associated with private access to the water, see photo at left) were identified along the length of Gulf Road. Recommended BMPs in this area include raising the profile of Gulf Road to accommodate infiltration swales and check dams, installation of bioretention cells, and deep sump catch basins.

Intersection of Broad Cove Road and Sellar Road (Site ID #13)

Moderate road shoulder erosion was observed flowing into a tributary at this site. Proposed restoration at this site includes adding a vegetated shoulder and ditch along the length of Broad Cove Road around the stream crossing and installation of multiple turnouts to divert runoff from the road before entering the stream.

During the 2015 shoreline survey. about 74% of the Pleasant Lake shoreline (or 132 parcels) scored 10 or higher, indicating shoreline conditions that are likely detrimental to lake water quality. These shoreline properties tended to have inadequate buffers, evidence of bare soil, and structures within 75 ft. of the shoreline.

Pleasant Lake parcel receiving a score of 14.

Pleasant Lake parcel receiving a score of 7.

PLAN IMPLEMENTATION STRATEGY & RECOMMENDATIONS

Management strategies for achieving the water quality goal and objectives involve using a combination of structural and non-structural BMPs, as well as an adaptive management approach (refer to Section 4). The recommendations of this plan should be carried out by a steering committee like the one assembled for development of this plan. A steering committee should include the leadership of PLPA, along with support from the watershed towns (Deerfield and Northwood), NHDES, SNHPC, conservation commissions, land trusts or conservation groups such as Bear-Paw Regional Greenways and Northwood Area Land Management Collaborative, schools and community groups, local businesses, and individual landowners.

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

- **Objective 1:** Take a sediment core of the deep spot of Pleasant Lake to assess organic matter content and source and aluminum-iron-phosphorus ratios to determine the cause of the low-oxygen impairment and the likelihood of internal phosphorus loading during anoxic periods. Increase the frequency of DO and temperature profile readings in late summer.

- **Objective 2:** Establish a regular lake monitoring program to gather more consistent water quality data at the deep spot, and use a laboratory with a method detection limit of less than 5 ppb so that a more precise in-lake phosphorus concentration can be computed for reduction targets.

- **Objective 3:**

    - WATERSHED & SHORELINE BMPS: Work with shorefront residents to encourage expanded participation in shoreline residential BMP implementation efforts, with initial focus on the eight high impact shoreline properties. PLPA should begin to contact shorefront landowners to generate interest and awareness in maintaining healthy shorefront buffers and to line up interested parties on a first-come, first-serve basis as grant funding is obtained. Watershed

NPS sites along Gulf Road near the NHFGD parking lot are currently being addressed by a Section 319 grant (see Section 1.5.3). PLPA should apply again for 2018 implementation funding to address other priority watershed NPS sites and shoreline properties. A funding subcommittee should be created to help find and apply for funding that supports all aspects of the Action Plan. **If efforts target priority BMPs (the eight high priority shoreline properties and all fifteen watershed NPS sites), total phosphorus load could be reduced by 22.7 kg/yr.** The strategy for reducing pollutant loading to Pleasant Lake will be dependent on available funding and labor resources, but will likely include a combination of approaches (e.g., larger watershed BMP sites and smaller residential shoreline BMP sites).

- MUNICIPAL PLANNING: Send representatives of PLPA to Board of Selectmen and Planning Board meetings to present the watershed plan and foster a relationship between local government and watershed stakeholders for the coordination of plan implementation. Provide information on LID and BMP descriptions to Selectmen, town staff, and Planning Board members. Encourage towns to consider making changes to ordinances to protect water quality. Suggestions include:

  - ✓ **Building and Wetland Buffer Setbacks** – Adopt uniform and more stringent setback guidelines in both towns (at least 100 feet from all waterbodies and wetlands).
  - ✓ **Conservation Subdivisions** – Increase the amount of land set aside in conservation subdivisions (for Northwood) to be comparable in both towns.
  - ✓ **Low Impact Development (LID)** – Amend stormwater management ordinances to define LID techniques, and to encourage LID use to the maximum extent possible.
  - ✓ Additionally, **it is recommended that the Town of Northwood work towards developing a Watershed Protection Ordinance specific to Pleasant Lake**. This ordinance could be like the existing ordinance in Deerfield, or perhaps developed jointly.

  Given future development potential, **it is critical for municipalities to develop and enforce stormwater management measures that prevent an increase in pollutant loadings from new and re-development projects**, particularly as future development may offset reduced loads from other plan implementation actions.

- SEPTIC SYSTEMS: Distribute educational information and lists of septic service providers to watershed residents. Host "septic socials" to start the conversation around septic system maintenance and replacement. Investigate grants and low-interest loans as a first step to upgrading identified problem systems in the watershed. Develop a septic system database by expanding from the information already gathered from the 2015 septic survey.

- ROADS: Work with ad-hoc private "road associations" to begin a discussion about four season road maintenance and management. Coordinate with NHDOT to discuss Rt. 107 culvert problems and incorporate solutions to the design before road resurfacing begins in summer 2017.

- LAND CONSERVATION & MANAGEMENT: Send a representative from PLPA to communicate with local conservation groups. The sooner this relationship is built, the sooner other objectives can be addressed (e.g., identifying priority areas for conservation).

ESTIMATED COSTS

The cost of successfully implementing this watershed plan is estimated at $545,000 over the next ten years. However, many costs are still unknown and should be incorporated to the Action Plan as information becomes available. A sustainable funding plan should be developed within the first year of this plan and revisited on an annual basis to ensure that the major planning objectives can be achieved over the long-term. This funding strategy would outline the financial responsibilities at all levels of the community (landowners, towns, community groups, and State and federal governments).

Estimated annual and ten-year costs for Pleasant Lake watershed restoration.

Category	Estimated Annual Costs	10-Year Total
Water Quality Monitoring	$29,500	$295,000
Watershed and Shoreline BMPs	$15,688	$156,878
Municipal Planning	$1,550	$15,500
Septic Systems*	$5,300	$53,000
Roads	$1,000	$10,000
Land Conservation and Management	$1,500	$15,000
Total Cost	**$54,538**	**$545,378**

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

EVALUATING PLAN SUCCESS

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

A 10% reduction is no easy task, and because there are many diffuse sources of phosphorus reaching the lake from existing residential development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.

ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS

ACRONYM	DEFINITION
ALU	Aquatic Life Use
BMP	Best Management Practices
CCSWCD	Cumberland County (ME) Soil and Water Conservation District
Chl-a	Chlorophyll-a
CWA	Clean Water Act
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
FBE	FB Environmental Associates
IC	Impervious Cover
LID	Low Impact Development
LLRM	Lake Loading Response Model
NAIP	National Agriculture Imagery Program
NCDC	National Climatic Data Center
NH GRANIT	New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GIS Clearinghouse)
NHD	National Hydrography Dataset
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHFGD	New Hampshire Fish and Game Department
NPS	Nonpoint Source Pollution
NWI	National Wetlands Inventory
ppb, ppm	parts per billion, parts per million
PCR	Primary Contact Recreation
PLPA	Pleasant Lake Preservation Association
SCC	State Conservation Commission
SDT	Secchi Disk Transparency
SNHPC	Southern New Hampshire Planning Commission
SOAK NH	Soak Up the Rain New Hampshire
SSPP	Site Specific Project Plan
TP	Total Phosphorus
UNHSWC	University of New Hampshire Stormwater Center
USEPA	United States Environmental Protection Agency
USLE	Universal Soil Loss Equation
VLAP	Volunteer Lake Assessment Program

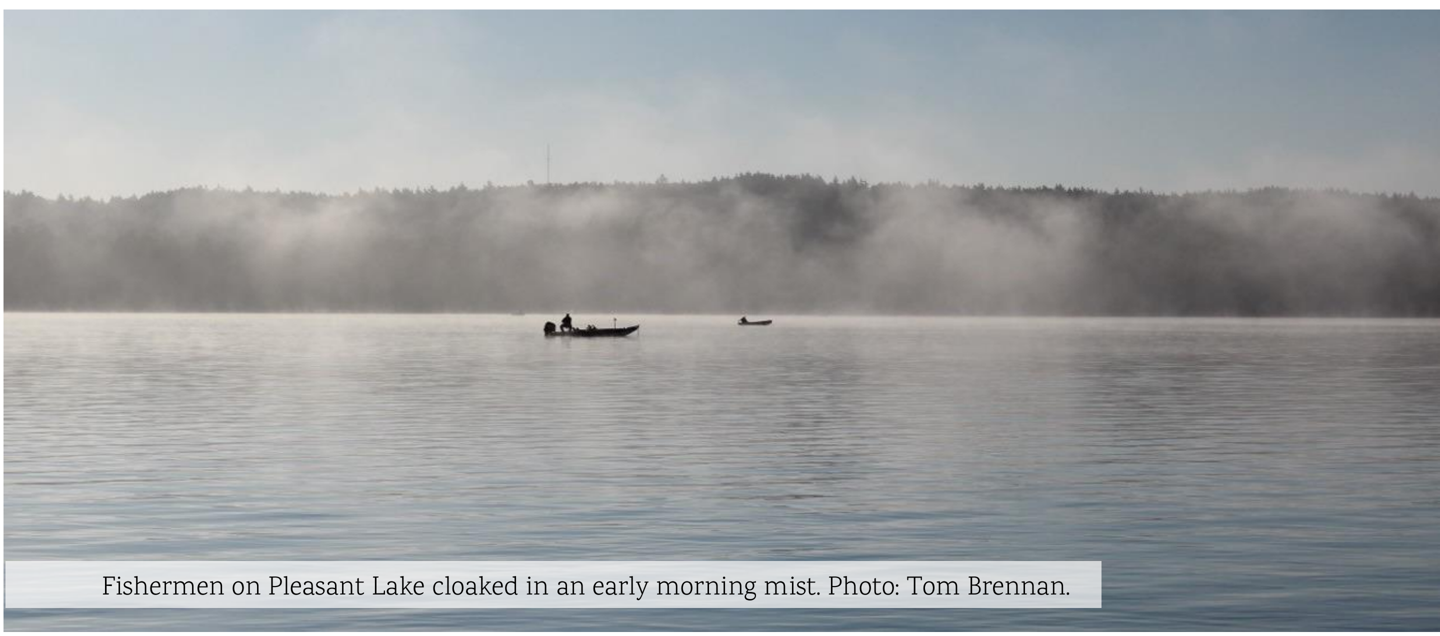
1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

Located in the Towns of Deerfield and Northwood in Rockingham County, New Hampshire, Pleasant Lake has attracted visitors to its shores for over 100 years. Lake residents, transient boaters, and summer tourists alike enjoy the lake's scenic beauty and quiet, rural character. The lake also provides potential drinking water supply for residents and highly-valued critical habitat for a diverse abundance of plants and animals. However, the water quality of Pleasant Lake is threatened by harmful pollutants in **nonpoint source (NPS) pollution** from developed areas in the watershed. Thus, taking proactive steps to properly manage and treat NPS pollution in the Pleasant Lake watershed is essential for continued ecosystem health and recreational enjoyment by future generations.

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

The Pleasant Lake Watershed Restoration Plan is the culmination of a major effort by many individuals who care about the long-term protection of water quality in the lake. Established in 1958 with the goal to protect and preserve the lake, the Pleasant Lake Preservation Association (PLPA), in partnership with the Southern New Hampshire Planning Commission (SNHPC), pursued funding for a Water Quality Planning Grant from the New Hampshire Department of Environmental Services (NHDES) with Clean Water Act (CWA) Section 604(b) funds from the United States Environmental Protection Agency (USEPA). Funding was awarded to SNHPC in 2014. Over the course of the project, stakeholders, including the New Hampshire Lakes Association, the



Fishermen on Pleasant Lake cloaked in an early morning mist. Photo: Tom Brennan.

Towns of Deerfield and Northwood, the New Hampshire Fish and Game Department (NHFGD), the NHDES Dam Bureau, and watershed residents, have demonstrated exceptional project collaboration. The project also tapped into PLPA's impressive and dedicated group of volunteers, who donated many hours of their time and diverse talents to all aspects of plan development.

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

As part of the development of this plan, a build-out analysis, water quality and assimilative capacity analysis, and volunteer shoreline/watershed stormwater surveys were conducted (Section 3). Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the historical, current, and projected amount of **total phosphorus (TP)** being delivered to the lake from the watershed (Section 3.3.2). An Action Plan (Section 5.2) with associated timeframes, responsible parties, and estimated costs was developed based on feedback from community members that attended the public forum in July 2016. The forum was designed to provide stakeholders with information on the watershed and water quality of Pleasant Lake, to solicit stakeholder input on action items, and to discuss the timing and elements of the watershed restoration plan. The Steering Committee helped further refine these inputs into relevant action items and recommendations.

The Pleasant Lake Watershed Restoration Plan includes nine key planning elements to address NPS pollution in impaired waters. These guidelines, set forth by the USEPA, highlight important steps in protecting water quality for waterbodies impacted by human activities, including specific recommendations for guiding future development, and strategies for reducing the cumulative impacts of NPS pollution on lake water quality.

> **Total Phosphorus (TP)** is one of the major nutrients needed for plant growth. It is generally present in small amounts (measured in parts per billion (ppb)) and limits plant growth in lakes. In general, as the amount of TP increases, the amount of algae also increases.
>
> **Dissolved Oxygen (DO)** is a measure of the amount of oxygen dissolved in water. Low oxygen can directly kill or stress organisms and release phosphorus from bottom sediments.

1.2 STATEMENT OF GOAL

Overall, the water quality of Pleasant Lake is excellent. The most recent trophic assessment by NHDES (1996) classified Pleasant Lake as oligotrophic, and the 2010 Senate Bill 426 passed in 2010 by the New Hampshire Legislature reclassified Pleasant Lake back to a Class A waterbody, the highest quality waterbodies. However, the lake is currently listed by NHDES as impaired for Aquatic Life Use for insufficient levels of **dissolved oxygen (DO)** (NHDES, 2014b).

Low DO can be a natural phenomenon in lakes that thermally stratify in late summer. However, an increase in the extent and duration of low DO in lakes can be detrimental to aquatic life by reducing their desired habitat of cooler, high-oxygen waters. This increase in low DO occurrence is typically attributed to excess nutrient inputs (e.g., phosphorus), which stimulate algal blooms and excessive plant growth. The algae and plants die and accumulate as organic matter on the lake bottom where they are decomposed – a process that consumes oxygen, causing low DO in bottom waters. Low DO can release sediment-bound phosphorus back into the water column (a.k.a., internal loading) where it can re-stimulate algal blooms and plant growth, creating a positive feedback to eutrophication.

Current phosphorus concentrations in Pleasant Lake are low and well within oligotrophic criteria set by NHDES, indicating that other factors, such as historical land use, may have contributed to the DO impairment observed today (full details in Section 3: Water Quality Assessment). Recovery potential of low DO is deemed excellent for Pleasant Lake, as it is 12th on the Lake Watersheds Recovery Potential Ranking list for NH (NHDES, 2014c). Although excess phosphorus loading from current land use may not be the cause of the low-oxygen impairment in Pleasant Lake, unmitigated sources of pollution (e.g., phosphorus, hydrocarbons, etc.) are expected to increase as development and other human activities in the Pleasant Lake watershed increase (e.g., conversion of small, seasonal properties to large, year-round homes). The anticipated increase in phosphorus loading and associated algal growth could further exacerbate DO depletion beyond what historic land use activities have caused. For this reason, phosphorus was used to set the water quality goal for Pleasant Lake.

The goal of the Pleasant Lake Watershed Restoration Plan is to improve the water quality of Pleasant Lake and prevent a future decline in lake water quality as a direct result of anticipated new development.

This goal will be achieved by accomplishing three major objectives.

OBJECTIVE 1: Investigate cause of the low-oxygen impairment in Pleasant Lake.

> The low-oxygen impairment in Pleasant Lake is likely caused by legacy organic matter loading from historical land use activities (e.g., logging, land clearing, farming, etc.). Sediment core analyses and better characterization of the current extent and duration of low oxygen in Pleasant Lake should be conducted to confirm this theory. Understanding the cause of the low-oxygen impairment will better inform management measures for improving and/or preventing further exacerbation of low oxygen conditions. Refer to Section 5.2.1 for specific action items and recommendations.

OBJECTIVE 2: Gather more consistent water quality data for Pleasant Lake.

> Lack of consistent water quality data during critical times of year (i.e., late summer) makes it difficult to characterize the current extent and duration of low oxygen in Pleasant Lake. In addition, recent phosphorus data typically fell below the laboratory detection limit of 5 ppb. Thus, a "true" summer median total phosphorus concentration could not be discerned and used as a baseline metric from which to set a target reduction goal. More data using a lower method detection limit for phosphorus are needed to update the model and determine specific benchmark reductions in in-lake phosphorus

concentrations. Until then, the third water quality objective focuses on reducing phosphorus loading to Pleasant Lake. Refer to Section 5.2.1 for specific action items and recommendations.

OBJECTIVE 3: Reduce current phosphorus loading by 10% (15 kg/yr) and prevent future phosphorus loading of 26 kg/yr to Pleasant Lake over the next ten years (2017-2026) to improve in-lake median total phosphorus concentration by 0.6 ppb.

The Steering Committee agreed that an aggressive reduction in phosphorus loading is needed to protect the excellent water quality of Pleasant Lake, particularly due to the uncertain disconnect between the currently-low in-lake phosphorus concentration and the low-oxygen impairment. Achieving this objective through the implementation of **Best Management Practices (BMPs)** and **low impact development (LID)** techniques will help reduce current in-lake phosphorus concentrations and prevent further DO depletion in the lake. Refer to Sections 5.2.2-5.2.6 for specific action items and recommendations.

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

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

Example of lakefront stormwater BMPs. Photo: AWWA.

1.3 INCORPORATING EPA'S NINE ELEMENTS

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

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

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

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

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

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

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

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

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

I. MONITORING COMPONENT: **Section 5.2.1** and the Action Plan describe the long-term water quality monitoring strategy for Pleasant Lake, the results of which can be used to evaluate the effectiveness of implementation efforts over time as measured against the criteria in (H) above. The goal of this plan is to improve water quality by lowering the in-lake phosphorus concentration and reducing the occurrence of low DO in bottom waters. The success of this plan cannot be evaluated without ongoing monitoring and assessment and careful tracking of load reductions following successful BMP implementation projects.

1.4 PLAN DEVELOPMENT AND COMMUNITY PARTICIPATION PROCESS

This plan was developed through the collaborative efforts of numerous Steering Committee meetings and conference calls between FB Environmental Associates (FBE) and other technical staff, including SNHPC, PLPA, DK Water Resource Consulting, Hoyle, Tanner & Associates, and NHDES (see Acknowledgments). On May 18, 2015, lead consultant FBE met with the Steering Committee about the development of the Pleasant Lake Watershed Restoration Plan. The meeting included an overview of the watershed plan development process and the role of the Steering Committee in that process.

A public presentation to kick-off the watershed restoration plan took place on June 27, 2015 at the PLPA Annual Meeting to give interested stakeholders an introduction to the main purpose of the plan and to explain how the watershed towns and residents can utilize this information to protect Pleasant Lake.

Additional Steering Committee meetings took place on October 22, 2015 and May 24, 2016. At the meeting in May 2016, FBE presented preliminary results of the LLRM to the Steering Committee. The objective of the meeting was to familiarize the Steering Committee with the model results and help guide the Steering Committee toward establishing a water quality goal for the watershed.


Community forum participants discuss potential action items that address threats to Pleasant Lake water quality. Photo: FBE.

On July 23, 2016, PLPA and FBE hosted a community forum at the Deerfield, NH Town Hall in conjunction with PLPA's Annual Meeting. The forum was designed to provide local stakeholders with information on the watershed and water quality of Pleasant Lake, to solicit stakeholder concerns, identify threats to water quality, and prioritize actions to mitigate identified threats. Over 90 people attended the community forum and provided valuable input to this plan. Attendees represented a diverse stakeholder set, including PLPA members, other organizational representatives, municipal staff, community business members, volunteers, and landowners. Attendees were broken out into four focus groups of ten or more people based on areas of concern (roads and septic systems, watershed and shorefront BMPs, municipal planning and conservation, and water quality monitoring).

From group discussions and additional actions provided by FBE, a total of 71 recommendations for achieving action items were identified and prioritized, including watershed ordinance development or refinement, public outreach program development, and water quality monitoring improvement. Recommendations from the forum were incorporated to the Action Plan (Section 5.2).

1.5 CURRENT WATERSHED EFFORTS

1.5.1 WATERSHED ASSOCIATION

PLPA has been committed to the preservation and protection of Pleasant Lake and its resources since it was incorporated in 1958. They survey and monitor the lake's quality regularly and encourage members to comply with all federal, State, and local laws and regulations that impact the safety, health, and quality of the lake environment. PLPA provides information and educational sources to inform members and others in the selection of appropriate practices for the safe use and protection of the natural resources in the lake area. They cooperate with local, regional, or State organizations that will enhance these objectives. PLPA encourages and supports recreational and social activities of interest and concern to the members and communities[1].

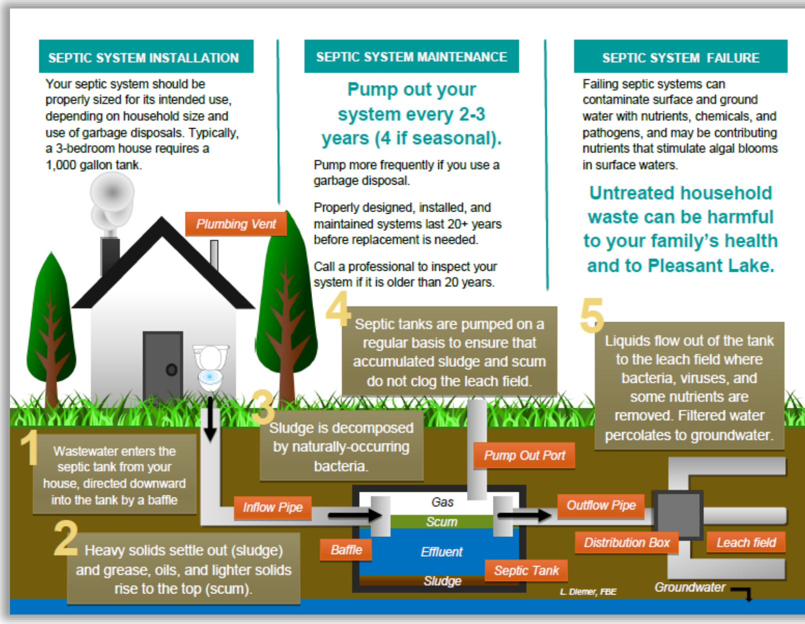
PLPA uses a district representation structure, with the watershed divided into nine districts, each with its own representative that serves on the Board of Directors. This allows equitable representation of all areas of the lake and fosters cooperation among all lake residents, who may not necessarily be immediate neighbors.

In 2014, PLPA implemented a fundamental change that perhaps laid the foundation for the development of the plan. PLPA Board Chairman Tom Brennan described this important transition:

> **"We began to think of ourselves as not just a Lake Association but as a Watershed Association. Up until that time, membership was only open to residents of the lake. The Board voted to open membership to anyone that wanted to support us and embarked on the process to change the bylaws accordingly. At the same time, we changed the name of the organization to reflect the broadened participation. The Association was founded in 1958 by lake residents whose goal was to protect and preserve the resource known as Pleasant Lake. In 2014, we became the Pleasant Lake Preservation Association. The goal remained the same but now the Association was open to anyone that wanted to help accomplish the objective."**
> **– Tom Brennan, 2016**

[1] *From https://pleasantlakenh.org/about/*

1.5.2 PUBLIC OUTREACH



Septic system brochure developed for PLPA.

Outreach efforts by PLPA are aimed at local and seasonal residents, summer visitors, and community decision-makers. The mission of PLPA is to educate, communicate, and coordinate with its members and the community about what can be done to protect, preserve, and improve the quality of Pleasant Lake. This message is widely distributed across the watershed by way of the Lake Host program, annual Fins 'n Fun Kid's Fishing Event, annual meetings, and many other events. Educational materials on the use of non-phosphorus based products, such as detergents and fertilizers, preventing erosion, and awareness of septic system issues are available to all interested residents through PLPA's website (https://pleasantlakenh.org/). In addition, PLPA publishes a semi-annual newsletter called *Pleasant Ponderings*, which includes updates on the Lake Host and Weed Watchers programs, lake events, and other watershed activities.

1.5.3 GULF ROAD 319 PROJECT

NHDES, along with the USEPA, are impressed with PLPA's involvement in and enthusiasm for preserving the water quality of Pleasant Lake. Prior to completion of this plan, PLPA was encouraged to apply for a Watershed Assistance Grant from Section 319 of the Clean Water Act in October 2015. The award was confirmed, and PLPA will receive $90,000 to reconstruct Gulf Road from NH RT 107 to just past the dam. A topographic and boundary survey of the roadway profile and cross section will be completed to help design the proper routing and treatment of stormwater runoff before it discharges to receiving waters. The Deerfield Board of Selectmen have committed to providing equipment and labor for road reconstruction that is tentatively planned for August 2017. The NH Fish and Game Department and the NHDES Dam Bureau will work with PLPA to design the BMPs; this team effort will provide benefits to all users of the lake.

2. WATERSHED CHARACTERIZATION

This section provides information on the local climate, demographic history, underlying soil and geographical characteristics, and past and present land use in the Pleasant Lake watershed. This information helped to guide goal development for protecting Pleasant Lake water quality.

2.1 POPULATION, GROWTH TRENDS, AND LAND COVER

2.1.1 DESCRIPTION, LOCATION, AND CLIMATE

Located in south-central New Hampshire, Pleasant Lake is a naturally-occurring lake that has been raised by a dam at the northern end (lake outlet). The 3.6 square-mile (2,315 acres) watershed spreads across two towns, with 82% of the watershed in Deerfield and 18% in Northwood. The boundary between the two towns is located along the eastern shore of the lake, with the entire surface area of the lake itself located in Deerfield (Appendix A, Map 1). From the dam outlet, water from Pleasant Lake flows north to Northwood Lake, which discharges to the Little Suncook River and ultimately the Suncook River, a major tributary to the Merrimack River.

Pleasant Lake is situated within a temperate zone of converging weather patterns from the hot, wet southern regions and the cold, dry northern regions, which causes various natural phenomena such as severe thunder and lightning storms, hurricanes, and heavy snowfalls. Typically, summers are moderately warm and winters are cold and snowy (NHDES, 2002). Climate records from Epping, New Hampshire dating back to 1963 were used to assess historical climate in the Pleasant Lake watershed; this station was the nearest station with the longest climate record (NCDC, 2016). The area experiences moderate to high rainfall and snowfall, averaging 46.9 inches of precipitation annually (climate normal, 1981-2010; NCDC, 2016). Monthly precipitation since 1963 averaged 3.6 inches (Figure 2-1). Winter temperatures averaged 24.5 °F, while summer temperatures averaged 67.9 °F. Average monthly temperature since 1963 ranged from 15.5 °F to 71.5 °F (Figure 2-1).

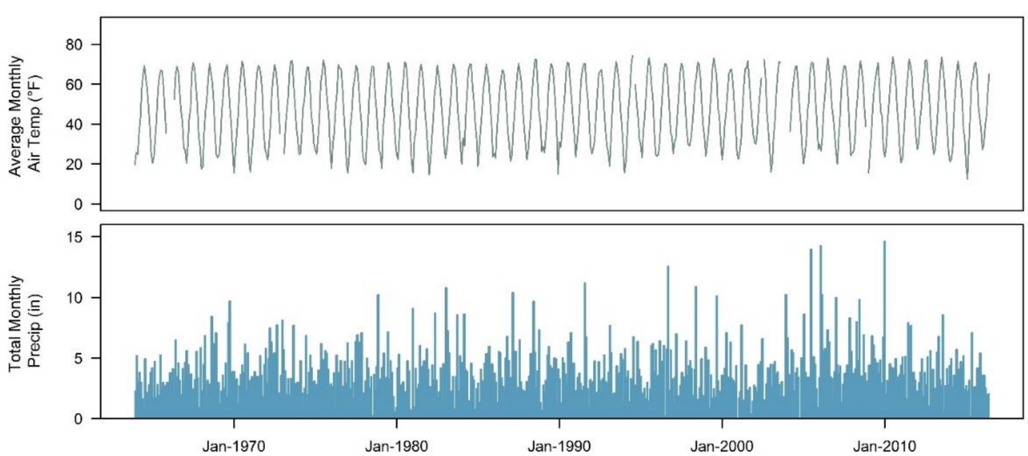


FIGURE 2-1. Monthly precipitation and average monthly air temperature from 1963 to present for Epping, NH weather station (Station ID USC00272800).

2.1.2 HISTORY AND POPULATION DEMOGRAPHICS

Understanding population growth and demographics, and ultimately development patterns, provides critical insight to watershed management, particularly as it pertains to lake water quality. The Towns of Northwood and Deerfield have been incorporated since 1773 and 1766, respectively (NHDES, 2002). Beginning in the 19th century, Pleasant Lake served as a water source for textile mills in downstream communities of the Suncook River Valley. The dam was built as part of the flowage rights owned by the mill companies (NHDES, 2002).

In more recent history, Pleasant Lake has been a popular summer recreational destination since at least the early 20th century (NHDES, 2002). Pleasant Lake is enjoyed by lake residents, day boaters, and visitors to the Deerfield Town Beach at Veasey Park, which was established in 1909. Vacationers typically visit from Independence Day to Labor Day, with the easy commute to Pleasant Lake from northern and southern New England particularly appealing. Over time, lakeshore seasonal homes have been converted to year-round single-family dwellings, and the number of full-time residents has grown. Residents appreciate the area for its small-town character.

Census records for Deerfield and Northwood date back to 1773, and from 1790 continue in ten-year intervals through 2010. Both communities grew until 1860 when the population began to decline to near-historic lows in the early 20th century (Figure 2-2; NHOEP, 2016). Both towns experienced steady population growth since the middle part of the last century (Table 2-1). The combined population of Deerfield and Northwood has grown from 1,748 people in 1960 to 8,521 people in 2010 – a 387% increase.

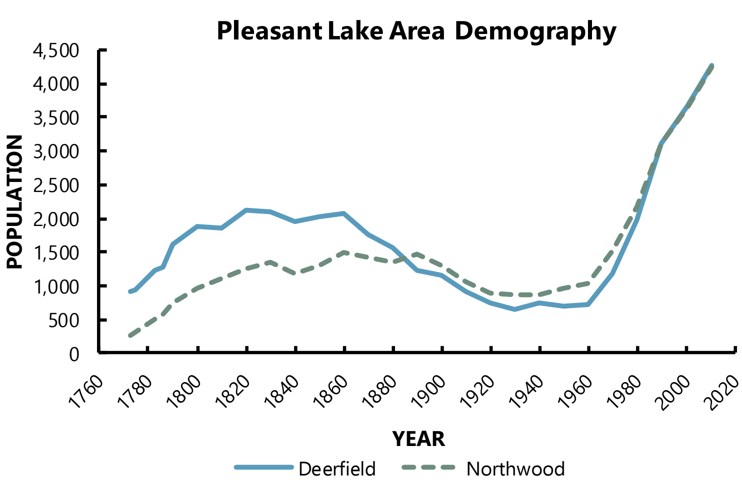


FIGURE 2-2. Historical demographic data for Deerfield and Northwood, NH. The population of these communities has grown dramatically over the last 50 years.

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

TABLE 2-1. US Census Bureau population estimates for Deerfield and Northwood, NH, 1960-2010.

Town	1960	1970	1980	1990	2000	2010	30 yr. Avg. Compound Annual Growth Rate (1980-2010)	20 yr. Avg. Compound Annual Growth Rate (1990-2010)	10 yr. Avg. Compound Annual Growth Rate (2000-2010)
Rockingham	98,642	138,951	190,345	245,845	277,359	295,223	--	--	--
Deerfield	714	1,178	1,979	3,124	3,678	4,280	2.60%	1.59%	1.53%
Northwood	1,034	1,526	2,175	3,124	3,640	4,241	2.22%	1.50%	1.47%
Combined	**1,748**	**2,704**	**4,154**	**6,248**	**7,318**	**8,521**	**2.42%**	**1.56%**	**1.53%**

The most recent demographic data (US Census Bureau, 2010) show a roughly even split between the under 19, 20-44, and 45-64 age categories. Seasonal (7-19%) and renter-occupied (11%) homes comprise small percentages of the residencies in these towns (Table 2-2), though the percentages are likely higher within the watershed area. The desirability of Pleasant Lake as a recreational destination, and increasingly as a permanent residence for newcomers, will likely stimulate continued population growth in the future. A new Senate Bill 146 (RSA 674:71 to :73) effective June 1, 2017 will allow the addition of accessory dwelling units (e.g., garage apartment, in-law suite) to single-family dwellings (SB 146, 2016). While Deerfield zoning ordinance meets the new bill's criteria, Northwood will need to make some adjustments, including increasing the maximum allowable square footage from 700 to 750 and the maximum number of bedrooms from one to two. The impact of this law on single-family dwellings within shoreland zones remains to be seen, and should be monitored as homeowners put the law to use. The potential for future population growth within the Pleasant Lake watershed is discussed further in Section 3.3.3.

TABLE 2-2. 2010 population demographics for watershed communities of Pleasant Lake.

State/County/Town	Total Pop.	Aged 0-19	Aged 20-44	Aged 45-64	Aged 65+	Total Housing Units	Total Occ. Houses[1]	Owner Occ. Houses[1]	Seasonal Houses[1]	Renter Occ. Houses[1]
New Hampshire	1,316,470	325,802	408,196	404,204	178,268	614,754	84.4%	59.9%	10.4%	24.5%
Rockingham County	295,223	73,825	87,489	96,485	37,424	126,709	90.8%	69.7%	4.8%	21.1%
Deerfield	4,280	1,106	1,257	1,497	420	1,743	88.2%	77.1%	6.9%	11.1%
Northwood	4,241	1,079	1,239	1,426	497	2,129	75.4%	64.6%	19.0 %	10.8%

[1]Percentage of total housing units.

2.1.3 LAND USE

Characterizing land use 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. Additionally, 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 use is also the essential element in determining how much phosphorus is contributing to a lake from the watershed (see Section 3.5 on Watershed Modeling).

Current land use in the Pleasant Lake watershed was determined using a combination of land use data from NH GRANIT's New Hampshire Land Cover Assessment 2001 [NHLC01], National Wetland Inventory (NWI) wetlands, National Hydrography Dataset (NHD) waterbodies, 2014 National Agriculture Imagery Program (NAIP) aerials, and Google Earth satellite images from May 7th, 2015. For more details on methodology, see Lake Loading Response Model report (FBE, 2016a).

While seventeen different land use types have been differentiated in the Pleasant Lake watershed (Appendix A, Map 2), three general land use types dominate the landscape (Figure 2-3). Forests, developed areas, and water/wetlands represent over 90% of the watershed land use. Forests, including deciduous, evergreen, mixed habitats, and forested wetlands account for approximately 64% of the land use (1,480 acres). Wetland habitat and open water (including the surface area of Pleasant Lake) represent 23% of the land use (530 acres). Developed areas such as residential areas, lawns, and roads account for the third largest land cover totaling over 220 acres or 9% of the watershed. Agriculture represents 4% (85 acres), and includes row crops, pastures, and hayfields.

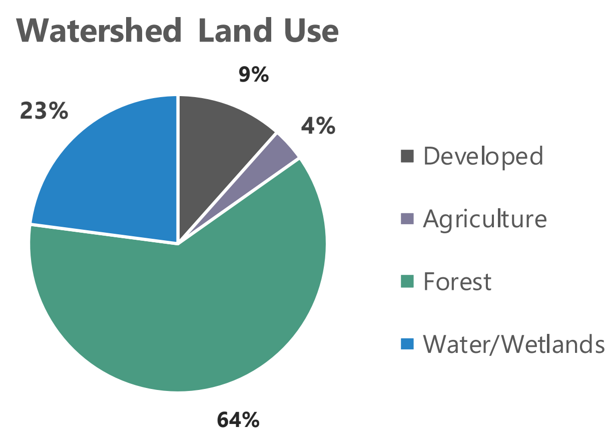
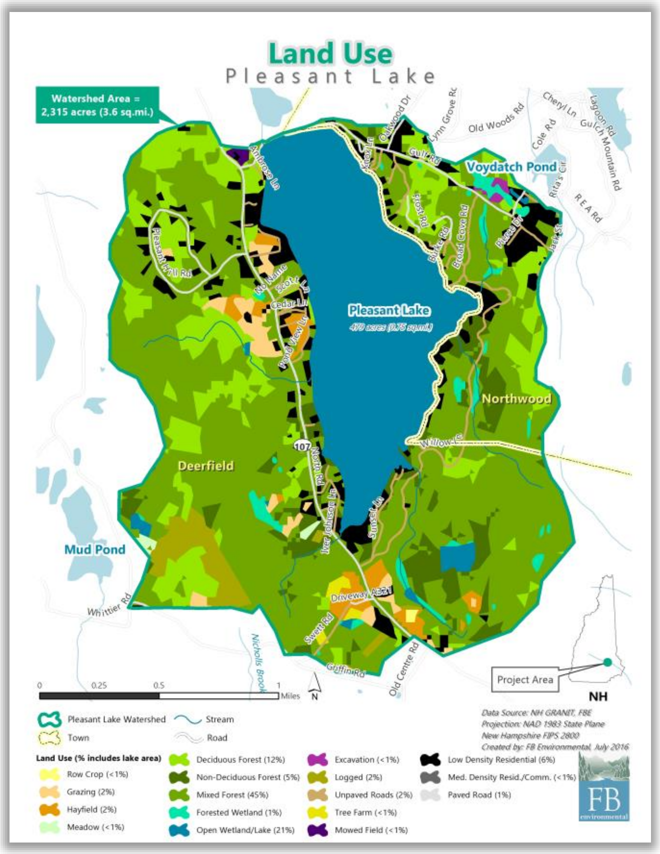


FIGURE 2-3. Watershed land use in the Pleasant Lake watershed. Includes lake surface area.

Developed areas within the Pleasant Lake watershed include **impervious cover (IC),** such as asphalt, concrete, and rooftops that force rain and snow that would otherwise soak into the ground to runoff as stormwater. Stormwater runoff carries pollutants to waterbodies that may be harmful to aquatic life, including sediments, nutrients, pathogens, pesticides, hydrocarbons, and metals. Studies have shown a link between the amount of impervious area in a watershed and water quality conditions (CWP, 2003). Developed area and



Land use within the Pleasant Lake watershed. Refer to Appendix A, Map 2 for larger map.

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

associated impervious cover is relatively low at 9% in the Pleasant Lake watershed, but includes many concentrated areas along the lake shoreline and along major routes through the watershed. The build-out analysis conducted for the watershed, coupled with projected population growth trends, indicates that the percentage of impervious cover will continue to increase. Therefore, it is imperative that watershed communities incorporate LID techniques into new development projects. More information on LID strategies and BMP implementation can be found in the Action Plan in Section 5.2.

2.1.4 LAND CONSERVATION

Roughly 12% (284 acres) of the watershed is conserved land (Appendix A, Map 3). These parcels are owned and managed by a mix of private entities and nonprofit land trusts. These conserved area help protect the lake, provide important wildlife habitat, and allow public recreational use. Land owners interested in permanently protecting their land have a variety of conservation options available to them. Contact Bear-Paw Regional Greenways for more information at http://www.bear-paw.org/.

2.2 PHYSICAL FEATURES OF THE WATERSHED

2.2.1 TOPOGRAPHY

Pleasant Lake exists at 578 feet above sea level (fasl; NHDES, 2002) and is encompassed by wooded hills in all directions. The highest peak in the watershed (Levi Hill) is located along the northwestern boundary near Pleasant Hill Road at 982 fasl (Appendix A, Map 4). Gulf Hill bounds the watershed on the eastern side in the Town of Northwood.

2.2.2 SOILS & GEOLOGY

SURFICIAL GEOLOGY

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

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

The surficial geology of the Pleasant Lake watershed is dominated by glacial till, which comprises 75% of the area (Appendix A, Map 5). Large ice blocks likely occupied the lake basins of Pleasant and Northwood Lakes during the glacial era, and left behind some glacial till around the margins (NHGS, 2016). The till in this area is also sometimes formed into drumlins, which are streamlined hills of thick till as much as 80 feet thick. However, most of this area is classified as thin glacial till, which is less than 10 feet thick with many areas of exposed bedrock outcrops. Palustrine swamp deposits (muck, peat, and silt) and glaciolacustrine/glaciofluvial deposits (coarse gravel and coarse to fine sand) account for less than 5% of the watershed. A small area of anthropogenic/artificial fill is also present near the Pleasant Lake dam.

SOILS

Seventeen different soil classifications are present in the Pleasant Lake watershed, demonstrating the capacity of the watershed to sustain a diversity of terrestrial and aquatic communities (Appendix A, Map 6). The Chatfield-Hollis-Canton complex (140B, 140C, 140D) covers the largest area in the watershed (47%, 1,099 acres), primarily in the upland areas (Table 2-3). This till-based complex is well-drained with a low soil erosion potential, which means that runoff can easily infiltrate these soils and movement of soil particles to surface waters is limited. Paxton fine sandy loam, the second most common soil series, covers 217 acres (9%) of the watershed. The next most common soils present in the watershed is the Scituate-Newfields complex (5%, 114 acres) and Walpole very fine sandy loam (5%, 110 acres), which is soil found along the stream corridors throughout the watershed (USDA, 2016). A full list of soil series found in the watershed can be found in Appendix B.

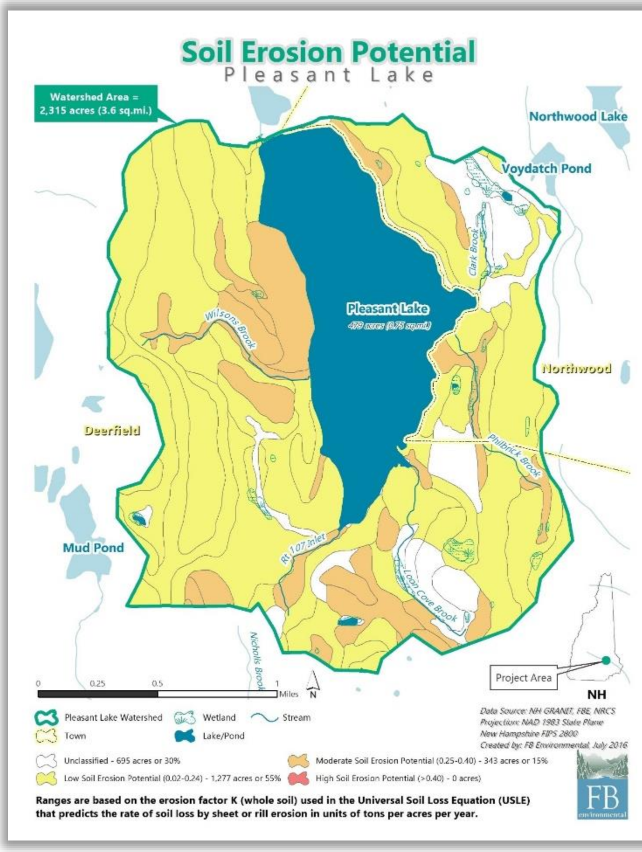
TABLE 2-3. Dominant soil series found in the Pleasant Lake watershed. Source: USDA, 2016.

Soil Series Name	Soil Erosion Potential (K Factor)	Parent Material	Available Water Storage (in profile)	Permeability (Ksat)	Drainage Class
Chatfield-Hollis-Canton	Low (0.15)	Till	Low to Very Low	Low to High	Well-drained
Paxton	Moderate to Low, depending on slope (0-0.28)	Coarse-loamy lodgment till on hills on uplands	Low	Very Low to Moderately Low	Well-drained
Scituate-Newfields	Low (0.2)	Till	Low to Moderate	Moderately Low to High	Moderately well-drained
Walpole	Moderate (0.37)	Very fine sandy loam in depressions	Low	High	Poorly-drained

SOIL EROSION POTENTIAL

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

The soil erosion potential for the Pleasant Lake watershed was determined from the associated erosion factor K_w[2] used in the Universal Soil Loss Equation (USLE). The USLE predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year. There are no areas of high soil erosion potential within the Pleasant Lake watershed. However, areas of moderate soil erosion potential account for 343 acres (15%) of the watershed (Appendix A, Map 7). Several areas along the shoreline, particularly along the western shore, of Pleasant Lake are classified as having moderate soil erosion potential. These areas should be monitored closely for erosion during and after any development projects to ensure that eroding soil is not degrading water quality. More effort and investment will be required to maintain the stability and function of these areas (compared to other areas with low soil erosion potential) and to prevent stormwater runoff from reaching surface waters.



Areas of moderate soil erosion potential cover 15% of the Pleasant Lake watershed. Refer to Appendix A, Map 7.

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

2.2.3 WETLANDS, STREAMS, OPEN WATER, AND RIPARIAN HABITAT

The Pleasant Lake watershed provides a plethora of critical water resources, with just over 17 acres of open water and wetlands (not including the lake), over 34 acres of forested wetland, and over 3 miles of mapped streams. The **riparian habitat** of the lake, wetlands, and tributaries is home to a diverse community of fish, birds, mammals, and plants that are dependent on clean water quality to flourish. Wetlands help maintain water quality by filtering nutrients and sediments from incoming stormwater runoff. Any decrease in the

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

extent of wetlands because of development will limit this natural filtration and cause detrimental long-term effects on water quality and diversity of inhabiting species.

NHFGD ranks habitat based on value to the State, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape. These habitat rankings are published in the State's 2015 Wildlife Action Plan, which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire. Over 785 acres (34%) of the Pleasant Lake watershed is considered Tier 1 habitat (highest ranked habitat in NH). Tier 1 habitat includes the entire surface area and shoreline of Pleasant Lake. Part of the Philbrick Brook headwaters is also considered Tier 1 (mostly Appalachian oak-pine forest). A smaller portion (23%) of the watershed, mostly hemlock-hardwood-pine forest in the western part of the watershed, is considered Tier 2 (highest ranked habitat in the biological region). Additional forested lands scattered throughout the watershed (24%) are considered Tier 3 (supporting landscapes). The remaining 19% of the watershed is unclassified and generally represents developed portions of the watershed. A map detailing priority habitats for conservation based on the NH Wildlife Action Plan can be found in Appendix A, Map 3.

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

2.2.4 LAKE MORPHOLOGY AND BATHYMETRY

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

The surface area of Pleasant Lake is 0.75 square miles (479 acres) with a mean depth of 23.6 ft (7.2 m) and maximum depth of 69.0 feet (21.0 m) at the deep spot (refer to Section 3; Appendix A, Map 8)[3]. The lake has

[3] Lake area was calculated from National Hydrography Dataset Waterbody shapefile and GIS desktop analysis of watershed land use (including shoreline). Lake volume was calculated based on the most recent NHDES bathymetry data available from NH GRANIT. Using the hydrologic budget determined by the Lake Loading Response Model, new flushing rates were calculated for the lake. The 2002 NHDES Pleasant Lake Diagnostic Study reported lake volume as 13,995,000 cubic meters, flushing rate as 0.4 times per year, lake area as 489 acres, mean depth as 7.0 m, and maximum depth as 19.8 m. Note – this is slightly less than the surface area listed by NHDES, as the lake shape and area came from the NHD_Waterbody shapefile used for land use assessment. The NHDES area is 3% larger than the NHD area.

approximately 4.5 miles (NHDES, 2002) of shoreline and over 3.7 billion gallons (14,023,020 m^3) of water. The **areal water load** is 11.5 ft/yr (3.5 m/yr), and the **flushing rate** is approximately 0.48 times each year. The low flushing rate of 0.48 means that the entire volume of Pleasant Lake is replaced every two years, which allows pollutants more time to settle in lake bottom sediments and/or be taken up by biota.

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

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.

2.3 DIRECT AND INDIRECT DRAINAGE AREAS

Watershed water load (which includes runoff and tributary flow) accounts for 77% of the total water entering Pleasant Lake on an annual basis. This fact makes the tributaries and their associated land covers critical to the water quality of Pleasant Lake. Rainfall makes up the additional water load to the lake (23%; septic systems are a minor water load input at <1%). Rainfall makes up a relatively large portion of the total water load to the lake because of the large lake surface area relative to watershed size. The most significant tributary drainage areas to Pleasant Lake are the Rt. 107 Inlet, which discharges to the southern end of the lake and accounts for 25% of the watershed water load, and the Direct Shoreline area, which accounts for 24% of the watershed water load. Other tributaries include Wilsons, Clark, Philbrick, Loon Cove, Branch, Farrelly, and Veasey Brooks, as well as an unnamed drainage that flows south from the Northwood side of the lake to the discharge area for Clark Brook (Appendix A, Map 9). A detailed summary of the water and nutrient loading analysis for the Pleasant Lake sub-basins is provided in Section 3.5.2.

2.4 INVASIVE SPECIES

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

PLPA has maintained a meticulous and active Lake Host program since 2002. The program has resulted in numerous "saves" for both variable-leaved (*Myriophyllum heterophyllum*) and Eurasian milfoil (*Myriophyllum spicatum*). While milfoil has not infiltrated Pleasant Lake, it is present in nearby Northwood Lake. The Lake Host program is vital to keeping Pleasant Lake free from this aquatic invader. Another invasive species, the Chinese mystery snail (*Cipangopaludina chinensis malleata*), has been present in Pleasant Lake since at least 2013 (Pleasant Ponderings, 2013). This non-native snail is known to be a host for a native parasite of freshwater bivalves (*Aspidogaster conchicola*; USGS, 2016) Additionally, PLPA has participated in the NHDES Weed Watchers program since 1988. Volunteers conduct weed surveys of the lake as a proactive approach to exotic plant control.

3. ASSESSMENT OF WATER QUALITY

This section provides an overview of the water quality standards that apply to Pleasant Lake, the methodology used to assess water quality, the past, current, and future state of water quality based on the assessment, the established water quality goal and objectives, and the potential pollutant sources in the watershed. Pleasant Lake presents a unique situation for water quality assessment and management, as most water quality data indicate that the lake is in excellent health, but the lake has been listed on the Section 303(d) list as impaired for Aquatic Life Use (ALU) since 2008 for insufficient levels of DO, or **anoxia**. Veasey Park Beach was also listed as impaired for Primary Contact Recreation (PCR) in 2012 due to elevated levels of ***E. coli***; however, this impairment has been removed from the Draft 2014 Section 303(d) list for New Hampshire as more recent data collection has not produced exceedances of State criteria for bacteria[4]. Due to the link between phosphorus and DO described in the sections below, as well as the potential for unmitigated sources of pollution (e.g., phosphorus) from watershed development in the coming years, phosphorus is the focus for the water quality assessment and goal setting described in this plan.

> **Anoxia** is a condition of low dissolved oxygen.
>
> ***Escherichia coli (E. coli)*** are bacteria present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies.

3.1 APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

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

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

[4] *http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/documents/2014-draft-deimpaired.pdf*

3.1.1 DESIGNATED USES & WATER QUALITY CLASSIFICATION

The CWA requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support, and include uses for aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife (Table 3-1). Surface waters can have multiple designated uses.

In New Hampshire, all surface waters are also legislatively classified as Class A or Class B, most of which are Class B (Env-Wq 1700). A brief description of these classes is provided in Table 3-2 (NHDES, 2014a). The 2010 Senate Bill 426 passed in the New Hampshire Legislature reclassified Pleasant Lake from Class B back to Class A waters, making Pleasant Lake a "high quality waterbody" in the State of New Hampshire.

Water quality criteria are then developed to protect these designated uses. Depending on the designated use and type of waterbody, water quality criteria can become more or less strict if the waterbody is classified as either Class A or B. Water quality criteria for lakes are discussed in Section 3.1.2.

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

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

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

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

3.1.2 LAKE WATER QUALITY CRITERIA

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

Water quality criteria for each classification and designated use in New Hampshire can be found in RSA 485 A:8, IV and in the State's surface water quality regulations (NHDES, 2008). Aquatic Life Use (ALU) and Primary Contact Recreation (PCR) are the two major uses of concern for Pleasant Lake.

AQUATIC LIFE USE (ALU)

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

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

Trophic State is the degree of eutrophication of a lake and is designated as oligotrophic, mesotrophic, or eutrophic. Generally, oligotrophic lakes are less productive or have less nutrients (i.e., low levels of phosphorus and Chlorophyll-a), deep Secchi Disk Transparency (SDT) readings (8.0 m or greater), and high DO 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.

As shown in Table 3-3, ALU criteria vary by lake **trophic state**, since each trophic state has a certain algal biomass (chlorophyll-a) that represents a balanced, integrated, and adaptive community. Exceedances of the chlorophyll-a criterion suggests that the algal community is out of balance. Since phosphorus is the primary limiting nutrient for growth of freshwater algae (chlorophyll-a), phosphorus is included in this assessment process. For

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

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

Lakes stratify into different thermal layers during the summer months. The **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. The **thermocline** or **metalimnion** is the markedly cooler, dynamic middle layer of rapidly changing water temperature. The top of this layer is distinguished by at least a degree Celsius drop per meter of depth. The **hypolimnion** is the bottom-most layer of the lake that experiences periods of low oxygen during stratification and is devoid of sunlight for photosynthesis.

ALU assessment, phosphorus and chlorophyll-a are combined per the decision matrix presented in Table 3-4. The chlorophyll-a concentration will dictate the assessment if both chlorophyll-a and phosphorus data are available and the assessments differ.

DO is also used as an indicator for ALU assessment and is critical to the balanced, integrative, and adaptive community of organisms (see Env-Wq 1703.19). For Class A waters, non-support use determinations are based on a daily average measurement of 75% DO saturation or less and an instantaneous DO measurement of 6 ppm or less, which apply to any depth in a vertical profile (except within 1 meter of lake bottom) collected from June 1 to September 30 (see Env-Wq 1703.07). Lakes that support coldwater fisheries must also meet a 7-day mean DO of 9.5 ppm and an instantaneous DO measurement of 8 ppm in the **epilimnion** (if stratified) or in the top 25% of the depth (if not stratified) from October 1 to May 14.

From 1974 through 2010, NHDES conducted trophic surveys of lakes to determine trophic state. The trophic surveys evaluated physical lake features, as well as chemical and biological indicators. **The most recent trophic survey by NHDES (1996) classified Pleasant Lake as oligotrophic. However, the 2002 NHDES Pleasant Lake Diagnostic Study suggested that the lake may be approaching the threshold between oligotrophic-mesotrophic due to low DO in bottom waters.** As described in Section 3.2, Pleasant Lake has excellent water quality with low levels of phosphorus and chlorophyll-a that are well below the ALU nutrient criteria; however, a significant volume of Pleasant Lake is impacted by low DO that does not meet State criteria for Class A waters (>6 ppm) or coldwater fisheries (>9.5 ppm). This unexpected disconnect between low phosphorus in the epilimnion of Pleasant Lake, but low levels of DO in bottom waters is explained in Section 3.2.

TABLE 3-4. Decision matrix for aquatic life use (ALU) assessment in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algal concentration.

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

PRIMARY CONTACT RECREATION (PCR)

For PCR, New Hampshire has a narrative criterion with a numeric translator or threshold for the primary indicator *E.coli*. The narrative criteria for PCR (Env-Wq 1703.03) states that "*All surface waters shall be free from substances in kind or quantity which float as foam, debris, scum or other visible substances, produce odor, color, taste or turbidity which is not naturally occurring and would render it unsuitable for its designated uses or would interfere with recreation activities.*" Nutrient response indicators, chlorophyll-a and cyanobacteria scums, are used as secondary indicators. Elevated chlorophyll-a levels or the presence of cyanobacteria scums interfere with the aesthetic enjoyment of swimming and/or may pose a health hazard. chlorophyll-a levels greater than or equal to 15 ppb or the presence of cyanobacteria scums are considered "not supporting" for PCR. These secondary indicators can provide reasonable evidence to classify PCR as "not supporting," but cannot result in a "fully supporting" designation. **Veasey Park Beach was listed as impaired for PCR in 2012 due to elevated levels of *E. coli;* however, this impairment has been removed from the Draft 2014 Section 303(d) list for New Hampshire as more recent data collection has not produced exceedances of State criteria for bacteria.**

3.1.3 ANTIDEGRADATION PROVISIONS

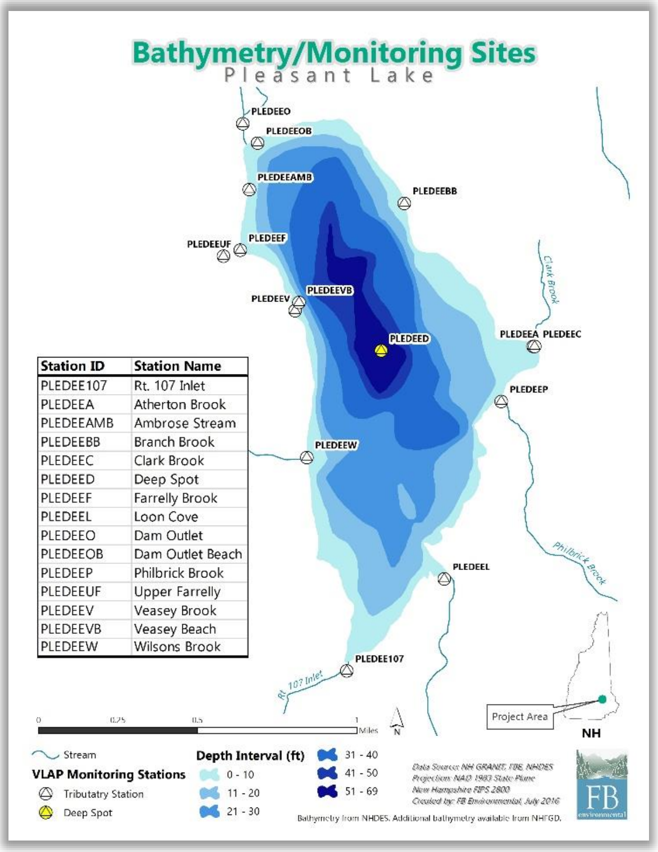
The Antidegradation Provision (Env-Wq 1708) in New Hampshire's water quality regulations serves to protect or improve the quality of the State's waters. The provision outlines limitations or reductions for future pollutant loading. Certain development projects (e.g., projects that require Alteration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

3.2 WATER QUALITY SUMMARY

3.2.1 STUDY DESIGN AND DATA ACQUISITION

FBE analyzed historical water quality monitoring data for key parameters (i.e., phosphorus, chlorophyll-a, water clarity, and DO and temperature profiles) to assess the state of Pleasant Lake. Pleasant Lake was first monitored by NHDES during a trophic survey in 1982, and again in 1996, at the deepest spot in the lake (Station ID: PLEDEED). More consistent water quality data have been collected through the New Hampshire Lake Survey Program and Volunteer Lake Assessment Program (VLAP) and PLPA from 1989 to present. In addition to monitoring at the deep spot, eight tributaries and the lake dam outlet were sampled beginning in 1989 for total phosphorus, turbidity, pH, and specific conductance. Additional data available for Pleasant Lake can be found in the NHDES Acid Outlets Study, which investigated the effects of acid rain on NH lakes, and the Pleasant Lake Clean Lakes Project in 2000, as part of the 2002 NHDES Pleasant Lake Diagnostic Study. A detailed summary of all available data, including sources and years of collection, can be found in Appendix A of the Pleasant Lake Water Quality Analysis (FBE, 2016b).

Data acquisition and analysis for Pleasant Lake followed protocols set forth in the Site Specific Project Plan (SSPP) in Appendix C. Analysis included a comparison of historical (2005 and earlier) and recent (2006-2015) seasonal (collected between May 24 and September 15) water quality data, statistical analysis of historical water quality trends, calculation of the median in-lake phosphorus concentration using only epilimnion core samples, and determination of current trophic state. Detailed descriptions of analysis methods and assessment of all water quality parameters can be found in the Pleasant Lake Water Quality Analysis (FBE, 2016b).



Bathymetry and monitoring site locations of Pleasant Lake and its tributaries. Refer to Appendix A, Map 8 for larger map.

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

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

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

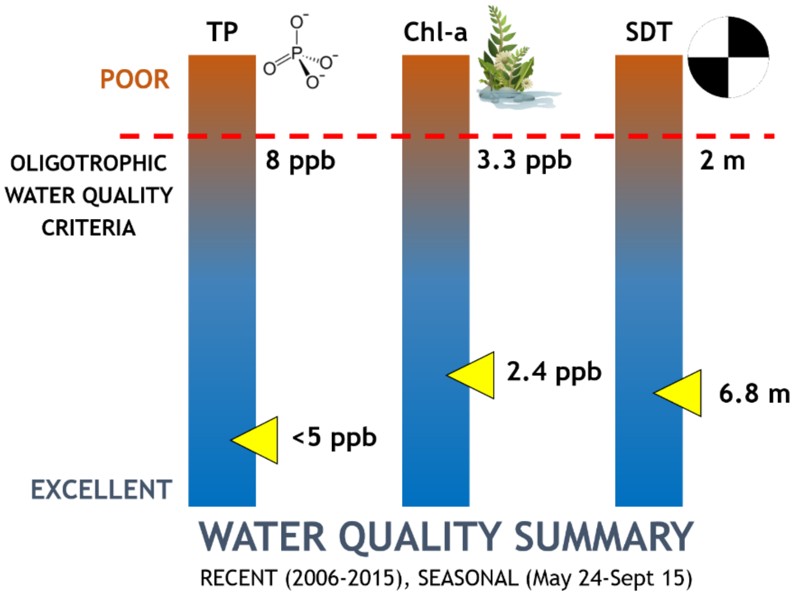


FIGURE 3-1. Visual summary of existing water quality in Pleasant Lake. Data represent recent (2006-2015) and seasonal (May 24-Sept 15) median or average calculations. TP = total phosphorus; Chl-a = chlorophyll-a; SDT = Secchi Disk Transparency. SDT is based on data collected with a scope.

Total phosphorus, chlorophyll-a, and SDT also show no statically significant trends in average annual data, indicating that these parameters have remained relatively stable (with some interannual variation due to weather) over the last several decades[5]. For instance, wetter years may deliver more phosphorus-laden sediment to waterbodies and reduce water clarity. Vice versa, drier years typically generate excellent water quality conditions in lakes by reducing the amount of pollutants washing off the landscape and into surface waters.

NOTE ON EXISTING MEDIAN TOTAL PHOSPHORUS CALCULATION FOR PLEASANT LAKE

Recent total phosphorus sample data collected from the epilimnion fell below the laboratory detection limit of 5 ppb. The full detection limit (5 ppb) was used for statistical calculations in the water quality assessment and goal setting, but does not reflect the "true" summer median epilimnetic total phosphorus concentration in Pleasant Lake. Actual in-lake total phosphorus concentrations are likely between 4 and 5 ppb. Therefore, determining specific benchmark reductions in in-lake phosphorus concentrations may not be appropriate until more data are collected using a laboratory with a method detection of <1 ppb. Given this, the water quality goal focuses on reducing phosphorus loading to Pleasant Lake and uses relative reductions in in-lake phosphorus concentration (e.g., 0.6 ppb) instead of a specific in-lake phosphorus concentration target.

3.2.3 DISSOLVED OXYGEN AND HYPOLIMNION TOTAL PHOSPHORUS

DO and water temperature profiles from the deep spot in Pleasant Lake show typical midsummer stratification for New Hampshire lakes, with high DO and warm water temperatures near the surface and a marked decrease in DO and water temperature below the metalimnion or thermocline (FBE, 2016b). DO can change dramatically with lake depth as a function of water density and biological consumption. Oxygen is produced in the top portion of a lake, where sunlight drives photosynthesis by algae and other plants and is consumed near the bottom of a lake, where organic matter accumulates and decomposes. Thus, low DO in

[5] *The 2015 VLAP report for Pleasant Lake does show a significantly decreasing (improving) trend in epilimnetic total phosphorus, but this is due to different handling of samples below laboratory the detection limit of 5 ppb; if the sample result is <5 ppb, then VLAP uses a value of half the detection limit (2.5 ppb) to calculate statistics. Given that most recent total phosphorus results fell below detection (< 5 ppb), it may be unreasonable to assume that all results are half the detection limit (2.5 ppb), so the full detection limit (5 ppb) was used for statistical calculations in this water quality assessment and watershed restoration plan (assuming total phosphorus concentrations are more likely between 4-5 ppb).*

bottom waters can be a natural phenomenon when thermal stratification in late summer separates oxygenated surface waters from bottom waters. However, an increase in the extent and duration of low DO in lakes can be detrimental to aquatic life by reducing their desired habitat (cooler, high-oxygen waters; NHDES, 2012). DO less than 1 ppm can also release sediment-bound phosphorus back into the water column (a.k.a., internal phosphorus loading) where it can re-stimulate algal blooms and plant growth, creating a positive feedback to eutrophication.

In Pleasant Lake, low DO in bottom waters (i.e., hypolimnion) is common and generally persistent year to year. Overall, about 42% of the lake volume in mid to late summer does not meet the Class A DO criterion of 6 ppm for the protection of aquatic life (FBE, 2016b). Though based only on a single profile collected in early August 2010, about 13% of the lake volume in mid to late summer also shows severe DO depletion (< 1 ppm) in bottom waters, which can trigger internal phosphorus loading. Slightly elevated hypolimnion phosphorus compared to epilimnion phosphorus shows that internal phosphorus loading is a potential concern for Pleasant Lake. It is difficult to discern the true extent and duration of anoxia that could trigger internal phosphorus loading in Pleasant Lake due to the lack of profile data for every year and during critical low-oxygen months (August-September). Most profile data were collected every other year and in June or July. **It will be important to continue monitoring DO and phosphorus on a yearly basis in late summer.**

NOTE ON POTENTIAL CAUSE OF DISSOLVED OXYGEN IMPAIRMENT

The 2002 NHDES Diagnostic Study and annual VLAP reports suggested that the existing low-oxygen impairment is likely caused by NPS pollution (i.e., phosphorus) in stormwater runoff and aging or failing septic systems. However, the low-oxygen impairment may be the result of high sediment oxygen demand from large amounts of organic matter on the lake bottom that is unrelated to current conditions. This organic matter may be natural phenomenon or from legacy human activities in the watershed (e.g., logging, land clearing, farming, etc.). Sediment analysis may help define the amount and source of phosphorus and legacy organic matter in the sediments and the likelihood that phosphorus will be released from the sediments to the water column under anoxic conditions.

3.2.4 TRIBUTARY WATER QUALITY ANALYSIS

Many of the tributaries to Pleasant Lake have been monitored since 1989 for phosphorus, turbidity, pH, **specific conductance**, and chloride (FBE, 2016b). Analysis of tributary water quality data can help to identify which tributaries may be impacting the water quality of Pleasant Lake and to prioritize those drainage areas for phosphorus and sediment management. Determination of median phosphorus for these tributaries also helps to inform the land use model (Section 3.3.2).

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

In summary, **Farrelly, Veasey, Loon Cove, and Branch Brooks should be prioritized for future monitoring and land use investigations of potential NPS pollution.** Farrelly, Veasey, and Branch Brooks showed elevated levels of both specific conductance and chloride, indicating that chloride from road salts is likely driving elevated specific conductance (Table 3-5). Fortunately, chloride concentrations fell below the chronic exposure limit of 230 ppm[6]. Farrelly and Veasey Brook also showed elevated turbidity, indicating potential soil erosion issues. Loon Cove Brook had the highest phosphorus concentration at 53 ppb; since much of the upstream drainage area of Loon Cove Brook is forested, phosphorus is likely coming from development near the outlet. pH in all tributaries is considered acidic (< 7.0) and of poor quality for aquatic life (< 6.5), reaching a minimum of 4.8 in Clark Brook and a maximum of 6.2 in Loon Cove and Wilsons Brooks. **Given the critically-low buffering capacity of Pleasant Lake (ranging from 0.7 to 3.5 ppm), the acidic contributions of these tributaries may further decrease pH in the lake and threaten aquatic life.**

TABLE 3-5. Summary data for Pleasant Lake tributaries and the dam outlet. Values represent the mean or median of annual means or medians for all available data (FBE, 2016b). Bold and italicized text highlights parameters and sites of concern. TP = total phosphorus.

Tributary/Outlet	Median TP (ppb)	Mean Turbidity (NTU)	Mean pH	Mean Spec Cond (μS/cm)	Mean Chloride (ppm)
Branch Brook	17	2.1	***5.9***	***172.0***	***42***
Clark Brook	24	4.6	***4.8***	55.3	14
Farrelly Brook	11	***10.4***	***5.8***	***448.9***	***84***
Loon Cove Brook	***53***	2.6	6.2	64.6	8
Philbrick Brook	21	1.1	***5.0***	18.8	2
Rt. 107 Inlet	16	1.1	***5.8***	96.4	7
Veasey Brook	21	***8.2***	***5.5***	***210.6***	***71***
Wilsons Brook	8	0.5	6.2	79.7	15
Dam Outlet	6	0.7	6.3	70.2	NA

3.3 WATERSHED MODELING

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

3.3.1 ASSIMILATIVE CAPACITY

A lake receives natural inputs of phosphorus in the form of runoff from its watershed. Phosphorus can be

[6] *http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/vrap_parameters.pdf*

taken up by aquatic life within the lake, settle in bottom sediments, or flow out of the lake to downstream waterbodies. In this sense, there is a natural balance between the amount of phosphorus flowing in and out of a lake system, also known as the ability of a lake to "assimilate" phosphorus. The **assimilative capacity** is based on factors such as lake volume, watershed area, and precipitation runoff coefficient. If a lake is receiving more phosphorus from the watershed than it can assimilate, then its water quality will decline over time as algal or cyanobacteria blooms become more frequent. In relation to water quality criteria, the assimilative capacity of a waterbody describes the amount of phosphorus that can be added to a waterbody without causing a violation of the water quality criteria.

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

Oligotrophic waterbodies, such as Pleasant Lake, have water quality criteria set at 8 ppb for total phosphorus and 3.3 ppb for chlorophyll-a. NHDES requires 10% of the criteria be kept in reserve; therefore, median total phosphorus and chlorophyll-a must be at or below 7.2 ppb and 3.0 ppb, respectively, to achieve Tier 2 High Quality Water status. Tier 2 waters, or high quality waterbodies, have one or more water quality parameters that are better than the water quality criteria and that also exhibit reserve capacity of at least 10% of the total assimilative capacity. Based on the NHDES assimilative capacity analysis (Table 3-6), **Pleasant Lake falls in the Tier 2 category (High Quality Waters) for oligotrophic lakes.**

TABLE 3-6. Summary of total phosphorus (TP) and chlorophyll-a (Chl-a) assimilative capacity analysis results for Pleasant Lake. Existing data reflects seasonal (May 24 – September 15) and recent (2006-2015) data.

Lake and Station	Existing Median TP (ppb)	Remaining TP Assim. Capacity (ppb)	Existing Median Chl-a (ppb)	Remaining Chl-a Assim. Capacity (ppb)	Analysis Results
Pleasant Lake Deep Spot (PLEDEED)	5.0	+2.2	2.4	+0.6	Tier 2

3.3.2 LAKE LOADING RESPONSE MODEL (LLRM) RESULTS

A second analysis, known as the Lake Loading Response Model (LLRM), was used to link watershed loading with in-lake total phosphorus concentrations to predict the past, current, and future water quality of Pleasant Lake (FBE, 2016a). The LLRM is an Excel-based model that incorporates data on land cover, watershed boundaries, point sources, septic systems, waterfowl, rainfall, and an estimate of internal lake loading, combined with many coefficients and equations from scientific literature on lakes and nutrient cycles, to trace water and phosphorus loads (in the form of mass and concentration) from these various pollutant sources in the watershed, through tributary basins, and into the lake. The model is then able to develop a water and phosphorus loading budget for the lake and its tributaries, and make predictions about chlorophyll-a concentrations and Secchi Disk Transparency (SDT) readings based on the estimated phosphorus loading.

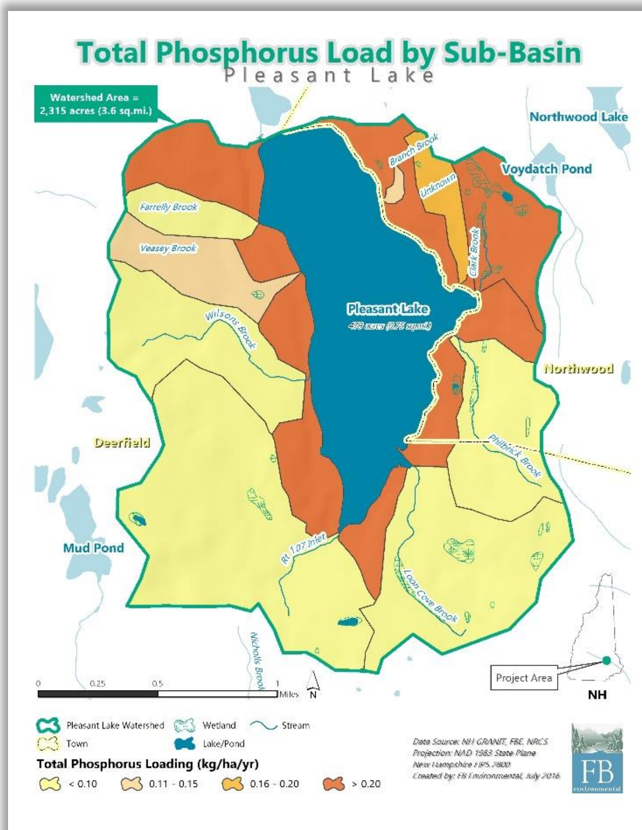
As shown in Table 3-7, LLRM results indicate that **the greatest phosphorus load comes from watershed runoff, which accounts for 65% of the current total phosphorus loading to Pleasant Lake**. Atmospheric deposition accounts for about 14% of the phosphorus load, which is a larger proportion than is typical for NH lakes, but seems appropriate for Pleasant Lake given that the surface area of the lake is large compared to the watershed area. Septic systems account for 15% (see Section 3.5.2 for details on the septic system survey); internal loading accounts for 4% (see FBE, 2016a for details on calculation assumptions); waterfowl account for 2%. Although developed areas cover only 12% of the watershed (see Section 2.1.3), developed areas are contributing 62% of the phosphorus load to Pleasant Lake; agriculture covers 5% of the watershed, but contributes 17% of the phosphorus load to Pleasant Lake (FBE, 2016a).

The model also estimated current phosphorus loading from each of the ten sub-basin drainage areas (tributaries and the direct shoreline) in the Pleasant Lake watershed. **The Direct Shoreline sub-basin contributes the highest phosphorus load per unit area (0.26 kg/ha/yr) to Pleasant Lake** (Appendix A, Map 10), as well as the largest phosphorus load in total mass (46.1 kg/yr). Direct shoreline areas are usually high phosphorus contributors because of their proximity to lakes and high-density development. Given this, the direct shoreline of a lake deserves special attention in any lake protection plan. Also of note, **Clark Brook, draining the northeastern corner of the watershed in Northwood, contributes the second highest phosphorus load per unit area (0.24 kg/ha/yr) to Pleasant Lake**.

It should be noted that during model calibration, measured in-stream phosphorus for Loon Cove and Philbrick Brooks were higher than model predictions. Both sub-basins are located on the east side of the lake where development is concentrated near the stream outlets (also part of the Direct Shoreline sub-basin). This development may be functioning as a point source to the sample location or available data may not accurately represent annual average concentrations in these streams. Further investigation may be warranted to confirm these data and potential phosphorus sources.

TABLE 3-7. Total phosphorus (TP) and water loading summary by source for Pleasant Lake.

Loads to Pleasant Lake	TP (kg/year)	TP (%)	Water (m^3/year)	Water (%)
Atmospheric Deposition	21	14%	1,532,355	23%
Internal Loading	6	4%	NA	NA
Waterfowl	3	2%	NA	NA
Septic Systems	23	15%	23,475	<1%
Watershed Runoff	100	65%	5,162,276	77%
Total Load To Pleasant Lake	**153**	**100%**	**6,718,106**	**100%**



The direct shoreline area of the lake contributes the most phosphorus per hectare per year. Refer to Appendix A, Map 10 for a larger map.

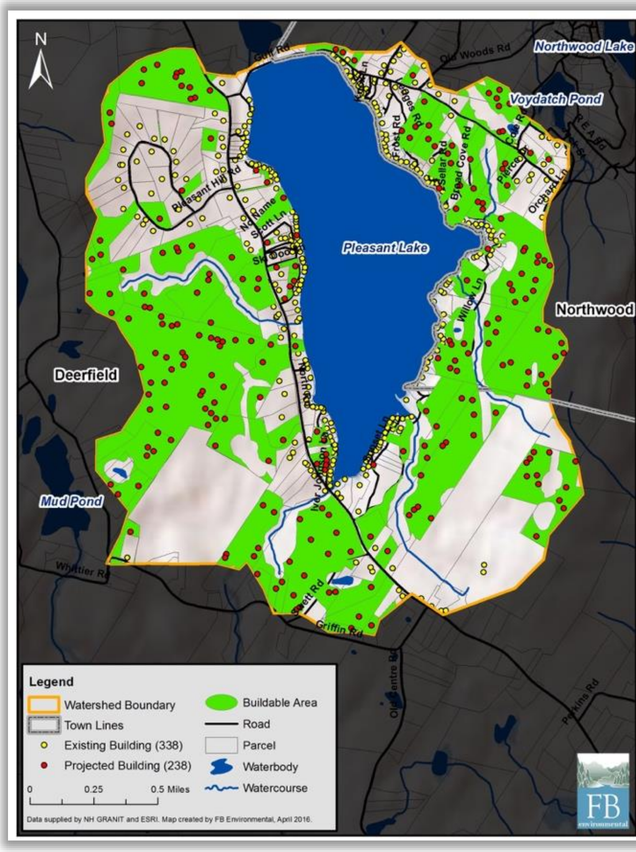
Nonetheless, **development near the outlets of Loon Cove and Philbrick Brooks should be a priority for lake protection efforts.** Full details of the modeling results and methods can be found in the LLRM report (FBE, 2016a).

3.3.3 HISTORICAL & FUTURE PHOSPHORUS LOADING: BUILD-OUT ANALYSIS

Once the LLRM for Pleasant Lake was calibrated for current in-lake phosphorus concentration, manipulations could be made to land use and other factor loadings to estimate historical and future phosphorus loading (e.g., what in-lake phosphorus concentration was prior to development and what in-lake phosphorus concentration might be following full build-out of the watershed under current zoning restrictions).

To predict the historical phosphorus load, FBE manipulated the model so that all development was converted back to natural vegetation, septic system inputs were set to zero, and internal loading estimates were negligible or non-existent (assuming anoxic conditions observed today are the result of excess organic matter loading from historical human activities in the watershed). The historical phosphorus load for pre-development conditions was estimated at 45 kg/yr, with an in-lake phosphorus concentration of 1.9 ppb. This historical load is about 240% less than the current load and represents an estimate of the best possible water quality for the lake.

To predict the future phosphorus load from increased development, FBE first performed a **build-out analysis** for portions of Deerfield and Northwood within the Pleasant Lake watershed (FBE, 2016c). The build-out analysis identified an estimated 863 acres (48%) of the entire 1,794-acre study area as developable (Appendix A, Map 11). Up to 238 new buildings (a 70% increase from 2016) could be added at **full build-out** by the year 2052, using a conservative growth rate of 1.56%. This predicted



Buildable area (in addition to existing developed land), existing buildings, and projected buildings within the Pleasant Lake watershed. Refer to Appendix A, Map 11 for larger map.

A **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.

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.

increase in development was then input to the model; the future phosphorus load was estimated at 245 kg/yr, with an in-lake phosphorus concentration of 9.9 ppb (Table 3-8). This future load is about 60% more than the current load and represents an estimate of the worst possible water quality for the lake.

Pleasant Lake may experience a 60% increase (from 153 to 245 kg/yr) in phosphorus loading at full build-out by 2052. The Direct Shoreline and Rt. 107 Inlet sub-basins are most at risk for increases in phosphorus loading because of anticipated development.

Results of the build-out analysis reinforce the concept of comprehensive planning at the watershed level to address future development and its effect on the water quality of Pleasant Lake. Future development will increase the amount of polluted runoff that drains to Pleasant Lake. **Therefore, it is recommended that town officials revisit zoning ordinances to ensure that existing laws encourage smart, low-impact development** (see Sections 3.5.1 and 5.2.3).

TABLE 3-8. Historical (pre-development), current, and future (at full build-out) phosphorus loads by source in the Pleasant Lake watershed.

	Historical		Current		Future	
Predicted Median In-Lake Total Phosphorus (ppb)	**1.9**		**6.4**		**9.9**	
Input Category	P (kg/yr)	%	P (kg/yr)	%	P (kg/yr)	%
Atmospheric Deposition	21	47%	21	14%	21	9%
Internal Loading	0	0%	6	4%	6	2%
Waterfowl	3	7%	3	2%	3	1%
Septic Systems	0	0%	23	15%	29	12%
Watershed Runoff	21	46%	100	65%	186	76%
Total Load to Lake	**45**	**100%**	**153**	**100%**	**245**	**100%**

3.4 ESTABLISHMENT OF WATER QUALITY GOAL

The Steering Committee used the results of the water quality analysis, assimilative capacity analysis, and watershed modeling to make an informed management decision and set an appropriate **water quality goal** for Pleasant Lake. **The goal of the Pleasant Lake Watershed Restoration Plan is to improve the water quality of Pleasant Lake and prevent a future decline in lake water quality as a direct result of anticipated new development.** This goal will be achieved by accomplishing three major objectives. More detailed action items to achieve these objectives are provided in the Action Plan (Section 5.2).

A **water quality goal** helps to quantify the amount of reduction in pollutant loading needed to achieve desired water quality conditions.

OBJECTIVE 1: Investigate cause of the low-oxygen impairment in Pleasant Lake.

Pleasant Lake is currently listed by NHDES as impaired for Aquatic Life Use for insufficient levels of DO (NHDES, 2014b). DO levels less than 6 ppm are common in Pleasant Lake, and are possibly impacting about 42% of the lake volume in mid to late summer. The 2002 NHDES Diagnostic Study and annual VLAP reports suggested that the existing low-oxygen impairment is likely caused by NPS pollution (i.e., phosphorus) in stormwater runoff and aging or failing septic systems. However, the water quality of Pleasant Lake is excellent with phosphorus and chlorophyll-a concentrations well below oligotrophic criteria set by NHDES. This suggests that other factors, such as historical land use, may have contributed to the low-oxygen impairment observed today. The low-oxygen impairment is very likely the result of high sediment oxygen demand from large amounts of deposited organic matter that may be a natural phenomenon or from legacy human activities in the watershed (e.g., logging, land clearing, farming, etc.). It is recommended that the cause of the low-oxygen impairment be investigated so that appropriate management measures can be enacted. Sediment core analysis may help define the amount and source of legacy organic matter in bottom sediments. Refer to Section 5.2.1 for specific recommendations.

OBJECTIVE 2: Gather more consistent water quality data for Pleasant Lake.

Although phosphorus loading from current land use may not be the cause of the existing low-oxygen impairment in Pleasant Lake, unmitigated sources of pollution (e.g., phosphorus, hydrocarbons, etc.) are expected to increase as development and other human activities in the Pleasant Lake watershed increase (e.g., conversion of small, seasonal properties to large, year-round homes). The anticipated increase in phosphorus loading and in-lake phosphorus concentration, along with associated algal growth, could further exacerbate DO depletion beyond what historic land use activities have likely caused. For this reason, phosphorus was used to set the third water quality objective for Pleasant Lake. However, recent total phosphorus sample data collected from the epilimnion fell below the laboratory detection limit of 5 ppb. The full detection limit (5 ppb) was used for statistical calculations in the water quality assessment and objective setting, but does not reflect the "true" summer median epilimnetic total phosphorus concentration in Pleasant Lake. Actual in-lake total phosphorus concentrations are likely between 4 and 5 ppb. Therefore, determining specific benchmark reductions in in-lake phosphorus concentrations may not be appropriate until more data are collected using a laboratory with a method detection of <1 ppb. As such, the third water quality objective focuses on reducing phosphorus loading to Pleasant Lake and uses relative reductions in in-lake phosphorus concentration (e.g., 0.6 ppb) instead of a specific in-lake phosphorus concentration target. The in-lake phosphorus concentration target, along with the low-oxygen impairment status, should be revisited after several years of consistent data collection. Refer to Section 5.2.1 for specific recommendations.

OBJECTIVE 3: Reduce current phosphorus loading by 10% (15 kg/yr) and prevent future phosphorus loading of 26 kg/yr to Pleasant Lake over the next ten years (2017-2026) to improve in-lake median total phosphorus concentration by 0.6 ppb.

Although the existing in-lake total phosphorus concentration is well within oligotrophic criteria and shows that there is significant reserve capacity for the lake to assimilate additional nutrients under a "business as usual" scenario, the Steering Committee agreed that a strict water quality goal and objective should be established to protect the excellent water quality of Pleasant Lake, particularly due to the uncertain connection between the currently-low in-lake total phosphorus concentration and the low-oxygen impairment. This objective was designed to be an aggressive target and to set the bar high as motivation to complete work in the Action Plan. **A 10% reduction is no easy task, and because there are many diffuse sources of phosphorus reaching the lake from existing residential development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.** Refer to Sections 5.2.2-5.2.6 for specific recommendations.

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

TABLE 3-9. Interim benchmarks for water quality objectives. Refer to Action Plan (Section 5.2) for specific recommendations. TP = total phosphorus. DO = dissolved oxygen.

Objective	Interim Benchmarks		
	2018	2021	2026
1. Investigate cause of the low-oxygen impairment in Pleasant Lake.	Team up with university or consultant to sample sediments and study cause of low oxygen	Re-evaluate water quality (TP, DO) and determine if cause of low DO warrants revision of objectives	Track any improvements in DO if able to remediate identified cause of low DO
2. Gather more consistent water quality data for Pleasant Lake.	Revise and implement annual monitoring program	Continue annual monitoring program; re-evaluate water quality (TP, DO)	Continue annual monitoring program; re-evaluate water quality (TP, DO)
3. Reduce current phosphorus loading by 10% (15 kg/yr) and prevent future phosphorus loading of 26 kg/yr to Pleasant Lake over the next ten years (2017-2026) to improve in-lake median total phosphorus concentration by 0.6 ppb.	Achieve 3% (5 kg/yr) reduction in TP loading; Prevent or offset 5 kg/yr in TP loading from new development	Achieve 5% (8 kg/yr) reduction in TP loading; Prevent or offset 10 kg/yr in TP loading from new development; re-evaluate water quality and track progress	Achieve 10% (15 kg/yr) reduction in TP loading; Prevent or offset 26 kg/yr in TP loading from new development; re-evaluate water quality and track progress

3.5 POLLUTANT SOURCE IDENTIFICATION

3.5.1 MUNICIPAL ORDINANCE REVIEW

Numerous studies have shown that the extent and type of development can degrade water quality of lakes and streams. Municipal land-use regulations are a guiding force for where and what type of development can occur in a watershed, and therefore, how much phosphorus can be discharged to local waterbodies via stormwater. **In fact, land-use and zoning ordinances are among the most powerful tools municipalities can use to protect their natural resources.** Future development in the Pleasant Lake watershed may increase annual phosphorus loading to the lake by 92 kg and cause significant water quality decline (see Section 3.3.3).

FBE conducted a municipal ordinance review of Deerfield's and Northwood's existing and proposed land use and zoning regulations; the full review served as a supplement to this plan and the buildout analysis described in Section 3.3.3 (FBE, 2016d). The following provides a summary of the New Hampshire Shoreland Zoning Standards and relevant land use and zoning restrictions for each watershed town (Table 3-10). The review provides information on how towns can improve standards pertaining to water quality protection.

TABLE 3-10. Summary of New Hampshire, Deerfield, and Northwood Shoreland Zoning Standards.

Standard	New Hampshire	Deerfield	Northwood
Area Encompassed Under RSA 483-B, or the Shoreland Water Quality Protection Act (SWQPA)	Regulated by SWQPA, development within and alterations to 250 ft from shoreline of: • Rivers, lakes, and ponds >10 ac. • Fourth order and greater streams and rivers. • Rivers or river segments designated under RSA 483, the Rivers Management and Protection Program. • Tidal waters subject to the ebb and flow of tide.	NA	NA
Impervious surface area limits (within Shoreland Zone or other defined area)	• >20% impervious cover requires a stormwater management plan. • >30% cover requires a stormwater management system designed and certified by a professional engineer.	• Buildings may not cover >25% of a lot. • Impervious cover limited to 30% in the Watershed Protection Overlay District.	Impervious cover limited to 20% in the Wellhead Protection Overlay District.
Septic system setbacks	• 75 ft for rivers and areas where there is no restrictive layer within 18 inches and where the soil down gradient is not porous sand and gravel. • 100 ft for soils with a restrictive layer within 18 inches of the natural soil surface. • 125 ft where the soil down gradient of the leach field is porous sand and gravel.	Not Evaluated.	Not Evaluated.
Natural woodland or wetland buffer	• Within 50 ft of reference line, a limited amount of tree and saplings may be removed (grid and point system), but vegetation <3 ft must remain intact.	• 100 ft buffer zone must be maintained along the edge of any tributary discharging to Pleasant	• 100 ft for prime wetlands. • 100 ft buffer also applies where the Wetland

Standard	New Hampshire	Deerfield	Northwood
	• At least 25% of the area between 50-150 ft must be left in an unaltered state. • No natural ground cover removed except footpath to the water < 6 ft wide and does not concentrate stormwater or contribute to erosion.	Lake and along the edge of any wetlands assoc. with the tributary. • 100 ft for any wetland. 75 ft for pre-existing lots at time of ordinance adoption (3/2005)	Conservation and Conservation Area Overlay Districts overlap. • 20-ft setback for all other wetland areas.
Primary building setback	50 ft from the reference line for primary structures.	75 ft from any river or stream, lake or pond.	50 ft in Shoreland Zone. 20 ft for waterbodies not covered under Shoreland Zone.
Conservation/cluster subdivisions	Not Evaluated.	Total area of open space must equal at least 50% of the Open Space Development's gross tract area. Not more than 50% of the open space may consist of lands within the Wetlands Conservation District or have >20% slopes.	• 1.5-acre zoning with 33% of land set aside. Required in Agricultural Soils Overlay District. • Open space should be a single contiguous area of substantial size, and must not be a thin strip surrounding the subdivision or a lot to buffer abutters.
Low Impact Development (LID)	Not Evaluated.	Defined in Section 330 – Pleasant Lake Watershed Protection Ordinance.	Not mentioned.

The review showed that towns within the Pleasant Lake watershed have room for improvement to protect water quality of the lake and streams in the watershed now and in the future. The primary focus areas for potential changes to ordinances are: buffer setbacks, conservation subdivisions, and low impact development. Examples of specific suggestions for new or revised ordinances include:

- Building and Wetland Buffer Setbacks – Adopt uniform and more stringent setback guidelines in both towns (at least 100 feet from all waterbodies and wetlands).
- Conservation Subdivisions – Increase the amount of land set aside in conservation subdivisions (for Northwood) to be comparable in both towns.
- Low Impact Development (LID) – Amend stormwater management ordinances to define LID techniques, and to encourage LID use to the maximum extent possible.

Additionally, **it is recommended that the Town of Northwood work towards developing a Watershed Protection Ordinance specific to Pleasant Lake**. This ordinance could be like the existing ordinance in Deerfield, or perhaps developed jointly. Northwood has several other Overlay Protection Districts in existence, including Wetlands and Conservation Overlay Districts, but none specific to watershed boundaries. More specific details relating to recommended municipal ordinances are outlined in the Action Plan (Section 5.2.4).

3.5.2 SEPTIC SYSTEM SURVEY

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

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

SNHPC, in cooperation with PLPA and FBE, conducted a septic survey by mail and online from July 15, 2015 to August 30, 2015 (SNHPC, 2015). The survey targeted properties within 250 feet of Pleasant Lake or a tributary draining to Pleasant Lake. Results of the survey were incorporated to the watershed loading model conducted by FBE (2016a) to estimate the total phosphorus loading to the lake from wastewater systems[7].

> Because septic effluent contains about one thousand times the concentration of phosphorus in lake waters (Gilliom and Patmont, 1983), a small amount of effluent can have a major impact on a lake as small as Pleasant Lake.

A total of 116 property owners responded to the survey by mail or online. The survey included questions about the landowner's perception of Pleasant Lake water quality and specific questions about the landowner's wastewater system (e.g., type of system, age of system, seasonal or year-round use, occupancy, types of water-using machines, etc.). Participants were also asked if they would be willing to make improvements to their property to help protect the water quality.

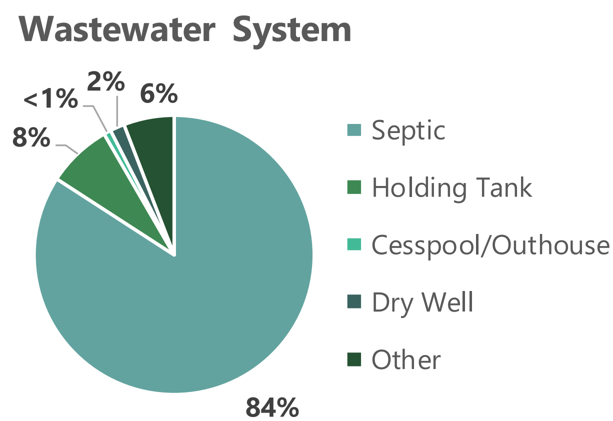


FIGURE 3-2. More than 80% of survey respondents have a septic system (Source: SNHPC, 2015).

Results of the septic survey indicated that most survey respondents have a septic system (84%; Figure 3-2). Approximately 16% use an alternative type of wastewater system, such as a cesspool, outhouse,

[7] *Additional information on unresponsive properties or incomplete responses from the survey was gathered by PLPA volunteers and incorporated into the final septic system data used for the LLRM.*

holding tank, or composting toilet. Most septic systems were less than 25 years old (67%), but most of those systems fell within the 11- to 25-year-old range (36%). Old systems (> 25 years old) made up 25% of the survey respondents, and year-round residents comprised 43% of all respondents (SNHPC, 2015).

Per the LLRM, **wastewater systems are the second largest source of phosphorus to Pleasant Lake, providing 15% (23 kg/yr) of the total phosphorus load to the lake**. Recommendations for addressing input from wastewater are provided in the Action Plan (Section 5.2.1).

3.5.3 WATERSHED AND SHORELINE SURVEYS

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

A watershed survey was conducted by technical staff from FBE and Hoyle, Tanner, & Associates on June 22, 2015. The team documented phosphorus-laden sediment erosion on the roads, residential properties, driveways, and municipal areas in the watershed using cameras and standardized forms. **Fifteen "hotspot" sites were identified and rated for impact level based on location, slope, amount of soil eroded, and proximity to the water (Appendix A, Map 12). Ten sites were found on public roads, two of which were rated as high impact. Another high impact site was at the parking lot for the NHFGD Boat Access.** Recommendations range from installing buffer plantings and infiltration swales to replacing culverts and reconstructing concrete aprons. Major hotspot areas are highlighted in Table 3-11. Estimated costs and pollutant reductions from recommended BMPs are included in Section 4.1.1, and full descriptions of identified sites can be found in Appendix D.

TABLE 3-11. Select "hotspots" of nonpoint source (NPS) pollution in the Pleasant Lake watershed.

NH Fish and Game Department (NHFGD) Boat Access Parking (Site ID #1)

This gravel/pavement parking lot in the NW corner of the watershed was identified as one of the primary sites contributing sediment due to gully erosion and sediment transport across Gulf Road to Pleasant Lake. Recommendations include the reconstruction of two bituminous concrete aprons directing runoff from the base of the parking area towards the vegetated woods between the parking area and the outlet tributary. Additionally, the width of the entrance should be evaluated for appropriate size to possibly remove excess pavement (see photo at left).

Gulf Road (Site ID #2, 3, 5, 6, 7, 8, 9, 10, 11, 12)

Due to its proximity to the lake, the runoff and sediment erosion from Gulf Road is a great concern for the integrity of Pleasant Lake, as there are large gullies along the road shoulder and a moderate slope near the NHFGD Boat Access Parking. Additionally, many small nonpoint source pollution sites (often associated with private access to the water, see photo at left) were identified along the length of Gulf Road. Recommended BMPs in this area include raising the profile of Gulf Road to accommodate infiltration swales and check dams, installation of bioretention cells, and deep sump catch basins.

Intersection of Broad Cove Road and Sellar Road (Site ID #13)

Moderate road shoulder erosion was observed flowing into a tributary at this site. Proposed restoration at this site includes adding a vegetated shoulder and ditch along the length of Broad Cove Road around the stream crossing and installation of multiple turnouts to divert runoff from the road before entering the stream.

A shoreline survey for Pleasant Lake was conducted on August 26, 2015 by FBE staff and local watershed volunteers. Teams identified areas of erosion and stormwater runoff along the shoreline of each lake by tax parcel. A total of 179 parcels were evaluated (Appendix E); 102 in the Town of Deerfield and 77 in the Town of Northwood. Each parcel was rated for buffer condition (1-5), bare soil extent (1-4), shoreline erosion extent (1-3), building setback distance (1-3), and slope (1-3). The score for each category rating was summed for each parcel to generate a total "Shoreline Disturbance Score." Lower scores equate to better shoreline condition, while higher scores correspond to inadequate shoreline condition with extensive erosion. **A Shoreline Disturbance Score of 10 or above indicates shoreline conditions that are likely detrimental to lake water quality. About 74% of the Pleasant Lake shoreline (or 132 parcels) scored 10 or higher** (Table 3-12); while this is typical for most NH lakes with a developed shoreline, it is a concern for water quality. These shoreline properties tended to have inadequate buffers, evidence of bare soil, and structures within 75 ft. of the shoreline. A map of shoreline survey results can be found in Appendix A, Map 13.

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

Average Scores per Parcel					Total
Buffer (1-5)	**Bare Soil (1-4)**	**Shoreline Erosion (1-3)**	**Distance (1-3)**	**Slope (1-3)**	**Shoreline Disturbance Score (0-18)**
3.2	2.2	1.1	2.4	1.6	**10.4**

4. MANAGEMENT STRATEGIES

> **Structural BMPs**, or engineered Best Management Practices (BMPs), are often at the forefront of most watershed restoration projects. However, **non-structural BMPs**, which do not require extensive engineering or construction efforts, can help reduce stormwater runoff and associated pollutants through operational actions, such as land use planning strategies, municipal maintenance practices, and targeted education and training.

The goal of the Pleasant Lake Watershed Restoration Plan is to improve the water quality of Pleasant Lake and prevent a future decline in lake water quality as a direct result of anticipated new development. This goal will be achieved by accomplishing three major objectives: 1) investigate the cause of the low-oxygen impairment in Pleasant Lake; 2) gather more consistent water quality data for Pleasant Lake; and 3) reduce current phosphorus loading by 10% (15 kg/yr) and prevent future phosphorus loading of 26 kg/yr to Pleasant Lake over the next ten years (2017-2026). The first two objectives require additional data collection detailed in Section 5.2.1 before specific management measures can be made. The third objective sets an aggressive phosphorus reduction target to protect the excellent water quality of Pleasant Lake from existing and future development and prevent any further exacerbation of the low-oxygen impairment. This ambitious effort is supported by the idea that existing and new development can be remediated or conducted in a manner that sustains environmental values, and that citizens, businesses, government, and other stakeholder groups can be responsible watershed stewards. The following section details management strategies for achieving the water quality goal and objectives using a combination of **structural and non-structural BMPs**, as well as an adaptive management approach. Specific action items are provided in the Action Plan (Section 5.2).

4.1 STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

FBE, along with volunteers, documented fifteen watershed NPS sites and 132 shoreline properties that directly impact water quality through the delivery of phosphorus-laden sediment (refer to Section 3.5.3)[8]. Consequently, structural BMPs are a necessary and important component for the improvement and protection of the water quality of Pleasant Lake. The best approach to treating these NPS sites is to:

- Address high priority watershed and shoreline survey sites with an emphasis on cost-efficient fixes that have a high impact to low cost per kg of phosphorus treated. The BMP matrix (Appendix D) sorts watershed NPS sites by impact-weighted cost to phosphorus reduction ratio. The shoreline survey results (Appendix E) are sorted from highest to lowest Shoreline Disturbance Scores.

[8] *fifteen sites were identified, but BMPs were not recommended for one site as BMPs from other locations (Gulf Road and Boat Launch Parking area) should capture the sediment on this launch site.*

- Work with landowners to get commitments for treating and maintaining sites. Workshops and tours of demonstration sites can help encourage landowners to utilize BMPs on their own property.

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

- Measure pollutant load reduction for each BMP installed.


Road shoulder erosion on Gulf Road before the boat launch. Photo: FBE

This approach will help guide the proper installation of structural BMPs in the watershed. More specific and additional recommendations (including public outreach) are included in the Action Plan in Section 5.2. For helpful tips on implementing residential BMPs, see the NHDES Homeowner's Guide to Stormwater Management (NHDES, 2016).

4.1.1 ESTIMATION OF POLLUTANT LOAD REDUCTIONS NEEDED

In total, remediation of the fifteen sites identified in the watershed survey will reduce the phosphorus load to Pleasant Lake by 14.2 kg/yr[9] and cost an estimated $67,000 to implement (Table 4-1; refer to Section 5.4 and Appendix D). **Of note, ten of these sites are located along town roads (namely Gulf Road).**

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

Site ID	Direct flow to:	Land Use Type	TP (kg/yr)*	BMP Cost Estimate**	Annual Cost**	10-yr Cost
13	Stream	Private Road	2.4	$1,260	$100	$2,260
3	Lake	Town Road	1.0	$3,000	$25	$3,250
14	Stream	Unknown Road	0.9	$1,000	$50	$1,500
15	Stream	Unknown Road	0.7	$800	$100	$1,800
9	Lake	Town Road	0.9	$1,080	$50	$1,580
10	Lake	Town Road	0.6	$720	$50	$1,220
2	Lake	Town Road	5.5	$30,000	$500	$35,000
11	Lake	Town Road	0.6	$1,080	$50	$1,580
7	Lake	Town Road	0.2	$648	$50	$1,148
1	Lake	Municipal/Public	1.2	$10,000	$500	$15,000

9 *It was assumed that addressing the fifteen sites would reduce all the phosphorus loading coming from those sites (since they tended to be bare soil/erosion gully or bank stabilization sites compared to shoreline buffer sites needing vegetation).*

Site ID	Direct flow to:	Land Use Type	TP (kg/yr)*	BMP Cost Estimate**	Annual Cost**	10-yr Cost
8	Lake	Town Road	0.05	$270	$25	$520
6	Lake	Town Road	0.05	$270	$25	$520
5	Lake	Town Road	0.05	$270	$25	$520
12	Lake	Town Road	0.05	$480	$50	$980
	TOTAL		**14.2**	**$50,878**	**$1,600**	**$66,878**

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

Using a simple scoring method, the shoreline survey served as an excellent tool for highlighting shoreline properties around the lake that exhibited significant erosion (refer to Section 3.5.3). This method of shoreline survey is a rapid technique to assess the overall condition of properties within the shoreland zone, but it does not allow for making specific BMP recommendations. Therefore, **high priority shoreline properties (8 parcels) should be resurveyed in person for specific BMP recommendations and more accurate estimated phosphorus reductions and implementation costs by site.** However, given some broad assumptions[10], the eight high priority properties (with score of 14) would cost about $24,000 ($3,000 each) to revegetate and mulch with volunteer labor, which would reduce the phosphorus load by 8.5 kg/yr (Table 4-2)[11]. Remediation of the 124 medium priority parcels (with scores 10-13) would each cost about $1,500 to revegetate and mulch with volunteer labor and could result in the reduction of an additional 19.7 kg/yr of phosphorus[12]. Note that the total phosphorus load calculated by the Region 5 model method differs from the LLRM output for the Direct Shoreline sub-basin. This is due to the large assumptions made in the Region 5 model and the fact that Urban 1 Low Density Residential phosphorus export coefficients are generalized and do not consider specific shoreline condition and proximity to the lake.

TABLE 4-2. Summary of properties with high (14) and medium (10-13) shoreline disturbance scores for Pleasant Lake. Refer to Appendix E for full results. Total phosphorus (TP) load with BMPs assumes 50% reduction efficiency.

# High Priority Parcels (Score 14)	# Medium Priority Parcels (Score 10-13)	TP Load for High Priority Parcels (kg/yr)	TP Load for Medium Priority Parcels (kg/yr)	Total TP Load (kg/yr)	TP Load Reduction with BMPs (kg/yr)
8	124	17.0	39.4	56.4	28.2

If all identified trouble areas are addressed (15 watershed and 132 shoreline sites), total phosphorus load to the lake could be reduced by 42.4 kg/yr. If efforts target priority BMPs (the eight high priority shoreline properties and all fifteen watershed NPS sites), total phosphorus load could be reduced by 22.7 kg/yr (Table 4-3).

[10] Based on the Region 5 model bank stabilization estimate for sandy soils, using 100 ft (length) by 5 ft (height) and moderate lateral recession rate of 0.2 ft/yr, high priority properties may each contribute about 4.675 lbs. P/yr or 2.121 kg P/yr.

[11] Given a 50% BMP efficiency rate.

[12] Based on the Region 5 model bank stabilization estimate for sandy soils, using 50 ft (length) by 3 ft (height) and moderate lateral recession rate of 0.1 ft/yr, medium priority properties may each contribute about 0.702 lbs. P/yr or 0.318 kg P/yr.

Implementing recommended BMPs from the watershed survey alone could reduce the phosphorus load by 14.2 kg/yr of the target reduction of 15 kg/yr. **However, the greatest improvement to water quality in Pleasant Lake will likely come not from addressing the watershed NPS sites, but from the shoreline survey sites where buffer improvements are necessary.** Outreach and technical assistance should be provided first to the eight shoreline properties with a high score of 14; addressing these properties will significantly reduce phosphorus loading by 8.5 kg/yr, reaching more than half of the target phosphorus load reduction. The strategy for reducing pollutant loading to Pleasant Lake will be dependent on available funding and labor resources, but will likely include a combination of approaches (e.g., larger watershed BMP sites and smaller residential shoreline BMP sites).

TABLE 4-3. Summary of total phosphorus (TP) reductions and estimated costs of high priority BMP implementations in the Pleasant Lake watershed.

Identified High Priority BMP Sites	TP Reduction (kg/yr)	Estimated Cost
Watershed NPS Sites (15 identified)	14.2	$67,000
High Priority Shoreline Properties (8 identified)	8.5	$24,000
TOTAL	**22.7**	**$91,000**

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

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

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

4.2 NON-STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Current zoning in the Pleasant Lake watershed presents considerable opportunity for continued development, as an estimated 48% of the watershed is still developable (see the build-out analysis in Section 3.3.3). The area's popularity as a permanent residence is growing, with seasonal homes being upgraded to year-round single-family dwellings. This may result in a 60% increase (from 153 to 245 kg/yr) in phosphorus loading to Pleasant Lake by 2052, with in-lake phosphorus concentrations climbing to 9.9 ppb by 2052 (see Section 3.3.3). Given this future development potential, **it is critical for municipalities to develop and enforce stormwater management measures that prevent an increase in pollutant loadings from new and re-development projects**, particularly as future development may offset reduced loads from other plan implementation actions. The impact of future development can be mitigated with the implementation of non-structural BMPs, such as land use planning, zoning ordinances, and low impact development requirements. **Though non-structural BMPs often receive little emphasis in watershed planning, it can be argued that local land use planning and zoning ordinances are the most critical components of watershed protection.**

The Town of Deerfield has already made great strides in watershed protection by adopting the Pleasant Lake Watershed Protection Ordinance in 2015 (Section 330 of the Town of Deerfield Zoning Ordinance). This ordinance provides more stringent limits to impervious cover within the Watershed Overlay District and includes provisions to limit "funnel development," which will prevent the creation of secondary "public" access points to the lake (and potentially new areas of NPS pollution). However, enforcement is key to the ordinance's effectiveness; a clear link needs to be established between ordinance stipulations and town enforcement of those stipulations. The Action Plan includes specific recommendations for more lake-friendly zoning and increased awareness of green development techniques in both Northwood and Deerfield (Section 5.2.3; see also Municipal Ordinance Review in Section 3.5.1). Non-structural recommendations, such as education and outreach to landowners, new watershed resident workshops, and other awareness campaigns, are also detailed in the Action Plan (Section 5.2).

4.3 ADAPTIVE MANAGEMENT APPROACH

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

> An **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.

The adaptive management components for implementation efforts should include:

- **Maintaining an Organizational Structure for Implementation.** Since the watershed spans two municipalities, a cooperating group representing both towns, PLPA, and other local businesses or groups, such as Bear-Paw Regional Greenways and the Northwood Area Land Management Collaborative, should be established to help coordinate the implementation of restoration actions identified in the pan. In effect, this group would be an expansion of the Steering Committee established during plan development. Refer to Section 5.1: Plan Oversight.

- **Establishing a Funding Mechanism.** A long-term funding mechanism to be guided by a steering committee should be established to provide financial resources for restoration 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 stormwater BMPs. Securing regular funding for an annual monitoring program is also critical to tracking plan success. Funding is a key element of sustaining the restoration process, and, once it is established, the management plan can be fully vetted and restoration actions can move forward. A combination of grant funding, private donations, and municipal funding must be used to ensure implementation of the plan. Refer to Section 5.4 for a list of potential funding sources.
- **Determining Restoration Actions.** This plan provides a unified watershed restoration strategy with prioritized recommendations for restoration using a variety of methods, including structural and non-structural restoration actions. A steering committee should use the proposed actions in this plan as a starting point for grant proposals. Once a funding mechanism is established, detailed designs for priority restoration actions on a project-area basis can be completed and their implementation scheduled. Refer to Section 5.2: Action Plan.
- **Continuing and Expanding the Community Participation Process.** Development of this plan has greatly benefited from the active involvement of an exceptionally-engaged group of watershed stakeholders, particularly within PLPA whose members offer a diversity of skills and interests. Over 90 watershed stakeholders participated in the community forum to develop the Action Plan (refer to Section 1.4). Plan implementation will require their continued and ongoing participation, as well as additional community outreach efforts to involve even more stakeholders throughout the watershed. A sustained public awareness and outreach campaign is essential to secure the long-term community support that will be necessary to successfully implement this plan. Refer to Section 5.2: Action Plan and Section 5.5: Educational Component.
- **Developing a Long-Term Monitoring Program.** An annual water quality monitoring program (including ongoing monitoring of watershed tributaries) is necessary to track the health of the lake. The monitoring program will provide feedback on the effectiveness of restoration practices at the sub-basin level, and will support optimization of restoration actions through the adaptive management approach. Refer to Section 5.2.1: Water Quality Monitoring.
- **Establishing Measurable Milestones.** A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critical to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure plan progress. Refer to Section 5.3: Indicators to Measure Progress and Section 3.4: Establishment of Water Quality Goal for interim benchmarks.

5. PLAN IMPLEMENTATION

5.1 PLAN OVERSIGHT

The recommendations of this plan should be carried out by a steering committee like the one assembled for development of this plan. A steering committee should include the leadership of PLPA, along with support from the watershed towns (Deerfield and Northwood), NHDES, SNHPC, conservation commissions, land trusts or conservation groups such as Bear-Paw Regional Greenways and Northwood Area Land Management Collaborative, schools and community groups, local businesses, and individual landowners. A steering committee will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce NPS pollution in the Pleasant Lake watershed. Periodic updates to the plan will need to be made to maintain the Action Plan and keep the plan relevant to current watershed activities. Measurable milestones (number of BMP sites, volunteers, funding received, etc.) should be tracked by a steering committee and reported to NHDES on a regular basis.

5.2 ACTION PLAN

The Action Plan was developed through the combined efforts of PLPA, SNHPC, FBE, and the current Steering Committee, as well as the public by way of feedback provided during the community forum held in July 2016. The Action Plan outlines responsible parties, approximate costs[13], and an implementation schedule for each recommendation within six major categories: (1) Water Quality Monitoring; (2) Watershed and Shoreline BMPs; (3) Municipal Planning; (4) Septic Systems; (5) Roads; and (6) Land Conservation and Management. Accompanying narrative sections also provide "short-term recommendations" or actions to be included in the first, immediate phase of plan implementation.

The Action Plan is a critical component of the plan because it provides a list of specific recommendations for achieving the water quality goal and objectives. The first two objectives require additional water quality data collection before specific management measures can be made; thus, **recommendations for Objectives 1 and 2 are prioritized in Section 5.2.1: Water Quality Monitoring.** The third objective sets an aggressive phosphorus reduction target to protect the excellent water quality of Pleasant Lake from existing and future development and prevent any further exacerbation of the low-oxygen impairment not a result of historical land use activities; thus, **recommendations for Objective 3 are prioritized in the remaining five categories of the Action Plan (Sections 5.2.2-5.2.6).**

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

5.2.1 WATER QUALITY MONITORING

An annual monitoring program is crucial to evaluating the effectiveness of watershed restoration activities and determining if the water quality goal and objectives are being achieved over time (per interim benchmarks set in Section 3.4). The Action Plan includes recommendations for enhancing current water quality monitoring efforts in the Pleasant Lake watershed; these recommendations build on PLPA's existing collaboration with the Volunteer Lakes Assessment Program. Recommendations for water quality monitoring are prioritized first by Objectives 1 and 2. Refer to Table 5.1.

SHORT-TERM RECOMMENDATIONS

- **Objective 1:** Take a sediment core of the deep spot of Pleasant Lake to assess organic matter content and source and aluminum-iron-phosphorus ratios to determine the cause of the low-oxygen impairment and the likelihood of internal phosphorus loading during anoxic periods. Increase the frequency of DO and temperature profile readings in late summer.

- **Objective 2:** Establish a regular lake monitoring program to gather more consistent water quality data at the deep spot, and use a laboratory with a method detection limit of less than 5 ppb so that a more precise in-lake phosphorus concentration can be computed for reduction targets.

5.2.2 WATERSHED AND SHORELINE BMPS

Shorefront residential property was identified during the community forum as a significant threat to the water quality of Pleasant Lake. Residents voiced concerns about accelerated shoreline erosion due to the raised water level (1.5 feet in 2013), increased boating activity, and lack of shoreline buffer.

Direct shoreline areas are typically among the highest for pollutant loading given their proximity to lakes and desirability for development. Watershed modeling for Pleasant Lake showed that the Direct Shoreline sub-basin contributed the greatest phosphorus load per unit area (0.26 kg/ha/yr) among all sub-basins. The 2015 shoreline survey of Pleasant Lake found that 74% of shoreline parcels showed characteristics detrimental to lake water quality, such as inadequate buffers, evidence of bare soil, and structures within 75 ft. of the shoreline. Thus, the shoreline deserves special attention in this plan.

Though a subset of eight (out of 179) shoreline properties with a disturbance score of 14 have been designated as high-priority for remediation, the ubiquity of medium-high disturbance scores (10-13) suggests that efforts should also target implementation of residential BMPs more broadly along the shoreline and throughout the watershed. This could be as simple as planting vegetated buffers, installing gravel driplines along roof edges, and ensuring that path and driveway runoff is filtered into the ground rather than running overland and into the lake. Coordination with landowners will be crucial for successful implementation of the BMPs identified in this Action Plan because many of these mitigation measures will need to be implemented on private land.

Fifteen (15) watershed NPS sites were identified during the watershed survey, some of which are currently being addressed through a Section 319 grant (for BMPs along Gulf Road near the NHFGD parking lot). A priority list of BMP recommendations for these watershed NPS sites can be found in Section 4.1 and Appendix D.

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

SHORT-TERM RECOMMENDATIONS

- **Objective 3:** Work with shorefront residents to encourage expanded participation in shoreline residential BMP implementation efforts, with initial focus on the eight high impact shoreline properties. PLPA should begin to contact shorefront landowners to generate interest and awareness in maintaining healthy shorefront buffers and to line up interested parties on a first-come, first-serve basis as grant funding is obtained. Watershed NPS sites along Gulf Road near the NHFGD parking lot are currently being addressed by a Section 319 grant (see Section 1.5.3). PLPA should apply again for 2018 implementation funding to address other priority watershed NPS sites and shoreline properties. A funding subcommittee should be created to help find and apply for funding that supports all aspects of the Action Plan.

5.2.3 MUNICIPAL PLANNING

Municipal land-use regulations are a guiding force for where and what type of development can occur in a watershed, and therefore, how water quality is affected because of this development. The build-out analysis indicates that there is room for improvement in protecting water quality through non-structural BMPs such as municipal ordinance adoption or revisions, especially as it relates to new development. Recommendations to achieve action items were based on an ordinance review by FBE and feedback from the community forum and Steering Committee. Many of the items relate to bringing ordinances from the two towns into agreement, especially assisting the Town of Northwood in creating a Watershed Overlay District like Deerfield. Other actions include incorporating this watershed restoration plan into town master plans, increasing the overall involvement of watershed residents in local governance, and providing education on LID and BMP techniques for both town staff and new watershed residents. Refer to Table 5.1.

SHORT-TERM RECOMMENDATIONS

- **Objective 3:** Send representatives of PLPA to Board of Selectmen and Planning Board meetings to present the watershed plan and foster a relationship between local government and watershed stakeholders for the coordination of plan implementation. Provide information on LID and BMP descriptions to Selectmen, town staff, and Planning Board members.

5.2.4 SEPTIC SYSTEMS

Septic systems were identified during the community forum as a significant threat to the water quality of Pleasant Lake. Based on watershed modeling, **wastewater systems, including septic systems, outhouses, and cesspools, are the second largest source of phosphorus to the watershed, contributing 15% (23 kg/yr) of the phosphorus load to Pleasant Lake.**

Meaningful reductions in phosphorus loading to the lake will be achieved if landowners take responsibility to check their systems, and make necessary upgrades, especially to old systems, cesspools, and outhouses. **A comprehensive septic database could be used to track maintenance and replacement history of systems within the watershed; this would be managed by each individual town, especially if a wastewater inspection and maintenance program was put into effect and enforced by the towns.** The 2015 septic survey completed by SNHPC and PLPA is an excellent start to compiling site-specific septic system data (see Section 3.5.2). The database could also be used to help track conversions of seasonal homes to permanent residences and any associated changes (or lack thereof) to wastewater treatment capacity. "Septic socials" are a great outreach tool to spread awareness of proper septic maintenance. Socials are an opportunity for neighbors to come together to socialize, while also learning about keeping healthy septic systems. One social could be held in each district, but it may be best to first target districts with problem areas identified in the septic survey. Refer to Table 5.1.

SHORT-TERM RECOMMENDATIONS

- **Objective 3:** Distribute educational information and lists of septic service providers to watershed residents. Host "septic socials" to start the conversation around septic system maintenance and replacement. Investigate grants and low-interest loans as a first step to upgrading identified problem systems in the watershed. Develop a septic system database by expanding from the information already gathered from the 2015 septic survey.

5.2.5 ROADS

Threats to water quality because of roads include undersized culverts, excess road salt and sand, lack of stormwater control, lack of resources to improve and maintain road infrastructure, and erosion from gravel roads in the watershed. The 2015 watershed survey identified twelve sites on town roads that are delivering nutrients and other pollutants to the lake. These sites are addressed in Section 5.2.2. However, other private roads in the watershed could benefit from improved road maintenance by residents, and the project team should begin a dialogue with the current ad-hoc private "road associations" about gravel road management. Additionally, the project team should collaborate with local road agents and the New Hampshire Department of Transportation (NHDOT) to ensure that due diligence is being taken to maintain roads in the watershed (including staff attendance at relevant trainings and workshops). Refer to Table 5.1.

SHORT-TERM RECOMMENDATIONS

- **Objective 3:** Work with ad-hoc private "road associations" to begin a discussion about four season road maintenance and management. Coordinate with NHDOT to discuss Rt. 107 culvert problems and incorporate solutions to the design before road resurfacing begins in summer 2017.

5.2.6 LAND CONSERVATION AND MANAGEMENT

Many stakeholders expressed the desire to work more collaboratively with other local conservation organizations, particularly Bear-Paw Regional Greenways and the Northwood Area Land Management Collaborative. Key action items are based on forging this new relationship and identifying needs and opportunities for land conservation in the watershed. Refer to Table 5.1.

SHORT-TERM RECOMMENDATIONS

- **Objective 3:** Send a representative from PLPA to communicate with local conservation groups. The sooner this relationship is built, the sooner other objectives can be addressed (e.g., identifying priority areas for conservation).

TABLE 5-1. Action Plan for the Pleasant Lake Watershed Restoration Plan.

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
WATER QUALITY MONITORING													
Investigate the cause of the low-oxygen impairment (Objective 1)	1) Team up with university or consultant to sample sediments (at the deep spot and possibly South Cove) and study cause of low oxygen (suggest assessing at least Al-Fe-P ratios and organic matter content). Determine if cause of low DO warrants revision of objectives. Currently part of possible PSU grant to fund sediment core analysis.		✓							✓	✓	2017-18	TBD
	2) Install 3-season buoy system in deep spot of Pleasant Lake to monitor DO and temperature throughout the water column using continuous data loggers. Cost includes initial setup and 5 years of maintenance by consultant.		✓							✓	✓	2017-21	$30,000
	3) Calculate the anoxic factor for Pleasant Lake to assess changes over time in DO and whether Pleasant Lake is approaching a "tipping point" when bottom waters are anoxic long enough to release excess phosphorus that stimulates productivity.		✓							✓	✓	2021-26	$1,500
	4) Track any improvements in DO if able to remediate identified cause of low DO.		✓							✓		2021-26	$1,000
Establish regular lake monitoring program to gather more consistent water quality data (Objective 2)	1) Conduct three annual sampling events at the deep spot in July, August, and September (prior to Sept 15) to include DO and temperature profile readings, Secchi Disk Transparency readings, hypolimnion grab samples for total phosphorus, and epilimnion core samples for total phosphorus, chlorophyll-a, pH, alkalinity, and color. Aim for biweekly Secchi Disk Transparency readings and monthly DO and temperature profile readings from May 24-Sept 15.		✓							✓	✓	2017-26	$75,000
	2) Use a laboratory with the ability to analyze phosphorus samples down to 1 ppb. UNH WQAL currently has this ability.		✓								✓	2017	N/A
	3) Re-evaluate water quality (total phosphorus, DO) at regular intervals based on interim benchmarks.		✓							✓		2018, 2021, 2026	$5,000

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
Consider expanding the regular lake monitoring program	1) Add additional parameters to collect from the epilimnion during the regular sampling events, including total dissolved nitrogen and total dissolved organic carbon.		✓							✓	✓	2017-26	$4,000
	2) Expand sampling outside normal season (June-Sept) to include spring and fall turnover. Cost assumes two extra sample events at the deep spot for the base program (hypo/epi total phosphorus, epi chlorophyll-a, pH, alkalinity, and color, plus DO and temperature profile readings).		✓							✓	✓	2017-26	$40,000
Monitor undercutting of lake shoreline	1) Team up with university or consultant on monitoring shoreline undercutting because of higher lake levels. Assess if changes to local boating regulations could remediate shoreline erosion due to wake action.		✓							✓	✓	2017-2026	TBD
Expand tributary monitoring program	1) Sample 8 tributary sites and the dam outlet for total phosphorus, turbidity, pH, alkalinity, specific conductivity or chloride, total dissolved nitrogen, and total dissolved organic carbon 2-3 times per year from June-September. Target Farrelly, Veasey, Loon Cove, and/or Branch Brooks, if funding limited.		✓							✓	✓	2017-26	$50,000
	2) Assess flow conditions of major tributaries to Pleasant Lake (i.e., runoff and baseflow monitoring). Compare to results from 2002 NHDES Diagnostic Study.		✓		✓					✓	✓	2017-26	$5,000
	3) Consider installing continuous data loggers measuring flow, DO, conductivity, and temperature at key tributary locations. These data would be useful in understanding water quality processes in the watershed. Coupled with water chemistry data, loading rates of nutrients may be calculated using the continuous flow data and used to update the land use model. Cost assumes initial setup at 3 sites and 5 years of maintenance by consultant.		✓							✓		2017-26	$70,000
Enhance awareness of water quality issues in the watershed	1) Contact local representatives and attend selectman meetings to voice concerns and stay informed.								✓			2017-26	N/A
	2) Create flyers/brochures for shorefront homes regarding BMPs and septic systems. Consider also creating a "new homeowner" packet that covers water quality related issues and ordinances in the watershed. Cost does not cover printing.	✓	✓		✓					✓		2017-26	$2,000
	3) Contribute interesting articles about water quality and watershed protection efforts to various media sources. Assumes volunteer labor.	✓	✓		✓							2017-26	N/A

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
	4) Work with SOAK Up the Rain NH to implement small scale BMPs and host concurrent residential stormwater workshops. Cost estimate does not include actual BMP implementation. Cost assumes printing, mailing to advertise events.		✓				✓					2017-26	$5,000
	5) Create educational annual "report cards" about Pleasant Lake water quality, presented in a format that is approachable to lay persons. Cost assumes initial consultant setup for $2,000, then $500/yr to update for nine additional years.	✓	✓		✓					✓		2017-26	$6,500
Maintain and/or improve current invasives management program	1) Support State legislation that increases funds for aquatic invasive plant (e.g., milfoil) eradication.	✓	✓	✓	✓				✓			2017-26	N/A
	2) Increase the number of volunteer inspectors for the Lake Host and Weed Watchers programs		✓									2017-26	N/A
	3) Expand invasive species monitoring programs to include insects and other animals not currently monitored (e.g., spiny waterflea).		✓									2017-26	N/A
Obtain more funding	1) Obtain funding from sources such as municipal contributions, NHDES grants, lake associations, targeted fundraising, and other grants related to climate change or invasive species studies.		✓	✓	✓				✓			2017-26	N/A
WATERSHED & SHOREFRONT BMPS													
Encourage expanded participation in developing a healthy buffer	1) Work with all shoreline residents to implement at least one conservation practice on their land. Goal: 75% participation. Assumes $500 cost-share for 100 residential properties.	✓	✓				✓					2017-26	$50,000
Address priority BMPs identified in surveys	1) Implement BMPs at the 8 high impact sites identified in the shoreline survey with disturbance scores of 14 or greater. Assumes cost of $3,000 per site to revegetate and mulch with volunteer labor. Expected to reduce pollutant load by 8.5 kg P/year.	✓	✓	✓			✓		✓			2017-26	$24,000
	2) Implement BMPs at the fifteen sites identified in the watershed survey located in the Pleasant Lake watershed. Cost estimate includes implementation and annual maintenance for all BMPs in a ten-year period. Expected to reduce pollutant load by 14.2 kg P/year. Gulf Road currently being addressed with 319 grant funds.	✓	✓	✓			✓		✓			2017-26	$66,878
	3) Develop a method of tracking and monitoring BMP implementation progress (e.g., NPS Site Tracker, which is different from the Region 5 model pollutant load calculation spreadsheet).	✓	✓							✓		2017-26	$5,000

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
Garner funding for action items	1) Create a subcommittee that develops a fundraising strategy and determines how funding is spent.	✓	✓	✓	✓							2017-19	N/A
	2) Establish a capital reserve fund for watershed towns to spend on lake protection initiatives. Cost covers labor to setup and maintain fund.			✓	✓							2017-26	$10,000
	3) Solicit residents for individual donations.		✓						✓			2017-26	N/A
	4) Develop a "Friends of the Watershed" program for donations from local businesses. A business can receive a sticker or plaque recognizing their support for protecting Pleasant Lake. Cost covers sticker/plaque purchase.		✓						✓			2017-26	$1,000
	MUNICIPAL PLANNING												
Adopt plan	1) Send representatives from PLPA to present the watershed plan to the BOS/planning boards of Deerfield and Northwood.	✓	✓	✓								Immediate - 2017	N/A
	2) Incorporate watershed plan recommendations into town master plans.			✓								2017-26	N/A
Improve municipal ordinances (to help mitigate the anticipated 26 kg P/yr loading increase due to predicated future development)	1) Work with the Town of Northwood to develop a Watershed Protection Ordinance like Deerfield.		✓	✓	✓							2017-26	TBD
	2) Meet with town staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, LID, and open space.		✓	✓						✓		2017-26	$1,000
	2a) Lot Coverage: adopt uniform requirements between both towns on Stormwater Management Plans for subdivisions, commercial, and multi-family development, and redevelopment disturbing 20,000 sq. feet or more.			✓	✓							2017-26	TBD
	2b) Setbacks (Shoreland Zoning): increase the setback distance to 100 feet within the shoreland zone of both towns.			✓	✓							2017-26	TBD
	2c) Wetland Buffers: increase the setback distance from all wetlands (not just prime wetlands) to 100 feet in Northwood.			✓	✓							2017-26	TBD
	2d) Steep Slopes: require design and implementation of BMPs on all development on slopes >15%.			✓	✓							2017-26	TBD
	2e) Conservation/Cluster Subdivisions: increase the amount of land set aside in conservation subdivisions to min. 50% of the development area (for Northwood only).			✓	✓							2017-26	TBD

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
	2f) LID: Amend Stormwater Management ordinances to state that the use of LID techniques is preferred and shall be implemented to the maximum extent possible.			✓	✓							2017-26	TBD
Investigate additional municipal ordinances relating to lake activities	1) Assess if more stringent wake restrictions may have a positive impact on the lake shoreline. Currently, the lake is governed by State law (RSA 270-D:2 - boats shall maintain headway (no wake) speed within 150 ft of the shoreline, docks, and mooring fields. See Water Quality Monitoring. (http://www.gencourt.state.nh.us/rsa/html/XXII/270-D/270-D-2.htm)		✓	✓	✓				✓		✓	2017-26	TBD
	2) Assess potential impact fireworks restrictions within Deerfield and Northwood may have on lake health. Local ordinances may be adopted to supersede State law. (http://www.nh.gov/safety/divisions/firesafety/special-operations/fireworks/documents/CommunityPermissibleRestrictedList06-30-16.pdf; http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-60.pdf)		✓	✓	✓				✓		✓	2017-26	TBD
Host trainings for public works, road agents, code enforcement officers, and ZBAs	1) Host training and investigate certification opportunities for public works, road agents, code enforcement officers, and ZBAs in watershed towns, where applicable.			✓								2017-26	$5,000
Improve municipal permitting process	1) Create list of BMP and LID descriptions for Town Selectman, ZBA, Planning Boards, and landowners.		✓	✓	✓					✓		2017-19	$1,500
Enhance watershed resident education of local land ordinances and best management practices	1) Hold informational workshops for new landowners, towns, and developers on relevant town ordinances (i.e., Pleasant Lake Watershed Protection Ordinance for Deerfield), conservation easements, and watershed goals. Goal: Host 1-2 workshops.	✓	✓	✓	✓			✓	✓	✓		2017-26	$5,000
	2) Utilize online points of contact (town and PLPA websites) to provide information on ordinances, LID, and BMPs for landowners (e.g., fact sheets).	✓	✓	✓	✓				✓	✓		2017-26	$3,000
	3) Reach out to residents converting camp properties to year-round single family homes to educate on watershed issues, LID, and BMPs.	✓	✓	✓	✓				✓			2017-26	N/A

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
SEPTIC SYSTEMS													
Enhance awareness of proper septic system maintenance and regulations	1) Distribute educational pamphlets on septic system function and maintenance in tax bills (to include recommended pumping schedules, proper leach field maintenance/planting, new/alternative septic system designs such as community septic or site-limited homes, etc.).	✓	✓	✓	✓					✓		2017-18	$2,000
	2) Create and distribute a list of septic service providers (create magnets, etc.).	✓	✓	✓	✓							2017-18	$500
	3) Host multiple "septic socials" in key neighborhoods near the lake to address link between septic system maintenance and water quality. Target educational campaign in areas with minimally-maintained or aging septic systems.	✓	✓						✓			2017-26	$1,500
Garner funding or discounts that support and encourage septic system maintenance	1) Coordinate group septic system pumping discounts. Assumes volunteer labor to coordinate. Pump-out costs responsibility of landowners.	✓	✓						✓			2017-26	N/A
	2) Investigate grants and low-interest loans (e.g., NHDES Clean Water State Revolving Fund, Section 319 Implementation Grant) to provide cost-share opportunities for septic system upgrades. Cost estimate based on resources to apply for grant.	✓	✓	✓					✓			2017-18	$1,500
	3) Encourage towns, conservation commissions, or local conservation partners to reserve a portion of conservation dollars for the watershed that can be used for septic system upgrades.		✓	✓	✓			✓				2017-26	N/A
Enforce town septic system regulations	1) Communicate with town departments to enforce occupancy loads and have septic system inventories in Master Plans.		✓	✓	✓							2017-26	TBD
	2) Inspect all home conversions from seasonal to permanent residences and property transfers for proper septic system size and design. Cost responsibility of property owner.			✓					✓			2017-26	N/A
Inventory status of septic and greywater systems in watershed	1) Reach out to landowners that did not or could not respond to the 2015 septic survey to gather additional information.	✓	✓							✓		2017-18	$3,000
	2) Conduct voluntary dye testing of high impact septic systems. Goal: 5 systems.	✓	✓	✓					✓			2017-18	$500
	3) Develop and maintain a septic system database for the watershed. Code Enforcement Office for each town to maintain database. Cost estimate based on initial setup by SNHPC or consultants.	✓	✓	✓	✓					✓		2017-26	$4,000
	4) Assess the impact of elevated lake levels (raised 1.5 ft in 2013) on the water table and potential interception of low-lying septic systems.	✓	✓	✓	✓					✓	✓	2017-19	$30,000

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
	5) Conduct an inventory of greywater systems in the watershed.	✓	✓	✓						✓		2017-18	$5,000
	6) Hire canine scent detection team to investigate shoreline septic systems.	✓	✓	✓	✓					✓		2017-20	$5,000
ROADS													
Develop maintenance priorities for roads within the watershed	1) Approach current ad-hoc "road associations" leaders about identifying their goals for stormwater management and four-season maintenance for their roads.		✓	✓					✓			2017-18	N/A
Coordinate culvert improvements with planned resurfacing of NH Route 107	1) Work with NH DOT to communicate known problems with culvert function along the State road so that they can be addressed during road resurfacing efforts set to take place in 2017.	✓	✓	✓		✓						2017	TBD
Create and manage drainage easements on roads	1) Work with road agents and landowners to create and manage drainage easements on private properties. This will help ensure that culverts and other drainage structures that cross private property are being properly maintained to control salt/sand and stormwater runoff from roads.		✓	✓	✓				✓			2017-26	TBD
Require training of road agents	1) If not already in place, require training for road agents on proper salt, sand, and equipment use (e.g. UNH Technology Transfer Center trainings for snow plot operators).			✓								2017-26	$5,000
Host road maintenance workshops	1) Hold workshops on proper road management.		✓	✓	✓							2017-26	$5,000
LAND CONSERVATION & MANAGEMENT													
Identify opportunities for land protection and conservation within the watershed	1) Collaborate with local conservation partners (e.g., Bear-Paw Regional Greenways, Northwood Area Land Management Collaborative) on land conservation initiatives within the watershed. Assign a liaison from PLPA to communicate with conservation groups.		✓		✓			✓				2017-26	N/A
	2) Fund tools, such as natural resource inventories, to help identify and target critical land for protection.			✓	✓			✓		✓		2017-26	$15,000
	3) Create a priority list of watershed areas that need protection based on natural resource inventory and identify potential conservation buyers and property owners interested in easements within the watershed.			✓	✓			✓	✓	✓		2017-26	N/A

ACTION ITEM	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SNHPC	PLPA	Towns	Cons. Comm.	NH DOT	SOAK NH	Cons. Partners	Residents	Consultant	Universities	SCHEDULE	ESTIMATED COST
Enhance enforcement of proper land management practices	1) Create better enforcement of forestry rules and regulations.			✓	✓				✓			2017-26	TBD
	2) Encourage easement holders to be notified and present at closings.			✓	✓			✓	✓			2017-26	N/A

5.3 INDICATORS TO MEASURE PROGRESS

The following environmental, programmatic, and social indicators and associated numeric targets (benchmarks) will help to quantitatively measure the progress of this plan in meeting the established goal and objectives for Pleasant Lake. These benchmarks represent short-term (2018), mid-term (2021), and long-term (2026) targets derived directly from actions identified in the Action Plan. Setting benchmarks allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. A steering committee should review the benchmarks for each indicator on an ongoing basis to determine if progress is being made, and then determine if the watershed plan needs to be revised because the targets are not being met.

Environmental Indicators are a direct measure of environmental conditions (Table 5-2). They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They assume that BMP recommendations outlined in the Action Plan will be implemented accordingly and will result in the reduction of median in-lake phosphorus concentration, as well as prevent further exacerbation of the low-oxygen impairment in Pleasant Lake. Note that the benchmarks for environmental indicators also reflect mitigation of anticipated water quality degradation because of new development.

TABLE 5-2. Environmental Indicators for Pleasant Lake.

ENVIRONMENTAL INDICATORS			
Indicators	Benchmarks*		
	2018	2021	2026
Reduce median in-lake total phosphorus in Pleasant Lake.	Achieve 3% (5 kg/yr) reduction; prevent or offset 5 kg/yr from new development	Achieve 5% (8 kg/yr) reduction; prevent or offset 10 kg/yr from new development	Achieve 10% (15 kg/yr) reduction; prevent or offset 26 kg/yr from new development
Improve DO conditions in bottom waters by reducing the duration and increasing depth of low DO occurrence.	5% fewer occurrences	10% fewer occurrences	50% fewer occurrences
Improve and/or maintain water clarity at the deep spot of Pleasant Lake.	0.1 m	0.2 m	0.4 m

**Benchmarks are cumulative starting at year 1.*

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

TABLE 5-3. Programmatic Indicators for Pleasant Lake.

PROGRAMMATIC INDICATORS			
Indicators	Benchmarks*		
	2018	2021	2026
Amount of funding secured for plan implementation (includes contributions from fundraisers, donations, and grants)	$50,000	$300,000	$500,000
Number of high priority shoreline sites remediated (8 identified)	2	4	6
Number of watershed survey sites remediated (14 identified)	2	5	10
Number of residential BMP demonstration projects completed	5	10	15
Linear feet of buffers installed in the shoreland zone	250	500	1,000
Number of updated or new ordinances that target water quality protection.	1	2	3
Number of voluntary septic system inspections (seasonal conversion and property transfer)	1	3	5
Number of voluntary septic system dye tests and inspections (watershed residents)	1	3	5
Number of septic system upgrades	1	3	5
Number of septic/stormwater "socials" held (1 in each district)	2	5	9
Number of parcels with new conservation easements	1	2	3
Number of copies of watershed-based educational materials distributed	50	100	250
Number of meetings with ad-hoc "road association" to discuss road maintenance	1	2	3

**Benchmarks are cumulative starting at year 1.*

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

TABLE 5-4. Social Indicators for Pleasant Lake.

SOCIAL INDICATORS			
Indicators	Benchmarks*		
	2018	2021	2026
Number of new association members	5	15	25
Number of volunteers participating in educational campaigns	10	15	20
Number of people participating in workshops or demonstrations	20	50	75
Number of lake hosts (partner with conservation commissions)	2	5	10
Number of newly-trained VLAP volunteers (partner with conservation commissions)	1	3	5
Number of active weed watchers (partner with conservation commissions)	2	5	10
Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance	10%	25%	50%
Percentage of shoreline residents installing at least one conservation practice	25%	50%	75%

**Benchmarks are cumulative starting at year 1.*

5.4 ESTIMATED COSTS & TECHNICAL ASSISTANCE NEEDED

The cost of successfully implementing this watershed plan is estimated at $545,000 over the next ten years (Table 5-5). **However, many costs are still unknown and should be incorporated to the Action Plan as information becomes available.** Estimated costs include both structural BMPs, such as fixing eroding roads and planting shoreline buffers, and non-structural BMPs, such as demonstration tours or workshops. Annual BMP costs were estimated based on a ten-year total for the initial BMP installation plus ten years of maintenance (refer to Table 4-1).

TABLE 5-5. Estimated annual and 10-year costs for Pleasant Lake watershed restoration.

Category	Estimated Annual Costs	10-year Total
Water Quality Monitoring	$29,500	$295,000
Watershed and Shoreline BMPs	$15,688	$156,878
Municipal Planning	$1,550	$15,500
Septic Systems*	$5,300	$53,000
Roads	$1,000	$10,000
Land Conservation and Management	$1,500	$15,000
Total Cost	**$54,538**	**$545,378**

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

Diverse funding sources and strategies will be needed to implement these recommendations. Funding to cover ordinance revisions and third-party review could be supported by municipalities through tax collection (as approved by majority vote by town residents). Monitoring and assessment funding could come from a variety of sources, including State and federal grants (Section 319, ARM, Moose Plate, etc.), municipalities, SNHPC, and PLPA donations. Funding to improve septic systems, roads, and shoreland zone buffers would likely come from property owners. As the plan evolves into the future, the formation of a funding subcommittee, as well as a steering committee, will be a key part in how funds are raised, tracked, and spent to implement and support the plan. The following list summarizes several possible outside funding options available to implement the Pleasant Lake Watershed Restoration Plan:

- **USEPA/NHDES 319 Grants (Watershed Assistance/Restoration Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management Plan, updated 2014) and protect high-quality waters. 319 grants are available for the implementation of watershed-based management plans. http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm
    - **PLPA has already been awarded a grant from NHDES as part of Section 319 of the Clean Water Act to support work along Gulf Road. PLPA's accomplishment in securing this competitive funding and successful completion of the project will be an asset during future grant funding applications. Refer to Section 1.5.3 for more information.**

- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. For the 2017 funding year, the total SCC grant request per application cannot exceed $24,000. http://agriculture.nh.gov/divisions/scc/grant-program.htm

- **Milfoil and Other Exotic Plant Prevention Grants (NHDES)** – Funds are available each year for projects to prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities. http://des.nh.gov/organization/divisions/water/wmb/exoticspecies/categories/grants.htm

- **Clean Water State Revolving Loan Fund (NHDES)** – "This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund nonpoint source, watershed protection and restoration, and estuary management projects that help improve and protect water quality in New Hampshire." http://des.nh.gov/organization/divisions/water/wweb/grants.htm

5.5 EDUCATIONAL COMPONENT

As detailed in Section 1.5, much effort is already being done by PLPA in the watershed to communicate with the public and to encourage community participation in watershed restoration and protection activities. PLPA is the primary entity for education and outreach campaigns in the watershed. PLPA should consider developing new educational campaigns or improving existing ones to reach more watershed residents. Educational campaigns specific to the six Action Plan categories are detailed in their respective tables (Section 5.2). A summary of key educational items in the Action Plan are as follows:

- Create flyers/brochures for shorefront homes regarding BMPs and septic systems. This could be included in a "new homeowner" packet that covers water quality related issues and ordinances in the watershed.
- Create educational annual "report cards" about Pleasant Lake water quality, presented in a format that is approachable to laypersons.
- Work with SOAK Up the Rain NH to host residential stormwater workshops and demonstration tours to raise awareness of maintaining healthy buffers.
- Develop a "Friends of the Watershed" program for donations from local businesses that recognizes their support of lake protection, but also spreads awareness of water quality issues.

ADDITIONAL RESOURCES

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

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

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

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

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

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Howes, Biology Dept., Woods Hole Oceanographic Institution, Woods Hole, MA. Accessible online: https://www.researchgate.net/publication/231275919_Differential_transport_of_sewage-derived_nitrogen_and_phosphorus_through_a_coastal_watershed

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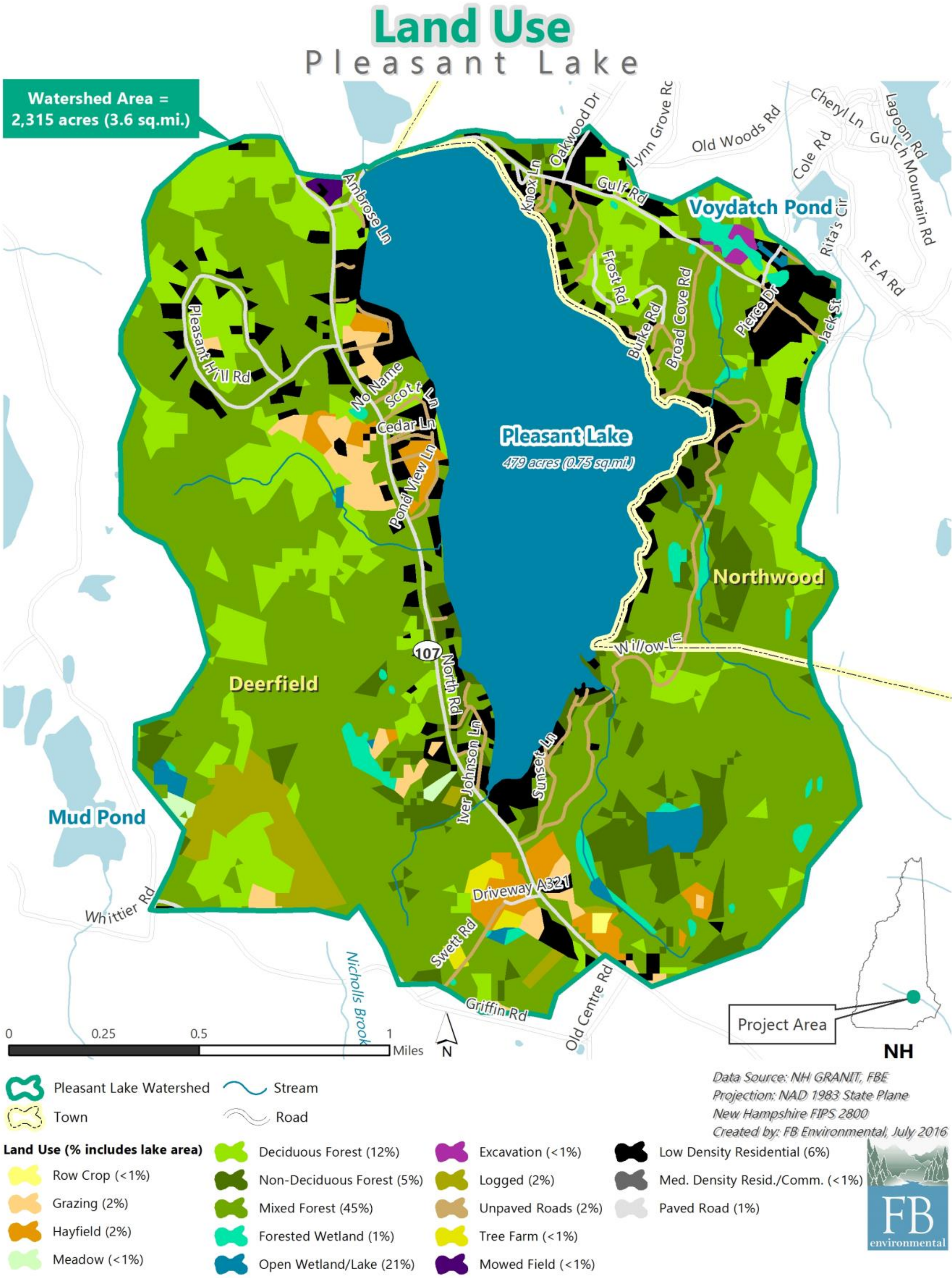
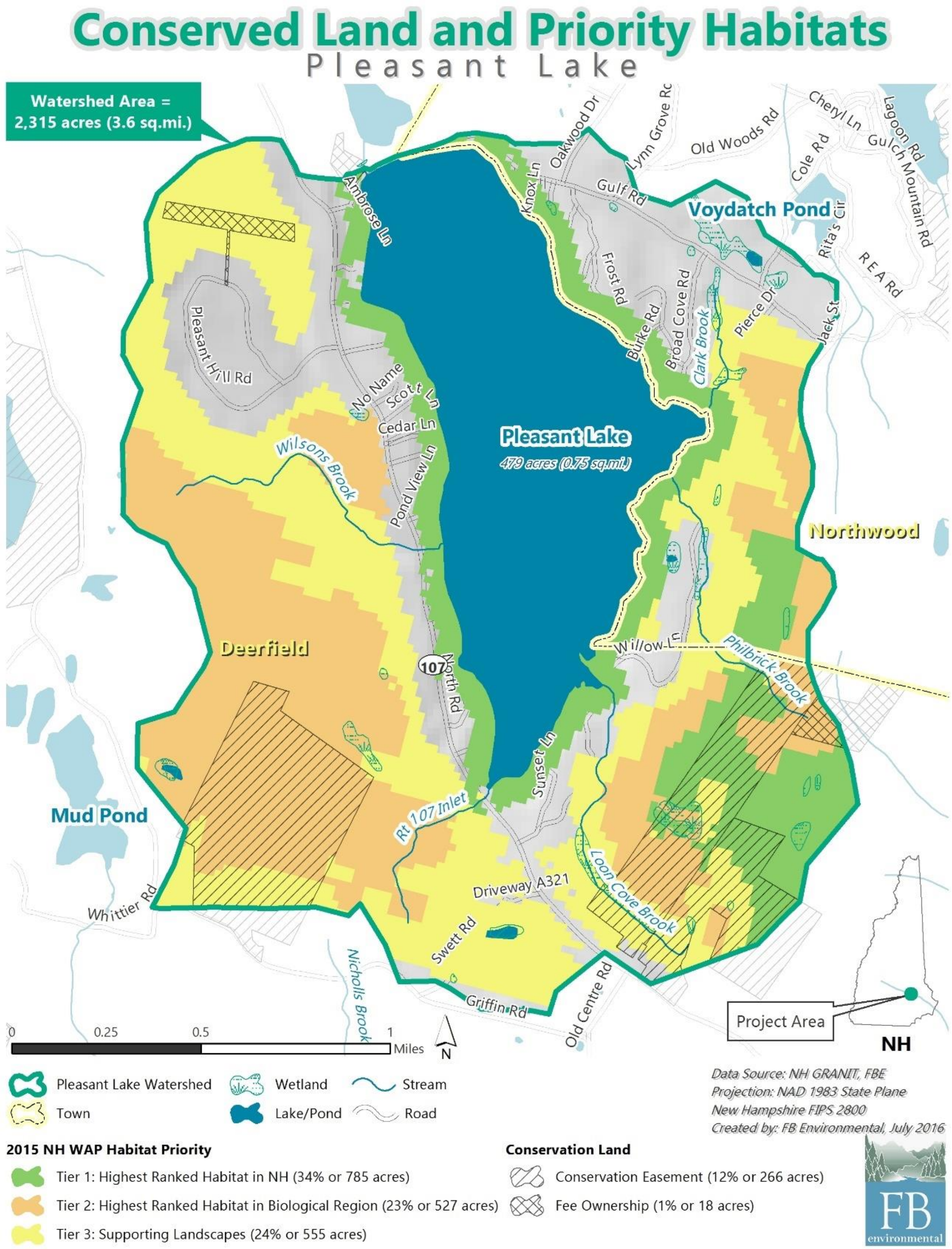
APPENDICES

APPENDIX A: THEMATIC WATERSHED MAPS

MAP 1


Land Use
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Pleasant Lake
479 acres (0.75 sq.mi.)
Voydatch Pond
Mud Pond
Deerfield
Northwood
Ambrose Ln
Oakwood Dr
Lynn Grove Rd
Old Woods Rd
Cheryl Ln
Lagoon Rd
Gulch Mountain Rd
Cole Rd
Knox Ln
Gulf Rd
Rita's Cir
R E A Rd
Frost Rd
Broad Cove Rd
Pierce Dr
Jack St
Burke Rd
Pleasant Hill Rd
No Name
Scott Ln
Cedar Ln
Pond View Ln
Willow Ln
107
North Rd
Iver Johnson Ln
Sunset Ln
Driveway A321
Swett Rd
Whittier Rd
Nicholls Brook
Griffin Rd
Old Centre Rd
0 0.25 0.5 1 Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Stream
Road
Data Source: NH GRANIT, FBE
Projection: NAD 1983 State Plane New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
Land Use (% includes lake area)
Row Crop (<1%)
Grazing (2%)
Hayfield (2%)
Meadow (<1%)
Deciduous Forest (12%)
Non-Deciduous Forest (5%)
Mixed Forest (45%)
Forested Wetland (1%)
Open Wetland/Lake (21%)
Excavation (<1%)
Logged (2%)
Unpaved Roads (2%)
Tree Farm (<1%)
Mowed Field (<1%)
Low Density Residential (6%)
Med. Density Resid./Comm. (<1%)
Paved Road (1%)
FB environmental

MAP 2

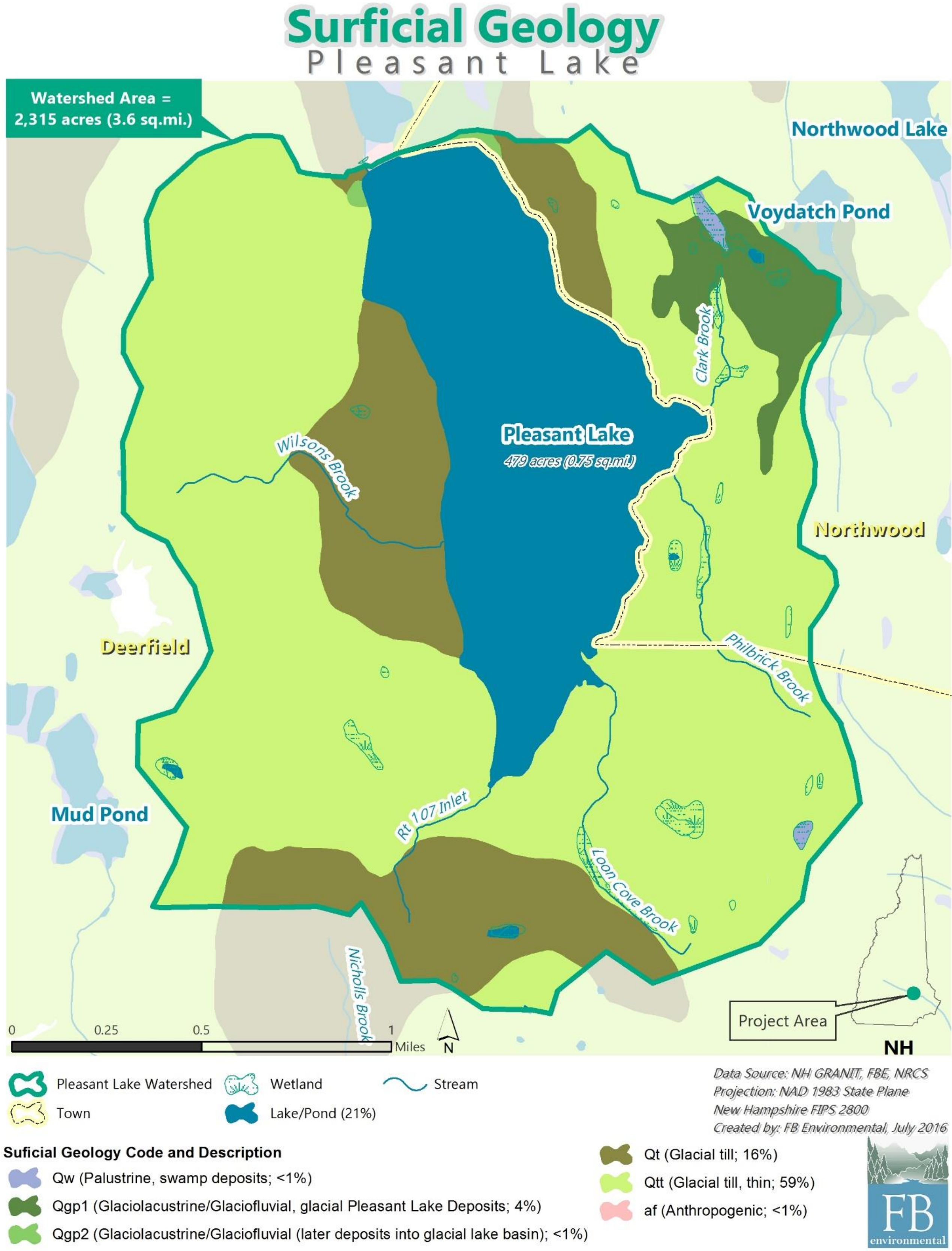


Conserved Land and Priority Habitats
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Pleasant Lake
479 acres (0.75 sq.mi.)
Voydatch Pond
Mud Pond
Deerfield
Northwood
Wilsons Brook
Clark Brook
Philbrick Brook
Loon Cove Brook
Rt 107 Inlet
Nicholls Brook
Ambrose Ln
Oakwood Dr
Lynn Grove Rd
Old Woods Rd
Cheryl Ln
Lagoon Rd
Gulch Mountain Rd
Cole Rd
Rita's Cir
R E A Rd
Knox Ln
Gulf Rd
Frost Rd
Broad Cove Rd
Burke Rd
Pierce Dr
Jack St
Pleasant Hill Rd
No Name
Scott Ln
Cedar Ln
Pond View Ln
North Rd
107
Willow Ln
Sunset Ln
Driveway A321
Swett Rd
Whittier Rd
Griffin Rd
Old Centre Rd
0
0.25
0.5
1
Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Wetland
Lake/Pond
Stream
Road
Data Source: NH GRANIT, FBE
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
2015 NH WAP Habitat Priority
Tier 1: Highest Ranked Habitat in NH (34% or 785 acres)
Tier 2: Highest Ranked Habitat in Biological Region (23% or 527 acres)
Tier 3: Supporting Landscapes (24% or 555 acres)
Conservation Land
Conservation Easement (12% or 266 acres)
Fee Ownership (1% or 18 acres)
FB environmental

MAP 3


Topography
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
479 acres (0.75 sq.mi.)
Deerfield
Northwood
0 0.25 0.5 1 Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Wetland
Lake/Pond
Stream
Contour lines are 10 feet apart.
Data Source: NH GRANIT, FBE, NRCS
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
FB environmental

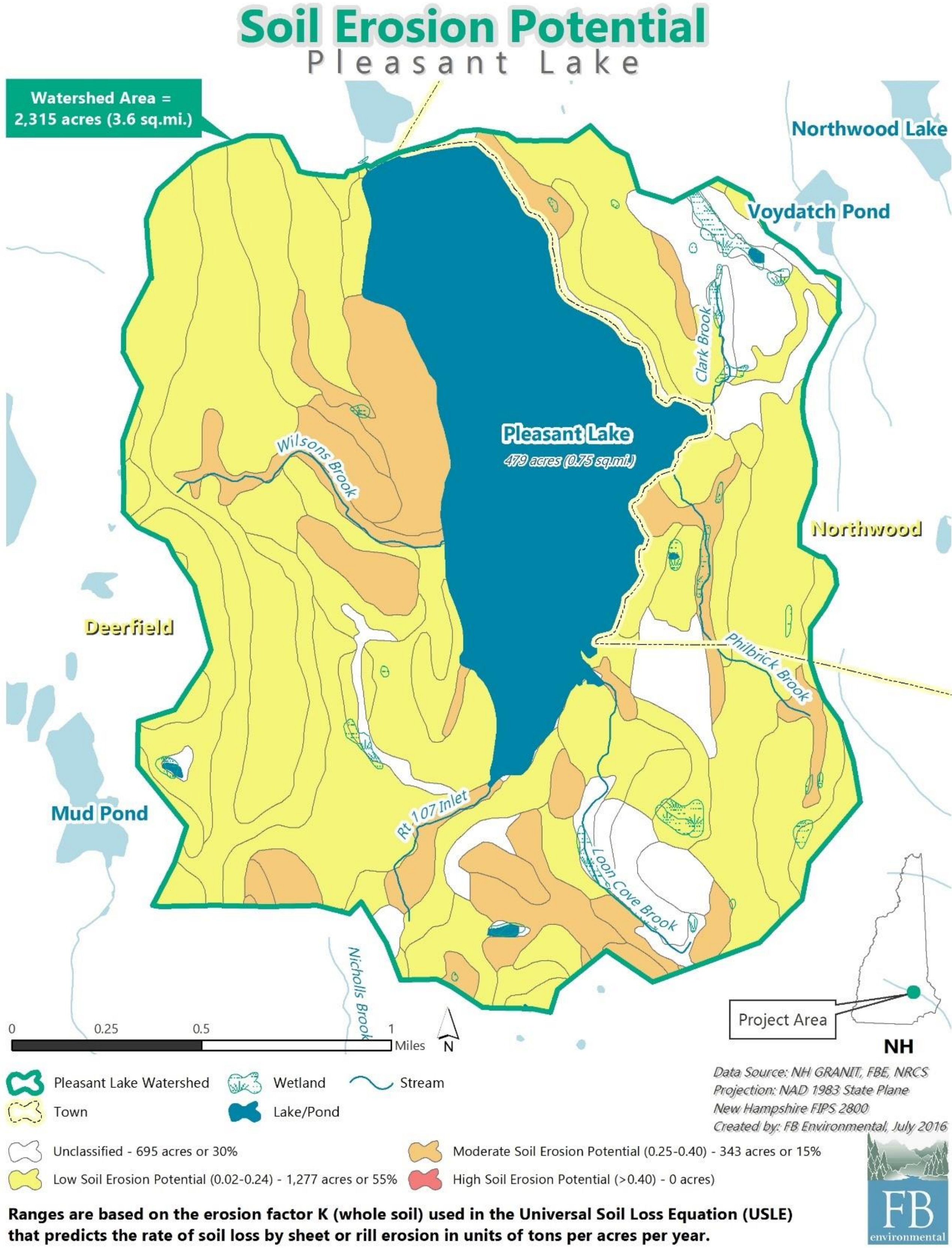
MAP 4


Surficial Geology
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Northwood Lake
Voydatch Pond
Clark Brook
Pleasant Lake
479 acres (0.75 sq.mi.)
Wilsons Brook
Northwood
Deerfield
Philbrick Brook
Mud Pond
Rt 107 Inlet
Loon Cove Brook
Nicholls Brook
0 0.25 0.5 1 Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Wetland
Lake/Pond (21%)
Stream
Data Source: NH GRANIT, FBE, NRCS
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
Suficial Geology Code and Description
Qw (Palustrine, swamp deposits; <1%)
Qgp1 (Glaciolacustrine/Glaciofluvial, glacial Pleasant Lake Deposits; 4%)
Qgp2 (Glaciolacustrine/Glaciofluvial (later deposits into glacial lake basin); <1%)
Qt (Glacial till; 16%)
Qtt (Glacial till, thin; 59%)
af (Anthropogenic; <1%)
FB environmental

MAP 5

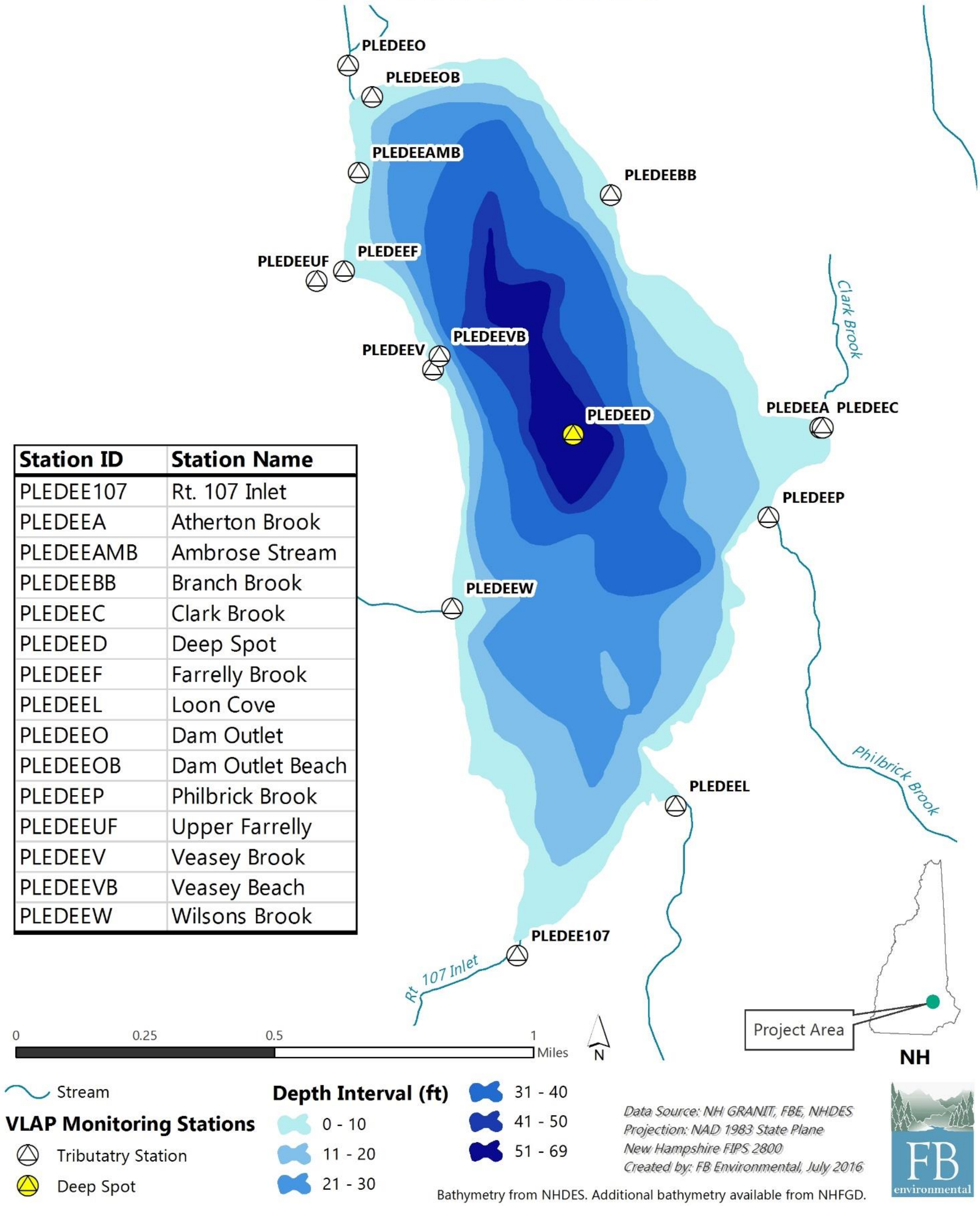
Soils
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Northwood Lake
Voydatch Pond
Clark Brook
Pleasant Lake
479 acres (0.75 sq.mi.)
Wilsons Brook
Northwood
Deerfield
Philbrick Brook
Mud Pond
Rt 107 Inlet
Loon Cove Brook
Nicholls Brook
0
0.25
0.5
1
Miles
N
Project Area
NH
Pleasant Lake Watershed
Town
Wetland
Lake/Pond
Stream
See key in Appendix B for a description of soil class units in the Pleasant Lake Watershed.
Data Source: NH GRANIT, FBE, NRCS
Projection: NAD 1983 State Plane New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
Soil Unit
125
12B
12C
140B
140C
140D
26B
26E
295
298
313A
314A
395
42C
43C
43D
446B
447B
447C
44B
44C
495
547A
547B
657B
66B
66C
66D
67B
67C
Water
FB environmental

MAP 6


Soil Erosion Potential
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Northwood Lake
Voydatch Pond
Clark Brook
Pleasant Lake
479 acres (0.75 sq.mi.)
Wilsons Brook
Northwood
Deerfield
Philbrick Brook
Mud Pond
Rt. 107 Inlet
Loon Cove Brook
Nicholls Brook
0
0.25
0.5
1
Miles
N
Project Area
NH
Pleasant Lake Watershed
Wetland
Stream
Town
Lake/Pond
Data Source: NH GRANIT, FBE, NRCS
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
Unclassified - 695 acres or 30%
Moderate Soil Erosion Potential (0.25-0.40) - 343 acres or 15%
Low Soil Erosion Potential (0.02-0.24) - 1,277 acres or 55%
High Soil Erosion Potential (>0.40) - 0 acres)
Ranges are based on the erosion factor K (whole soil) used in the Universal Soil Loss Equation (USLE) that predicts the rate of soil loss by sheet or rill erosion in units of tons per acres per year.
FB environmental

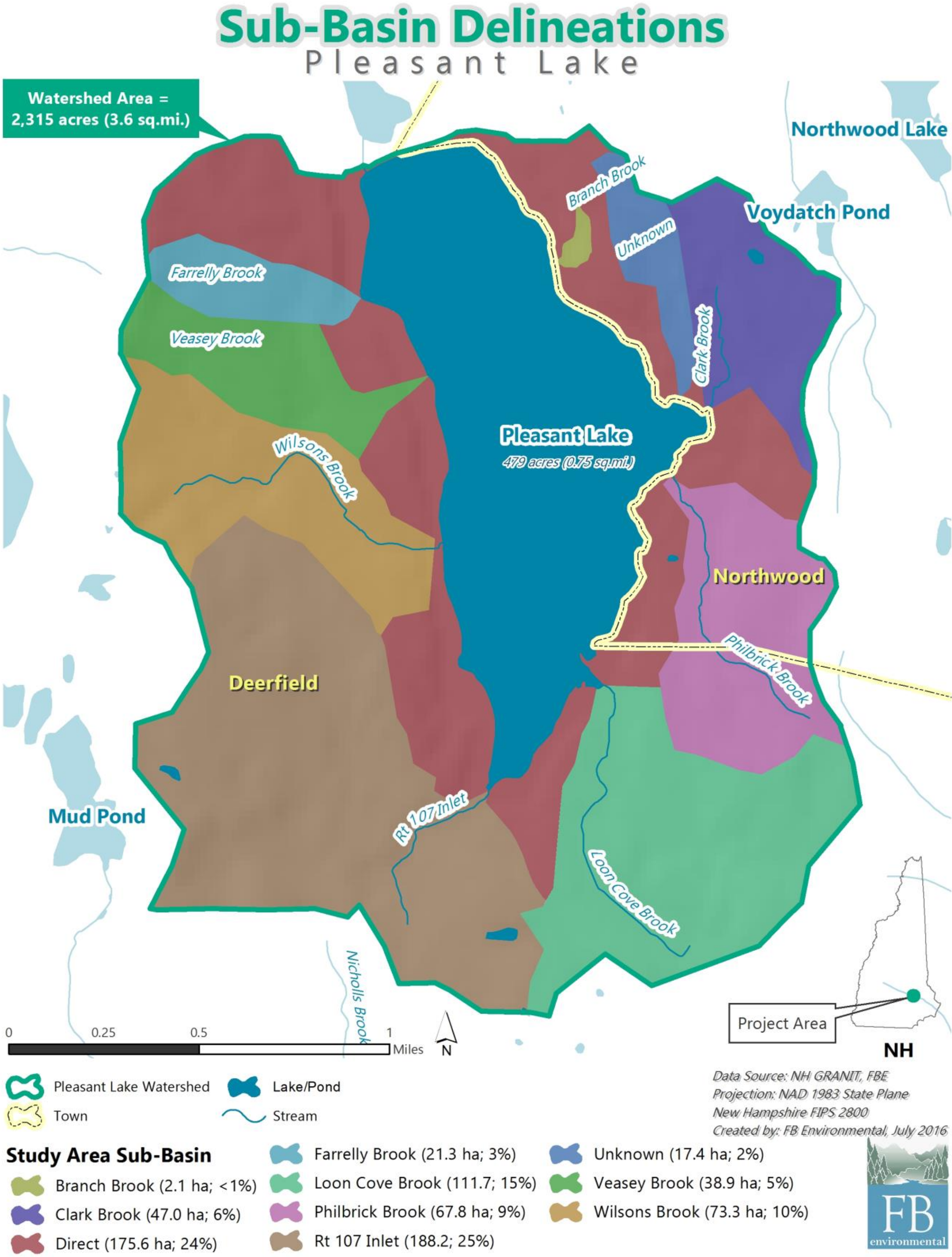
MAP 7

Bathymetry/Monitoring Sites
Pleasant Lake

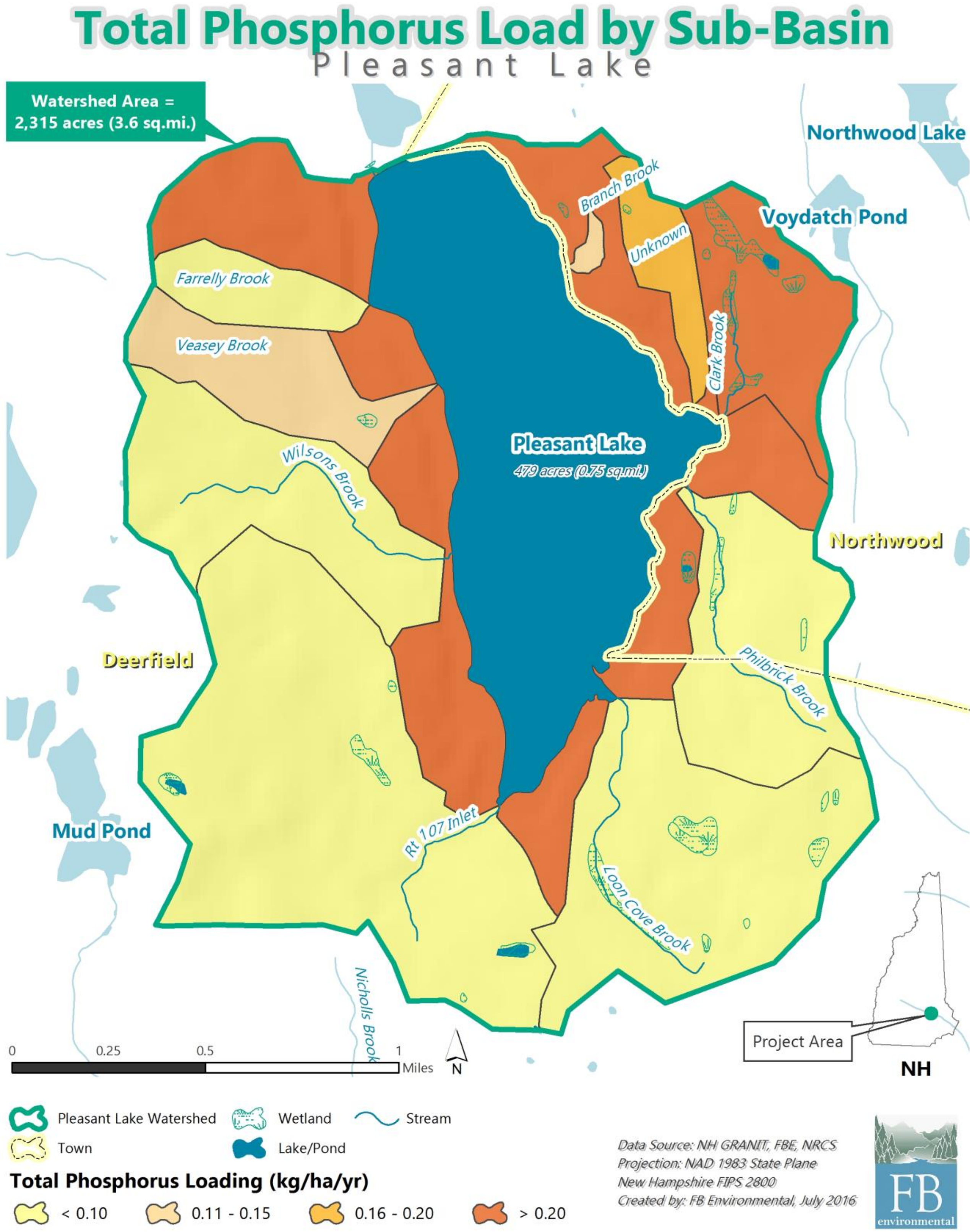


Station ID	Station Name
PLEDEE107	Rt. 107 Inlet
PLEDEEA	Atherton Brook
PLEDEEAMB	Ambrose Stream
PLEDEEBB	Branch Brook
PLEDEEC	Clark Brook
PLEDEED	Deep Spot
PLEDEEF	Farrelly Brook
PLEDEEL	Loon Cove
PLEDEEO	Dam Outlet
PLEDEEOB	Dam Outlet Beach
PLEDEEP	Philbrick Brook
PLEDEEUF	Upper Farrelly
PLEDEEV	Veasey Brook
PLEDEEVB	Veasey Beach
PLEDEEW	Wilsons Brook

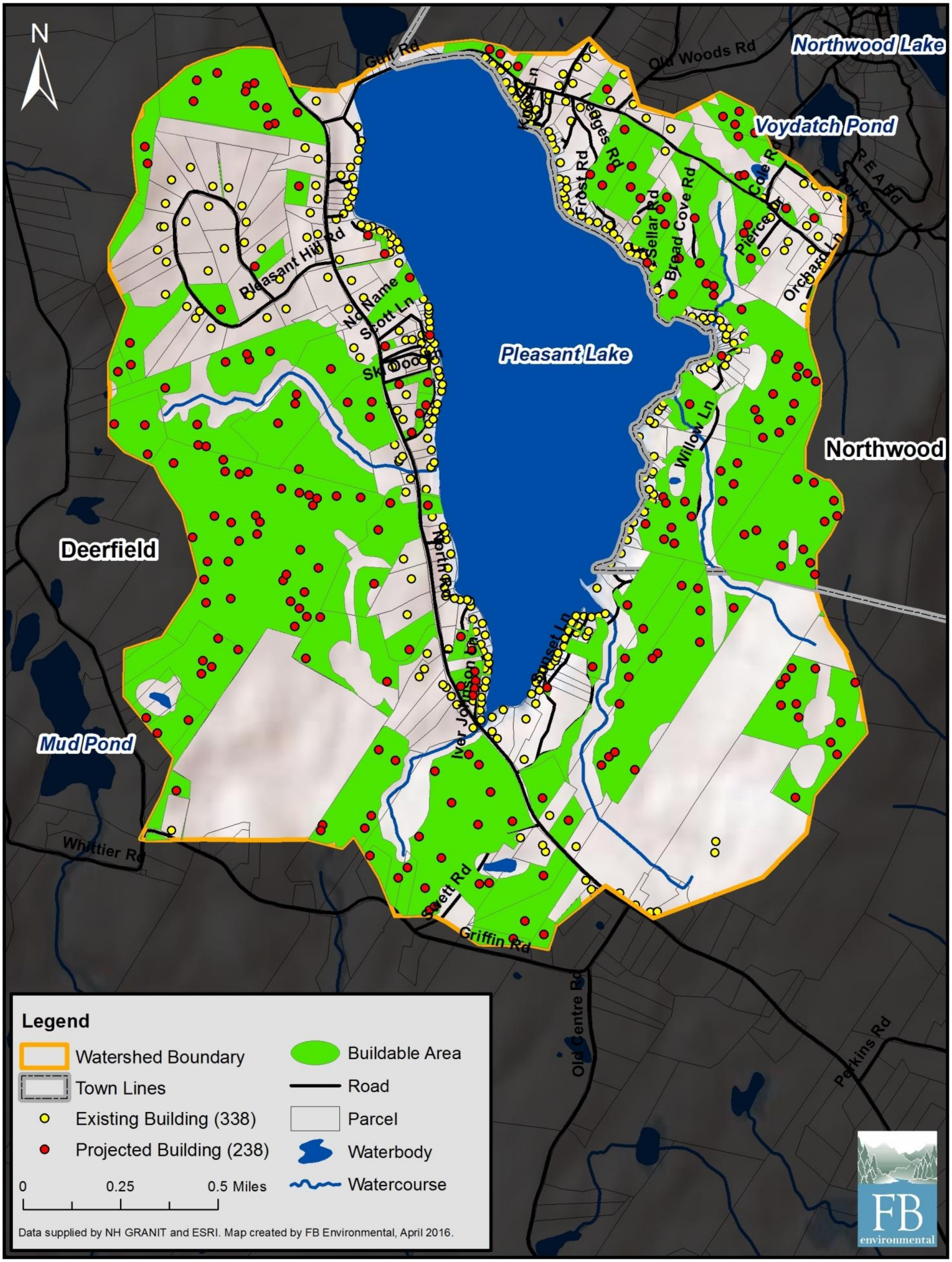
MAP 8


Sub-Basin Delineations
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Northwood Lake
Voydatch Pond
Branch Brook
Unknown
Clark Brook
Farrelly Brook
Veasey Brook
Wilsons Brook
Pleasant Lake
479 acres (0.75 sq.mi.)
Northwood
Philbrick Brook
Deerfield
Mud Pond
Rt 107 Inlet
Loon Cove Brook
Nicholls Brook
0 0.25 0.5 1 Miles
N
Project Area
NH
Pleasant Lake Watershed
Lake/Pond
Town
Stream
Data Source: NH GRANIT, FBE
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
Study Area Sub-Basin
Branch Brook (2.1 ha; <1%)
Clark Brook (47.0 ha; 6%)
Direct (175.6 ha; 24%)
Farrelly Brook (21.3 ha; 3%)
Loon Cove Brook (111.7; 15%)
Philbrick Brook (67.8 ha; 9%)
Rt 107 Inlet (188.2; 25%)
Unknown (17.4 ha; 2%)
Veasey Brook (38.9 ha; 5%)
Wilsons Brook (73.3 ha; 10%)
FB environmental

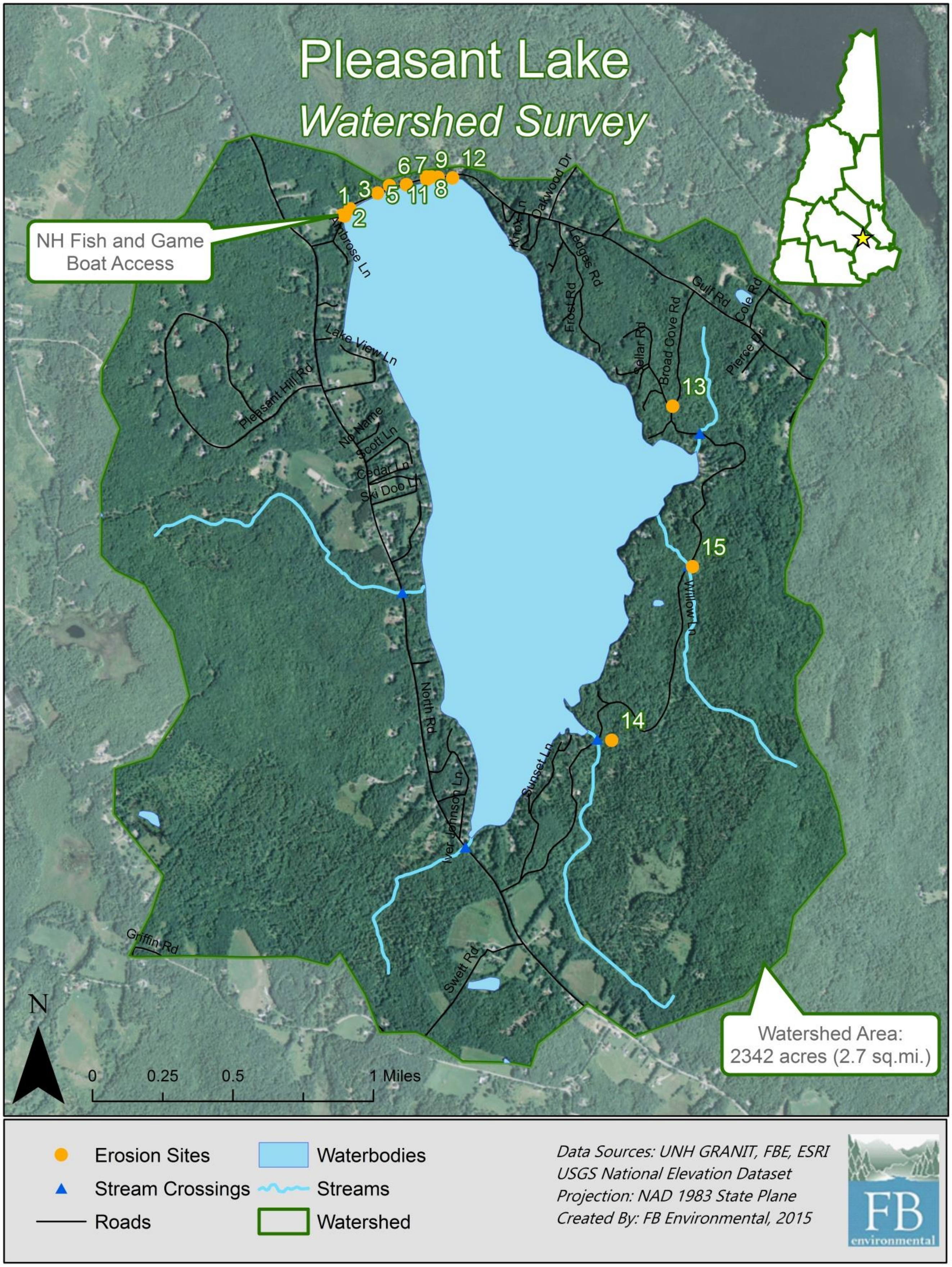
MAP 9


Total Phosphorus Load by Sub-Basin
Pleasant Lake
Watershed Area = 2,315 acres (3.6 sq.mi.)
Northwood Lake
Voydatch Pond
Branch Brook
Unknown
Clark Brook
Farrelly Brook
Veasey Brook
Wilsons Brook
Pleasant Lake
479 acres (0.75 sq.mi.)
Northwood
Deerfield
Philbrick Brook
Mud Pond
Rt 107 Inlet
Loon Cove Brook
Nicholls Brook
0 0.25 0.5 1 Miles
N
Project Area
NH
Pleasant Lake Watershed
Wetland
Stream
Town
Lake/Pond
Total Phosphorus Loading (kg/ha/yr)
< 0.10
0.11 - 0.15
0.16 - 0.20
> 0.20
Data Source: NH GRANIT, FBE, NRCS
Projection: NAD 1983 State Plane
New Hampshire FIPS 2800
Created by: FB Environmental, July 2016
FB environmental

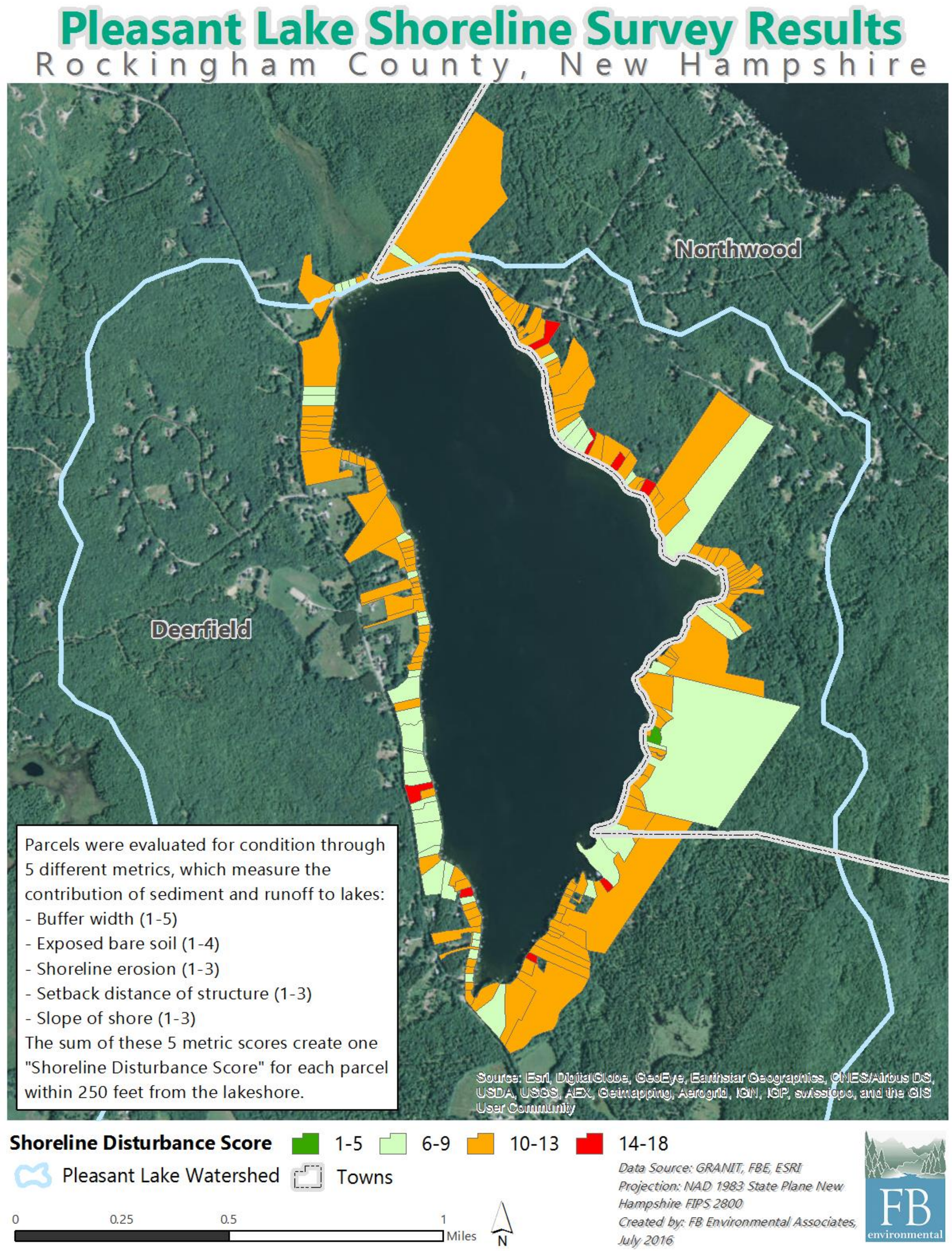
MAP 10


N
Northwood Lake
Voydatch Pond
Pleasant Lake
Northwood
Deerfield
Mud Pond
Gulf Rd
Old Woods Rd
Pleasant Hill Rd
No Name
Scott Ln
Frost Rd
Sellar Rd
Broad Cove Rd
Cole Rd
Pierce Dr
Orchard Ln
Willow Ln
North Rd
Sunset Ln
Iver Johnson Ln
Whittier Rd
Griffin Rd
Old Centre Rd
Perkins Rd
Legend
Watershed Boundary
Town Lines
Existing Building (338)
Projected Building (238)
Buildable Area
Road
Parcel
Waterbody
Watercourse
0
0.25
0.5 Miles
Data supplied by NH GRANIT and ESRI. Map created by FB Environmental, April 2016.
FB
environmental

MAP 11


Pleasant Lake
Watershed Survey
NH Fish and Game Boat Access
1
2
3
5
6
7
9
11
8
12
13
14
15
Ambrose Ln
Lake View Ln
Pleasant Hill Rd
No Name
Scott Ln
Cedar Ln
Ski Doo Ln
North Rd
Iver Johnson Ln
Sunset Ln
Swett Rd
Griffin Rd
Knox Ln
Oakwood Dr
Ledges Rd
Frost Rd
Sellar Rd
Broad Cove Rd
Gulf Rd
Cole Rd
Pierce Dr
Willow Ln
Watershed Area: 2342 acres (2.7 sq.mi.)
N
0
0.25
0.5
1 Miles
Erosion Sites
Stream Crossings
Roads
Waterbodies
Streams
Watershed
Data Sources: UNH GRANIT, FBE, ESRI
USGS National Elevation Dataset
Projection: NAD 1983 State Plane
Created By: FB Environmental, 2015
FB environmental

MAP 12


Pleasant Lake Shoreline Survey Results
Rockingham County, New Hampshire
Northwood
Deerfield
Parcels were evaluated for condition through 5 different metrics, which measure the contribution of sediment and runoff to lakes:
- Buffer width (1-5)
- Exposed bare soil (1-4)
- Shoreline erosion (1-3)
- Setback distance of structure (1-3)
- Slope of shore (1-3)
The sum of these 5 metric scores create one "Shoreline Disturbance Score" for each parcel within 250 feet from the lakeshore.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Shoreline Disturbance Score
1-5
6-9
10-13
14-18
Pleasant Lake Watershed
Towns
0
0.25
0.5
1
Miles
N
Data Source: GRANIT, FBE, ESRI
Projection: NAD 1983 State Plane New Hampshire FIPS 2800
Created by: FB Environmental Associates, July 2016
FB environmental

MAP 13

APPENDIX B: SOIL SERIES IN THE PLEASANT LAKE WATERSHED

TABLE B-1. Acreage and description of soil series in the Pleasant Lake watershed.

Code (MUSYM)	Soil Series Description	Acres	Percentage
125	Scarboro muck, very stony	31	1%
12B	Hinckley loamy sand, 3 to 8 percent slopes	45	2%
12C	Hinckley loamy sand, 8 to 15 percent slopes	7	0%
140B	Chatfield-Hollis-Canton complex, 3 to 8 percent slopes, very stony	49	2%
140C	Chatfield-Hollis-Canton complex, 8 to 15 percent slopes, very stony	727	31%
140D	Chatfield-Hollis-Canton complex, 15 to 35 percent slopes, very stony	323	14%
26B	Windsor loamy sand, 3 to 8 percent slopes	20	1%
26E	Windsor loamy sand, 15 to 60 percent slopes	2	0%
295	Freetown mucky peat, 0 to 2 percent slopes	<1	0%
298	Pits, sand and gravel	4	0%
313A	Deerfield fine sandy loam, 0 to 3 percent slopes	12	1%
314A	Pipestone sand, 0 to 5 percent slopes	20	1%
395	Swansea mucky peat, 0 to 2 percent slopes	19	1%
42C	Canton gravelly fine sandy loam, 8 to 15 percent slopes	4	0%
43C	Canton gravelly fine sandy loam, 8 to 15 percent slopes, very stony	23	1%
43D	Canton gravelly fine sandy loam, 15 to 25 percent slopes, very stony	17	1%
446B	Scituate-Newfields complex, 3 to 8 percent slopes	31	1%
447B	Scituate-Newfields complex, 3 to 8 percent slopes, very stony	54	2%
447C	Scituate-Newfields complex, 8 to 15 percent slopes, very stony	29	1%
44B	Montauk fine sandy loam, 3 to 8 percent slopes	24	1%
44C	Montauk fine sandy loam, 8 to 15 percent slopes	68	3%
495	Ossipee mucky peat	5	0%
547A	Walpole very fine sandy loam, 0 to 3 percent slopes, very stony	7	0%
547B	Walpole very fine sandy loam, 3 to 8 percent slopes, very stony	103	4%
657B	Ridgebury very fine sandy loam, 3 to 8 percent slopes, very stony	1	0%
66B	Paxton fine sandy loam, 3 to 8 percent slopes	22	1%
66C	Paxton fine sandy loam, 8 to 15 percent slopes	66	3%
66D	Paxton fine sandy loam, 15 to 25 percent slopes	40	2%
67B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	19	1%
67C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	69	3%
W	Water	475	20%
	Total	**2,315**	

APPENDIX C: SITE SPECIFIC PROJECT PLAN

SITE SPECIFIC PROJECT PLAN FOR:

PLEASANT LAKE WATERSHED RESTORATION PLAN DEVELOPMENT AND IMPLEMENTATION PHASE 1

NHDES Project # W-15-M-01

Under the New Hampshire Section 319 Nonpoint Source Grant Program QAPP
RFA# 08262
August 23, 2013

Revision #1
May 18, 2015

PREPARED BY:

Southern New Hampshire Planning Commission
438 Dubuque Street
Manchester, NH 03102
(603) 669-4664
www.snhpc.org

For Review:

Project Manager: ______________________________
Signature/Date
John Munn, SNHPC

Technical Project Manager/QA Officer: ______________________________
Signature/Date
Forrest Bell, FB Environmental Associates

NHDES Project Manager: ______________________________
Signature/Date
Stephen Landry, NHDES

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

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

For Receipt:

EPA Nonpoint Source Program Coordinator: ______________________________
Signature/Date
Erik Beck, USEPA

1-Distribution List

Table 1 lists people who will receive copies of the approved Site Specific Project Plan (SSPP) for "Pleasant Lake Watershed Restoration Plan Development and Implementation Phase 1" under the *New Hampshire Section 319 Nonpoint Source Grant Program Quality Assurance Project Plan* dated April 3, 2015.

Table 1. SSPP Distribution List.

Name	Project Role	Organization	Phone/E mail
John Munn	Project Manager	SNHPC	603-669-4664 jmunn@snhpc.org
Forrest Bell	Technical Project Manager/QA Officer	FB Environmental	207-221-6699 info@fbenvironmental.com
Don Kretchmer	Pollutant loading and in-lake water quality analysis	DK Water Resource Consulting	603-387-0532 dkretchmer@metrocast.net
Jennifer Jespersen	Task Manager	FB Environmental	207-221-6699 jenj@fbenvironmental.com
Kevin Ryan	Buildout Analysis	FB Environmental	207-221-6699 kevinr@fbenvironmental.com
Laura Diemer	Water Quality Data Review/LLRM	FB Environmental	603-828-1456 laurad@fbenvironmental.com
Jason Ayotte	BMP Matrix	Hoyle Tanner Associates	603-669-5555, ext 126 jayotte@hoyletanner.com
Stephen Landry	NHDES Project Manager	NHDES	603-271-2969 stephen.landry@des.nh.gov
Jillian McCarthy	Program QA Coordinator	NHDES	603-271-8475 jillian.mccarthy@des.nh.gov
Vincent Perelli	NHDES QA Manager	NHDES	603-271-8989 vincent.perelli@des.nh.gov
Erik Beck	EPA NPS Program Coordinator	EPA Region 1	617-918-1606 beck.erik@epa.gov

2-Project Organization

Figure 1 outlines the organizational structure of project personnel. Table 2 identifies their specific roles and responsibilities. John Munn, Project Manager, will oversee and communicate project progress to NHDES, partners, and stakeholders, with help from the Pleasant Lake Preservation Association (PLPA). Mr. Munn will also be responsible for documenting and notifying the partners and stakeholders of any changes made to the project.

Principal data users include the Southern New Hampshire Planning Commission (SNHPC), FB Environmental Associates (FBE), DK Water Resource Consulting, LLC, and NHDES, who will use the data to assist in the development of a watershed-based management plan for Pleasant Lake. Project personnel will present the data to the Pleasant Lake Watershed Advisory Committee, who will be the principal decision makers. The Pleasant Lake Watershed Advisory Committee will be comprised of representatives from SNHPC, the Towns of Deerfield and Northwood, PLPA, NH Fish and Game, NHDES, NHDOT, and landowners.

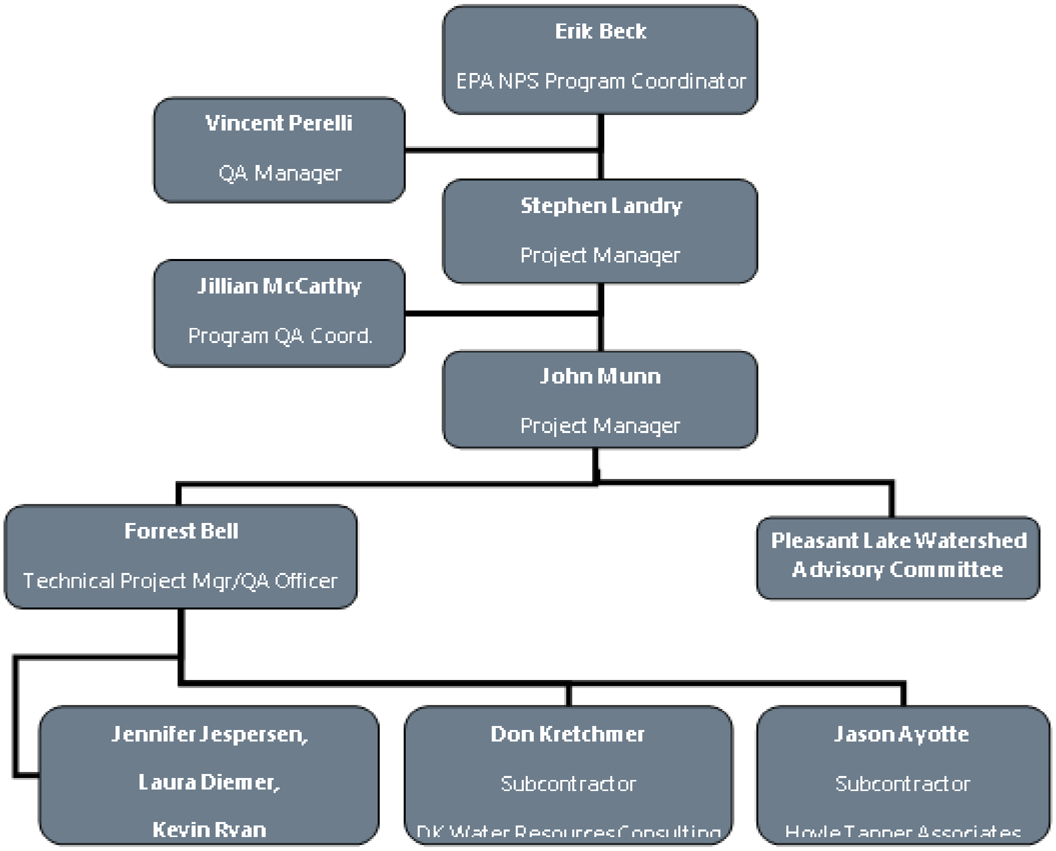


Figure 1. Project Organizational Chart.

Table 2. Personnel Responsibilities and Qualifications.

Name and Affiliation	Responsibilities	Qualifications
John Munn, SNHPC	Project Manager	On file
Forrest Bell, FBE	Technical Project Manager Project QA/QC Officer	On file
Don Kretchmer, DK Water Resources Consulting	Pollutant loading analysis, In-lake quality analysis, LLRM model specialist	On file
Jennifer Jespersen, FBE	Task Manager	On file
Laura Diemer, FBE	Water Quality Data and LLRM calculations	On file
Kevin Ryan, FBE	Build-out Analysis, CommunityViz Software	On file
Jason Ayotte, Holy Tanner Associates	BMP Design	On file
Jillian McCarthy, NHDES	SSPP review and other QA/QC activities	On file at NHDES
Stephen Landry, NHDES	Oversee projects funded by NHDES 319 Restoration Grants in Merrimack basin.	On file at NHDES
Vincent Perelli, NHDES	Reviews and approves QAPPs	On file at NHDES
Erik Beck, EPA Region 1	EPA NPS Program Coordinator	On file at EPA

3-Site Information

Pleasant Lake is a 493-acre lake in south-central New Hampshire, located in the Towns of Deerfield and Northwood (Figure 2). The eastern shore of the lake forms the border between these two towns. Pleasant Lake flows north to Northwood Lake and then west via the Little Suncook River to the Suncook River, a tributary to the Merrimack River. Pleasant Lake and its public beach in Deerfield (Veasey Park Beach) are both considered impaired by NHDES, as they do not support their designated uses of Aquatic Life (due to insufficient levels of dissolved oxygen) and Primary Contact Recreation (due to elevated levels of *E.coli* bacteria), respectively. Further, several indicators suggest that Pleasant Lake is a borderline Oligotrophic/Mesotrophic lake due to elevated phosphorus levels.

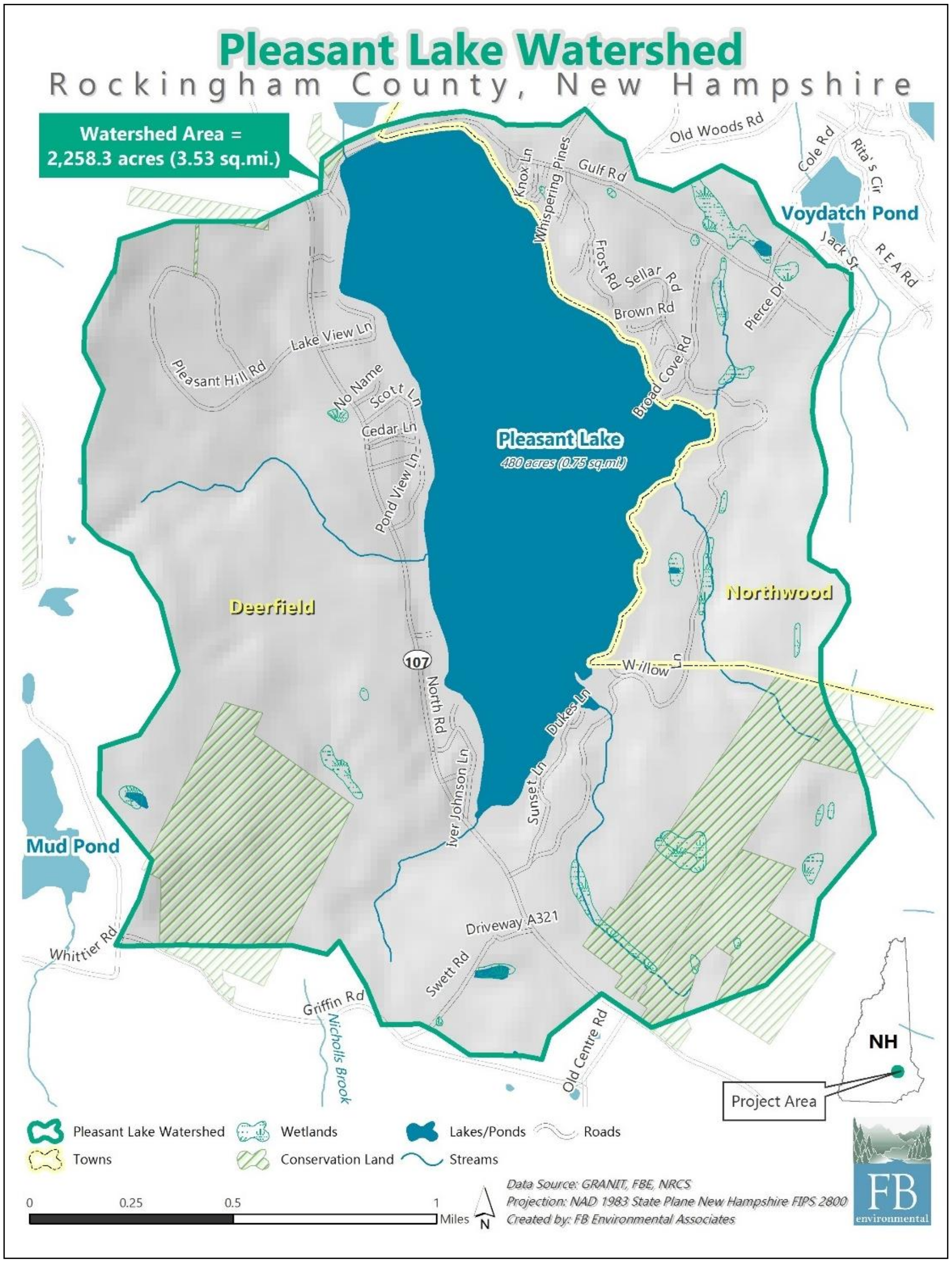


Figure 2. Pleasant Lake Watershed.

Though the 2,240-acre watershed is primarily rural and heavily forested, the lake shore is characterized by low-intensity development. A recent trend of converting small, seasonal, lake-front properties to larger, year-round homes has resulted in an increase in impervious cover and is likely threatening the water quality in Pleasant Lake. A primary concern for Pleasant Lake is the current and future contribution of nonpoint source (NPS) pollutants such as phosphorus from this increased development in the watershed.

The challenge is to reduce nutrient loading to Pleasant Lake to prevent a further decline in water quality and trophic status. As the lake is currently thought to be a borderline oligotrophic/mesotrophic lake, the implementation of an aggressive watershed management plan should be successful in reducing phosphorus concentrations to improve water quality so Pleasant Lake can meet the overall lake classification of oligotrophic.

4-Project Rationale

The Pleasant Lake Watershed Restoration Plan Development and Implementation Phase 1 project represents part of the long-term strategy designed to protect the water quality of Pleasant Lake. The strategy was developed through a collaborative effort between SNHPC and PLPA.

Pleasant Lake does not support the designated uses of Aquatic Life and Primary Contact (swimming) due to insufficient dissolved oxygen concentrations in the lake and elevated E.coli bacteria counts at the Veasey Park Beach respectively. Pleasant Lake (NHLAK700060502-09-01) and Veasey Park Beach (NHLAK700060502-09-02) both appear on the 2012, 305(b)/303(d) Assessment for failure to meet designated uses. Several indicators reveal that Pleasant Lake may be a borderline Oligotrophic/Mesotrophic waterbody due to elevated phosphorous in the water column, and a decline of dissolved oxygen in the hypolimnion. Pleasant Lake also appears in the 2013 New Hampshire Nonpoint Source Management Plan (Appendix C) ranked 12th for those surface waters having a high watershed recover potential.

The 2002 Diagnostic Study and NH VLAP annual assessments show that the existing impairments are likely caused by nonpoint source (NPS) pollution in stormwater runoff and aging or failing septic systems. Both of these sources are identified as priorities within the New Hampshire Nonpoint Source Management Plan with stormwater ranked as the number one contributor of NPS pollution to surface waters in New Hampshire. Development of a watershed restoration plan will assist the community in focusing their efforts on nutrient reduction by identifying sources of pollutants within the Pleasant Lake watershed that have led to the impairments.

5-Project Approach/Study Design

Preliminary analysis of the Pleasant Lake watershed indicates that the morphology and hydrology of the Pleasant Lake watershed makes it highly sensitive to development and therefore it plays a significant role in impacting the overall water quality of the entire lake, emphasizing the importance of management planning in this watershed.

The scope of work for this phase of the project begins the development of an EPA, nine key element, Pleasant Lake Watershed Restoration Plan that addresses the impairments in the lake by identifying sources of pollutants and the actions necessary to improve water quality and overall aquatic life health in the watershed.

Near-term results and outcomes expected from this phase in development and implementation of the restoration plan include: 1) setting an in-lake threshold for phosphorus; 2) identification and prioritization of site specific BMPs to reduce sediment and nutrient loading; 3) improved septic system maintenance through education and outreach to property owners; 4) education on gravel road BMPs; and 5) sediment removal and nutrient reductions achieved through the implementation of stormwater improvements, as well as small stormwater improvement projects on homeowner sites.

This stakeholder-driven process will assist the communities in understanding how land use and future development impacts their local water quality, and why development of a restoration plan is a necessary task for successful lake quality management planning and implementation.

To ensure successful development of the restoration plan, Southern New Hampshire Planning Commission has contracted with FBE to perform the watershed assessment, pollutant load and in-lake modeling analyses, identification of mitigation actions, and estimation of pollution reductions necessary for improving the water quality of Pleasant Lake.

Completion of the following tasks will occur:

- **Evaluate existing water quality data for completeness and validity in the Pleasant Lake watershed from all available sources.** The NHDES OneStop data portal will be used to access data that has been pre-screened and quality checked by NHDES. The datasets include information from NHDES lake trophic surveys and data from the NH Volunteer Lake Assessment Program (VLAP). Water quality data will be used to assess current water quality conditions, determine the assimilative capacity, and assist the Water Quality Advisory Committee in setting a water quality goal for phosphorus. Details of the sources of water quality data and method for determining the assimilative capacity and water quality goal are provided in Sections 6 and 7 of this plan. DK Water Resources Consulting will collaborate with FBE to complete this task.
- **Complete phosphorus loading analysis for the Pleasant Lake watershed.** An estimation of internal P loading, septic system P loading, future loading scenarios, and other potential sources will be determined. A threshold for phosphorus loading in the watershed will be established using the Lake Loading Response Model (LLRM). Details of the LLRM are provided in Section 8 of this plan, as well as details regarding who will complete each task.
- **Verify watershed P load models using in-lake P prediction models.** Details of the prediction models are included in Section 8 of this plan.

The results of the water quality and assimilative capacity analyses, pollutant load, in-lake analysis, and build-out analysis will be used to:

- **Formalize the water quality goal for Pleasant Lake.** The water quality goal will be established by the Pleasant Lake Watershed Advisory Committee with guidance provided by SNHPC, FBE, and DK Water Resources Consulting.
- **Generate pollution reduction estimates** required to meet the water quality goal using approved land use/load reduction models and manufacturers' specification sheets on BMP performance.

It is anticipated that the water quality analyses, assimilative capacity analysis, and pollutant loading analysis will be completed by September 2015. The in-lake analysis and build-out analysis will be completed by January 2016.

6-Historical Data Information

Data exist for the deep spot of Pleasant Lake from 1989 to present. According to NHDES VLAP reports, phosphorus, chlorophyll-a, and transparency have remained stable over the collection period. Elevated phosphorus in the hypolimnion indicates that internal loading may be a source of phosphorus. Several tributaries to Pleasant Lake have also been sampled, including Branch Brook, Clarks Brook, Farrelly Brook, Loon Cove, Philbrick Brook, Route 107 Inlet, Veasey Brook, and Wilsons Brook. Phosphorus and turbidity were elevated in Branch Brook, Clarks Brook, and Loon Cove following a rain event, suggesting that stormwater runoff is a significant issue in these subwatersheds.

Water quality data is collected by volunteers from the PLPA participating in VLAP. Water samples are transported to the DES Limnology Center where QA/QC protocols are followed for processing and analysis. The data is accepted and entered into the Environmental Monitoring Database (EMD) managed by NHDES.

7-Establishing Water Quality Goals

Potential pollution threats to water quality include stormwater runoff, development, recreation, septic systems, erosion, and land-use practices. The goal of this project is to protect surface waters in the watershed from these threats by developing a Watershed Restoration Plan that will establish in-lake and watershed load reduction goals for phosphorus.

A water quality goal for total phosphorus (TP) will be established for Pleasant Lake by the Advisory Committee. This will be based on the results of the water quality analysis conducted by DK Water Resources Consulting and FBE. The data will be divided into two categories – "historical" data greater than 10 years old, and "current" data collected within the last 10 years. The seasonal (May 15-October 15) median for the deep spot will be determined for both TP and Chl-*a*, then the median of the annual medians will be calculated for the lake.

The assimilative capacity of a waterbody describes the amount of pollutant that can be added to that waterbody without causing a violation of the water quality criteria. The water quality nutrient criterion for phosphorus has been set at 8 µg/L for an oligotrophic waterbody (High Quality Water). The NHDES requires 10% of the State standard to be kept in reserve; therefore phosphorus levels must remain below 7.2 µg/L to be in the Tier 2 High Quality Water category.

Assimilative Capacity (AC) for Total Phosphorus (TP)

- Total AC = (Water Quality Standard - 8µg/L TP) – (Best Possible WQ - 0 µg/L TP) = 8 µg/L TP
- Reserve assimilative capacity = Total AC – (0.10 x Total AC) = 7.2 µg/L TP
- Remaining assimilative capacity = 7.2 µg/L – Current Median TP

An analysis of a waterbody's assimilative capacity is used to determine the total assimilative capacity, the reserve assimilative capacity, and the remaining assimilative capacity of each water quality parameter being considered. This information is then used to determine water quality goals and actions necessary to achieve those goals. The assimilative capacity analysis is conducted in accordance with the Standard Operating Procedure for Assimilative Capacity Analysis for New Hampshire Waters.

Currently, Pleasant Lake is categorized as borderline Oligotrophic/Mesotrophic (NHDES, Environmental Monitoring Database). The process of establishing a water quality goal will be guided by the assimilative capacity analysis conducted by DK Water Resources Consulting and FBE. FBE will first determine whether the current median water quality of the lake is greater than the reserve assimilative capacity. If the median water quality value is greater than the reserve assimilative capacity (Tier 2 - exceeds standards), then the water quality goal will be considered based on the current median value and historic water quality data. If the median water quality value falls within the reserve capacity (Tier 1), then the water quality goal will be determined based on historical water quality and potential reductions needed to get water quality values back to the high quality range. Once the initial calculations have been completed and reviewed by FBE and DK Water Resource Consulting, the Advisory Committee will help finalize the water quality goals.

8-Loading Models

A. Watershed Phosphorus Loading

The Lake Loading Response Model (LLRM; version "*Lake Loading Response Model_LLRM_ver2010*") (also called SHEDMOD or ENSR-LRM) will be used to assess current nutrient loads from the watershed, and the load reductions that would result from the implementation of best management practices (BMPs). This model was developed by AECOM for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land use, total phosphorus (TP) export coefficients, and adding septic system loading into the model (AECOM, 2009). This model provides the best fit for the Pleasant Lake watershed, and has been used extensively for more than 30 recent lake TMDLs in New Hampshire. A recently completed (and NHDES-approved) LLRM model version, such as the one used in Moultonborough Bay Inlet in 2015, will be used as the starting point. The LLRM User Guide contained in the *Total Maximum Daily Load for Robinson Pond, Hudson, NH* (AECOM and NHDES, 2011) will serve as the primary documentation on the model.

Data needed for input to the LLRM includes water quality monitoring data (TP, Chl-*a*, and transparency); physical characteristics, such as lake surface area, volume, and flushing rate; tributary monitoring data, including discharge;

corrected land use data; sub-watershed land area delineations; precipitation data; and septic system data (typically available from the US Census Bureau). Weather data will be downloaded from the National Oceanic and Atmospheric Association (NOAA) National Climate Data Center (NCDC). Tributary discharge data will be used, where available, from USGS gauging stations in the watershed. Sub-watershed land area will be delineated using the most current data possible. In the absence of data that meet project standards for completeness and validity, LLRM default values will be used, pending approval by the Advisory Committee.

Geographical Information Systems (GIS) data will be obtained by FBE to assist with the land-use assessment and to delineate land use area by land use type (in acres) for input to the LLRM. GIS land use data are available from the State of New Hampshire GIS website (GRANIT). The NH Land Cover Assessment 2001 or NHLC01, consists of the most recent and detailed classification of land cover in New Hampshire based on satellite images acquired between 1990 and 1999, with further revisions in 2001 (GRANIT). These data will be used for the land-use loading analysis as described below in the section titled *Future Loading Model/Build-Out Analysis*. GIS land-use coverages will be ground-truthed by FBE based on field observations, stakeholder input, and publicly-available, recent aerial photography to ensure the best coverages for input to the model.

Laura Diemer of FBE will run the model. FBE staff have used watershed loading models for several years, and have successfully applied results from LLRM, AVGWLF, PREDICT, and the USEPA Region 5 Models to many watershed plans. FBE Senior Project Manager, Jennifer Jespersen, and DK Water Resources Consulting Principal, Don Kretchmer, will serve as Task Managers on the project, and will provide technical oversight and confirm that the information used for the model is correct. NHDES will provide technical assistance and review of modeling methods and results. Laura will make edits to the model based on feedback from Jennifer Jespersen, Don Kretchmer, NHDES, and the Advisory Committee members.

B. In-Lake Total Phosphorus Concentrations

Results of the watershed TP modeling will be input to a series of empirical models that provide predictions of in-lake TP concentrations, Chl-*a* concentrations, algal bloom frequency, and water clarity. Also referred to as TP retention modeling, the model estimates in-lake P concentrations based on physical and chemical lake characteristics including lake volume, mean depth, watershed area, flushing rate, and estimated watershed P loading. Because of the imperfect nature of any model to predict processes within natural systems, the model will compare six different in-lake P models including: Kirchner-Dillon (1975), Vollenweider (1975), Larsen-Mercier (1976), Jones-Bachman (1976), Reckhow General (1977), and Nürnberg (1998). The average of the six empirical models will be used as the predicted TP value for each of the lakes with some exceptions (it may be determined that one of the models is most representative, or a model could be eliminated as inapplicable, which will be documented both in the model spreadsheet and in all applicable reports). The predicted in-lake TP concentration will be compared to actual in-lake water quality data analysis (discussed above). Additional predictions (Chl-*a*, water clarity, and bloom probability) will be determined based on the median in-lake TP concentration.

C. Future Loading Model/Build-Out Analysis

FBE will conduct a buildout analysis to analyze the effects of predicted future watershed development on the water quality of Pleasant Lake. The buildout analysis uses GIS-based zoning data and CommunityViz® software to estimate future development within the watershed. The analysis will combine projected population estimates, current zoning restrictions, and a host of additional development constraints (e.g. conservation lands, steep slopes, wetlands, existing buildings, soils with development suitability, unbuildable parcels, etc.) to determine the extent of buildable area in the watershed. Future P loading will be estimated under full or partial buildout (depending on the timeline of full buildout) and an assessment of the potential effects of future development as it relates to water quality goals.

Kevin Ryan will conduct the buildout analysis. Kevin is proficient in the use of CommunityViz®, having used it for several similar watershed-based planning projects. Task Manager, Jennifer Jespersen, will provide QA/QC of the buildout data inputs and results of the analysis. This model has been used effectively for previous watershed management plans, including Province Lake and the Salmon Falls Headwaters Lakes.

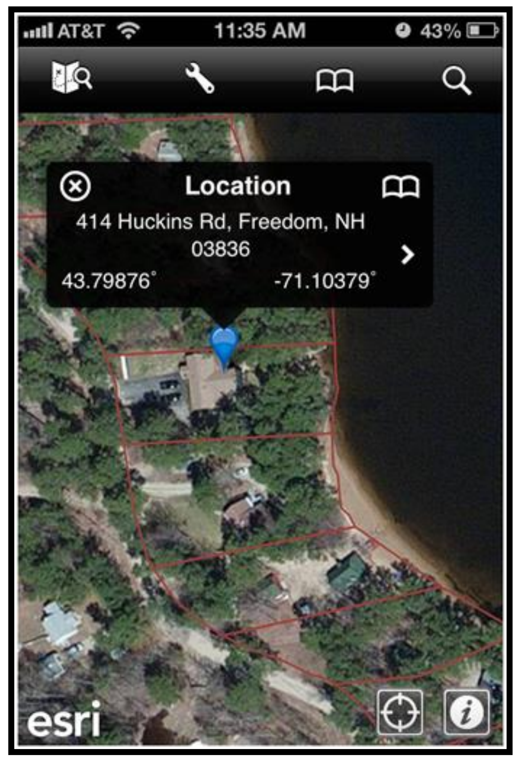
D. Shoreline Survey and Stormwater Impact Assessments

FBE, in collaboration with SNHPC, will work with local volunteers to conduct an assessment of watershed properties adjacent to water resources within the watershed to determine potential water quality impacts from stormwater and septic systems. The assessment will include two components: 1) a shoreline survey, and 2) a windshield survey of the watershed.

Shoreline Survey

To help characterize the effects of shoreline development (including septic systems), and to assist stakeholders with targeting and implementing shoreline best management practices (BMPs), shoreline development will be evaluated and assigned an NPS pollution impact rating. Best professional judgment will be used to establish subjective determinations of potential impact ratings. The visual survey includes a residential dwelling tally, along with rating estimates for potential NPS pollution impacts based on the presence or absence of vegetated buffers, distance of dwelling from shoreline, shoreline erosion, presence of exposed soil, and percent slope of the lot (see field sheet in Appendix A). In addition to the impact rating, shoreline surveyors will estimate the residency status of the dwelling (seasonal vs. year-round) and other notable features, such as retaining walls or private boat launches.

To perform the shoreline survey, developed properties within 100 feet of the lakes will be identified by FBE using GIS. Properties will be evaluated by boat, approximately 50 feet from the shore. Properties will be identified through the use of the Esri® ArcGIS® smartphone app, which will allow surveyors to determine their current position in relation to lakeshore properties using aerial imagery, parcel boundary GIS data, and real-time GPS positioning. Paper maps of lakeshores and parcel boundaries will be created as a secondary method of determining the location of individual parcels adjacent to water resources. The survey is expected to take place in October 2015.



Screen capture of Esri® ArcGIS® smartphone application, showing current aerial imagery, parcel boundaries (red lines), and street addresses of homes. In the field, the GPS location of the phone is also included in the display.

BMP Survey

While the shoreline survey will focus on developed land along the lake shoreline, the stormwater survey will document sources of NPS pollution throughout the rest of the watershed. This BMP survey will be performed by car, and include a checklist documenting sources of NPS pollution including, but not limited to, roadside runoff to tributaries, direct runoff to lakes, runoff from development, conversion of seasonal to year-round residences, use of fertilizers, gravel excavation, erosion from poorly-buffered properties, and runoff from parking lots adjacent to tributaries (Appendix B). The survey will focus on developed land outside of the immediate shoreline with an emphasis on properties within 75 feet of streams, stream crossings, and other sensitive environmental areas. The survey is expected to take place in May or October of 2015. Technical leaders from FBE will team up with volunteers to conduct the survey.

E. Pollutant Load Reduction Estimates

The "Simple Method" load reduction model will be used to calculate load reduction estimates for areas of the watershed that are shown to contribute substantial amounts of phosphorus to Pleasant Lake. The Simple Method is an established empirical model that estimates nutrient or pollutant export amount from watershed sites based on drainage area, precipitation patterns, land use, and known concentrations of pollutants. This method has been used many times by FBE for Watershed Management Plans. It is described in detail by the Minnesota Pollution Control Agency[1].

[1] Minnesota Pollution Control Agency, *Minnesota Stormwater Manual.* "The Simple Method for estimating phosphorus export," accessed December 20, 2013. http://stormwater.pca.state.mn.us/index.php/The_Simple_Method_for_estimating_phosphorus_export

Load reduction estimates will be calculated by Laura Diemer of FBE and reviewed by project staff for completeness and rationality. Data will be evaluated using the best professional judgment of qualified staff and comparisons to load reduction estimates generated from similar watershed analyses in New Hampshire. FBE Task Manager, Jennifer Jespersen, will evaluate all loading estimates for the purpose of QA/QC.

The Advisory Committee will identify and prioritize areas of the watershed to install pollutant runoff controls using Best Management Practices (BMPs) based on the results of the load reduction estimate analysis. FBE will estimate load reductions for approximately 50 of the identified BMPs. BMPs will be prioritized based on specific load reduction estimates to identify the top priority BMPs. FBE will provide recommendations for a post-BMP monitoring program to confirm that the desired BMPs are achieving the desired pollutant removal. These estimates will guide future implementation efforts in the watershed to help reduce phosphorus levels in Pleasant Lake. Any observations, trends, conclusions, and limitations in the data will be documented by FBE in the final report and reported to the Advisory Committee.

9-Quality Objectives and Criteria

The utility of model outputs, and the confidence in decisions made based on those outputs, are only as strong as the data used to build and calculate the model. FBE will make certain that all data used to inform model outputs have gone through careful QA/QC analyses. The bulk of water quality and GIS data used in this project will be obtained through NHDES, and will therefore have been through a screening process for quality assurance and completeness.

Water quality data will be obtained from NHDES OneStop. The historical water quality data for Pleasant Lake has been collected by volunteers participating in the NHDES VLAP program. Each season's data is reviewed by personnel with the NHDES Limnology Center to ensure QA/QC protocols have been met before it is transferred for acceptance into the Environmental Monitoring Database (EMD) managed by NHDES.

GIS spatial data will be obtained by FBE for the LLRM. GIS land-use data will be obtained from the State of New Hampshire GIS website (GRANIT). The NH Land Cover Assessment 2001 (or NHLC01) consists of the most recent and detailed classification of land cover in New Hampshire based on satellite images acquired between 1990 and 1999, with further revisions in 2001 (GRANIT). GIS land use data will be ground-truthed by FBE based on field observations and publicly-available recent aerial photography to ensure the most accurate land use information is used for input to the models.

10-Quality Control

Quality control checks will be performed by FBE Task Manager, Jennifer Jespersen, to ensure that information collected for the project is accurately entered into spreadsheets. QA/QC checks will be conducted on all spreadsheets for inconsistencies. If errors are identified, FBE Project Manager, Forrest Bell, will review the input values, identify and correct the error to ensure that no incorrect information is used in any model calculation. In addition, FBE Task Manager, Jennifer Jespersen, will review all model inputs, calculations, and outputs for the purpose of QA/QC. All QA/QC issues identified will be properly documented, along with the appropriate steps taken to resolve the issues.

11-Final Products and Reporting/Schedule

The following deliverables will be provided to NHDES by the Project Manager, John Munn, during the project period:

- Summary of Water Quality Data and Assimilative Capacity Analysis – **July 2015**
- Documentation of methods used to establish and justify water quality goal. – **September 2015**
- Final LLRM report, buildout analysis report, and associated PowerPoint presentations that detail current and future pollution source loads by land use type for each sub-watershed. – **September 2015 - January 2016**

- Final watershed assessment report and a prioritized matrix spreadsheet that contains pollutant load reduction and preliminary cost estimates for at least 50 BMP sites identified in the shoreline and windshield surveys. – **January 2016**
- Draft and final watershed restoration plan with a prioritized watershed action plan, list of measurable milestones, and criteria for measuring progress. – **July 2016**

Semi-annual reports documenting all work performed on the project at the appropriate intervals throughout the duration of the project will be submitted to NHDES by the Project Manager, John Munn, as required in the contract. The semi-annual reports shall comply with the NHDES and EPA requirements found in the semi-annual report guidance document provided to grant recipients by NHDES. A comprehensive final report in both electronic and hard-copy will be submitted to NHDES on or before the project completion date by the Project Manager, John Munn. The final report shall include a description of all tasks completed and shall comply with the NHDES and EPA requirements found in the final report guidance document provided to grant recipients by NHDES.

ATTACHMENT 1

Lake Shoreline Condition Assessment

Lake: **Pleasant Lake**

Date: ________________

Key:	
Shoreline:	B=Beach, R = Riprap/Retaining Wall, N = Natural, D = Mostly or all docks, L = Mostly Lawn, T = Trees, P = Plants, ST = Some trees
Buffer:	1 = Excellent Buffer (all natural vegetation - trees of mixed sizes and shrubs), 2 = Good (some trees and shrubs, some bare areas); 3= Moderate (a few small trees/shrubs,some lawn); 4= Minimal (mostly lawn, some shrubs); 5= No Buffer (all lawn/bare)
Bare Soil:	1=No exposed Soil, 2= minimal exposed Soil, 3= Fair amount of exposed soil,4=Large amounts of exposed soil
Shoreline Erosion:	1=No Erosion Visible, 2=Some Erosion Visible, 3=Moderate to Severe shoreline erosion
Distance:	1 = more than 150', 2 = 75 - 150', 3 = house/camp less than 75' from shore
Slope:	1=Little to no slope (3 - 8%), 2=Moderate Slope (8 - 20%), 3=Steeply sloped (>20%)
Total	Total of all columns (Buffer → Slope)

ID#	Town - Map# - Lot# *or brief description*	S	YR	No Structure	Shoreline - B, R, N, D, L, T, P, ST	Buffer (1 - 5)	Bare Soil (1 - 4)	Shoreline Erosion (1 - 3)	Distance (1 - 3)	Slope (1 - 3)	Total	Photo?	Comments
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
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19													
20													

ATTACHMENT 2

2015 Pleasant Lake Stormwater Survey

Sector & Site ______________ Date________________ Surveyor Initials ________________________
Location *(house #, road, utility pole #)* ____
Building Color _______________________ Landowner Name ____
Tax Map & Lot _______________________ Talked to Landowner? ❒ No ❒ Yes ________________________

- **GPS Coordinates in UTM 83:** ☐ ☐ ☐ ☐ ☐ ☐ ☐
- ***(in NAD83 or WGS84)*** ☐ ☐ ☐ ☐ ☐ ☐ ☐

Photo #'s:

Direct Flow to (check ONE): ❒ Lake ❒ Stream ❒ Ditch ❒ Vegetation

Land Use/Activity Circle ONE	**Description of Problems** Circle ALL that apply	
• State Road Town Road Private Road Driveway • Residential Commercial Municipal / Public Beach Access Boat Access Trail or Path Logging Agriculture • Construction Site • Gravel Operation **OTHER:** Conversion from Seasonal-Yr Round	**Surface Erosion** • Slight Moderate • *Severe* • ***Culvert*** Unstable Inlet / Outlet Clogged Crushed / Broken Undersized **Ditch** • Slight Erosion *Moderate Erosion* Severe Erosion Bank Failure Undersized **Road Shoulder Erosion** • Slight Moderate Severe **Roadside Plow/Grader Berm**	• ***Soil*** Bare Uncovered Pile Delta in Stream/Lake Winter Sand *Roof Runoff Erosion* Roof Gutter **Shoreline** ***Undercut*** Lack of Shoreline Vegetation Inadequate Shoreline Vegetation Erosion Unstable Access Artificially Created Beach **Agriculture** Livestock Access to Waterbody Tilled Eroding Fields Manure Washing off Site • ***OTHER:*** Fertilizers

Size of Area Exposed or Eroded (length & width): ______________________________

Recommendations		
Culvert *Armor Inlet/Outlet* Remove Clog Replace Enlarge Lengthen Install Plunge Pool • • ***Ditch*** *Vegetate* Armor with Stone Reshape Ditch Install Turnouts Install Ditch Install Check Dams Install Sediment Pools **Other:**	**Roads / Driveways** Remove Grader/Plow Berms Build Up Add New Surface Material • Gravel • Recycled Asphalt • Pave Reshape (Crown) Grade Vegetate Shoulder Install Catch Basin Install Detention Basin Install Runoff Diverters • Broad-based Dip • Open Top Culvert • Rubber Razor • Waterbar • • ***Construction Site*** Mulch Silt Fence / EC Berms Seed / Hay Check Dams	• ***Paths & Trails*** Define Foot Path Stabilize Foot Path Infiltration Steps Install Runoff Diverter (waterbar) • • ***Roof Runoff*** Infiltration Trench @ roof dripline Drywell @ gutter downspout Rain Barrel **Other** Install Runoff Diverter (waterbar) Mulch/Erosion Control Mix Rain Garden Infiltration Trench Water Retention Swales **Vegetation** Establish Buffer Add to Buffer No Raking Reseed bare soil & thinning grass

Impact: *Consider size of site, slope, amount of soil eroded, proximity to water*

High:	*Large area with significant erosion and direct flow to water*
Medium:	*Sediment transported off site but does not reach high magnitude*
Low:	*Limited transport of soil off site, small site with no evidence of rills or gullies*

Cost of Materials	***Cost of Labor***	***Definition of Cost***
High	*High*	*Greater than $2,500*
Medium	*Medium*	*$500-$2,500*
Low	Low	Less than $500

Septic Survey Completed? ❒ No ❒ Yes ____

Mail–in Septic Survey left at house? ❒ No ❒ Yes ______________________________________

APPENDIX D: BMP MATRIX

Site	Location	Issues	Recommendations	Sediment (t/yr)	Phosphorus (kg/yr)	Nitrogen (lbs/yr)	BMP Cost Estimate	BMP Annual Maintenance Cost Estimate	10-yr Cost
13	Intersection of Broad Cove Rd and Sellar Rd	Moderate road shoulder erosion	Vegetate ditch; install turnouts; vegetate shoulder	6.3	2.4	10.6	$1,260.00	$100.00	$2,260.00
3	Gulf Road - Boat Access to Dam	Severe road shoulder erosion	Add 0.068 acres (2962.1 sq ft) of grass pavers on the lakeside of the dam to reduce runoff. Add one deep sump catch basin.	2.8	1.0	4.7	$3,000.00	$25.00	$3,250.00
14	#3 Willow Lane	Moderate road shoulder erosion	Install check dams; compost box	2.3	0.9	3.9	$1,000.00	$50.00	$1,500.00
15	Willow Ln Stream Crossing	Unstable inlet/outlet at culvert; crushed/broken culvert (collapsed headwall)	Armor inlet/outlet of culvert	0.4	0.7	7.3	$800.00	$100.00	$1,800.00
9	Gulf Road - across from posted dirt access road	Shoreline erosion	Establish buffer	2.2	0.9	3.8	$1,080.00	$50.00	$1,580.00
10	Gulf Road	Inadequate shoreline vegetation; shoreline erosion	Establish buffer	1.5	0.6	2.5	$720.00	$50.00	$1,220.00
2	Gulf Road (Hill to Boat Launch)	Severe road shoulder erosion	Install 6 deep sump catch basins 331 ft of perforated pipe down the hillslope. Create vegetation swales on either side of Gulf Rd with check dams. leading down the hillslpe (966 ft). Add three bioretention systems.	14.4	5.5	24.5	$30,000.00	$500.00	$35,000.00
11	Gulf Road	Lack of shoreline vegetation	Establish buffer	1.5	0.6	2.5	$1,080.00	$50.00	$1,580.00
7	Gulf Road Pole #9	Slight road shoulder erosion; inadequate shoreline vegetation	Establish vegetated buffer	0.6	0.2	1	$648.00	$50.00	$1,148.00
1	Fish & Game Boat Access Parking Lot	Moderate Surface Erosion	Reconstruct apron in parking lot to direct runoff to existing swale (two bit. Conc. Aprons).	3	1.2	5.1	$10,000.00	$500.00	$15,000.00
8	19 Gulf Road	Slight road shoulder erosion	Stabilize foot path; establish buffer	0.1	0.0	0.1	$270.00	$25.00	$520.00
6	Deerfield/Northfield Town Line	Slight road shoulder erosion	Stabilize foot path; establish buffer	0.1	0.0	0.1	$270.00	$25.00	$520.00
5	14A Gulf Road	Slight road shoulder erosion	Stabilize foot path; establish buffer	0.1	0.0	0.2	$270.00	$25.00	$520.00
12	Gulf Road	Slight road shoulder erosion	Establish buffer	0.1	0.0	0.1	$480.00	$50.00	$980.00
4	Gulf Road Boat Launch	**Decided not to put any BMPs on this site - BMP's from Gulf Road and Boat**							
			TOTAL	**35.4**	**14.2**	**66.4**	**$50,878.00**	**$1,600.00**	**$66,878.00**

APPENDIX E: SHORELINE SURVEY RESULTS

Summary of disturbance scores for high and medium impact shoreline parcels (shoreline disturbance score > 10) identified during the 2015 shoreline survey by volunteers. B=Beach, R = Riprap/Retaining Wall, N = Natural, D = Mostly or all docks, L = Mostly Lawn, T = Trees, P = Plants, ST = Some trees

ID#	Town - Map# - Lot#	Shoreline	Buffer (1 - 5)	Bare Soil (1 - 4)	Shoreline Erosion (1 - 3)	Setback (1 - 3)	Slope (1 - 3)	Total
6	207-4		4	3	2	2	3	14
17	207-17		5	4	1	3	1	14
3	118-26	D,B	4	4	2	3	1	14
15	118-14	D,B	5	4	1	3	1	14
18	118-11	R	4	4	1	2	3	14
3	119-21	B,D	5	4	1	3	1	14
5	207-71	D,B	4	4	1	3	2	14
1	207-50	D,R	5	3	1	3	2	14
7	207-39		4	3	1	3	2	13
11	114-8	T,P	4	3	1	2	3	13
11	118-18	D	3	4	1	3	2	13
16	118-13	D,B	4	4	1	1	3	13
11	119-13	D	4	4	1	3	1	13
1	119-6	D,B	4	4	1	2	2	13
6	121-14	R	4	4	1	3	1	13
6	207-70	D	4	3	1	3	2	13
7	207-5		4	1	1	3	3	12
1	204-41	P,T	3	3	1	3	2	12
12	205-69		4	2	1	3	2	12
14	205-71		5	1	1	3	2	12
20	206-5		5	2	1	3	1	12
2	206-7		4	2	1	3	2	12
7	206-14		5	1	1	3	2	12
13	206-25		5	1	1	3	2	12
15	206-28		3	3	1	3	2	12
16	206-29		3	3	1	3	2	12
17	206-30		4	2	1	3	2	12
5	207-32		4	3	2	1	2	12
16	114-1	D	3	2	1	3	3	12
17	115-1	R,D	4	3	1	3	1	12
1	118-31	R,D	5	2	1	3	1	12
2	118-30	D,B	4	3	1	3	1	12
6	118-23	D	3	2	2	3	2	12
17	118-12	D,B	3	4	1	2	2	12
2	119-22	D,B	4	3	1	3	1	12
5	119-20	R	5	3	1	1	2	12
12	119-12	D,B	4	3	1	3	1	12
7	121-13	R	4	3	1	3	1	12
9	121-11	D	3	3	1	3	2	12
12	121-8	D	3	3	1	3	2	12
19	121-1	D	4	4	1	2	1	12
1	240-7	D,B	3	4	1	2	2	12
11	207-60	D	3	3	1	3	2	12
12	207-59	D	3	3	1	3	2	12
15	207-56	D	4	3	1	2	2	12
17	207-54	D	3	3	1	3	2	12
19	207-52	D,R	3	3	1	3	2	12
20	207-51	R	3	3	1	3	2	12
12	207-11		4	2	1	2	2	11
19	207-19		4	1	1	3	2	11
4	204-44		4	2	1	2	2	11
5	204-45		3	2	1	3	2	11
11	205-68		4	2	1	2	2	11

ID#	Town - Map# - Lot#	Shoreline	Buffer (1 - 5)	Bare Soil (1 - 4)	Shoreline Erosion (1 - 3)	Setback (1 - 3)	Slope (1 - 3)	Total
13	205-70		3	2	1	3	2	11
17	205-76		4	3	1	1	2	11
1	206-6		3	2	1	3	2	11
8	206-16		4	2	1	2	2	11
9	206-18		4	3	1	1	2	11
10	206-17		4	2	1	2	2	11
10	207-42		5	1	1	3	1	11
11	207-43		5	1	1	3	1	11
1	204-31	D/ROAD	5	3	2	NA	1	11
18	118-37	D,B	3	2	1	3	2	11
7	118-22	D	3	2	1	3	2	11
19	118-10	D	3	3	1	2	2	11
1	119-23	D	3	4	1	2	1	11
4	119-19	B,D	3	3	1	2	2	11
9	119-15	D,B,R	3	3	1	3	1	11
10	119-14	D	4	2	1	3	1	11
14	119-10	D,B,R	4	3	1	2	1	11
15	119-9	B,R	4	3	1	2	1	11
16	119-8	B,R	4	3	1	2	1	11
17	119-7	B	4	3	1	2	1	11
18	120-16	B	4	3	1	2	1	11
19	120-17	B	4	3	1	2	1	11
20	120-15	B	4	3	1	2	1	11
2	119-5	B	3	4	1	1	2	11
4	121-16	B	3	4	1	1	2	11
10	121-10	R,D	3	3	1	3	1	11
11	121-9	R,D	3	3	1	3	1	11
20	240-8	D	4	3	1	2	1	11
8	207-63	D	3	3	1	2	2	11
13	207-58	D	3	3	1	2	2	11
16	207-55	D	3	3	1	3	1	11
2	207-48	D	3	3	1	3	1	11
2	204-32	R,B	5	3	2	NA	1	11
15	207-15		3	2	1	3	1	10
16	207-16		4	2	1	2	1	10
20	207-20		3	2	1	2	2	10
6	205-55		3	2	1	2	2	10
7	205-56		3	1	1	3	2	10
8	205-57		4	1	1	2	2	10
9	205-66		3	2	1	3	1	10
10	205-67		4	2	1	2	1	10
15	205-72		3	1	1	3	2	10
16	205-73		4	1	1	2	2	10
19	206-4		3	1	1	3	2	10
3	206-8		3	1	1	3	2	10
5	206-13		3	1	1	3	2	10
6	205-79		4	2	1	1	2	10
14	206-26		3	1	1	3	2	10
20	206-33		2	1	2	2	3	10
1	207-21		3	2	1	2	2	10
2	207-28		3	1	1	3	2	10
8	207-40		3	2	1	3	1	10
12	207-44		3	2	1	3	1	10
14	207-46		4	2	1	1	2	10
9	114-6	D	3	3	1	2	1	10
14	114-3	D	3	2	1	3	1	10
15	114-2	P	3	2	1	3	1	10
19	118-36	D	3	2	1	3	1	10
20	118-35	D,R	3	2	1	3	1	10
	118-33	D	3	2	1	3	1	10

ID#	Town - Map# - Lot#	Shoreline	Buffer (1 - 5)	Bare Soil (1 - 4)	Shoreline Erosion (1 - 3)	Setback (1 - 3)	Slope (1 - 3)	Total
4	118-25	D	2	2	2	1	3	10
8	118-21	D,B,R	2	2	1	3	2	10
9	118-20	R,D,B	3	1	1	3	2	10
10	118-19	D	3	2	1	3	1	10
6	119-18	D	2	3	1	3	1	10
7	119-17	T,D	2	2	1	3	2	10
13	119-11	D,B	5	2	1	1	1	10
5	121-15	R	3	2	1	3	1	10
15	121-5	D,R	3	2	1	3	1	10
16	121-4	D,R	3	2	1	3	1	10
18	121-2	D	3	2	1	3	1	10
2	207-75	B	3	3	1	1	2	10
9	207-62	D	3	2	1	3	1	10
10	207-61	D	2	2	1	3	2	10
14	207-57	D	2	3	1	2	2	10
18	207-53	D	2	3	1	3	1	10
3	207-47	D	4	2	1	1	2	10
6	204-36	D	3	2	1	3	1	10
7	204-37	D	3	2	1	3	1	10
1	206-34		2	1	1	3	2	9
5	207-3		2	1	1	3	2	9
8	207-6		2	1	1	2	3	9
9	207-7		2	1	1	3	2	9
10	207-8		2	1	1	3	2	9
11	207-9		3	1	1	2	2	9
14	207-14		3	1	1	3	1	9
3	204-43		2	1	1	3	2	9
18	206-3		3	1	1	3	1	9
11	206-23		3	1	1	2	2	9
18	206-31		2	2	1	2	2	9
3	207-30		4	1	1	1	2	9
4	207-31		3	?	1	3	2	9
9	207-41		3	1	1	3	1	9
4	204-34	ST	3	2	1	2	1	9
5	118-24	D	2	2	2	1	2	9
12	118-17	D	2	2	1	2	2	9
13	118-16	D	2	2	1	2	2	9
14	121-6	D,R	2	2	1	3	1	9
17	121-3	D,R	2	2	1	3	1	9
3	207-73	T	2	2	1	2	2	9
10	114-7	D	3	2	1	2	1	9
13	207-12		3	1	1	1	2	8
18	207-18		2	2	1	2	1	8
2	204-42	P,T	2	1	1	2	2	8
4	206-9		3	1	1	1	2	8
12	206-24		3	1	1	2	1	8
19	206-32		2	1	1	2	2	8
6	207-38		2	1	1	3	1	8
13	207-45		3	1	1	1	2	8
13	114-4	D	2	1	1	3	1	8
14	118-15	D,B	2	2	1	2	1	8
20	119-24	D	2	2	1	1	2	8
	119-4	B	3	2	1	1	1	8
3	119-3	D	2	2	1	1	2	8
8	121-12	D	2	1	1	3	1	8
4	207-72	B,D	2	3	1	1	1	8
7	207-69	D,B	2	1	1	3	1	8
5	204-35	B, ST	3	2	1	NA	1	7
8	119-16	D	2	1	1	2	1	7
3	204-33	ST	3	2	1	NA	1	7

ID#	Town - Map# - Lot#	Shoreline	Buffer (1 - 5)	Bare Soil (1 - 4)	Shoreline Erosion (1 - 3)	Setback (1 - 3)	Slope (1 - 3)	Total
8	204-38	D, ST	3	2	1	NA	1	7
2	206-35		1	1	1	1	2	6
3	207-1		1	1	1	1	2	6
4	207-2		1	1	1	1	2	6
12	114-5	T,P	1	1	1	1	1	5
13	121-7	D,R	1	1	1	1	1	5