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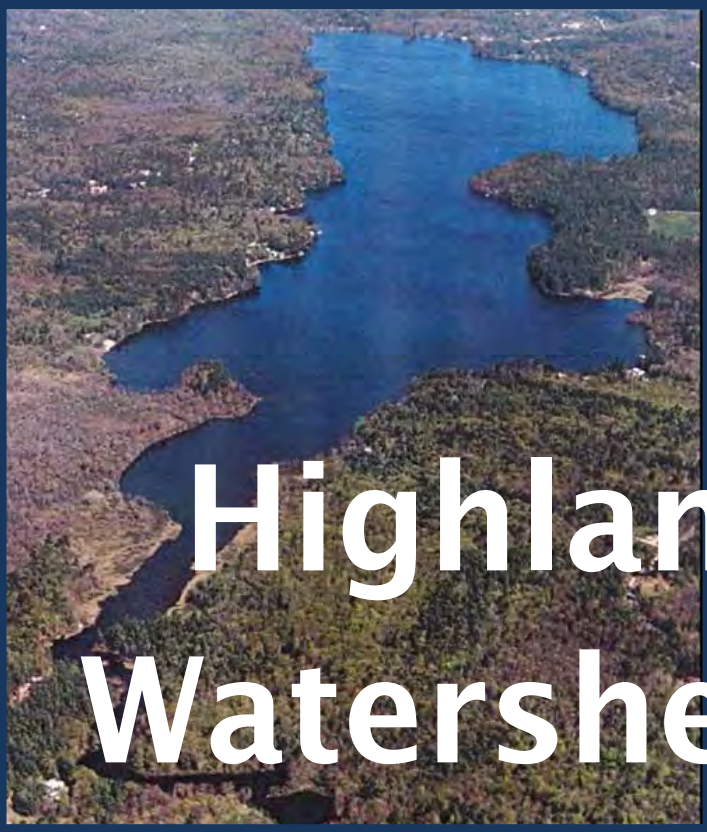
Assist and educate the public to promote stewardship of soil & water resources.



Highland Lake Watershed-Based Management Plan

2020-2030

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EOE

Acknowledgments

Funding for this Plan was provided in part by the U.S. Environmental Protection Agency under Section 604b of the Clean Water Act and administered by the Maine Department of Environmental Protection (MDEP). The 604b projects funding this Plan were grant projects #20180008 the *Highland Lake Watershed-Based Management Plan Project* and #2017PT16 *Highland Lake Watershed Assessment Project* both managed by the Cumberland County Soil and Water Conservation District. Additional funding was provided by the Towns of Falmouth and Windham with in-kind support from Highland Lake Association and watershed residents.

This Plan was developed by members of Highland Lake Leadership Team's (HLLT) Watershed Management Committee also referred to as the Plan's Technical Advisory Committee. Members of this Committee include:

Cumberland County Soil and Water Conservation District (CCSWCD)
- Heather Huntt, 604b Grant Project Coordinator
- Christopher Brewer, Interim 604b Grant Project Coordinator

Highland Lake Association (HLA)
- Kim White, HLA Vice Present and HLLT Co-Chair
- Rosie Hartzler, HLA President and HLLT Board Member

Maine Department of Environmental Protection (MDEP)
- Jeff Dennis, Biologist
- Wendy Garland, Interim 604b Grant Project Agreement Administrator
- Amanda Pratt, 604b Grant Project Agreement Administrator

Town of Falmouth
- Kimberly Darling, HLLT Board Member

Town of Windham
- Gretchen Anderson, HLLT Staff Representative and HLA Board Member

This Plan will be implemented under the direction of HLLT. Current members include:
- Dennis Brown, HLA President, HLLT Chair
- Rebecca Cummings, Windham Town Councilor
- Kimberly Darling, Falmouth Energy and Sustainability Coordinator
- Rosie Hartzler, HLA Vice President
- Nancy Lightbody, Falmouth Conservation Commission, HLLT Co-Vice Chair
- John MacKinnon, HLA Board Member
- Tom Peterson, Windham Resident
- Nathan Poore, Falmouth Town Manager
- Barry Tibbetts, Interim Windham Town Manager
- Tom Verlee, HLA Board Member, HLLT Member
- Kim White, HLA Vice President, HLLT Co-Vice Chair

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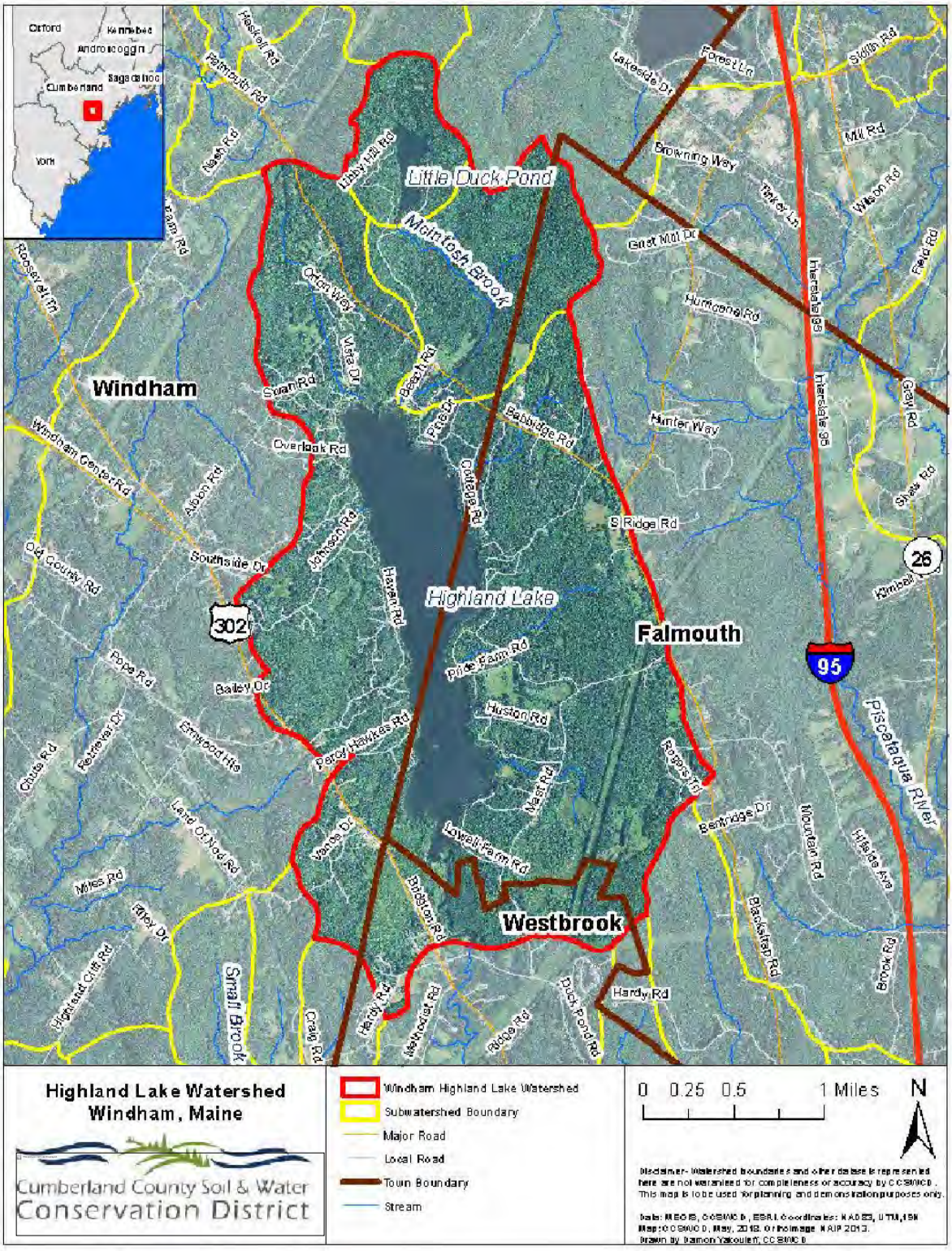


Figure 1. Highland Lake Watershed Map

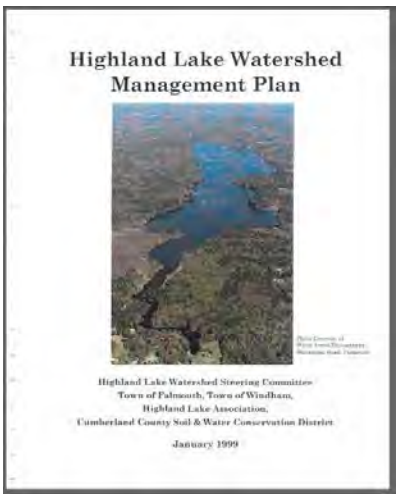
Summary

Concerned Landowners at the 2018 Highland Lake Association

The development of this Plan was initiated due to serious water quality concerns following a picocyanobacterial (*Cyanobium*) bloom first noticed in 2014 on Highland Lake, a 623-acre lake (8.5 square mile watershed) located in the towns of Falmouth, Westbrook, and Windham (**Figure 1**). These yearly summer (late July to early August) picocyanobacterial blooms are the only blooms of their kind known be occurring in New England. As a lake once listed by the Maine Department of Environmental Protection (MDEP) as impaired and having experienced over two decades of extensive remediation efforts to be removed from the impairment list in 2010, the picocyanobacterial blooms are of great concern as they indicate a decline in water quality and the threat of the lake becoming relisted. An impaired relisting would make Highland Lake the only lake in greater Portland and Cumberland County to be listed as such.

As of this writing, the cause(s) of the picocyanobacterial blooms remain unknown, and many hypotheses are being explored. It is known that Highland Lake's phosphorus levels have been increasing in recent years. Phosphorus is an energy source to picocyanobacteria and other algae and can lead to lower water clarity and dissolved oxygen. Therefore, regardless the specific cause(s) of the picocyanobacterial blooms, actions should be taken now to reduce phosphorus entering Highland Lake.

This Plan serves as a dynamic guidance document to reduce phosphorus loading into Highland Lake over the next 10 years (2020-2030) to allow the lake to maintain its Class GPA water quality status. Specific action items to accomplish this goal are listed in **Appendix A: 2020 Highland Lake Action Items.** The Plan is an update to the *1999 Highland Lake Watershed Management Plan* and the *2003 Phosphorus Control Action Plan and TMDL*. This Plan was written by Cumberland County Soil and Water Conservation District (CCSWCD) with guidance from a Technical Advisory Committee consisting of members from the Highland Lake Leadership Team's (HLLT) Watershed Management Committee and with input received from the public. In compiling this Plan, all suspected sources of phosphorus input into Highland Lake were reviewed and explored with the primary sources having been documented through the 2018 Highland Lake Watershed Survey. Funding for this Plan was provided in part by the U.S. Environmental Protection Agency under Section 604b of the Clean Water Act and administered by the MDEP. Additional funding was provided by the Towns of Falmouth and Windham with in-kind support from Highland Lake Association and watershed residents. This Plan will be implemented under the direction of HLLT.



1999 Highland Lake Watershed Management Plan

Incorporating EPA's 9-Elements

The U.S. Environmental Protection Agency (EPA) lists 9 elements needed in improving water quality and required to be addressed when compiling an EPA-approved watershed-based management plan. The 9 elements, and where they are addressed in this Plan are listed below. For more information on EPA's 9 elements, please refer to their "Handbook for Developing Watershed Plans to Restore and Protect Our Waters".

1. Identification of causes that will need to be controlled to achieve the load reductions described in (2.)
    - Section 5.A. Identifying Sources of Phosphorus starting on page 14
    - Table 1. Potential Sources of Phosphorus Loading on page 16
2. Estimates of load reductions expected for the management measures described in (3.)
    - Section 5.B. Phosphorus Loading Estimates on page 18
3. Description of management measures that will need to be implemented to achieve load reductions described in (2.)
    - Section 6B. Objectives and Management Measures starting on page 21
    - Appendix A. Highland Lake Action Items
4. Estimate of technical and financial assistance needed and/or the sources and authorities that will be relied upon to implement this plan.
    - Section 10. Oversight, Roles and Responsibilities on page 29
    - Section 11. Funding on page 30
    - Appendix A. Highland Lake Action Items
5. Information/education component that will be used to enhance public understanding of this plan
    - Section 9 Education and Outreach
    - Appendix A. Highland Lake Action Items (#5)
6. Schedule for implementing management measures described in (3.)
    - Section 7. Schedule on page 25
    - Appendix A. Highland Lake Action Items
7. Description of interim, measurable milestones for determining whether management measures described in (3.) are being implemented
    - Section 8A. Milestones and Table 2. starting on page 26
8. Set of criteria that can be used to determine whether load reductions described in (2.) are being achieved
    - Section 8B Water Quality Benchmarks and Table 3. on page 28
9. Water quality monitoring component to evaluate effectiveness of implementation measured against the established criteria described in (8.)
    - Section 8C. Monitoring on page 28
    - Appendix A. Highland Lake Action Items (#1.E.)

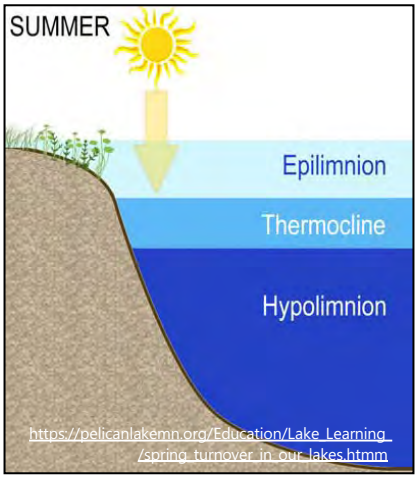
1. Purpose

The goal of this Plan is to maintain Highland Lake's Class GPA status by reducing phosphorus loading while continuing to investigate additional causes for the lake's water quality decline and picocyanobacterial blooms. To achieve this goal, this Plan provides a strategy and schedule for reducing phosphorus loading to the Lake over the next 10 years (2020-2030). This Plan was written by Cumberland County Soil and Water Conservation District (CCSWCD) with guidance from a Technical Advisory Committee consisting of members from Highland Lake Leadership Team's (HLLT) Watershed Management Committee. HLLT was created in 2018 for the Towns of Falmouth and Windham, the Highland Lake Association, the Maine Department of Environmental Protection (MDEP), and CCSWCD to work together to improve and maintain the water quality of Highland Lake for the benefit of residents, the Towns, and future generations. This Plan was funded in part by the U.S. Environmental Protection Agency (EPA) under Section 604b of the Clean Water Act and administered by the MDEP. Additional funding was provided by the Towns of Falmouth and Windham with in-kind support from Highland Lake Association and watershed residents. This Plan will be implemented under the direction of HLLT.

2. The Lake and It's Watershed

Watershed: Area that drains to a particular waterbody.

Highland Lake, originally known as Duck Pond, is 623-acre lake with an 8.5 square mile watershed located in the towns of Falmouth, Windham, and Westbrook, Maine (**Figure 1**). Highland Lake is fed by springs and streams with approximately 12 major tributaries flowing into the lake. The lake outlets into Mill Brook at the Highland Lake dam located at the southern end of the lake which then flows into Presumpscot River prior to emptying into Casco Bay. The lake, which stratifies in the summer and "turns over" twice a year, has an average depth of 22 feet with a maximum depth of 67 feet and a hydrologic retention time of 1.43 years (or flushing rate of 0.7 times/year).



Lake Stratification

Highland Lake is the closest lake to Maine's most populous city, Portland, and is quite developed with 283 properties inhabiting the lake's over 7 miles of shoreline and over an additional 1,100 properties throughout the watershed. These properties consist mostly of year-round residents with a handful being agriculture, logging, and small commercial properties. Highland Lake is currently listed by the State as a threatened NPS Priority Watershed and is on the State's list of lakes Most at Risk from New Development. This GPA- classified lake was once listed as impaired (from 1990 to 2010) due to poor water quality and there is a threat of this lake returning to an impaired status in future years should water quality trends continue to decline with the continued occurrence of annual picocyanobacterial blooms in late July/early August. If relisted, it would become the only one of Cumberland County's lakes to be impaired.

The lake is highly valued by the local community for its numerous recreational opportunities and the conveniences of nearby Portland. Recreational uses of the lake and its watershed include swimming, boating, water skiing, snowmobiling, and ice and open water fishing. A public boat launch at the south end of the lake provides carry-in boat access that is heavily enjoyed by greater Portland fishing and kayaking enthusiasts. There are also numerous private boat launches and right-of-way access points shared by road associations and residents. The Town of Falmouth has over 300 acres in conserved land in the northern part of the watershed that encompasses over half a mile of McIntosh Brook.

Eastern Box Turtle

The watershed contains State-listed habitat for the endangered Eastern Box Turtle and habitat suitable to support the endangered long-eared bat and small whorled pogonia. The watershed also provides suitable habitat to nearly two dozen species of migratory birds. A dam built in the mid-1930s at the lake's outlet originally blocked off the native sea-run fish passage. After a series of modifications from 1999-2011 (fish ladder in 1999, stream channel alteration in 2004, and downstream culvert replacements in 2011), Highland Lake has established a self-sustaining alewife population in which increasing numbers (40,000-60,000 individuals) have been able to enter the lake in a season. Resident fish in Highland Lake include largemouth bass, smallmouth bass, pickerel, American eel, hornpout, white perch, yellow perch, sunfish, and brook trout. The Maine Department of Inland Fisheries and Wildlife (IFW) once stocked the lake with brown trout and landlocked salmon but discontinued in 2011 when an IFW proposed trailer-accessible boat ramp was turned down by the local community largely due to fear of infestation of invasive milfoil.

3. Past and Current Water Quality Problems

Over the past forty years, the water quality of Highland Lake has been declining. Transparency in the water column has decreased from an average of 6 to 7 meters in the mid-1970s to around 5 meters and phosphorus concentrations have increased from around 8 parts per billion (ppb) to 10 ppb or more in recent years.

In 1990, the Maine Department of Environmental Protection (MDEP) listed the lake as being impaired (meaning it no longer met its Class GPA standards) for aquatic life due to a declining water quality trend. This decline was attributed to increased phosphorus runoff into the lake from polluted runoff. Extensive efforts to reduce polluted runoff throughout the watershed were implemented from 1997-2010. These efforts included:

- Conducting a watershed survey in 1997 with funding from the U.S. EPA under Section 604b Clean Water Act that identified 104 potential water quality impact sites mostly associated with private roads.

- Developing the *1999 Highland Lake Watershed Management Plan* and the *2003 Phosphorus Control Action Plan and TMDL* to list methods needed to improve the lake's water quality.
- Applying for and implementing three grant projects, *Highland Lake Conservation Projects Phase I, II, and III*[1], that combined:
    - Provided technical assistance to more than 300 landowners.
    - Addressed 42 private and public roads and 51 residential properties.
    - Helped create and support a Highland Lake Youth Conservation Corps that addressed nearly 200 sites.
    - Reduced pollutant loading to the lake by an estimated 278 tons of sediment (1,070 pounds of phosphorus) per year.
    - Provided extensive education and outreach through hands-on workshops and presentations, advertising and articles, and watershed boundary signs and flyers.
    - Hosted a community forum in 2009 to in which approximately 50 residents and stakeholders attended to provide updated action items to the management plan.

Following these efforts, the water quality trend from 1998 through 2009 indicated a persistent stabilization of trophic state. In 2010 MDEP removed Highland Lake from its list of impaired waters and the restoration effort was highlighted as a Nonpoint Source Success Story by EPA.

Site Work Completed on Cove Road in Early 2000s

Despite this success, overall phosphorus levels in the lake have been gradually increasing. Phosphorus levels have also become higher in the late summer months when compared to the overall season average which is a trend of highly productive lakes. **Figure 2** shows Highland Lake's average phosphorus concentration from 1974 to 2016. This graph shows an overall gradual increase in total phosphorus and the switch to higher phosphorus rates in the summer with the blue line representing the average concentration per year of the entire sampling season (May – October) and red representing the average concentration per year for just the late summer months (July – September).

[1] Phase I grant project was partially funded with State of Maine Bond Funds. Phase II and III grant projects were partially funded by EPA under Section 319 of the Clean Water Act.

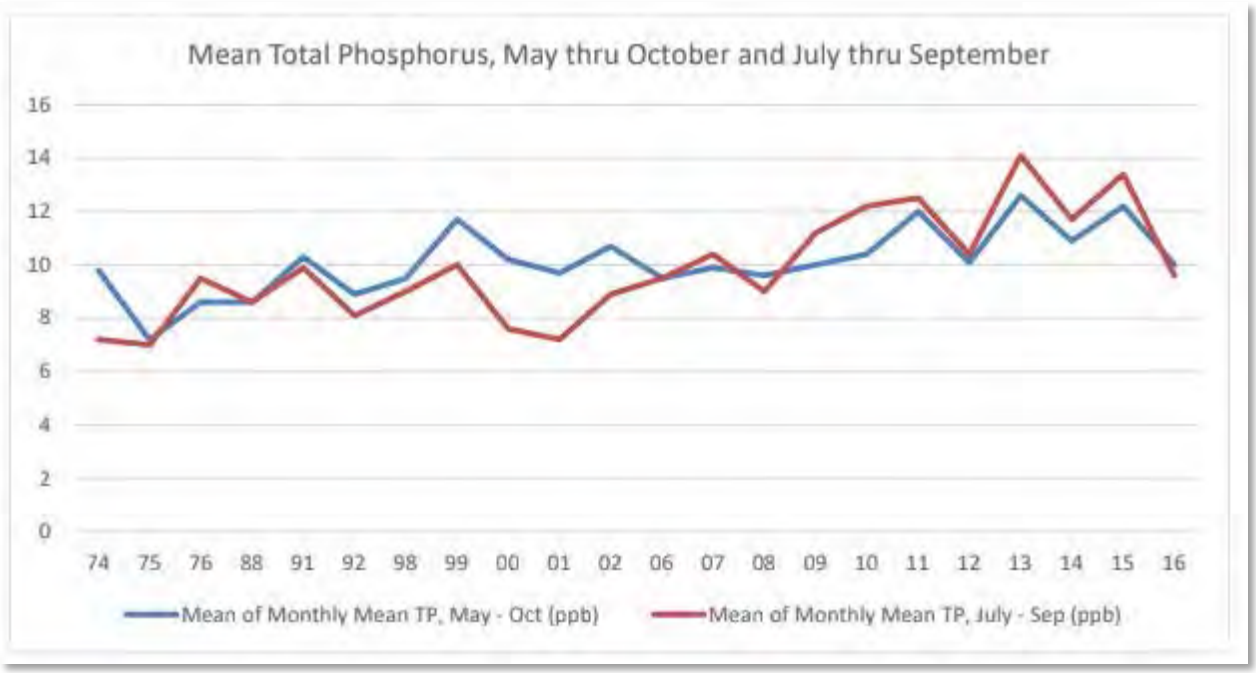


Figure 2. Mean of Monthly Mean TP from 1974 to 2016 for Years with Data (Dennis, Jeff; Bacon, Linda, Maine DEP Division of Environmental Assessment, Highland Lake Summary, September 2017)

In addition to increased phosphorus readings, the recent blooms of the picocyanobacteria *Cyanobium*, a very small, non-colonial bacteria (yet commonly referred to as blue-green algae) is of great concern. These blooms lasted a few weeks from late July to mid-August between 2014 and 2017. During the blooms, transparency of the lake water dropped from more than 5 meters to less than 2 meters. In 2018 and 2019 the bloom began on the same schedule but ended quickly with transparencies dropping to 3 meters.

It is likely this lake could become relisted as impaired in the near future due to increasing phosphorus levels (which feed algal growth and result in decreased dissolved oxygen levels) and persistent picocyanobacterial growth.

Secchi Disk (Used to Measure Lake Transparency) Surrounded by Cyanobacteria

4. What is Causing Highland Lake's Problems?

A. Phosphorus

Highland Lake's Water Quality Problems:

- Increased phosphorus
- Decreased water clarity
- Algal blooms

Highland Lake is fortunate that, unlike other lakes that have nuisance algal blooms, significant amounts of phosphorus are not recycled into the water column from the bottom sediment when the deep water loses its oxygen in August and September. This may be due to aluminum in the bottom sediments that binds to the phosphorus.

This means that the predominant source of phosphorus to the lake is the watershed. Phosphorus is transported into lakes even in completely undisturbed, forested watersheds through surface runoff, groundwater, and atmospheric deposition; Yet development and the removal of forested land can increase the likelihood of excess phosphorus washing into the lake. Removing forested lands and installing hardened surfaces like roads, houses, trails, lawns, etc. can lead to increased erosion and the transport of sediment downhill into Highland Lake through its watershed drainage. Nutrients, such as phosphorus, readily bind to sediment and thus the washing of sediment also means the washing of phosphorus off site and into the lake.

Unnaturally high phosphorus loading can greatly affect water quality by overfeeding a lake resulting in more algae, decreased water clarity, and a decrease in the amount of dissolved oxygen in the water needed by fish and other more advanced organisms. Phosphorus can also wash or leach into the lake from fertilizers, lawn clippings, septic systems, and paved and gravel roads. Other pollutants that can wash into Highland Lake as land uses change may include metals from cars, salt from winter ice treatment, pesticides and hydrocarbons (exhaust, oil), and bacteria from pet waste and failing septic systems.

Removing forested and vegetated lands 1) increases the likelihood of erosion and the movement of sediment and phosphorus into the lake; 2) removes the filtering capacity of the land to treat excess phosphorus and pollutants before entering the lake; and 3) impacts the hydrology of the watershed. A natural forested landscape provides uneven terrain and a thick organic duff layer that can absorb and filter rainwater and snowmelt. When development occurs, vegetation is removed, and the landscape is reshaped and smoothed which increases runoff and decreases filtration. The hardened landscape also increases how quickly rainwater and snowmelt wash through the watershed's drainage system. This

Forested Shorelines Help Water Quality

can increase erosion in ditches and streams contributing more sediment and phosphorus to the lake.

Phosphorus concentrations have increased over time in Highland Lake. A 2017 summary report by MDEP[2] states that "Highland Lake appears to have undergone significant eutrophication since 1974 when data was first collected on the lake. Some lakes have a natural trophic cycle that alternates between lower and higher states, but in this case, watershed development likely played and will continue to override any natural cycling."

B. Picoplankton Blooms

Eutrophication: Excess nutrients in a lake resulting in aquatic plant overgrowth and reduced oxygen within the water column.

The 2014-2017 picoplankton blooms led to renewed and widespread concern about Highland Lake's water quality. Since it is very unusual to have this type of algae associated with a bloom, several research partners also became interested in studying the issue. As a result, the lake was monitored intensively in 2018 and 2019 with the goal of determining the cause(s) of the picocyanobacteria bloom, and additional monitoring is planned for 2020.

Since the amount of algal production in the lake is limited by the concentration of phosphorus in the water, the potential magnitude of the picocyanobacteria bloom is also limited by phosphorus. Less phosphorus will result in less of a bloom, if a bloom occurs. It is not, however, clear that the incidence of the bloom is a result of increased phosphorus. Other factors may determine whether algal production in the upper waters of the lake is dominated by picocyanobacteria, which are particularly effective in reducing transparency, or by a more typical assemblage of phytoplankton. Some factors that may be contributing to Highland Lake's phosphorus budget that were not as important in the past are changes in weather patterns associated with climate change and import or export of phosphorus from the lake with the alewife run, both of which are discussed in sections C and D.

Phytoplankton

[2] "Highland Lake Summary", J. Dennis and L. Bacon, September 2017, presented to the Windham Town Council on 1/30/18.

Alewives

C. Changes in Interspecies Ecology/Alewives

Beginning in 2012, wild runs of alewives began returning to Highland Lake, with the run reaching approximately 40,000 adults in 2014. While the alewife run has the potential to be either a net input or a net loss of phosphorus to the lake, depending most likely on how easily the adults and young alewives can leave the lake to return to the ocean, this phosphorus dynamic is not the only way in which alewives may contribute to the incidence of picocyanobacterial blooms. It is possible that changes in the lake's food chain because of alewife predation may create conditions that allow picocyanobacteria to become abundant, if only for a short time.

D. Changes in Weather Patterns

Frozen Highland Lake

Intense storms that have the potential to cause significant erosion in the watershed have become more frequent in recent decades. This increases the potential for phosphorus loading from erodible surfaces (roads, driveways, etc.) in the watershed. Warmer air temperatures will reduce the duration of ice cover in the winter and allow lake stratification to begin earlier in the spring and last longer into the fall. Longer stratification has the potential to cause an increase in the duration and extent of anoxia (lack of oxygen) in the bottom waters. Warmer temperatures may also contribute to higher levels of algal production in the water column.

5. Reducing Phosphorus Input into Highland Lake

Reducing Phosphorus is a known action that can improve Highland Lake's water quality.

Although there is expected to be more than one factor contributing to Highland Lake's decline in water quality, **reducing phosphorus** is a known action that can be immediately addressed to help reduce algal production and maintain Highland Lake's Class GPA status. While reducing phosphorus loading to the lake, additional factors that could be affecting the lake's water quality should also be further investigated.

A. Identifying Sources of Phosphorus

The Plan's Technical Advisory Committee (TAC) listed and reviewed the most likely sources of phosphorus washing into Highland Lake. The TAC also attempted to determine how much phosphorus each source was likely contributing to prioritize which sources should be addressed first. Recent survey work was done to identify specific inputs of phosphorus into the lake and to help prioritize which sources of phosphorus are most likely contributing the greatest amount of phosphorus to the lake.

Erosion Documented through 2018 Watershed Survey

Recent survey work completed includes:

i. 2018 Highland Lake Watershed Survey

Conducted in May 2018 through HLA; primarily documented erosion sites throughout the watershed and properties with minimal vegetated buffers. 129 erosion sites were documented with 71 sites being residential and driveways and 27 sites being private roads. During this time, agricultural sites were also identified, and one-on-one outreach was made to these properties. All of these sites are listed in a Highland Lake 'Site Tracker', a database with corresponding photos and site locations, maintained by HLA which prioritizes sites based on estimated impact to the lake's water quality and keeps track of sites needing to be addressed versus sites that have been addressed. The watershed survey methods and specific survey sites identified can be found in **Appendix B. 2018 Highland Lake Watershed Survey Report.**

ii. Road Best Management Practice (BMP) Survey

Conducted by TAC members over the summer of 2019. 34 roads were reviewed to determine how well BMPs are being maintained and are functioning to prevent sediment from washing into Highland Lake. Out of the 34 road sites reviewed, 19 did not need maintenance nor addressing largely due to HLA's assistance getting municipal funds to address high priority road sites from the 2018 Highland Lake Watershed Survey. A summary of these findings with a documentation table can be found in **Appendix C. Highland Lake Road BMP Survey Summary.**

Infiltration Trench at Swan Road's Right-of-Way

iii. Assessment of Highland Lake Tributary Road Crossings

MDEP staff surveyed the lake's perennial tributary road crossings (stream crossings) on June 24, 2019 and identified 5 tributary stream road crossings with notable issues that may be contributing to channel instability and bank/channel erosion during significant runoff events. A summary of these findings can be found in **Appendix D: Assessment of Highland Lake Tributary Road Crossings for Geomorphological Impacts**.

iv. Septic System Survey Summary

In 2019, the Towns of Falmouth and Windham staff reviewed files and compiled data on parcels that are most likely to be at risk of contaminating Highland Lake from excess nutrient due to age, proximity of septic system leach fields to the water, and underlying soils. 21 parcels that met these criteria were identified. A summary of these findings can be found in **Appendix E. Highland Lake Septic System Survey Summary.**

Table 1 lists the most likely current sources of phosphorus affecting Highland Lake as suspected and investigated by the Plan's Technical Advisory Committee (TAC). This Table also includes likely impacts (high, medium, low) of each source to Highland Lake based on source type, prevalence, and proximity to Highland Lake or water channels/tributaries that lead to Highland Lake and/or calculated estimate of pollutant loading.

Table 1. Potential Sources of Phosphorus Loading

Roads - *erosion from private and public roads that may be contributing phosphorus into Highland Lake*	**Investigations:** ▪ 31 roads (27 private roads and 4 public roads) were identified in the 2018 Watershed Survey. Most of the road sites (77%) were identified as having a medium to high impact to the lake's water quality. A list of these sites can be found in **Appendix B.** ▪ In 2019, TAC members surveyed BMPs (Best Management Practices) on all 31 roads identified as impacting the lake in the 2018 Watershed Survey plus an additional 3 roads with no impacts observed in 2018. Road BMPs help to prevent erosion and the washing of sediment and nutrients into the lake yet need to be maintained to function properly. The types of BMPs needing maintenance varied and most commonly included ditches, turnouts, sediment basins, culverts, and gravel roads. Out of the 34 road sites reviewed, 19 did not need maintenance nor addressing largely due to HLA's assistance getting municipal funds to address high priority road sites from the 2018 Highland Lake Watershed Survey. A summary of these findings with a documentation table can be found in **Appendix C.** **Estimated Impact:** High
Residential Properties – *erosion and practices on individual residential properties can contribute phosphorus to Highland Lake*	**Investigations:** ▪ 64 residential properties plus 7 driveways were identified in the 2018 Watershed Survey listed in **Appendix B**. Most of the residential properties (66%) identified were recorded as being a low impact to the lake's water quality. However, there were more residential sites than any other land use identified as likely to be contributing phosphorus into the lake. Therefore, residential sites could have a large input of phosphorus into the lake when combined. ▪ Approximately 60 properties were also recorded in the 2018 Watershed Survey as lacking sufficient shoreline vegetative buffers. **Estimated Impact:** High/Medium
Stream Crossings and Hydromodifications – *can alter water flow and could increase erosion and flow of excess sediment and phosphorus into the lake*	**Investigations:** ▪ The 2018 Watershed Survey identified one stream crossing issue (see **Appendix B.),** however, many of the road sites identified may also have stream channel impacts. ▪ An assessment of the lake's tributary road crossings was done by staff from MDEP on 6/24/19. This assessment identified five tributary stream road crossings with notable issues that may be contributing to channel instability and bank/channel erosion during significant runoff events. A summary of these findings can be found in **Appendix D.** ▪ The Maine Stream Habitat Viewer documented stream crossings that are barriers or potential barriers to aquatic organism / fish passage. Many of these barriers also greatly impact water flow and can cause water quality impacts. Undersized culverts can also create NPS problems if they are

	overtopped or washed out during large storm events. Eight sites within the Highland Lake Watershed have been identified: 6 potential barriers and 2 barriers. A list of these sites can be found in **Appendix F. Highland Lake Watershed Sites within the Maine Stream Habitat Viewer** **Estimated Impact:** High/Medium
Livestock/Animal Operations – *potential areas in which phosphorus from manure may wash into tributaries and drainages flowing into Highland Lake*	**Investigations:** ▪ Animal waste can contribute high amounts of phosphorus into the watershed. Loss of only a small amount of this manure in stormwater can be a very significant source of phosphorus. ▪ HLLT and this Management Plan's TAC identified 2 active agricultural parcels within the watershed which are listed in Highland Lake's Site Tracker maintained by HLA. HLLT has been working with the Maine Department of Conservation, Agriculture, and Forestry to conduct site visits to these parcels, provide technical assistance recommendations, and pursue cost share incentives for addressing sites in which phosphorus may be washing offsite. **Estimated Impact:** Potentially very high depending on management and number of animal units
Logging Operations – *largest concern would be unstable stream crossings that could wash sediment and phosphorus into the streams flowing into Highland Lake*	**Investigations:** ▪ HLA reached out and conducted site walks on current logging operations in 2018. Logging was being conducted according to a logging management plan and it did not appear that sediment and phosphorus were washing offsite. **Estimated Impact:** Low
Fertilizers – *nutrients/phosphorus applied on land to encourage plant growth yet may wash into the lake*	**Investigations:** ▪ TAC members did not think fertilizers are being used in great quantities watershed-wide on residential properties based on visual observations and familiarity with the watershed community. ▪ This Plan's TAC also did not think there were many fields within the watershed, if any, that spread manure. ▪ TAC members confirmed that the Towns do not apply fertilizer to town-owned parcels within the watershed. ▪ A landowner survey would be needed to verify how much fertilizer is being placed on watershed parcels however the TAC did not feel this is likely to be a great enough impact to pursue/devote resources to. **Estimated Impact:** Likely Low

Septic Systems – *phosphorus may enter the lake through ground water for systems that are failing or are leaching in very poor soils*	**Investigations:** ▪ In 2019, the Towns of Windham and Falmouth compiled and reviewed septic system records and identified 21 parcels that are more likely to be contributing phosphorus to Highland Lake based on their age, proximity to the lake, and underlying soils. ▪ A summary of the Towns of Windham's and Falmouth's septic system review can be found in **Appendix E.** ▪ Relatively few parcels identified as possibly having at risk septic systems, yet these impacts could be great if any of these systems are contributing untreated leachate to the lake. ▪ A voluntary onsite investigation of the identified parcels would be needed to determine if these parcels are impacting the lake. Continuing to explore the potential impact of high-risk septic systems is included as Action Item 1.D. in **Appendix A.** **Estimated Impact:** Unknown
Alewife Migration – *number of fish entering and exiting Highland Lake and the amount of nutrients they consume versus leave behind*	**Investigations:** ▪ Dr. Karen Wilson from the University of Southern Maine monitors alewife populations entering and exiting Highland Lake. In 2018 and 2019, she led efforts to investigate potential impacts of alewives to the lake's food chain. According to Dr. Wilson, investigations thus far indicate alewives are not providing a net input nor output of phosphorus into Highland Lake[3]. ▪ Action Item 6 in **Appendix A** calls for establishing a Dam Committee to help ensure alewives can freely migrate out of the lake each summer and fall to prevent any additional phosphorus to remain in the lake. **Estimated Impact:** Unknown

B. Phosphorus Loading Estimates

i. Annual Phosphorus Load and Load Reduction Target

From the mid-1980s through 2010 phosphorus concentrations in Highland Lake averaged about 10 micrograms per liter (µg/l) and resulted in generally good, acceptable lake clarity. Since 2010 the mean annual phosphorus concentrations in Highland Lake in the top layer of the lake (epilimnion) during open water season have fluctuated between 10 µg/l and 12 µg/l. Based on the lake's morphometry (shape) and hydrology (water movements), modeling (Vollenweider, 1976, Larsen and Mercier, 1976) suggests an annual phosphorus load to the lake of 590 to 700 pounds

[3] 2019 Highland Lake Association Annual Meeting Presentation "Highland Lake Update – 2018-2019" by Dr. Karen Wilson.

of phosphorus per year (lb P/yr) is occurring to support current lake phosphorus levels of 10 ug/l to 12 ug/l. Thus, to obtain in-lake phosphorus readings of 10 µg/l or less, phosphorus loading into the lake should be reduced by approximately 118 lb P/yr. Reducing phosphorus loading to maintain in lake phosphorus levels at 10 ug/l or less will result in a more stable and consistently acceptable condition, though this by itself may not be sufficient to prevent picocyanobacteria blooms.

ii. Phosphorus Sources

Erosion Documented through 2018 Watershed Survey

Because of relatively high aluminum concentrations in the deep-water sediments of Highland Lake, the lake does not appear to recycle significant amounts of phosphorus from its bottom sediments even though deep water oxygen levels drop precipitously in late summer. It is therefore assumed that a large majority of the phosphorus load to the lake is from external sources including 1) erosional sources from roads and residential development; 2) leachate from a likely small number of inadequate septic systems on particularly sensitive soils; 3) a few, mostly small, agricultural sources, but particularly one large horse operation; and 4) from background forest, groundwater and atmospheric contributions. There is also a potential that, in years when migrating and young of the year alewives have a difficult time leaving the lake, that they are contributing a net input of phosphorus to the system.

iii. Projected Phosphorus Load Reductions

Although it is difficult to determine loading numbers, the Technical Advisory Committee anticipated that the load reduction target of 118 pounds of phosphorus per year could be achieved by reducing loading from the following sources: roads and residential NPS sites, septic systems, agriculture, and alewives as explained below. Actual pollutant load reductions will be documented as BMPs are implemented. Pollutant loading reductions will be calculated using methods approved and recommended by MDEP and US EPA and reported to MDEP for any work funded by Section 319 Clean Water Act grants.

a. Road and Residential Sites

This plan's Action Items include many projects that address erosional phosphorus sources from roads and residential development. Realistically conservative estimates of the phosphorus load reduction associated with those projects that address high and medium priority sites indicate likely reductions of 10 to 30 lb P/yr depending on assumptions about the concentration of

phosphorus in the eroded soil, the amount of soil eroded annually from each project site, and the reduction effectiveness of the BMPs applied.

b. Septic Systems

Phosphorus impacts to the lake from septic systems is currently unknown. While high-risk parcels have been identified, these systems need to be inspected to determine if leachate is short-circuiting to the lake. An action item of this plan is to continue to explore potential impact of septic systems on the lake's water quality (1.D. in **Appendix A**.). Specific inspection methods, outreach to encourage volunteer inspections, and exploration of funding sources for septic upgrades will be pursued as part of this task.

Manure From One Horse Can Contribute Approximately 18 Pounds of Phosphorus Per Year
(https://esc.rutgers.edu/fact_sheet/horses-and-manure/)

c. Agriculture

A large horse farm in the watershed recently changed hands. Estimates of the phosphorus load from this property and the likely reductions associated with any best management practices that might be adopted or constructed cannot be made until it is clear how intensely the site will be used (e.g. # of resident and visiting horses) and what suite of management practices would be feasible. The potential for significant load reduction compared to the level of phosphorus export that was likely leaving the site in recent years is high. Pursuit of opportunities to reduce load from this source is a high priority.

d. Alewives

Though there is insufficient data available to quantify the potential for the alewife migration to result in a net input of phosphorus to the lake, efforts to provide effective egress opportunities for the migrating adults and young of the year alewives will insure that, if anything, there is a potentially significant net export of phosphorus from the lake.

6. Plan's Goal, Objectives, and Action Items

A. Goal

The goal of this Plan is to maintain Class GPA water quality classification standards for Highland Lake by reducing and preventing phosphorus loading into Highland Lake over the next 10 years (2020-2030).

B. Objectives and Management Measures

Reducing and preventing phosphorus loading will be done by addressing the largest sources of phosphorus impacts listed in **Table 1.** This is to be achieved over the next 10 years by implementing management measures or BMPs under the following objectives:

i. Continue Monitoring and Tracking for Pollution Sources

Continued monitoring for new pollution sources will be conducted by HLA. HLA will add identified sites to the Highland Lake NPS Site Tracker to be addressed with grant cost share (see 6.B.ii. Reduce Known Pollutant Loading to the Lake). Yearly monitoring will be primarily of roads, the largest known impact to the lake, but also include residential properties and known agriculture sites where permission has been granted.

The Towns of Windham and Falmouth along with MDEP will also explore the potential impact of septic systems to Highland Lake's water quality. MDEP will work with Maine's Soil Scientist to develop an inspection protocol for determining if a high-risk septic system is likely to be impacting water quality. MDEP and Maine's Soil Scientist will work with the Towns in obtaining voluntary access to inspect granted high-risk systems. Methods to address water quality impacting systems will be determined by all involved parties and may include septic system repair or replacement.

In-lake water quality monitoring will continue for basic lake trophic indicators (dissolved oxygen, phosphorus, clarity). This will be completed primarily by HLA volunteers following the Lake Stewards of Maine guidance and Quality Assurance Project Plan (QAPP) for water sampling. Additional water quality testing to investigate controls on nutrient dynamics and phytoplankton composition (e.g. tracking phytoplankton, alewife egress, food web studies, climate change impacts) will be conducted by HLA- and HLLT-contracted scientists and consultants. Yearly water quality monitoring plans will be created under the direction of the HLLT each spring with summaries of collected data compiled each fall/early winter. Water quality monitoring data will be used to determine if milestones are being met/if action items completed from this Plan are meeting the overall goal in reducing phosphorus levels in the lake and improving overall water quality.

ii. Reduce Known Pollutant Loading to the Lake

Buffer Workshop Held in June 2019

Eliminating and/or reducing the impacts of known pollutant loading will greatly reduce the amount of sediment and phosphorus from washing into Highland Lake. The first focus will be on the highest impact sites starting with roads and outreach to the few identified agriculture sites. Residential sites will then be pursued as they are suspected as having a large collective impact to the lake's water quality. Sites to be addressed will have been listed in the Highland Lake NPS Site Tracker. Currently, most of these sites include

those documented in the **2018 Highland Lake Watershed Survey Report in Appendix B.**

In addressing the highest impact sites, a variety of structural practices will be installed through landowner outreach and grant cost-share incentives depending on the land use. Management measures or BMPs for the different types of land use are likely to include:

- Gravel Roads: ditch installations and stabilizations, road resurfacing and grading, culvert enlargement and stabilization
- Agricultural Properties: building manure storage facilities, fencing animals away from drainage swales and streams, installing water systems, establishing small-scale hobby farm nutrient management plans
- Residential Properties: vegetative buffer plantings, driveway and walking path stabilization and water diversion; roof dripline trenches

As private roads were identified as having the largest number of high impact water quality sites in the 2018 Watershed Survey, a series of workshops will be held specifically to explore additional long-term actions that can help keep BMPs functioning. This includes exploration of increasing private road associations, creating a possible watershed-wide road association, pursuing economy-of-scale road material purchases, creating new ordinance language, provide road-specific recommendations, etc.

The overall goal is to remove 118 lb P/yr (see Section 5.B.i.).

iii. Limit/Prevent New Phosphorus Inputs into the Lake

Ways to reduce and/or prevent new sources of phosphorus will be explored and established where necessary to save the need for remediation efforts later. To-date, HLA and HLLT's Ordinance Committee have provided ordinance updates to the Towns to address water quality impacts of future development within the watershed. This includes the Town of Windham adopting ordinance language to limit the maximum phosphorus amounts for new development to 0.02 lbs/acre/year and establishing mandatory third-party review of all projects that come before the Planning Board. As the Highland Lake Watershed is fairly built-out, there does not appear to be a lot of new updates needed in regard to future new developments. Instead, the Towns, with guidance from HLLT, will review current ordinance language and work to ensure ordinances are enforced. MDEP will also work to enforce current State Erosion and Sediment Control Law. HLLT will conduct final ordinance reviews in 2020 and 2021 to confirm all necessary language is to limit and prevent new sources of phosphorus such as exploring ways to limit/prevent phosphorus into the lake from possible future agriculture practices.

Action Item 5 in **Appendix A**, Expand Education and Outreach to Modify Behavior for Lake Pollution Reduction, will also greatly assist in limiting/preventing new phosphorus input from washing into Highland Lake through outreach to targeted lake stakeholders.

iv. Maintain Installed Conservation Practice

Installed conservation practices, which are placed to reduce and eliminate sediment and phosphorus from entering the lake, will be maintained to ensure the lake's protection. Ongoing maintenance reduces the likelihood of expensive remediation costs and will keep sediment and phosphorus out of the lake.

Phosphorus Loading can be Best Reduced by:

1. Mimicking natural shorelines; and
2. Keeping sediment out of the lake!

Maintenance efforts depend on the type of conservation practice installed. For most roads, maintenance involves cleaning sediment and debris out of ditches, basins and turnouts; Regrading gravel roads and removing grader berms; and Repairing damaged or degraded infrastructure. Regardless of the land use type, specific maintenance recommendations will be provided to landowners and/or those maintaining practices installed with cost share funds. The HLLT Watershed Management Committee and the Highland Lake Education and Outreach Plan will also incorporate strategies to encourage ongoing maintenance of all installed conservation practices. This may include yearly phone, letter, and/or email reminders to road associations and contractors or creating low-cost maintenance assistance opportunities.

v. Expand Education and Outreach to Modify Behavior for Lake Pollution Reduction

As part of this Plan, HLLT's Education and Outreach Committee will create and follow a 10-year Highland Lake Education and Outreach Plan. Increasing lake protection awareness and creating lake protection behavior changes throughout the lake's watershed is the best method for long-term lake protection. Management measures may include hosting frequent lake protection workshops (such as low impact property maintenance/YardScaping, septic system care, vegetative buffers); Creating and distributing outreach material; Establishing landowner incentives (possibly a LakeSmart or similar program or native plant discounts); and Encouraging residents and private road associations to seek technical assistance for erosion problems.

The Education and Outreach Plan will be created in the first year and will then be implemented in the following 9 years under the guidance of HLLT's Education and Outreach Committee.

vi. Manage Alewife Migration

Alewives do not currently appear to be contributing additional phosphorus to Highland Lake. A strategy to ensure alewives are not contributing a net phosphorus allocation to the lake would be to make sure they can exit the lake freely. The first step in doing this is to establish a Highland Lake Dam Management Committee. This Committee would include multiple stakeholders who would work to create objectives and a timeline for dam management tasks related to improving alewife migration out of Highland Lake. This may include tasks such as determining the optimum water level for alewife egress, creating a dam/water level management plan for improved alewife egress that involves all interests, and modifying the outlet to ensure alewife migration can easily be facilitated. The Committee will be established in the first year of the

Highland Lake Management Plan. They will create objectives and timelines for dam management tasks also in this first year that can then be implement for the remaining 10 years of the Plan.

vii. Continue Leadership Efforts and Evaluate Effectiveness of the Plan

Continuing the leadership and activity of the Highland Lake Leadership Team (HLLT) which is overseeing this Management Plan will assist in ensuring the Plan is being implemented. HLLT's Watershed Management Committee will meet at least two times per year to evaluate the effectiveness of the Plan and update the Plan as necessary.

The HLLT will continue leadership efforts by holding a minimum of four meetings per year and actively appointing new members. As the leadership team is only as strong as its team members, HLLT will work to assist in strengthening HLA's membership participation and involvement including assistance in creating yearly goals for the lake association.

Yearly community updates on HLLT's efforts and the implementation of the Highland Lake Watershed Management Plan will be provided to the public via Town Council meetings, HLA's Annual Meeting, as well as website updates, emails, and publications.

viii. Develop Funding Mechanisms to Support Plan Implementation

This Plan's action items involve costs and resources. To ensure adequate resources are available, a committee will be established in 2020 to develop a Funding Plan specifically for supporting the action items of this Plan. The Funding Plan will be created by the committee in the first two years (2020-2021) and will explore seeking grant, in-kind, municipal, and community funds for action items to include:

- Repairing/retrofitting or replacing high-risk septic systems;
- Conducting yearly water quality sampling;
- Providing technical assistance and cost-sharing in addressing known pollutant sources;
- Providing community education and outreach to reduce phosphorus loading into Highland Lake; and
- Exploring long-term funding mechanisms to continue to support efforts of the Plan.

C. Action Items

Specific action items for this Plan's objectives can be found in **Appendix A**. This table includes a time frame for each action to be completed within, a list of parties responsible for completing that action, potential funding sources to be used to assist in accomplishing each action, and estimated cost for each action to be performed. The original objectives and action items of this Plan were compiled by the TAC. Public input was incorporated as a result of the following outreach:

- Presentation of Action Items to Windham Town Council on 10/15/19
- Presentation of Action Items to Falmouth Town Council on 10/16/19
- Presentation of Action Items and open discussion through public forum held at Cornerstone Church in Windham on 10/23/19
- Review and open discussion of Action Items at HLLT Meeting on 11/4/19

Presentation and Discussion of Action Items at Public Forum Held on 10/23/19

7. Schedule

The implementation of this Plan is broken into three phases which allows for more concentrated areas of focus:

A. Phase I: 2020-2023 (4 years)

The primary focus of Phase I will be to address the highest water quality impact sites identified in the 2018 watershed survey. These are mostly road sites. In addition to assisting with on-the-ground fixes, CCSWCD will also work with private roads to aid in sharing resources, providing one-on-one technical assistance, and exploring economy of scale benefits through partnering with other road associations.

B. Phase II: 2024-2026 (3 years)

Phase II projects will focus on addressing the next level of highest priority water quality impact sites. Most of these sites will be residential sites and will need the Highland Lake Leadership Team's Education and Outreach Committee to continue to help with community outreach.

C. Phase III: 2027-2030 (3 years)

Phase III projects will focus on the remaining highest impact sites. This Phase will revisit sites previously addressed sites to determine if project amendments are needed and will explore the needs of the watershed for the next 10-years depending on current water quality status and progress made to-date.

8. Milestones, Benchmarks, and Monitoring

A. Milestones

Interim milestones assist in determining whether the Plan's objectives and management measures are being implemented. **Table 2.** provides milestones for each of the Plan's objectives. This Table will be reviewed yearly and at the end of each Phase by the HLLT Watershed Management Committee to determine if the Plan's objectives and management measures are being met.

Table 2. Milestones

Objectives:	**Phase I – Milestones (by end of 2023)**	**Phase II – Milestones (by end of 2026)**	**Phase III- Milestones (by end of 2030)**
1. Continue Monitoring and Tracking for Pollution Sources	HLA has groundtruthed and documented (through updating NPS Site Tracker) all new phosphorus pollution sites each year.		
	Property owners of all 21 identified at-risk septic system parcels have been contacted. 20% (4 parcels) have been inspected to determine if their system is affecting water quality.	Actions pursued (i.e. system repaired or replaced) to address septic systems indicating water quality impacts to Highland Lake. Remaining high-risk systems inspected (17).	
2. Reduce Known Pollutants to the Lake (Target: 118 lb phosphorus reduction)	10-15 high impact sites addressed (primarily road sites)	10-15 high impact sites addressed (primarily residential and agriculture sites)	10-15 of the highest remaining impact sites addressed
3. Limit/Prevent New Phosphorus Inputs into the Lake	No Target (No increase in net phosphorus to Highland Lake)		
4. Maintain Installed Conservation Practices	30% of private roads have maintained their installed conservation practices.	60% of private roads have maintained their installed conservation practices.	90% of private roads have maintained their installed conservation practices.

Table 2. Milestones - Continued

Objectives:	**Phase I – Milestones (by end of 2023)**	**Phase II – Milestones (by end of 2026)**	**Phase III- Milestones (by end of 2030)**
5. Expand Education and Outreach to Modify Behavior for Lake Pollution Reduction[4]	Initial implementation of HLLT's Education and Outreach Plan has resulted in an anticipated increased awareness from the watershed community that sediment is not good for the lake likely shown through surveys of pre and post education knowledge.	Continued implementation of the Education and Outreach Plan has resulted in an anticipated 50% of the watershed's shoreline zone residents aware that sediment is not good for the lake likely shown through surveys of pre and post education knowledge.	Continued implementation of the Education and Outreach Plan has resulted in an anticipated 30% of the watershed implementing actions to prevent or reduce sediment from washing into Highland Lake likely shown through surveys of pre and post education knowledge.
i. Manage Alewife Migration[5]	Dam outlet is consistently cleared of debris and blockages following dam management measures.	Lake water levels are consistently (3+ years in a row) meeting goal range of determined dam management measures.	
ii. Continue Leadership Efforts and Evaluate Effectiveness of the Plan	HLLT's Watershed Management Committee is active and meets at least two times per year to discuss this Plan's effectiveness. Summary of meetings and updated changes to the Plan are available.		
iii. Develop Funding Mechanisms to Support Plan Implementation[6]	10 grant proposals submitted (two municipal grants per year and two Section 319 Clean Water Act grants within the four years of Phase I)	At least one Section 319 Clean Water Act grant proposal submitted	Funding obtained based on Highland Lake Funding Plan

[4] Specific goals and targets to be detailed in to-be-completed Highland Lake Watershed Education and Outreach Plan.
[5] Specific goals and targets to be detailed in to-be-completed Highland Lake Dam Management Plan.
[6] Specific goals and targets to be detailed in to-be-completed Highland Lake Funding Plan.

B. Water Quality Benchmarks

Water quality benchmarks (or targets) are used to ensure that the overall intent of the Plan's goal and objectives are being met through the action items and milestones accomplished. If targets are not being met, the reason may be due to inability to complete the action items, the inability to complete the action items effectively, or that the action items are not sufficient enough to meet the objectives and goal and thus new actions must be taken.

The Plan's goal to reduce and prevent phosphorus loading into Highland Lake to attain water quality standards can be measured by looking at both water quality condition and estimated phosphorus load reduction. **Table 3.** provides the environmental targets needed to achieve these goals per each of the three phases of this 10-year plan.

Table 3. Water Quality Benchmarks

Benchmarks:	**After Phase I (in 2024)**	**After Phase II (in 2027)**	**After Phase III (in 2030)**
1. Decrease in annual phosphorus concentrations in the top layer of the lake (epilimnion) during open water season. Current: 10 ug/l – 12 ug/l Goal: 10 ug/l or less	Annual means of less than 12 ug/l	Annual means of less than 11 ug/l	Annual means of 10 ug/l or less
2. Increased annual mean water clarity. Current: 5 meters Goal: 6.5 meters	5.5 meters	6 meters	6.5 meters

C. Monitoring

In-lake monitoring will continue to track basic lake trophic indicators including color, alkalinity, pH, specific conductivity, total phosphorus, secchi disk transparency, chlorophyll-a, dissolved oxygen, and temperature as part of action item 1.E. in **Appendix A.** This information will determine if targets in **Table 3**. are being met. This data will continue to be primarily be collected by HLA volunteers under the guidance and approved Quality Assurance Project Plan of the Lake Stewards of Maine. Additional water quality data will be gathered to investigate the cause of the picocyanobacterial blooms through the University of Southern Maine, MDEP, and other New England experts. Through the HLLT, a yearly water quality monitoring plan and end of year report out will be completed of all water testing performed.

9. Education and Outreach

Education and outreach, and more importantly, long-term lake stewardship are the most important elements in achieving the 10-year goals of this Plan. When water quality problems initially appeared in Highland Lake, a management plan was created, and a large community of residents and various stakeholders came together to address and fix high phosphorus runoff/problem sites. However, once the urgency subsided, the majority of high impact sites had been addressed and the lake's water quality started to stabilize, community involvement declined. Over time, maintenance efforts and repairs of BMPs decreased and new sources of erosion and phosphorus inputs into the lake developed as the immediate water quality danger was assumed to be over.

To learn from the past, it is important that a strategic approach for ongoing education and outreach is pursued on Highland Lake. A well thought out, strategic approach is needed as education and outreach alone won't change behaviors in an effective way to protect Highland Lake. These changes occur over time, with targeted and unified messages to targeted audiences. To give this task the importance that it deserves, HLLT's Education and Outreach Committee will develop a 10-year Education and Outreach (E&O) Plan tailored to the needs of Highland Lake (Action Item 5.A. in **Appendix A**.). This Plan will be created in 2020 and follow EPA's guidance in including the following:

- Definition of Education and Outreach goals
- Identification and analysis of target audiences
- Tailored and packaged messaging for each audience
- Distribution methods of getting the messages out
- Evaluation of the effectiveness of education and outreach efforts

Estimated funding for these efforts will be determined in the E&O Plan which will work with the to-be-formed Funding Plan Committee of the Watershed Management Plan. Funding these efforts is crucial to the success of the E&O Plan and thus the long-term protection of Highland Lake

10. Oversight, Roles and Responsibilities

A. Oversight

This Plan will be led under the direction of the Highland Lake Leadership Team (HLLT). The HLLT is comprised of 5 or 11 appointed members of the towns of Falmouth and Windham and the Highland Lake Association. HLLT's purpose is for the towns, lake association, MDEP, and CCSWCD "…to work together to improve and maintain the water quality of Highland Lake for the benefit of the residents, the Towns, and future generations."[7]

[7] https://www.windhammaine.us/603/Highland-Lake-Leadership-Team

B. Roles and Responsibilities

The HLLT will continue to establish subcommittees or working groups to fulfill the goals and objectives of this Plan and will be the overarching entity ensuring the action items of the Plan are followed. For each Action Item listed in **Appendix A,** a designated responsible party(ies) is listed who will take the lead in implementing the action. These parties include HLA, Town of Falmouth, Town of Windham, MDEP, CCSWCD, private road residents, Maine State Soil Scientist, Lake Stewards of Maine, University of Southern Maine, Maine Department of Agriculture, Conservation, and Forestry (MDACF), HLLT, specific HLLT subcommittees, residents, property owners, and private road associations.

11. Funding

Appendix A lists the estimated cost of implementing this Plan over the next 10 years. It lists estimated cost per year (with phase/years/number of years), estimated total cost, and potential funding source(s). Potential funding sources and resources generally include the local community and stakeholders (HLA, Town of Falmouth, Town of Windham, private road residents/associations, and property owners and residents). Some sources of funding may include grant funds (federal and state), donations (HLA members), and State employee and program staff time and resources. The total estimated cost for implementing this Plan over the next 10 years is $1.3 million (approximately $130K/year). A large majority of this cost is in-kind labor and resources. To ensure adequate funding is available to implement the action items of this Plan, a Funding Plan Committee will be established as a subcommittee of the HLLT. In addition to HLLT appointed members for this committee, outside members will be sought with background in fundraising and financials.

Appendices

A. Highland Lake Action Items

B. 2018 Highland Lake Watershed Survey Report

C. Highland Lake Road BMP Survey Summary

D. Assessment of Highland Lake Tributary Road Crossings for Geomorphological Impacts

E. Highland Lake Septic System Survey Summary

F. Highland Lake Watershed Sites within the Maine Stream Habitat Viewer

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
1. Continue Monitoring and Tracking for Pollution Sources						
A. Review and assess potential phosphorus inputs into the lake (i.e. erosion sites, fertilizer use, pet waste, waterfowl, etc.)	I, II, III	2020-2030	HLA	HLA (in-kind)	$400	$4,000
B. Regularly update and maintain Highland Lake's 'Site Tracker' with information on new and addressed polluted runoff sites	I, II, III	2020-2030	HLA	HLA (in-kind)	$100	$1,000
C. Monitor private road conditions	I, II, III	2020-2030	Private Road Residents, HLA	HLA (in-kind) and Private Road Residents (in-kind)	$400	$4,000
D. Continue to explore potential impact of septic systems on the lake's water quality						
i. Continue compiling data on the watershed's septic systems (i.e. collecting missing data through landowner surveys, inspection reports during property transfers, etc.)	I, II, III	2020-2030	Towns of Windham and Falmouth	Towns of Windham and Falmouth (in-kind)	$200	$2,000
ii. Contact homeowners with presumed high-risk systems to encourage advanced inspections	I, II	2020-2026	Towns of Windham and Falmouth	Towns of Windham and Falmouth (in-kind)	$200	$400
iii. Conduct advanced septic system inspections with interested homeowners with potential high-risk systems	I, II, III	2020-2030	Towns of Windham and Falmouth, DEP, Maine State Soil Scientist	Towns of Windham and Falmouth, DEP, Maine State Soil Scientist	$8,000	$8,000
E. In-lake monitoring: Continue monitoring basic lake trophic indicators. Investigate controls on nutrient dynamics and phytoplankton composition (e.g. tracking picocyanobacteria, alewife egress, food web studies, climate change impacts)						
i. Work with stakeholders and experts to identify topics of study, determine methodologies, and evaluate results	I, II, III	2020-2030	HLA, HLLT	HLA and HLLT members	$1,000	$10,000
ii. Develop yearly plans for studying in-lake issues	I, II, III	2020-2030	HLA, HLLT, Lake Stewards of Maine, University of Southern Maine, DEP	In-kind services of responsible parties	$200	$2,000
iii. Conduct yearly water qualtiy monitoring of basic health indicators and other previously determined topics of study according to yearly plan	I, II, III	2020-2030	HLA, HLLT, Lake Stewards of Maine, University of Southern Maine, DEP	In-kind services of responsible parties, Town of Windham and Falmouth, HLA member donations	$20,000	$200,000

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
iv. Review and report on data results at end of each year to help determine plan for following year	I, II, III	2020-2030	HLA, HLLT, Lake Stewards of Maine, University of Southern Maine, DEP	In-kind services of responsible parties	$1,000	$10,000
2. Reduce Known Pollutant Loading to the Lake						
A. Address Highest Priority Non-Residential NPS Sites						
i. Provide technical assistance to private roads and associations to review NPS impacts to water quality and to develop road maintenance plans and/or improvement designs	I	2020-2023	CCSWCD, HLA, DEP	US EPA / DEP 319 funding[i], Town of Windham and Falmouth, HLA Board Members (in-kind)	$1,600	$6,400
ii. Provide technical assistance to pre-determined agriculture sites to create plans and agreements for installing BMPs	I	2020-2021	CCSWCD, DEP, MDACF	US EPA / DEP 319 funding, Town of Windham and Falmouth, HLA Board Members (in-kind)	$3,200	$6,400
iii. Install conservation practices to address highest impact polluted runoff sites	I	2020-2023	Private Road Residents	US EPA / DEP 319 funding, HLA, Town of Windham Watershed Grants, Road Associations, Residents	$50,000	$200,000
iv. Develop specific strategies for addressing challenging high impact sites (4-6 Total Sites)	I, II	2020-2026	HLLT Watershed Management Committee	HLA, DEP, Towns of Windham and Falmouth	$3,200	$19,200
v. Implement specific strategies for addressing each of the challenging high impact sites (4-6 Total Sites)	I, II	2021-2026	HLLT Watershed Management Committee	US EPA / DEP 319 funding, HLA, Town of Windham Watershed Grants, Towns of Windham and Falmouth (in-kind)	$8,000	$48,000
B. Address Second Round of Highest Priority NPS Sites (Primarily Residential)						
i. Determine methods/incentives to address multiple residential sites	I	2020	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$2,800	$2,800
ii. Implement determined methods/incentives to address multiple residential sites	II	2024-2026	CCSWCD, HLA, Towns of Windham and Falmouth, DEP	US EPA / DEP 319 funding, HLA, Residents, Towns of Windham and Falmouth (in-kind)	$3,000	$9,000
iii. Provide technical assistance to property owners with polluted runoff sites to install conservation practices	II	2024-2026	CCSWCD, HLA, DEP	US EPA / DEP 319 funding, Town of Windham and Falmouth, HLA Board Members (in-kind)	$1,200	$3,600

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
iv. Install conservation practices to address medium and low impact polluted runoff sites	II	2024-2026	Residents, Property Owners	US EPA / DEP 319 funding, HLA, Town of Windham Watershed Grants, Residents	$50,000	$150,000
v. Provide outreach, incentives, and assistance to property owners to install native plants for water quality improvement targeting properties with inadequate shoreline vegetative buffers	II	2024-2026	CCSWCD, HLA, Towns of Windham and Falmouth	US EPA / DEP 319 funding, HLA, Towns of Windham and Falmouth, Local Nurseries	$2,500	$7,500
C. Address Remaining Highest Priority NPS Sites						
i. Provide technical assistance to property owners and/or road associations with polluted runoff sites to install conservation practices	III	2027-2030	CCSWCD, HLA, DEP	US EPA / DEP 319 funding, Town of Windham and Falmouth, HLA Board Members (in-kind)	$1,200	$3,600
ii. Install conservation practices to address remaining NPS impact sites	III	2027-2030	Residents, Property Owners, Road Associations	US EPA / DEP 319 funding, HLA, Town of Windham Watershed Grants, Residents, Property Owners, Road Associations	$50,000.00	$150,000.00
iii. Explore methods to continue to offer incentives to address any remaining NPS Sites	III	2027-2030	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$2,800.00	$8,400.00
D. Address Ongoing Water Quality Impacts of Existing Private Roads						
i. Hold a series of workshops (2 minimum) to explore methods to effectively reduce impacts of existing private roads on Highland Lake's water quality (i.e. explore potential solutions a watershed-wide road association, discuss legalities of town involvement with private roads)	I	2020-2022	HLLT Watershed Management Committee	US EPA / DEP 319 funding, HLA, Towns of Windham and Falmouth (in-kind), Residents, Outside Speakers (in-kind)	$4,800	$9,600
ii. Create a plan to implement methods determined to effectively reducing impacts of existing private roads on Highland Lake's water quality	II	2024	HLLT Watershed Management Committee with workshop attendee input	US EPA / DEP 319 funding, HLA, Towns of Windham and Falmouth, Residents, Outside Speakers (in-kind)	$8,000	$8,000
iii. Implement determined methods to effectively reduce impacts of existing private roads on Highland Lake's water quality and install conservation practices	III	2027-2030	HLLT Watershed Management Committee	US EPA / DEP 319 funding, HLA, Towns of Windham and Falmouth	$40,000	$120,000

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
3. Limit/Prevent New Phosphorus Inputs into the Lake						
A. Review ordinances and provide suggested updates to Towns for limiting and preventing new phosphorus inputs into the lake	I	2020-2021	HLLT Ordinance Committee	Towns of Windham and Falmouth, HLA (in-kind)	$5,000	$10,000
B. Ensure enforcement of ordinances by towns and State Erosion and Sediment Control Law by Maine DEP for new development in the watershed	I, II, III	2020-2030	HLLT Ordinance Committee, HLA	HLA (in-kind), Towns of Windham and Falmouth	$800	$8,000
C. Develop a strategy to limit/prevent phosphorus input into the lake from future agriculture practices	I	2022	HLLT Watershed Management Committee, Department of Agriculture, Conservation, and Forestry, Agriculture property owners	Towns of Windham and Falmouth, HLA (in-kind),	$3,200	$3,200
D. Implement strategy to limit/prevent phosphorus input into the lake from future agriculture practices	II	2023-2025	HLLT Watershed Management Committee, Department of Agriculture, Conservation, and Forestry, Agriculture property owners	Towns of Windham and Falmouth, HLA (in-kind)	$5,000	$15,000
4. Maintain Installed Conservation Practices						
A. Coordinate collaborative purchasing for conservation practice maintenance services (i.e. catch basin cleaning, road sweeping) and material (i.e. erosion control mulch)	I	2021-2023	HLLT Watershed Management Committee	US EPA / DEP 319 funding, HLA (in-kind), Towns of Windham and Falmouth	$2,500	$7,500
B. Inspect conservation practices to prompt ongoing maintenance	I, II, III	2020-2030	HLA, CCSWCD, Private Road Residents	US EPA / DEP 319 funding, HLA (in-kind), Private Road Residents (in-kind)	$1,600	$16,000

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
C. Determine methods to enhance/encourage ongoing private road maintenance, such as:	I	2020	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA	$3,000	$3,000
i. Phone, letter, email reminders to road associations and contractors *ii. Providing maintenance contractors contacts and services* *iii. Setting up volunteer or low-cost maintenance assistance (possibly youth conservation corps or lake volunteer corps)*						
D. Implement determined methods to enhance/encourage ongoing private road maintenance	I	2021-2023	HLLT Watershed Management Committee	US EPA / DEP 319 funding, HLA, Towns of Windham and Falmouth	$2,500	$7,500
5. Expand Education and Outreach to Modify Behavior for Lake Pollution Reduction						
A. Develop an education and outreach plan for the Highland Lake Watershed, such as:	I	2020	HLLT Education and Outreach Committee	Towns of Windham and Falmouth, HLA (in-kind), DEP	$4,800	$4,800
i. Establish landowner incentives for lake protection (i.e. LakeSmart or similar program, native plant discounts, etc.) *ii. Offer landowner workshops (i.e. YardScaping or conservation landscaping, vegetative buffers, septic system care, etc.)* *iii. Create and distribute outreach material (i.e. public service announcement, handouts, etc.)* *iv. Encourage residents and private road associations to reach out for assistance if their property or private road has an*						
B. Implement Education and Outreach Plan	I,II,III	2020-2030	HLLT Education and Outreach Committee	Towns of Windham and Falmouth, HLA (in-kind), DEP	$5,000	$50,000
6. Manage Alewife Migration						
A. Create a Highland Lake Dam Management Committee to include multiple stakeholders (HLLT members, City of Westbrook, University of Southern Maine, Maine Inland Fisheries and Wildlife, Maine Department of Marine Resources, Casco Bay Estuary Partnership, etc.)	I	2020	HLLT	In-kind services of HLLT and Dam Management Committee Members	$500	$500
B. Determine objectives and timeline for dam management tasks to improve alewife migration into and out of Highland Lake. Tasks to possibly include:	I	2020	Highland Lake Dam Management Committee	In-kind services of Dam Management Committee Members	$4,800	$4,800
i. Determine optimum water level for alewife egress						

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
ii. Create dam/water level management plan for improved alewife egress that involves all interests						
iii. Modify the outlet to ensure alewife migration can easily be facilitated						
C. Implement dam management objectives	I, II, III	2020-2030	Highland Lake Dam Management Committee	In-kind services of Dam Management Committee Members, HLA	$2,000	$20,000
7. Continue Leadership Efforts and Evaluate Effectiveness of the Plan						
A. Continue efforts of HLLT	I, II, III	2020-2030	Towns of Windham and Falmouth, HLA	Towns of Windham and Falmouth, HLA (in-kind)	$5,000	$50,000
i. Hold a minimum of 4 meetings per year						
ii. Actively appoint new members						
B. Strengthen participation and involvement of HLA members	I, II, III	2020-2030	HLA with HLLT support	HLA, Towns of Windham and Falmouth	$2,000	$20,000
i. Create yearly HLA goals						
C. Meet a minimum of 2 times per year to evaluate effectiveness of Plan and update the Plan as necessary	I, II, III	2020-2030	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$4,800	$48,000
D. Provide community updates on the progress of implementing this Highland Lake Watershed Management Plan *(include 319 grant projects being pursued and their status and overall information from the greater HLLT)*	I,II,III	2021-2030	HLLT Board Members, HLLT Watershed Management Committee, HLLT Education and Outreach Committee	Towns of Windham and Falmouth, HLA (in-kind)	$440	$3,960
i. Present updates to Falmouth and Windham Town Councils						
ii. Actively appoint new members						
iii. Provide ongoing updates on Plan's accomplishments through websites, emails, and publications						
8. Develop Funding Mechanisms to Support Plan Implementation						
A. Create a Committee to Develop a Funding Plan	I	2020	HLLT	Towns of Windham and Falmouth, HLA (in-kind)	$1,000	$1,000
B. Develop a Funding Plan to Support Action Items (to include C-H)	I	2020-2021	HLLT Management Plan Funding Committee	Towns of Windham and Falmouth, HLA (in-kind)	$3,000	$6,000

Action Items	Phase(s)	Year(s)	Responsible Party(ies)	Potential Funding Source(s)	Estimated Cost Per Year	Estimated Total Cost
C. Pursue funding to address identified high-risk septic systems	I, II	2023-2024	HLLT Management Plan Funding Committee	US EPA/DEP 319 funding, Maine State Revolving Loans, Small Community Grants Program, Maine Municipal Bond Bank	$1,600	$3,200
D. Pursue funding to conduct yearly water quality sampling	I, II, III	2020-2030	HLA	HLA (in-kind)	$500	$5,000
E. Pursue Section 319 grant funding to provide technical assistance and cost-sharing to address known pollutant sources and assist with education and outreach efforts						
i. Apply for 319 grant to target highest priority non-residential NPS sites	I	2020	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$5,500	$5,500
ii. Apply for 319 grant to target second round of highest priority NPS sites (primarily residential)	I	2023	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$5,500	$5,500
iii. Apply for 319 grant to target remaining highest priority NPS sites	II	2026	HLLT Watershed Management Committee	Towns of Windham and Falmouth, HLA (in-kind)	$5,500	$5,500
F. Pursue Town of Windham watershed grant funding to provide technical assistance and cost-sharing to address known pollutant sources	I, II, III	2020, 2023, 2026	HLA	HLA (in-kind)	$960	$2,880
G Seek local sponsorships for supplies and/or grant funding to address small, low-hanging polluted runoff sites	II	2024-2025	HLA	HLA (in-kind)	$320	$640
H Develop long-term funding mechanisms to continue to support overseeing, evaluating, and updating the Management Plan	I	2020-2023	HLLT Management Plan Funding Committee	TBD	$4,800	$19,200
					Total Estimate (over 10 years)	$1,320,580

HIGHLAND LAKE, MAINE
FALMOUTH, WESTBROOK, WINDHAM

2018 Highland Lake Watershed Survey

March 2019 ~ Highland Lake Association

Prepared by
Watershed Survey Steering Committee
Highland Lake Association

Photograph by
Skip Robinson

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Watershed Survey Volunteers

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Highland Lake Association

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Special thanks and appreciation to John MacKinnon of The Highland Lake Association Board of Directors for his professional time and assistance with this Watershed Survey project.

TABLE OF CONTENTS

Introduction

This report was prepared to inform and provide guidance to everyone concerned about preserving and protecting Highland Lake. It provides the results and analysis of a watershed survey conducted on May 19, 2018, followed by visits to all the sites identified during the survey for purposes of quality assurance and control of field data collected by the volunteers. In addition, this report includes basic information about how to protect lake water quality.

The survey builds on extensive past local efforts. A watershed survey was previously conducted in April and May of 1997. As a result, 104 sites were identified with potential to impact the water quality in Highland Lake, of which almost half (42%) were associated with private camp roads.

To address sites identified during the 1997 watershed survey, three phases of Section 319 Clean Water Act (CWA) implementation grant funds were applied for and awarded from 1999 to 2010. A Youth Conservation Corps (YCC) program was also established during that time. These programs provided technical assistance to more than 300 landowners, addressed 42 private and public roads and 51 residential properties, and enabled the YCC to install Best Management Practices (BMPs) on 176 sites reducing pollutant load by an estimated 278 tons of sediment (1,070 pounds of phosphorus) per year. Extensive education and outreach were also provided through hands-on workshops and presentations, advertising and articles, watershed boundary signs and flyers, and a public forum.

In addition to the Highland Lake Watershed Survey and Implementation Plan completed in 1998, a watershed management plan was completed in 1999 and a Phosphorus Control Action Plan and TMDL (Annual Phosphorus Load Report) was completed and approved in 2003.

The 2018 watershed survey serves to supplement/enhance findings from the 1997 watershed survey, identify new potential sources of runoff pollution, and to update planning for the continued protection of Highland Lake water quality. Results of this watershed survey with proposed recommendations will be included in an updated watershed-based management plan for Highland Lake.

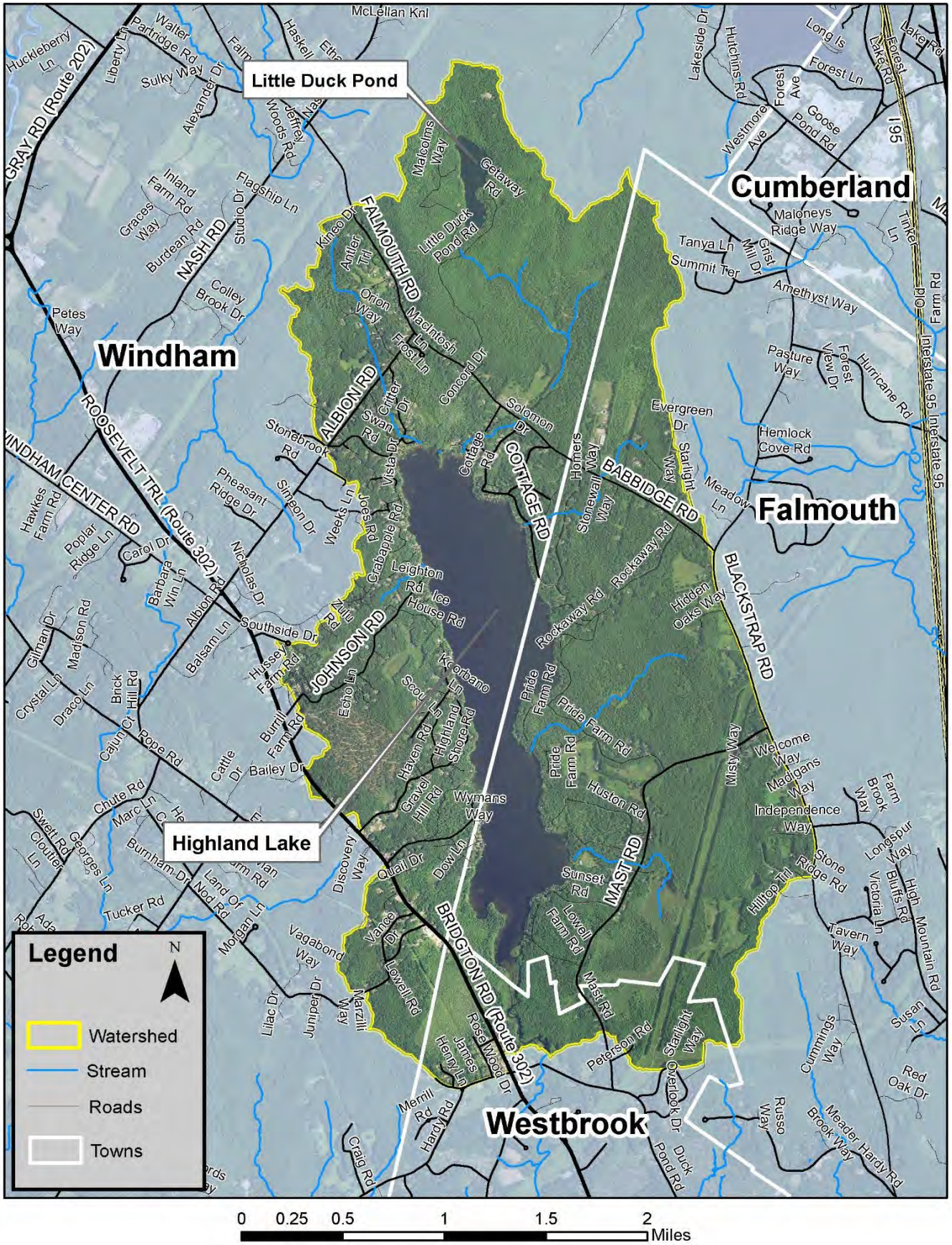
Highland Lake Watershed

A watershed encompasses all the land sloping toward a water body, such as Highland Lake. Runoff from rainfall and snowmelt in this watershed area eventually reaches the lake via a network of streams, ditches, and overland flow. Highland Lake's watershed (**Figure 1**) encompasses approximately 8.5 square miles within the towns of Falmouth, Windham, and Westbrook in Cumberland County, Maine. Six perennial streams drain into the lake along with several intermittent streams. The approximate 7-mile perimeter is developed with 283 lakefront properties and an additional 1,176 properties in the surrounding watershed area according to a recent Highland Lake Association compilation of property assessment records.

The lake itself covers 641 acres, has a volume of approximately 14,000 acre-feet, and serves as the headwaters for Mill Brook, a major tributary of the Presumpscot River which flows into Casco Bay. The maximum depth is 67 feet, with an average depth of 22 feet. Hydrologic retention time is 1.43 years. The lake is deep enough that it stratifies in the summer, and "turns over" twice per year. The lower layer (hypolimnion) is about 15% of the lake volume.

The lake is populated with of a variety of resident warm water fish species including largemouth bass, smallmouth bass, pickerel, American eel, hornpout, white perch, yellow perch, and sunfish. The only cold-water fish native to the lake are brook trout but they are only present in very small quantities according to a gill net survey conducted by Inland Fisheries and Wildlife (IFW) approximately 12 years ago. IFW previously stocked the lake with brown trout beginning in the 1970's and then landlocked salmon beginning in the 2000's but the fish stocking program ceased in 2011 when the decision was made by Falmouth and Windham to not endorse or support a state-owned trailer accessible boat ramp proposed by IFW. The concern expressed by the towns and most lake residents was the increased risk of the introduction and infestation of invasive milfoil into the lake as would be poised by a public boat ramp.

FIGURE 1: HIGHLAND LAKE WATERSHED MAP



In addition to resident freshwater fish species, alewives have been successfully reintroduced into Highland Lake by the Maine Department of Marine Resources. Alewives are anadromous, meaning that they migrate to freshwater to spawn but otherwise live in saltwater except for a brief period after they hatch. What started as a stocking program of a few thousand fish in the early 2000s, has developed into annual returns numbering in the tens of thousands of adult alewives. An estimated 65,000 adult alewives returned to Highland Lake in early summer 2018, a record number of fish since they were first reintroduced. Monitoring of alewife returns is currently led by faculty from the University of Southern Maine. American eel that live in the lake also migrate to spawn, but in their case, they spawn in saltwater (Sargasso Sea).

Current recreational uses of the lake and land surrounding the lake include swimming, boating, water skiing, ice and open water fishing, and snowmobiling. Both motor boating and fishing during the open water season are heavy.

Water Quality

Highland Lake Water Quality

Water quality has been tested in Highland Lake by several different entities (primarily HLA) from 1974 to present day. Since 1974, Highland Lake appears to have undergone significant ***eutrophication***. By its definition, ***eutrophication*** is the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the productivity of algae, usually resulting in the depletion of dissolved oxygen. Lakes with high levels of productivity are considered ***eutrophic***.

The Statutory Water Classification for Maine lakes, ***Class GPA***, requires a stable or decreasing (improving) trophic state in lakes, and that lakes be free of culturally induced ***algal blooms*** that impair their use and enjoyment. In Maine lakes, the amount of phosphorus in the lake controls the amount of algae production in a lake. Since algae is the primary food source in the system, it controls the amount of zooplankton and the fish that the system can support. Although nutrients are necessary for plant growth on land and in water, water bodies that are overloaded with nutrients are subject to ***algal blooms*** that can rob the water of the dissolved oxygen that aquatic organisms need to survive.

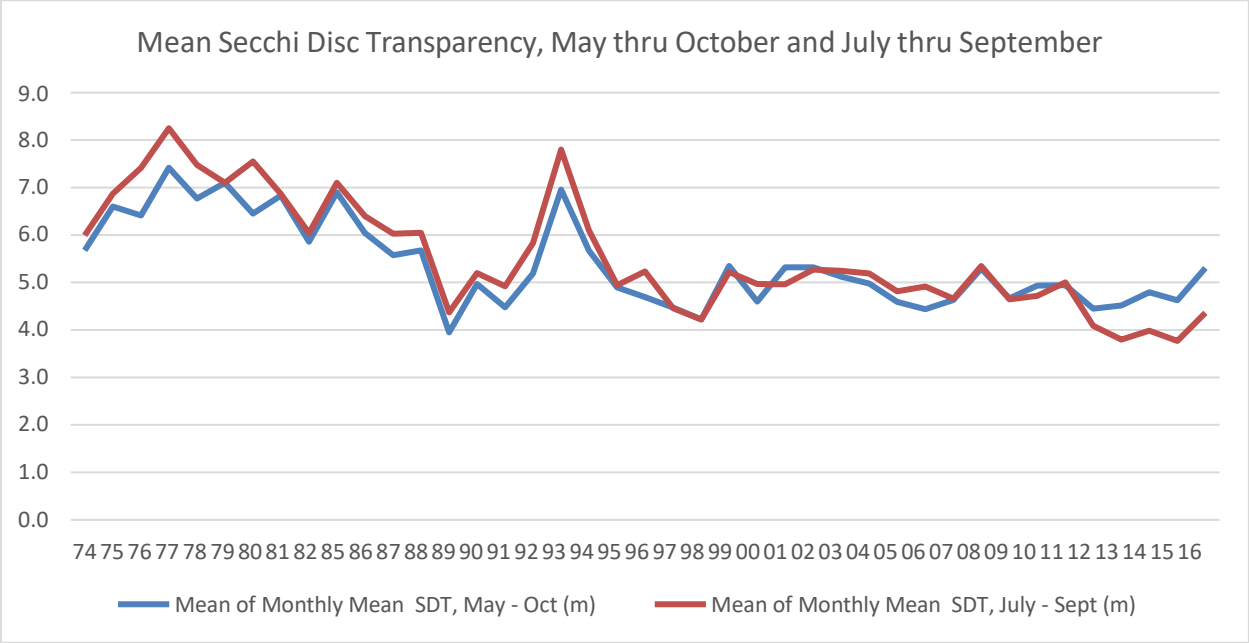
Secchi Disc Transparency (SDT) is a simple method used for testing water clarity. It is also a strong, though indirect, measure of the quantity of algae suspended in the water. The more transparent the water column, the less algae that is present in the lake. **Figure 2** shows how Highland Lake's average transparency has dropped since 1974, from between 6 and 7 meters down to less than 5 meters. **Figure 3** illustrates average phosphorus concentrations in the lake over the same period. There are gaps in the phosphorus record when phosphorus data was not collected, but it shows the progression of average phosphorus concentrations from around 8 parts per billion (ppb) in the mid-1970s to 10 ppb or more in recent years. As is frequently the case with lakes experiencing eutrophication, the changes were not smooth and continuous. Highland Lake appears to have moved from a relatively stable low trophic state in the 1970s and early 1980s through a period of transitions with a low in 1989 and a high in 1993 to settle into a new stable condition from the mid-1990s to 2007. This is followed by a period of increasing trophic state culminating in what is assumed to be picocyanobacteria (Pcy) blooms in 2014 through 2017. The Pcy blooms (SDTs of less than 2 meters), consistently started in the third or fourth week in July and ended in

Algal Blooms

A surplus of nutrients in a water body can cause an algal bloom, or algae population explosion, that can turn clear water to a cloudy green color. In extreme cases, thick, foul smelling scum forms on the water and fish kills may occur when decomposing algae depletes the water's oxygen supply. Lakes are considered to be experiencing an algae bloom when SDT is less than 2 meters. Blooms of picocyanobacteria (Pcy) that have occurred in Highland Lake are unusual in that their abundance relative to other algae typically decreases with increasing trophic state and rarely make up a significant portion of the algal biomass. Highland Lake appears to be the exception for at least part of the summer.

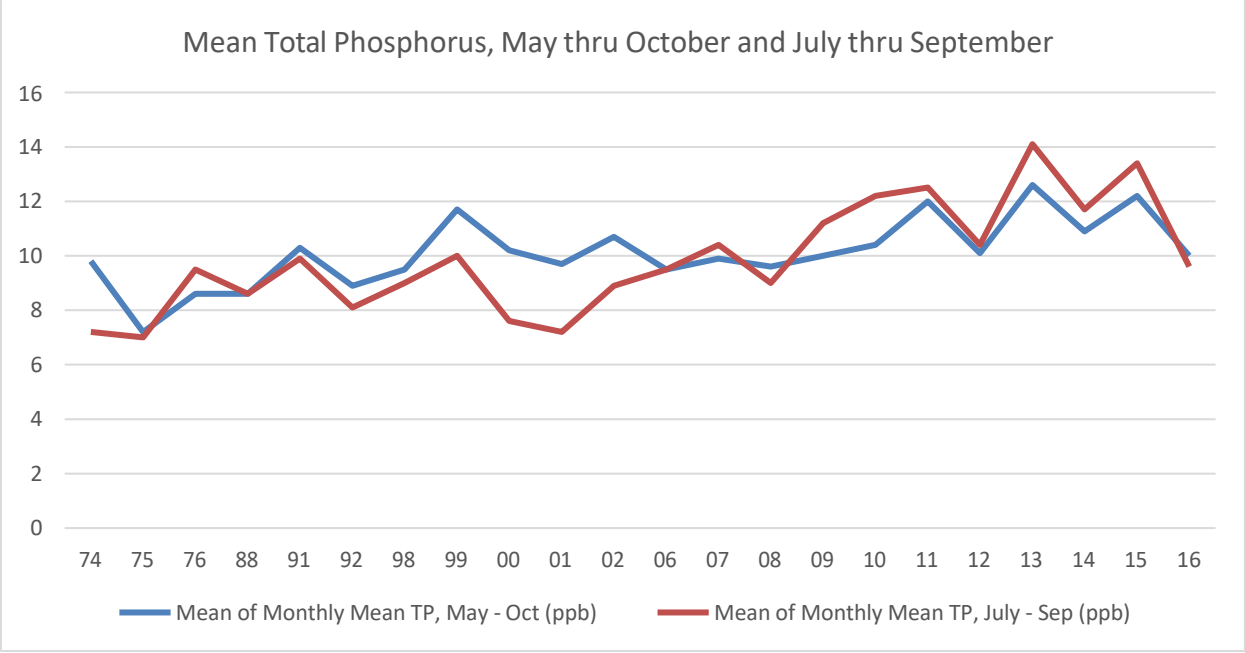
the first or second week in August. They are bracketed by SDTs of 4 meters or more. The consistency of the timing, appearance and duration of the blooms have led researchers to believe that the same species of Pcy was responsible for the blooms in each of those years.

Figure 2. Mean of Monthly Mean SDT in meters from 1974 to 2016[1].



[1] Dennis, Jeff; Bacon, Linda, Maine DEP Division of Environmental Assessment; Highland Lake Summary, September 2017

Figure 3. Mean of Monthly Mean TP in ppb from 1974 to 2016 for Years with Data[1].



[1] Dennis, Jeff; Bacon, Linda, Maine DEP Division of Environmental Assessment; Highland Lake Summary, September 2017

A change in seasonal succession is also reflected in **Figures 2 and 3**. In **Figure 2**, the blue line represents average SDT for the period of May through October in each year. The red line represents average SDT for July through September. When the red line is above the blue line, it indicates that the clearest water with the least algae is occurring during the summer months. Conversely, when the blue line is on top, the less clear

water with the most algae is occurring during the summer months. In the relatively stable period in the 1970s and early 1980s, the clearest water occurs during the summer time. With increasing trophic state since that time, the lake became less clear and more productive during the summer, a seasonal succession pattern typical of high productivity lakes. The phosphorus data in **Figure 3** suggests that same trend, with summer total phosphorus concentrations being lowest in the summer during the early years and highest during the summer in recent years.

The consistent decline in water quality through the 1980s led the Maine Department of Environmental Protection (Maine DEP) to list the lake as impaired in 1990 and no longer meeting its Class GPA standards due to late summer dissolved oxygen depletion (later modified to include increasing trophic state based on the long-term trend of decreasing transparency). Intense efforts to reduce polluted runoff throughout the watershed from 1999 through 2010 resulted in the lake being removed from the impaired list in 2010 because it had maintained a stable trophic state for more than 10 years and thus met the statutory water quality criteria of having a stable or decreasing trophic state.

However, as a result of continuing development trends in the area and the water quality conditions, Highland Lake remains on the Maine DEP Nonpoint Source (NPS) Priority List as one of 151 threatened lakes because it is on a "watch list" of particularly threatened lakes and is "sensitive to additional phosphorus inputs".[2] Yearly picocyanobacteria (Pcy) blooms from 2014-2017 make the lake highly likely of being relisted as an impaired waterbody, which would make it the only lake in Cumberland County to be listed as impaired.

The purpose of the NPS list is to encourage NPS abatement work in watersheds most vulnerable to NPS pollution. The list is used to help prioritize Maine DEP NPS water pollution control efforts and encourage local communities to take action to restore or protect waters impaired or threatened by NPS pollution.

NPS Priority Watersheds

Maine DEP maintains a list of watersheds where water quality is impaired or considered particularly threatened by polluted runoff.

A watershed must be listed by as an NPS Priority Watershed in order to be eligible to apply for 319 grant funding under the Clean Water Act that can be used to remediate phosphorous inputs.

Highland Lake is on the NPS Priority Watersheds list.

2018 Water Quality Testing

In order to determine the reasons why Highland Lake is apparently unique among all the lakes in New England and rare in North America for supporting Pcy blooms, an intensive data collection effort was conducted from May through October 2018. The effort was conducted to test the following hypotheses:

- phosphorus drives the Pcy blooms;
- unstable fish/food web interactions release Pcy from predation by the zooplankton and allow Pcy populations to increase dramatically;
- climate changes have influenced lake stratification and increase the possibility of a bloom, and;
- a combination of any or all three of the above hypotheses drives the Pcy blooms.

Dr. Karen Wilson, an associate research faculty at University of Southern Maine, is leading the field program. Many of the samples collected during the 2018 field program have yet to be analyzed as of the publication date of this report. Consequently, there is no interpretation of 2018 data in this report.

[2]Maine Department of Environmental Protection; Nonpoint Source Priority Watersheds List; http://www.maine.gov/dep/land/watershed/nps_priority_list/NPS%20Priority%20List%20-%20Lakes.pdf

Water Quality Monitors

The HLA is fortunate to have a dedicated group of trained and certified volunteers to monitor lake water quality and to patrol for invasive plant species. Together, HLA Monitors and Patrollers create a first alert system, keeping careful watch for potential problems. As of this writing, our volunteers are:

Certified Water Quality Monitors

Tom Bannen
Emma Dennison
Laura Duran
Tim Hawkins
Ericka Hutchinson
Jim Linsley
David Nadeau
Richard Qualey
Terry Theodose
Meg Thurrell
Kim White
John Wilcox
Keith Williams
Karen Wilson
Adam Zemans

Certified Invasive Plant Patrollers

Ann Carr
Terry Theodose
Keith Williams
Adam Zemans

Threats to Lake Water Quality

What puts water quality at risk? The biggest pollution culprit in Highland Lake and other Maine lakes is **polluted runoff or NPS pollution.** Polluted runoff is found in stormwater runoff from rain and snowmelt. During and after storms and snowmelt, streams and overland flow washes soil and other pollutants into lakes from the surrounding landscape.

In an undeveloped, forested watershed, stormwater runoff is slowed and filtered by tree and shrub roots, understory plants, leaves, and other natural debris on the forest floor. It then soaks into the uneven forest floor and filters through the soil. In a developing watershed, however, stormwater does not always receive the filtering treatment the forest once provided. Runoff from impervious surfaces, such as rooftops, compacted soil, and gravel camp roads becomes connected and speeds up, often channelized. The runoff becomes a destructive erosive force as it is greater in both velocity and volume than stormwater in an undeveloped landscape. Not only is the increase in stormwater volume and velocity problematic in a developing watershed, but pollutants in the stormwater runoff can be harmful as well.

Polluted runoff can contain a variety of pollutants, depending on the land use in the watershed. In developing watersheds, runoff typically contains the following pollutants:

- elevated levels of nutrients such as nitrogen and phosphorus
- sediment from soil erosion
- bacteria
- toxic substances such as pesticides, herbicides, petroleum products, and metals

Polluted Runoff

Also called nonpoint source pollution or NPS. Pollution from diffuse, seemingly insignificant sources (such as erosion, roads, septic systems) that, when combined, add up to a significant amount of pollution in a watershed. The pollutants of greatest concern to Maine lakes are typically nutrients and sediment. They deliver a one-two punch to lake water quality when sediment settles onto the lake bottom smothering aquatic organisms and nutrients feed algae growth resulting in depleted oxygen in the water and increasing trophic state.

Nutrients

As previously noted, the amount of phosphorus in Maine lakes controls the amount of aquatic plant, particularly algae, production in a lake. Increases in phosphorus levels usually result in noticeable changes to water. Algae need phosphorus in order to grow. So, when phosphorus levels increase, lake algal populations also increase, causing a decline in water transparency. These algal blooms may eventually lead to depletion of the lake water's oxygen supply, often resulting in the eventual loss of some fish species.

Phosphorus is abundant in the environment, but in an undisturbed environment it is tightly bound up by soil and organic matter for eventual use by plants. Natural systems conserve and recycle nutrients, water, and other materials needed to sustain plant growth. Water is stored in depressions on the uneven forest floor and seeps into the ground to become groundwater, thereby preventing it from running over the land surface and exporting valuable nutrients from the system.

Land development changes the natural landscape in ways that alter the normally tight cycling of phosphorus. The removal of vegetation, smoothing of the land surface, compaction of soils, and creation of impervious surfaces combine to reduce the amount of precipitation retained onsite, dramatically increasing the volume of stormwater runoff. These changes to the land surface and the associated increase in stormwater runoff dramatically increase phosphorus export. Stormwater flowing over the land surface picks up phosphorus and transports it in soluble form or attached to eroded soil particles. The phosphorus in stormwater comes from natural and human sources, including eroded soil, road dust, septic waste, pet waste, lawn fertilizer and detergents.

Sediment

Sediment from soil erosion not only carries attached nutrients and toxic substances into lakes, it also can settle out and smother habitat located on the lake bottom. It can clog and abrade fish gills, hinder freshwater shellfish feeding, smother eggs and insect larvae, and fill in the pore space between bottom cobbles where some species of fish lay eggs. Large volumes of sediment that settle out can also create an ideal substrate for nuisance and invasive aquatic plants such as variable-leaved milfoil.

Bacteria

All the households and businesses in the Highland Lake watershed rely on on-site septic systems to dispose of their wastewater. After solids are trapped in a septic tank, wastewater is distributed through a subsurface drain field and allowed to percolate through the soil. Bacteria and nutrients are effectively removed by filtration and decomposition of wastewater through the soil profile, if the septic system is properly sited, installed, and maintained. However, when wastewater breaks out from the subsurface onto the ground surface or passes through the soil profile without adequate treatment, a septic system is said to have failed and is no longer providing adequate treatment of bacteria. The regional rate of septic system failure across the country is reported to range from 5% to nearly 40%, with an average of about 10%.[3] The introduction of the Maine Septic Code in 1974 standardized septic system design and is credited with significantly reducing the rate of septic system failure in this state. The causes of septic system failure are numerous: inadequate soils, poor design, hydraulic overloading, tree growth in the drain field, old age, and failure to clean out the septic tank. The following factors can increase the risk of septic system failure:

- systems that are older than 20 years;
- systems situated on small lots;
- systems that service second homes or provide seasonal treatment;
- systems adjacent to shorelines or ditches; and systems that are located on thin or excessively permeable soils or are close to bedrock or the water table.

[3] Albert Frick Associates; Drumlin Environmental LLC; Watershed Solutions Inc; "Cape Neddick River Watershed-Based Management Plan", June 2013.

The design life of most septic systems is 15 to 30 years, at which point major rehabilitation or replacement may be needed. Based on the age of development in the watershed, Town records are expected to show that a significant percentage of the septic systems in the Highland Lake watershed are at least 30 years old. In addition, preliminary evaluation of soils along or near the shoreline of Highland Lake found that about 25% of the lots around the lake have either shallow to bedrock soils and/or highly permeable soils that could lead to failure of septic systems installed on those lots.[4]

Toxic Substances

Toxic substances in polluted runoff can originate from the following potential sources that can be found in residential or commercial areas:

- Oil, grease, and antifreeze leaking or washed from cars and boats onto gravel and paved surfaces are ultimately flushed into drainageways.
- Accidental spills from gassing up motor boats on the lake can be a direct contributor to water pollution.
- Accidental spills from corroded or damaged home heating oil tanks.
- Homes and businesses equipped with sump pumps and floor drains that discharge into drainageways can produce severe toxic effects on a lake depending on the types of chemicals stored in these buildings.
- Pesticides and herbicides applied to lawns, gardens, and crops can eventually find their way into the lake, even if they are applied according to manufacturer's instructions. Some herbicides and insecticides, such as diazinon, can be harmful to aquatic life even at very low levels.

Many of the toxic substances found in polluted runoff are persistent in the environment, meaning that they degrade slowly and can accumulate in the food chain.

Why Protect the Lake?

Why should we protect the lake from polluted runoff?

- The lake contains valuable habitat for fish, birds and other wildlife.
- Highland Lake provides recreational opportunities to watershed residents and to visitors. It is an important contributor to the local economy.
- A 1996 University of Maine study demonstrated that lake water quality affects property values. For every meter (3-foot) decline in water clarity, shorefront property values can decline as much as 10 to 20 percent![5] Declining property values affect individual landowners as well as the economics of the entire community.
- Once a lake has declined, it can be difficult and prohibitively expensive to restore. Following a decade of work to reduce watershed nutrient sources, an alum treatment was used in the summer of 2018 to rid East Pond in Smithfield, Maine of algae blooms. It cost approximately $1.1 million and is anticipated to be effective for 15-20 years.
- Sediment and nutrients that wash into the pond encourage the growth of invasive plants and can cause algae blooms, all of which impact the habitat for fish and other lake species.

[4]Dennis, Jeff; Maine DEP Division of Environmental Assessment, Highland Lake Leadership Team Meeting Minutes, September 10, 2018

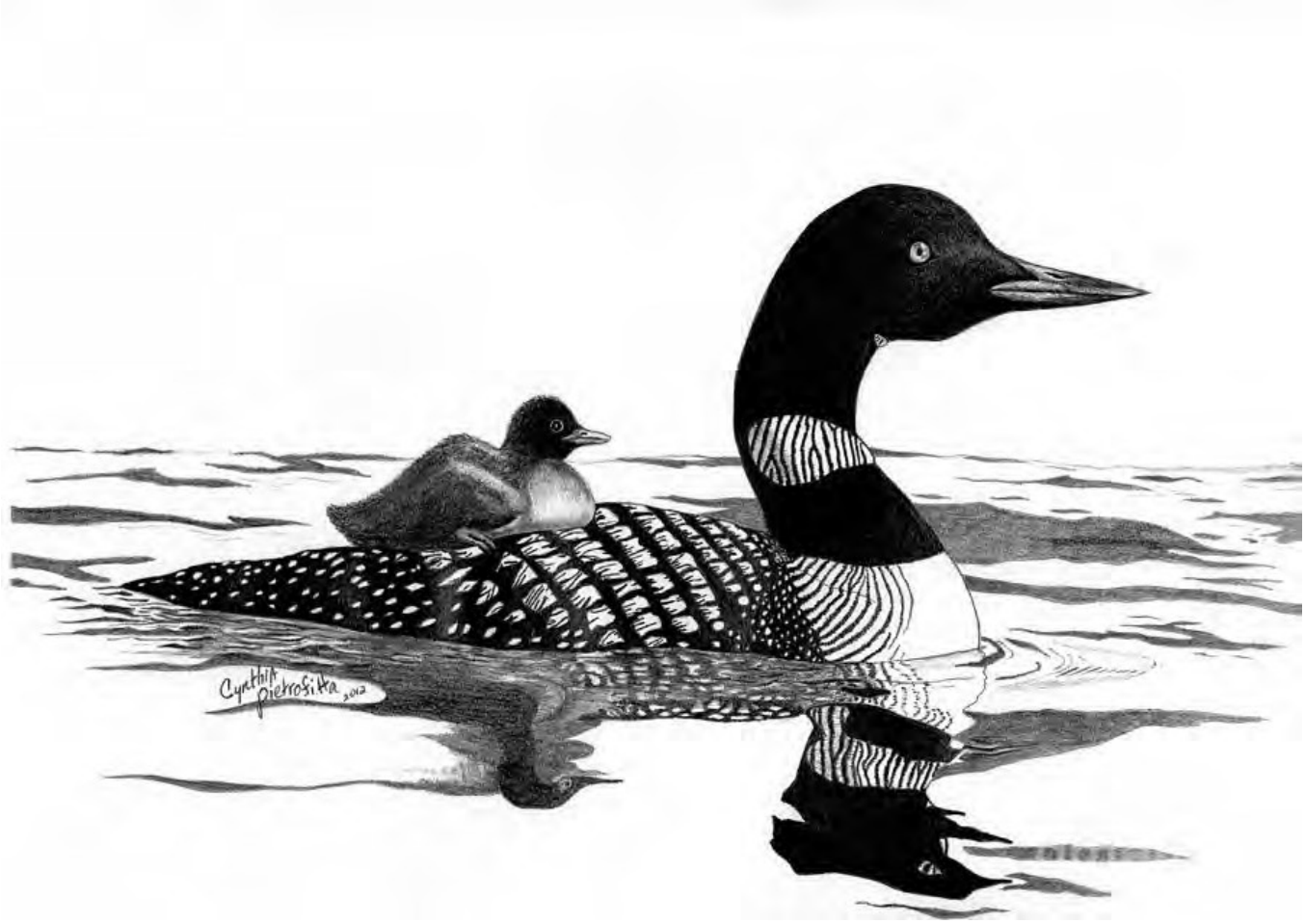
[5] Bouchard, Roy; Boyle, Kevin; Michael, Holly, "Water Quality Affects Property Prices: A Case Study of Selected Maine Lakes," 1996. University of Maine.

What Are We Doing Now?

What is being done to protect the lake from polluted runoff?

The steering committee for the Highland Lake Watershed Survey was formed in order to identify soil erosion issues in the watershed, raise funds to conduct a survey, and continue educating users of the lake on how to protect it now and for future generations. Volunteer watershed surveys have been found to be one of the most effective ways to protect lake water quality by getting citizens involved in identifying existing and potential sources of polluted runoff.

It is the hope of the steering committee that through the survey and associated education and outreach efforts, the local community will find the social and financial resources it needs to further guard against the degradation of Highland Lake. The 2018 Highland Lake Watershed Survey Report will be the foundation of the updated watershed management plan, which is needed in order to apply for federal funding to remedy some of the issues identified during the survey. Already, the community has secured municipal and private support. Both the financial and community support will need to grow in order for the plan to be put into action.



Watershed Survey Overview

Purpose of the Watershed Survey

The primary goals of the 2018 Highland Lake Watershed Survey were to:

- Identify and prioritize existing sources of polluted runoff, particularly soil erosion sites, in the Highland Lake Watershed.
- Raise public awareness about the connection between land use and water quality, and the impact of soil erosion on Highland Lake.
- Inspire people to become active watershed stewards.
- Provide the basis to obtain additional funds to assist in fixing identified erosion sites.
- Make general recommendations to landowners for fixing erosion problems on their properties.
- Use the information gathered as one component of a long-term lake protection strategy.

The purpose of the survey was NOT to point fingers at landowners with problem spots, nor was it to seek enforcement action against landowners not in compliance with ordinances. Watersheds are complex and interconnected. While it is important to be accountable for the problems that arise, there is no individual or single entity responsible for any current or future water quality issues in Highland Lake. Rather, it is the accumulation of all inputs, past and present, that are responsible for water quality degradation. It is the hope that, through future projects, the steering committee can work together with landowners to solve erosion problems on their properties or help them learn how to best accomplish solutions on their own.

Local citizen participation was essential in completing the watershed survey and will be even more important as protection planning and project funding goals are pursued. With the leadership of the steering committee and assistance from agencies concerned with lake water quality, the opportunities for stewardship are limitless.

The steering committee hopes that readers of this report will think about their own property and then try some of the recommended conservation measures. Everyone has a role to play in lake protection!

The Survey Method

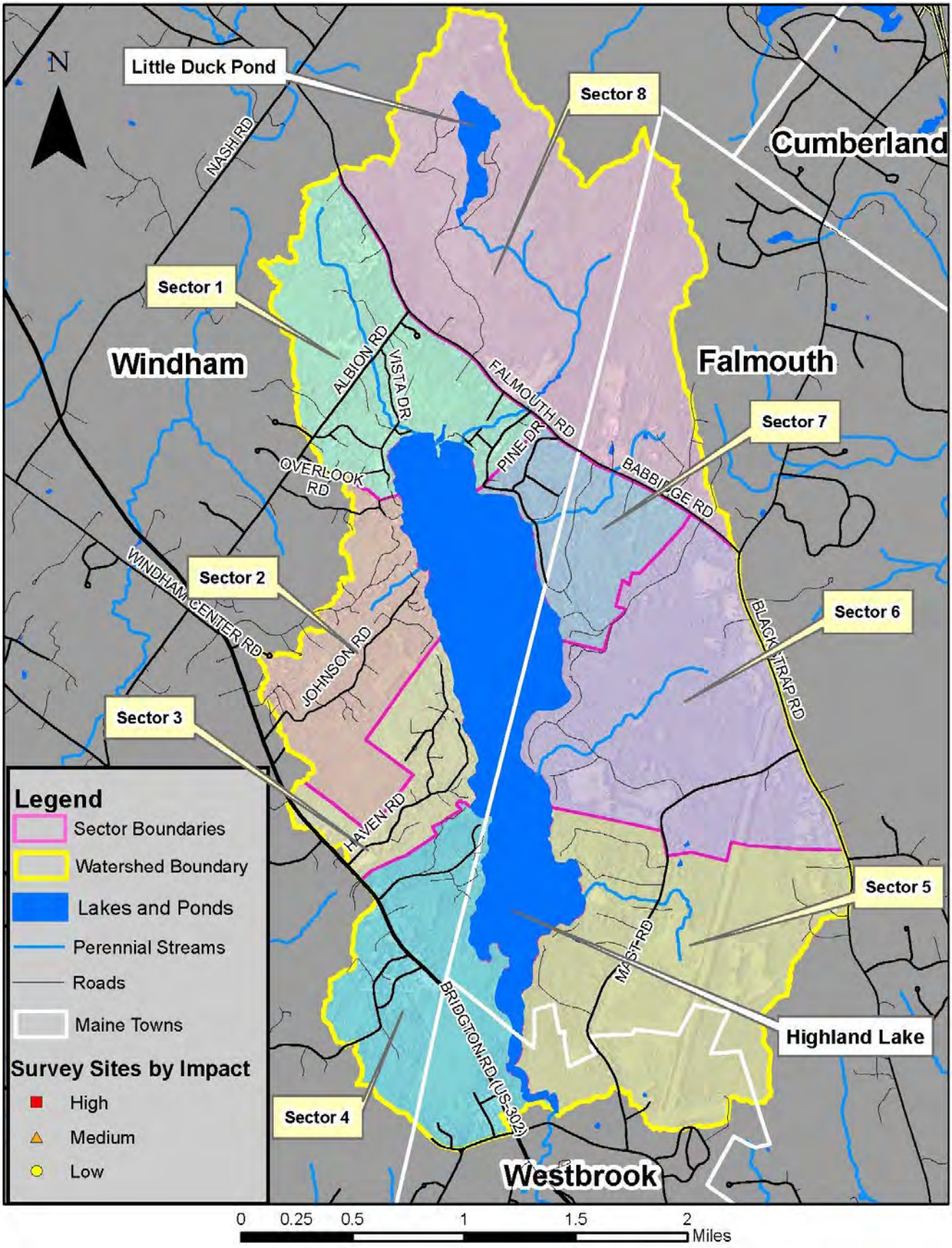
A watershed survey gives an idea of soil erosion impacts at one point in time. Land use in the Highland Lake watershed is constantly changing. This report does not account for sites that have been fixed since the survey nor does it represent other improvements to or degradation of the watershed. It will be up to future surveyors to incorporate those changes.

The survey was conducted by volunteers with the assistance of trained technical staff. Several groups and consultants served in this role. On May 19, 2018, our 33 volunteers were trained in survey techniques during a two-hour classroom workshop. Following the classroom training, the volunteers and technical staff spent the remainder of that day documenting erosion on the roads, properties, driveways, and trails in their assigned sectors using cameras, GPS units and standardized forms. Survey volunteers were split into eight teams to conduct field observation and documentation. An overview map of the entire watershed area divided into eight sectors is provided in **Figure 4**.

Problem Sites

If soil erosion reaches the lake or a stream or ditch that connects with the lake, it is considered a problem site. The distance to the lake does not make a difference. The attached or dissolved phosphorus can eventually reach the lake. According to DEP, the same holds true for erosion that enters wetlands.

FIGURE 4: HIGHLAND LAKE WATERSHED SURVEY SECTORS



For each identified NPS site, survey teams completed a Highland Lake Watershed Survey form (Appendix A). Throughout this report, sites are identified using the format Sector 1, Site 1 and often abbreviated in the format 1-1, 1-2, 1-3, etc. Volunteers scored the overall impact of each site using the scoring system provided on the survey form (**Table 1**). As shown on **Table 1**, there are three types of soil erosion that were rated by the survey teams. An explanation of each type, from least to most serious, is provided below.

- **Sheet Erosion:** Erosion of a relatively thin layer of soil, without channel formation, as a result of water flowing over bare ground.
- **Rill Erosion:** Erosion that results in shallow channels (no more than a few inches deep) from water flowing over bare ground.
- **Gully Erosion:** Erosion that results in deep, wide channels from water flowing at a high rate and causing a significant deep cutting action into bare ground.

The "Area" column on the survey form is self-explanatory and "Buffers and Other Filters" refers to presence or absence of a strip of vegetation (buffer) that would intercept runoff from an NPS site before it enters a stream or the lake. A well-developed buffer can dramatically reduce the amount of sediment and other pollutants carried in runoff from a site.

Two experienced HLA members conducted follow-up visits to all the sites for quality assurance and control purposes. This resulted in changes to scores for some sites and eliminated some sites that were judged to have no impact on the lake.

TABLE 1: LAKE SURVEY FORM – METHOD OF ASSIGNING IMPACT

Impact: Circle one choice in each column, add the three selected numbers together, and then circle the site's corresponding impact rating (high, medium, or low).

Type of Erosion	Area	Buffers and Other Filters	IMPACT
Gully - 3	Large - 3	No filter, all channelized direct flow into lake or stream - 3	~~High~~: 8-9 pts
Rill - 2	Medium - 2	Some buffer or filtering, but visible signs of concentrated flow and/or sediment movement through buffer and into lake - 2	Med: 6-7 pts
Sheet - 1	Small - 1	Significant buffer or filtering* - 1	Low: 3-5 pts

* Confirm there is likely sediment/runoff delivery. If not, do not write up as a site.

The collected data was entered into a computer database to create a spreadsheet, and the documented erosion sites were plotted on maps. The sites were ranked based on their impact on the lake, in addition to being evaluated based on the technical ability needed to fix the problem and the estimated cost of fixing the problem.

A description of sites and associated rankings are discussed in the next section of this report. Maps of the erosion sites are located in **Appendix B**, and a spreadsheet with data from the documented sites is located in **Appendix C**. For the sake of brevity, not all site data from the survey forms were entered into the **Appendix C** spreadsheet. The excluded data will be used at a later date when plans are made for site mitigation. Contact the HLA at ***rosiehartzler@highlandlakemaine.org*** for additional site information.

Watershed Survey Findings

Volunteers and technical staff documented 129 sites across the watershed that currently, or have the potential to, negatively affect the water quality of Highland Lake. The number of sites documented were roughly distributed in relation to the density of development among the eight sectors.

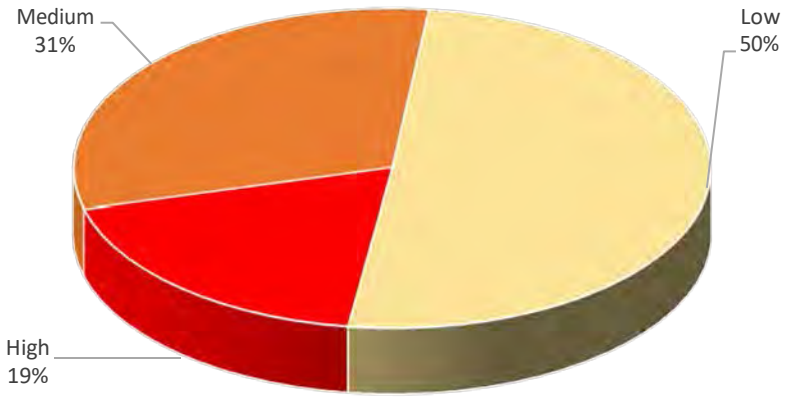
As previously stated, each site was rated high, medium, or low impact based on the type of erosion, the size of the area eroded, and the type of buffering or filtering that the erosion underwent before entering a stream, ditch, or the lake.

Of these, 65 sites were rated as low impact, 40 sites as medium impact, and 24 sites as high impact. Overall, approximately 50% of the sites found were rated high or medium impact. **Table 2** presents impact data for each survey sector and **Figure 5** displays the percentage of each impact rating across all sectors.

TABLE 2: IMPACT COUNTS PER SECTOR

Sector	Total Count	High (8-9)	Medium (6-7)	Low (3-5)
1	10	3	7	0
2	22	5	1	16
3	21	4	9	8
4	17	4	6	7
5	7	0	3	4
6	18	2	6	10
7	26	5	6	15
8	8	1	2	5
TOTALS	**129**	**24**	**40**	**65**

FIGURE 5: IMPACT RATING BY PERCENT FOR ALL SECTORS



Primary Land Use Activity

While documenting erosion sites, surveyors were also asked to select land use categories associated with each site. These categories included residential, private road, boat access, driveway, trail or path, construction site, town road, beach access, and stream crossing. The number and percentage of sites in each land use category across all survey sectors are displayed in **Figure 6.** The distribution of impact ratings for each land use category is displayed in **Figure 7**.

FIGURE 6: NUMBER AND PERCENTAGE OF SITES BY LAND USE

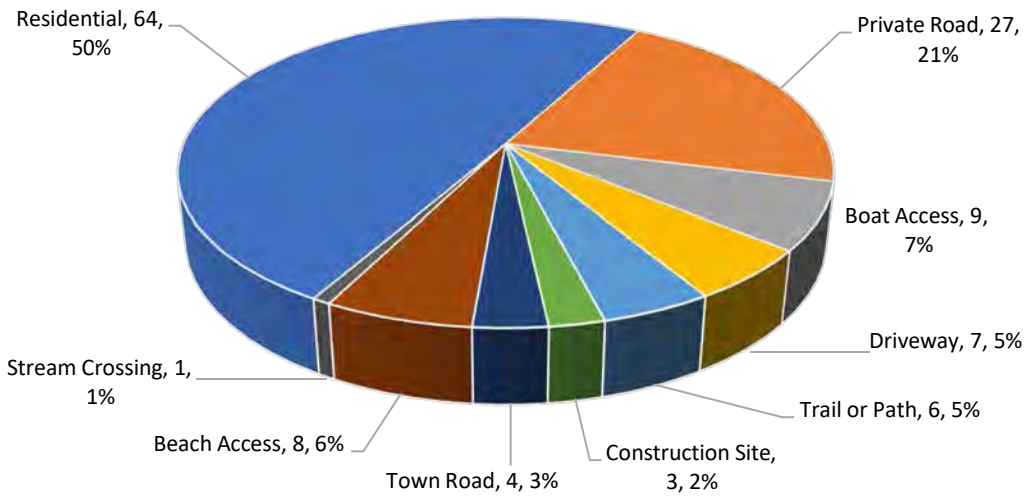
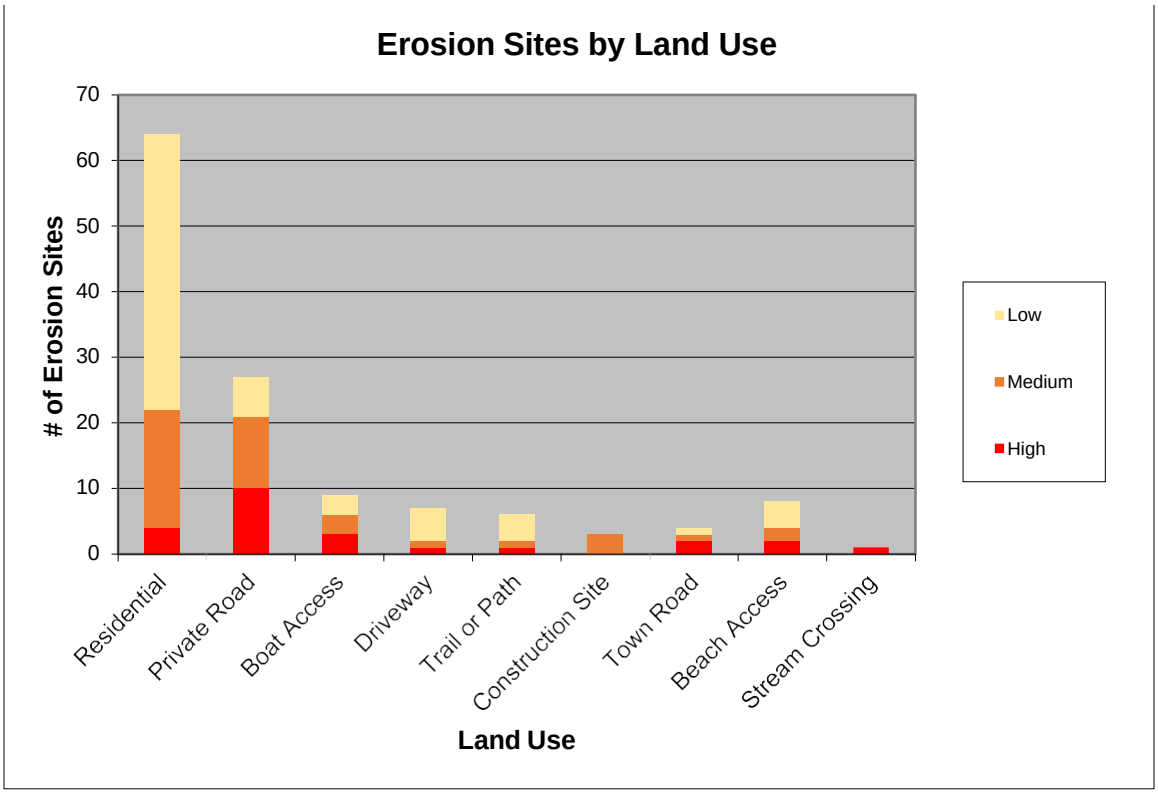


FIGURE 7: IMPACT RATING DISTRIBUTION FOR EACH LAND USE CATEGORY



Summary of Findings by Land Use Group

As shown in **Figures 6 and 7**, the residential and private road land use categories make up the vast majority of NPS sites identified during the survey. Between them, they also have the most sites in each impact rating (high, medium, and low) as compared to the other land use categories. Because they are the predominate land use categories, and to simplify analysis of land use data, other land use categories that are closely aligned with residential and private roads have been grouped together to create the "Residential Group" and the "Road Group". Since the boat access, trail or path (all right-of-ways to the lake), and construction site land use categories don't align with either the Residential Group or the Road Group, they are treated as the "Miscellaneous Group". The three groups and their respective land use categories are presented in **Table 3**, followed by an analysis of each.

TABLE 3: LAND USE CLASSIFICATIONS AND THEIR CATEGORIES

Residential Group	Road Group	Miscellaneous Group
Residential	Private Road	Boat Access
Driveways	Town Road	Construction Site
Beach Access	Stream Crossing	Trail or Path

Residential NPS Sites

The number of NPS sites that fall under the Residential Group (79 sites) exceeds the number of sites found under the Road Group (32 sites) and the Miscellaneous Group (18 sites) combined. This is not surprising considering the amount of shoreline development and that nearly all shoreline development includes cleared land for yards, driveways or parking areas, and direct access from the dwellings to the shore. All the Residential Group land uses (residential, driveways, and beach access) have the potential to contribute significant quantities of sediment to the lake because runoff from one land use oftentimes combines with runoff from another land use, compounding the effects of each. For example, runoff from a driveway located in the upper part of a lot can combine with roof runoff from structures located on the lot which then combine with runoff from pedestrian access to the shore. It is significant to note that shoreline vegetation, which would otherwise intercept and trap sediment in runoff from uphill land uses, is inadequate or absent at a total of 43 sites. **Table 4** shows problems associated with the Residential Group and a count of sites affected by each problem.

TABLE 4: SUMMARY OF FINDINGS FOR THE RESIDENTIAL GROUP

Problem Description	Count of Sites
Soil - Bare	67
Surface Erosion - Sheet	50
Shoreline - Inadequate Shoreline Vegetation	22
Shoreline - Lack of Shoreline Vegetation	21
Shoreline - Erosion	16
Roof Runoff Erosion	17
Surface Erosion - Rill	15
Shoreline - Unstable Access	9
Shoreline - Undercut	5

Ditch - Gully Erosion	3
Soil - Uncovered Pile	3
Ditch - Sheet Erosion	2
Culvert – Clogged, Ditch - Bank Failure, Ditch – Undersized, Soil – Delta in Stream/Lake, Surface Erosion – Gully, Ditch – Rill Erosion, Culvert – Unstable Inlet/Outlet, Soil - Winter Sand, Road Shoulder Erosion - Rill	1 each

Examples:

Residential

This site is representative of several residential group land uses where the combined runoff from each has caused significant sheet erosion in the yard and along the shoreline. Runoff from the lower driveway combined with runoff from the roof and compacted bare soil in the yard is discharging sediment directly into the lake. In addition, without a delineated and stable path for beach access, vegetation is unable to take root and stabilize the shoreline.

Driveways

This site is representative of typical driveway problems that can occur when runoff flows directly down the driveway, gaining in both velocity and volume as it nears the lake. These two factors combine to erode the driveway surface material and the resulting sediment is deposited into the lake. Because driveways see light vehicular use relative to roads, runoff diverters can be placed across driveways at intervals, breaking up the flow of water and sediment and depositing it into adjacent wooded areas rather than the lake.

Beach Access

This site is representative of problems that can occur when runoff from upper areas of a lot is allowed to flow unimpeded to the beach. Beaches are very susceptible to erosion as is apparent by the severe rill erosion that can be seen below the steps. To protect the beach from erosion, runoff from the upper lot area must be diverted into a vegetated buffer that can slow and infiltrate runoff. In the absence of an adequate buffer, infiltration practices can be constructed to collect and infiltrate runoff.

Road NPS Sites

The number of NPS sites that fall under the Road Group (private road, town road, stream crossing) account for 25% of all NPS sites, with private road sites (27 sites) far outnumbering the number of town road sites (4 sites). Although the number of NPS sites in the Road Group are fewer than those in the Residential Group, the number of high impact sites in the Road Group (12) is nearly double the number of high impact sites in the Residential Group (7).

The greater number of high impact road sites is largely a function of most private roads in Falmouth and Windham being unpaved and subject to chronic erosion due to snowmelt and stormwater runoff. Private unpaved roads require regular maintenance to stabilize road surfaces and to clean out culverts and ditches that collect sediment. In the absence of regular maintenance, culverts become blocked and ditches fill with sediment, oftentimes leading to the discharge of road material and winter sand directly into the lake. Uncontrolled runoff from roads can also exacerbate erosion problems on residential sites. Although the town roads around Highland Lake are paved (e.g., Cottage Road), a lack of maintenance can lead to some similar problems. **Table 5** shows problems associated with the Road Group and a count of sites affected by each problem.

TABLE 5: SUMMARY OF FINDINGS FOR THE ROAD GROUP

Problem Description	Count of Sites
Soil - Bare	11
Culvert – Unstable Inlet/Outlet	9
Road Shoulder Erosion - Rill	7
Surface Erosion - Gully	7
Soil – Winter Sand	7
Surface Erosion - Sheet	6
Culvert - Clogged	5
Ditch – Gully Erosion	5
Ditch – Rill Erosion	5
Surface Erosion - Rill	4

Road Shoulder Erosion - Gully	3
Roadside Plow/Grader Berm	3
Ditch - Undersized	2
Road Shoulder Erosion - Sheet	2
Ditch – Sheet Erosion	2
Ditch – Bank Failure	2
Shoreline - Undercut	2
Soil – Uncovered Pile, Culvert – Crushed/Broken, Soil – Delta in Stream/Lake, Shoreline – Erosion, Culvert - Undersized	1 each

Examples:

Private Road

This site is representative of several private road problems observed around the lake. Sheet flow from the road surface concentrates along the edge of the road and, in the absence of a stable drainageway, runoff is cutting into the road shoulder producing rill and gully erosion. Winter sand that has accumulated on the road surface and the road bank is washed down to the bottom of the hill by the force of the flowing water. Because the road is sunken relative to the surrounding landscape, there is also no place to divert or "turnout" the water into the adjacent wooded area.

Town Road

This site is representative of some of the problems observed along town roads. Although town roads where problems were observed are paved and therefore resistant to erosion, the ditches running alongside the roads are very susceptible to erosion if they aren't vegetated or lined with stone. Also, ditches along town roads can fill with winter sand (shown here) as they do along private roads, potentially resulting in erosion problems downstream. Ongoing ditch maintenance is key to preventing these types of problems.

Stream Crossing

This site is representative of the problems that can occur where roads cross over streams. Runoff from roads can erode slopes around culvert inlets and outlets if they are not stabilized with stone and/or vegetation, particularly if the stream crossing is at a low point in the road. Also, as more road material gets pushed to the edge of roads, the culverts can become clogged. The velocity of water flowing through a culvert can also lead to erosion of stream bottoms and banks.

Miscellaneous NPS Sites

The number of NPS sites that fall under the Miscellaneous Group (boat access, construction site, trail or path) account for 14% of all NPS sites, with boat access sites having generally higher impact (three high impact and three medium impact) than the trail or path and construction site land uses.

- **Boat Access** - The greater number of high impact boat access sites can be attributed to a large area of generally unstable aggregate "ramp" surface that slopes directly into the lake, exacerbated by wheel ruts formed in the ramp surface from vehicular and trailer traffic. The wheel ruts tend to channel runoff down the entire length of the ramp, so that in addition to sediment, other pollutants such as oil and grease dripping from cars and trailers drain directly into the lake.
- **Trails/Paths** - Although not as great a concern as boat access sites, trails and paths can be a significant source of sediment if walking surfaces are left bare and worn down so that runoff is channeled down the

trail or path all the way to the lake. The greater volume of foot traffic that generally occurs on path right-of-ways to the lake can lead to more wear and tear.

- **Construction Sites** - Construction sites can also be a significant source of sediment but, because they are subject to the Maine Erosion and Sedimentation Law which took effect in 1997 (and applies to all organized areas of the State), any activity that involves filling, displacing or exposing soil or other earthen materials requires the individual(s) "who conducts, or causes to be conducted" the work shall take measures to prevent unreasonable erosion of soil or sediment beyond the site or into a protected resource such as a river, stream, brook, lake, pond, or wetland. Town code enforcement offices typically have a system in place whereas permits are issued and inspections conducted to make sure that the requirements of the law are enforced. Nevertheless, three construction sites were identified and rated as medium impact during the watershed survey. **Table 6** shows problems associated with the Miscellaneous Group and a count of sites affected by each problem.

TABLE 6: SUMMARY OF FINDINGS FOR THE MISCELLANEOUS GROUP

Problem Description	Count of Sites
Soil - Bare	12
Surface Erosion - Sheet	10
Shoreline - Erosion	4
Surface Erosion - Rill	5
Shoreline – Unstable Access	3
Shoreline – Inadequate Shoreline Vegetation	3
Shoreline – Lack of Shoreline Vegetation	2
Surface Erosion – Gully, Soil – Delta in Stream/Lake, Shoreline – Undercut	1 each

Examples:

Boat Access

This site is representative of boat access problems caused by runoff flowing straight toward the lake over a loose aggregate surface. Flow is concentrated in wheel ruts created by heavy vehicular and trailer traffic. By the end of the ramp, the volume and velocity of the flow is often enough to wash out the end of the ramp. Large quantities of sediment enter the lake this way as evidenced by the deltas that sometimes extend into the lake from boat ramps. Similar to problems on many private roads, there is no ditch or areas where the water can get off the ramp and into vegetation bordering the ramp.

Construction Site

This site is representative of construction sites where the absence of a sediment barrier such as silt fence or an erosion control mix berm could potentially lead to direct discharge of sediment into the lake. Prior to construction, erosion control plans must be prepared and approved by the towns and erosion and sedimentation controls installed. Contractors must maintain the controls over the course of construction to ensure they remain effective. Under the Erosion and Sediment Control Law, landowners and/or contractors could potentially be fined for failing to comply with requirements of the law.

Trail or Path

This site is representative of problems with trails or paths that typically lead to the lake. The combination of a steep bank, bare soil, and no vegetated buffer for runoff to be disbursed results in a chronic erosion problem. Non-Residential Group trails or paths with problems identified during the survey are used by several landowners with deeded access, consequently, the amount of foot traffic is higher and the damage greater than on paths used by individual homeowners. Practices to protect the ground and surrounding vegetation must be installed to protect the slope and allow runoff to infiltrate before it reaches the lake.

Survey Recommendations

Table 7: Summary of Recommendations for Residential Group (Residential, Driveways, and Beach Access Land Uses)

Best Management Practice Recommendation	Total	References
Construction Site: Silt Fence/EC Berms	1	Maine Erosion and Sediment Control Practices Field Guide for Contractors https://www.maine.gov/dep/land/erosion/escbmps/esc_bmp_field.pdf
Culvert: Armor Inlet/Outlet	1	
Culvert: Install Plunge Pool	1	
Culvert: Remove Clog	1	
Ditch: Armor with Stone	3	
Ditch: Install Check Dams	3	
Ditch: Install Sediment Pools	2	
Ditch: Remove Debris/Sediment	3	
Ditch: Vegetate	2	Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf
Driveways: Add New Surface Material (Gravel)	3	
Driveways: Add New Surface Material (Recycled Asphalt)	6	
Driveways: Add New Surface Material (Unspecified Type)	10	
Driveways: Build Up	3	
Driveways: Remove Grader/Plow Berms	1	
Driveways: Reshape (Crown)	7	
Driveways: Runoff Diverters (Broad-Based Dip)	1	
Driveways: Runoff Diverters (Open Top Culvert)	1	
Driveways: Runoff Diverters (Rubber Razor)	3	
Driveways: Runoff Diverters (Unspecified Type)	5	
Other: Infiltration Trench	2	Infiltration Trench Factsheet https://www.pwd.org/sites/default/files/infiltration_trench.pdf
Other: Install Runoff Diverter (waterbar)	7	Water Bars Factsheet https://www.pwd.org/sites/default/files/waterbar.pdf
Other: Mulch/Erosion Control Mix	43	Erosion Control Mix Factsheet https://www.pwd.org/sites/default/files/erosion_control_mix.pdf
Other: Rain Garden	10	Rain Gardens Factsheet https://www.pwd.org/sites/default/files/rain_garden.pdf
Other: Water Retention Swales	2	Maine Stormwater Best Practices Manual, Volume III. BMP Technical Design Manual https://www.maine.gov/dep/land/stormwater/stormwaterbmps/vol3/volume%20III%20May%202016.pdf
Paths & Trails: Define Foot Path	13	Paths & Walkways Factsheet https://www.pwd.org/sites/default/files/paths_and_walkways.pdf
Paths & Trails: Infiltration Steps	18	Infiltration Steps Factsheet https://www.pwd.org/sites/default/files/infiltration_steps.pdf

Paths & Trails: Install Runoff Diverter (waterbar)	5	Water Bars Factsheet https://www.pwd.org/sites/default/files/waterbar.pdf
Paths & Trails: Stabilize Foot Path	12	Paths & Walkways Factsheet https://www.pwd.org/sites/default/files/paths_and_walkways.pdf
Roof Runoff: Drywell at Gutter Downspout	5	Drywells Factsheet https://www.pwd.org/sites/default/files/dry_wells.pdf
Roof Runoff: Infiltration Trench at Dripline	14	Dripline Trench Factsheet https://www.pwd.org/sites/default/files/dripline_trench.pdf
Roof Runoff: Rain Barrel	7	Rain Barrels Factsheet https://www.pwd.org/sites/default/files/rain_barrels.pdf
Vegetation: Add to Buffer	31	The Buffer Handbook: A Guide to Creating Vegetated Buffers for Lakefront Properties https://www.maine.gov/dep/land/watershed/buffhandbook.pdf
Vegetation: Establish Buffer	22	
Vegetation: No Raking	15	The Buffer Handbook Plant List https://www.maine.gov/dep/land/watershed/buffer_plant_list.pdf
Vegetation: Reseed Bare Soil/Thinning Grass	27	

Appendix D provides a glossary for the Residential Group BMPs recommended in **Table 7**. All the references are available from either the Maine DEP and/or the Portland Water District (PWD). The factsheets that are referenced are produced by both Maine DEP and the PWD and were sourced from a series of 24 factsheets available to homeowners that answer many how-to questions. The factsheets profile common conservation practices that homeowners can use to protect water quality and include detailed instructions, diagrams, and color photos about installation and maintenance. The series includes the following:

- Construction BMPs
- Dripline Trench
- Drywells
- Erosion Control Mix
- Infiltration Steps (2)
- Infiltration Trench
- Open-Top Culverts
- Paths and Walkways
- Permitting
- Rain Barrels
- Rain Gardens
- Rubber Razors
- Shoreline Stabilization
- Turnouts
- Waterbars

The series also includes six native plant lists. Each one is tailored to different site conditions (e.g., full sun and dry soils). The lists include plant descriptions and color photos of each plant to make plant selection easier. They can be used in conjunction with The Buffer Handbook and The Buffer Handbook Plant List referenced in **Table 7**. Another useful tool and quick reference for building buffers along the lakeshore is the "Lakes Like Less Lawn" brochure provided in **Appendix E**.

Based on the complexity of many of the Residential Group sites and the range of recommendations available for fixing problems, homeowners would benefit from preparation of a project plan detailing how

they plan to fix identified problems on their property. A comprehensive approach is necessary so that the various fixes are compatible with one another and the property. Factors such as how the land is used, frequency of use, space limitations, types of soil, slope of the land, proximity to the water, shade or sun, existing vegetation, cost of fixes, and the technical expertise required to design and construct fixes should be taken into consideration. Ideally, the project plan would include a map or sketch of existing conditions on the property, property details such as the factors mentioned above, how and where water flows, soil information, BMP choices, and where the BMPs will be located.

The New Hampshire Homeowner's Guide to Stormwater Management (Do-It-Yourself Stormwater Solutions for Your Home), produced by the New Hampshire Department of Environmental Services, can be used as a complementary document to the references provided in **Table 7** and provides excellent guidance on selecting BMPs and planning their implementation. It can be downloaded at: https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-11.pdf. The flowcharts in **Figures 8 and 9** were copied from the New Hampshire Guide and can be used to assist homeowner's with BMP selection. **Figure 8** shows a flowchart for selecting infiltration BMPs and **Figure 9** shows a flowchart for selecting storage and conveyance BMPs.

One-on-one technical assistance can also be obtained from CCSWCD (www.cumberlandswcd.org) or lake association volunteers (www.highlandlakemaine.org). CCSWCD offers both technical and engineering-tailored solutions depending on site circumstances. CCSWCD provides assistance for a nominal fee unless outside financial support can be obtained (most likely from grant funding).

FIGURE 8: Infiltration Best Management Practices Flowchart

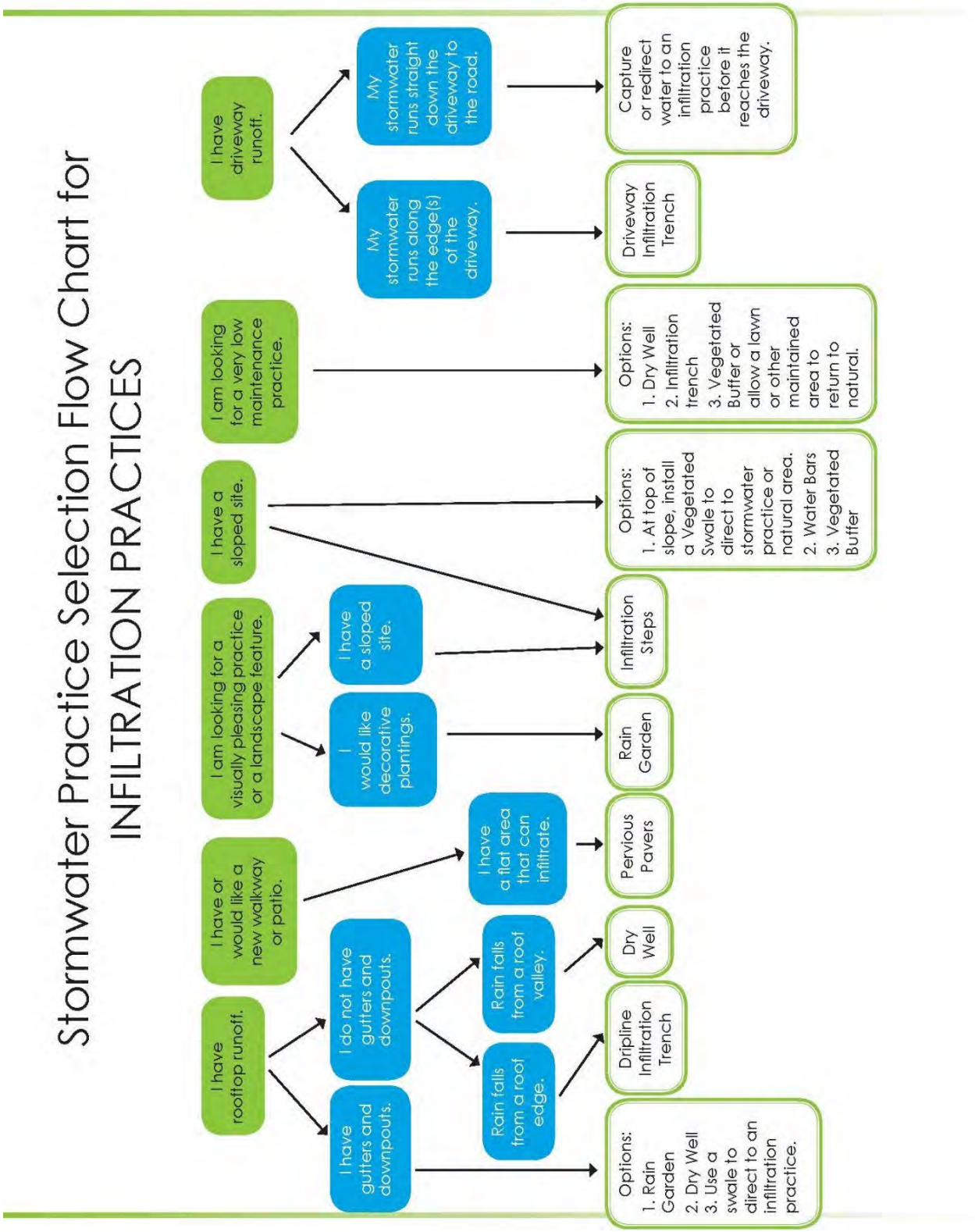


FIGURE 9: Storage and Conveyance Best Management Practices Flowchart

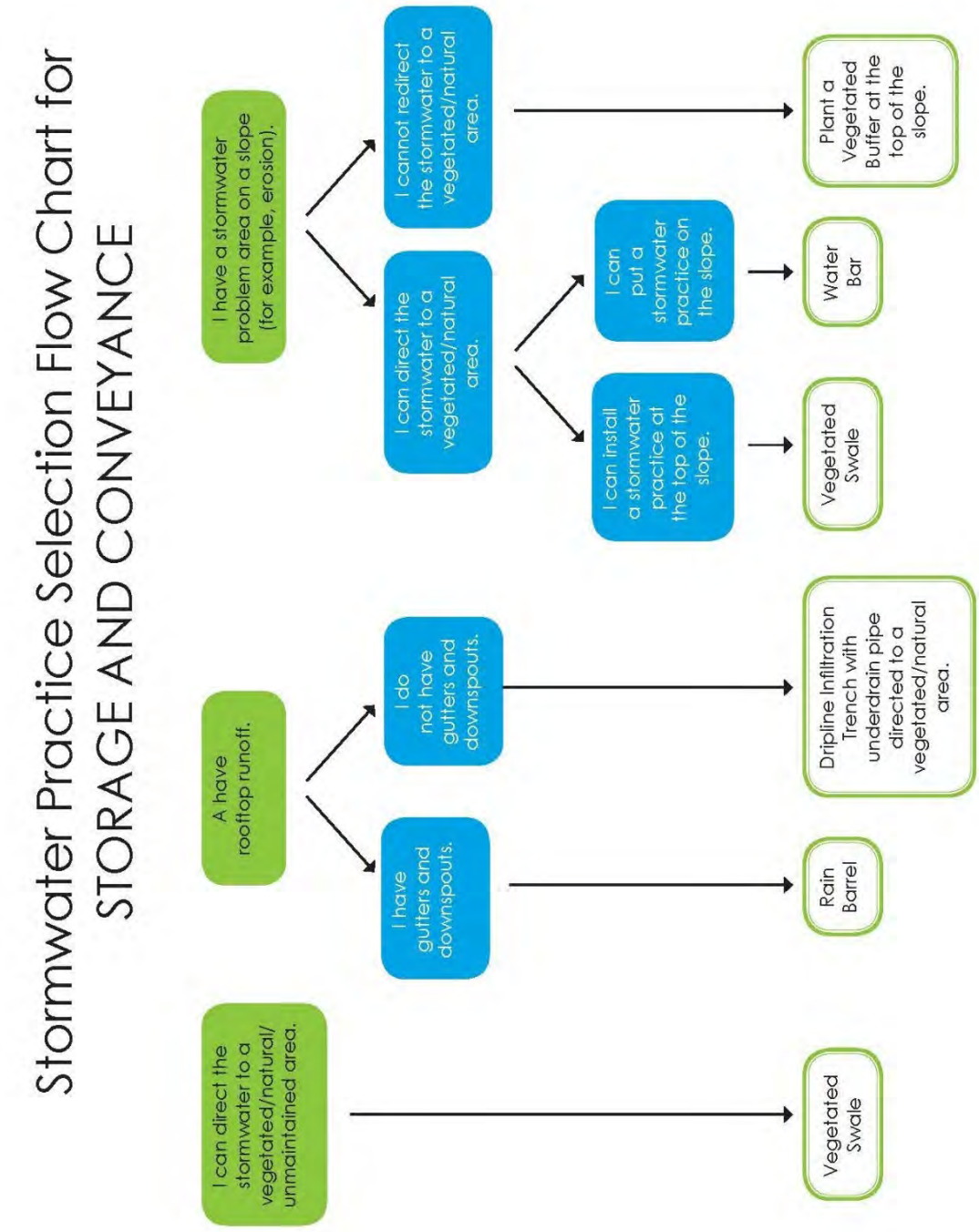


Table 8: Summary of Recommendations for Road Group (Private Road, Town Road, and Stream Crossing Land Uses)

Best Management Practice Recommendation	Total	References
Culvert: Armor Inlet/Outlet	7	Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf
Culvert: Enlarge	2	
Culvert: Install Culvert	1	
Culvert: Install Plunge Pool	3	
Culvert: Lengthen	3	
Culvert: Remove Clog	6	
Culvert: Replace	1	
Ditch: Armor with Stone	5	
Ditch: Install Check Dams	4	
Ditch: Install Ditch	5	
Ditch: Install Sediment Pools	8	
Ditch: Install Turnouts	3	
Ditch: Reshape Ditch	1	
Ditch: Remove Debris/Sediment	6	
Ditch: Vegetate	4	
Other: Mulch/Erosion Control Mix	1	Erosion Control Mix Factsheet https://www.pwd.org/sites/default/files/erosion_control_mix.pdf
Roads: Add New Surface Material (Pave)	5	Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf Maine DOT Construction Manual http://www.maine.gov/tools/whatsnew/attach.php?id=615454&an=1
Roads: Add New Surface Material (Recycled Asphalt)	2	
Roads: Add New Surface Materials (Unspecified Type)	7	
Roads: Remove Grader/Plow Berms	7	
Roads: Reshape (Crown)	6	
Roads: Runoff Diverters (waterbar)	3	
Roads: Vegetate Shoulder	4	
Vegetation: Add to Buffer	2	
Vegetation: Establish Buffer	1	
Vegetation: No Raking	1	
Vegetation: Reseed Bare Soil/Thinning Grass	1	

The BMP glossary in **Appendix D** provides explanations for the Road Group BMPs recommended in **Table 8.** Because they are specific to roads, most are distinct from the BMPs recommended for the Residential Group. Fortunately, most of the Road Group BMP recommendations can be found in a single reference (Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads: https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf). The Manual covers a wide range of topics related to road construction and maintenance on private roads including laws affecting camp road owners, forming a road association, property boundaries and easements, hiring a contractor, and planning and budgeting. While the Gravel Road Maintenance Manual applies primarily to private roads, the Maine DOT Construction Manual listed under references is better suited for town roads and perhaps private roads with road associations that have substantial resources for road reconstruction and/or paving.

Table 9: Summary of Recommendations for Miscellaneous Group (Boat Access, Construction Site, and Trail or Path Land Uses)

Best Management Practice Recommendation	Total	References
Boat Launch: Add New Surface Material (Gravel)	1	Gravel Road Maintenance Manual: A Guide for Landowners on Camp and Other Gravel Roads https://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf
Boat Launch: Add New Surface Material (Pave)	1	
Boat Launch: Add New Surface Material (Recycled Asphalt)	3	
Boat Launch: Add New Surface Material (Unspecified Type)	5	
Boat Launch: Buildup	3	
Boat Launch: Install Runoff Diverters (Rubber Razor)	2	
Boat Launch: Install Runoff Diverters (waterbar)	1	
Boat Launch: Reshape (Crown)	3	
Boat Launch: Vegetate Shoulder	1	
Construction Site: Mulch	3	Maine Erosion and Sediment Control Practices Field Guide for Contractors https://www.maine.gov/dep/land/erosion/escbmps/esc_bmp_field.pdf
Construction Site: Seed/Hay	2	
Construction Site: Silt Fence/EC Berms	2	
Other: Mulch/Erosion Control Mix	7	Erosion Control Mix Factsheet https://www.pwd.org/sites/default/files/erosion_control_mix.pdf
Paths & Trails: Infiltration Steps	2	Infiltration Steps Factsheet https://www.pwd.org/sites/default/files/infiltration_steps.pdf
Paths & Trails: Install Runoff Diverter (waterbar)	2	Water Bars Factsheet https://www.pwd.org/sites/default/files/waterbar.pdf
Paths & Trails: Stabilize Foot Path	3	Paths & Walkways Factsheet https://www.pwd.org/sites/default/files/paths_and_walkways.pdf
Vegetation: Add to Buffer	3	The Buffer Handbook: A Guide to Creating Vegetated Buffers for Lakefront Properties https://www.maine.gov/dep/land/watershed/buffhandbook.pdf The Buffer Handbook Plant List https://www.maine.gov/dep/land/watershed/buffer_plant_list.pdf
Vegetation: Establish Buffer	1	
Vegetation: No Raking	1	
Vegetation: Reseed bare soil & thinning grass	1	

The BMP glossary in **Appendix D** provides explanations for Miscellaneous Group BMPs recommended in **Table 9**. Almost all of the recommended BMPs in **Table 9** are also listed in Tables 7 and/or 8 but, because of circumstances relating to location, enforcement, and/or usage, they warrant special attention. The BMPs for this Group may be similar to the other two Groups but could differ somewhat in how they are designed, constructed, and maintained. For instance, a more engineered approach may be necessary on these BMPs because of their higher usage and/or because of regulatory aspects based on their proximity to water and level of enforcement.

Next Steps

Where Do We Go From Here?

December 2018 to December 2019:

A group designated as the Technical Advisory Committee (TAC) that includes representatives from the HLA, CCSWCD, Maine DEP, and the Towns of Falmouth and Windham has been tasked with developing the Highland Lake Watershed-Based Management Plan. The purpose of the Project is to create a 10-year adaptable guidance plan for improving water quality in Highland Lake in order to maintain its ***Glass GPA*** state water quality listing. To learn more about ***Class GPA*** standards: http://www.mainelegislature.org/legis/statutes/38/title38sec465-A.html

The Project will focus primarily on strategies that improve water quality. These include:

- Septic survey and summary report.
- Utilizing the results of the Watershed Survey to implement mitigation strategies in the watershed.
- Implementing effective Water Quality Sampling Protocols with the goal of improving water quality and to support the ongoing effort to identify factors contributing to the ***Pcy*** blooms.
- Modeling to determine phosphorus levels in Highland Lake.
- Collaborating with the Towns of Falmouth and Windham in the ongoing work of creating and implementing ordinances that serve to better protect and preserve Highland Lake.
- Survey of existing BMPs in the watershed to determine effectiveness and potential need for repair and/or improvement.
- Creation of action items with cost estimates, prioritization, and timelines.
- Community outreach and public involvement.

The above strategies will be used in the preparation of a Watershed-Based Management Plan. To be accepted by Maine DEP and the Environmental Protection Agency (EPA), the plan will include the following nine elements:

1. An identification of the causes and sources of pollution.
2. An estimate of the load reductions expected for the management measures described.
3. A description of the NPS management measures and targeted critical areas.
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.
5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.
7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established.

Early 2019:

Upon approval by the Maine DEP, the Plan serves as the basis for application to the EPA for grant funding under Section 319 of the Clean Water Act, which can be used to implement NPS projects in the Highland Lake watershed.

Spring 2020:

Once the completed Highland Lake Watershed-based Management Plan has been completed, CCSWCD will work with the Technical Advisory Committee to submit an application for 319 funds.

Spring 2021:

Earliest potential date that EPA Section 319 funds could become available should proposal be awarded.

Summer 2021:

Tentative start of mitigation projects in the Highland Lake watershed that utilize 319 funds.

Where Do I Get More Information?

Contacts

- **Highland Lake Watershed Survey Steering Committee**
  Highland Lake Association, Inc.
  PO Box 1684
  Windham, ME 04062
  Rosie Hartzler and Kim White, Co-Chairs
  (207) 415-3727 / rosiehartzler@highlandlakemaine.org
- **Cumberland County Soil & Water Conservation District**
  35 Main Street Suite 3, Windham, ME 04062
  Heather Huntt, Project Manager
  (207) 892-4700 / hhuntt@cumberlandswcd.org
  www.cumberlandswcd.org
- **Maine Department of Environmental Protection**
  Division of Environmental Assessment, Bureau of Water Quality
  312 Canco Road, Portland, ME 04103
  Wendy Garland, Environmental Specialist
  (207) 615-2451, wendy.garland@maine.gov
- **Lake Stewards of Maine**
  24 Maple Hill Road, Auburn, ME 04210
  Scott Williams, Executive Director
  (207) 783-7733 / stewards@lakestewardsme.org

Permitting Basics

Protection of Maine's watersheds is ensured through the goodwill of lake residents and through laws and ordinances created and enforced by the State of Maine and local municipalities. The following laws and ordinances require permits for activities adjacent to wetlands and waterbodies.

Shoreland Zoning Law—Construction, clearing of vegetation and soil movement within 250 feet of lakes, ponds, and many wetlands, and within 75 feet of most streams, falls under the Shoreland Zoning Act, which is administered by each Town through the Code Enforcement Officer and the Planning Board.

Natural Resources Protection Act (NRPA) - Soil disturbance & other activities within 75 feet of the lakeshore or stream also falls under the NRPA, which is administered by the DEP.

Contact the DEP and Town Code Enforcement Officer if you have any plans to construct, expand or relocate a structure, clear vegetation, create a new path or driveway, stabilize a shoreline or otherwise disturb the soil on your property. Even if projects are planned with the intent of enhancing the environment, contact the DEP and town to be sure rules are properly followed.

How to apply for a Permit by Rule with DEP:

To ensure that permits for small projects are processed swiftly, the DEP has a streamlined permit process called **Permit by Rule**. These one-page forms are simple to fill out and allow the DEP to quickly review the project.

- Fill out a notification form and submit fee and any required materials before starting any work. Forms are available from your town code enforcement officer, Maine DEP offices, or online at www.maine.gov/dep/land/nrpa/pbrform.pdf
- The permit will be reviewed by DEP within 14 days. If you do not hear from DEP in 14 days, you can assume your permit is approved and you can proceed with work on the project.
- Follow all standards required for the specific permitted activities to keep soil erosion to a minimum. It is important that you obtain a copy of the standards so you will be familiar with the law's requirements.

Appendix A: Highland Lake Watershed Survey Form

Final Site #_____ Checked by _____ Date _____

Highland Lake Watershed Survey

REMINDER: Only write up if there is likely transport of sediment or phosphorus into the lake.

Sector & Site _____ Date_____ Surveyor Initials _____

Location *(house #, road, utility pole #)* _____

Building Color _____ Landowner Name _____

Tax Map & Lot _____ Talked to Landowner? _____

Flow into Lake via (check ONE): ❒ Directly into Lake ❒ Stream ❒ Ditch ❒ Minimal Vegetation

Note: If flow does not make it into lake, do not fill out a form. It would not be considered a site.

GPS Coordinates in **UTM**
(no degrees or decimal points)

0						

Land Use/Activity Circle ONE	**Description of Problems** Circle ALL that apply	
State Road*	**Surface Erosion**	**Soil**
Town Road*	Sheet	Bare
Private Road*	Rill	Uncovered Pile
Driveway*	Gully	Delta in Stream/Lake
Residential	**Culvert**	Winter Sand
Commercial	Unstable Inlet / Outlet	**Roof Runoff Erosion**
Municipal / Public	Clogged	**Shoreline**
Beach Access	Crushed / Broken	Undercut
Boat Access*	Undersized	Lack of Shoreline Vegetation
Trail or Path	**Ditch**	Inadequate Shoreline Vegetation
Logging	Sheet Erosion	Erosion
Agriculture	Rill Erosion	Unstable Access
Construction Site	Gully Erosion	**Agriculture**
OTHER:	Bank Failure	Livestock Access to Waterbody
	Undersized	Tilled Eroding Fields
* Is it: paved, gravel or other/unknown?	**Road Shoulder Erosion**	Manure Washing off Site
	Sheet	**OTHER:**
	Rill	
	Gully	
	Roadside Plow/Grader Berm	

Slope: ❒ Flat ❒ Moderate ❒ Steep **Size of Area Exposed or Eroded** (length & width): _____

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

Impact: Circle one choice in each column, add the three selected numbers together, and then circle the site's corresponding impact rating (high, medium, or low).

Type of Erosion	Area	Buffers and Other Filters	IMPACT
Gully - **3**	Large - **3**	No filter, all channelized direct flow into lake or stream - **3**	High: 8-9 pts
Rill - **2**	Medium - **2**	Some buffer or filtering, but visible signs of concentrated flow and/or sediment movement through buffer and into lake - **2**	Med: 6-7 pts
Sheet - **1**	Small - **1**	Significant buffer or filtering* - **1**	Low: 3-5 pts

* Confirm there is likely sediment/runoff delivery. If not, do not write up as a site.

Cost to Fix

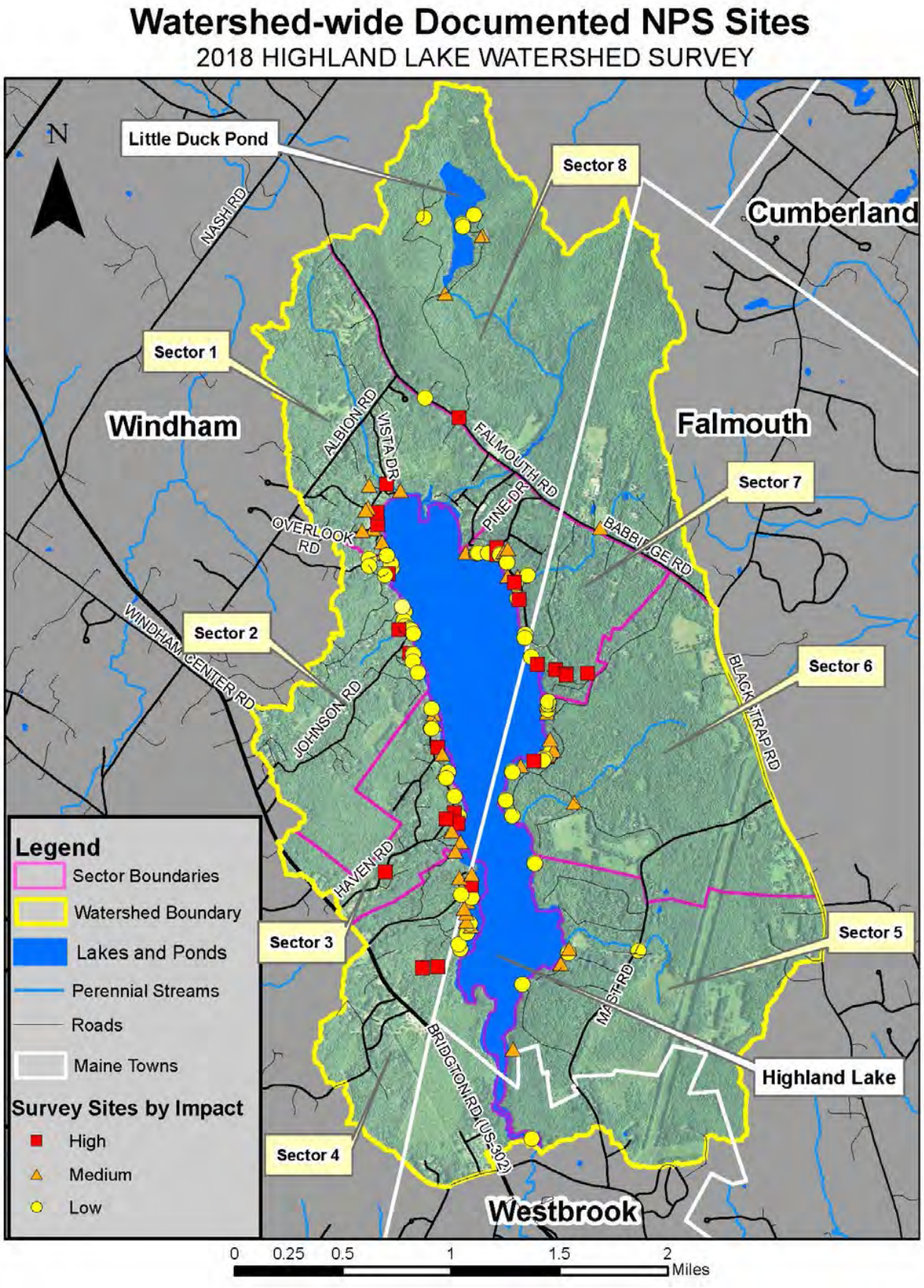
High:	Greater than $2,500
Medium:	$500-$2,500
Low:	Less than $500

Technical Level to Install

High:	Site requires engineered design
Medium:	Technical person should visit site & make recommendations
Low:	Property owner can accomplish with reference materials

Appendix B: Survey Maps

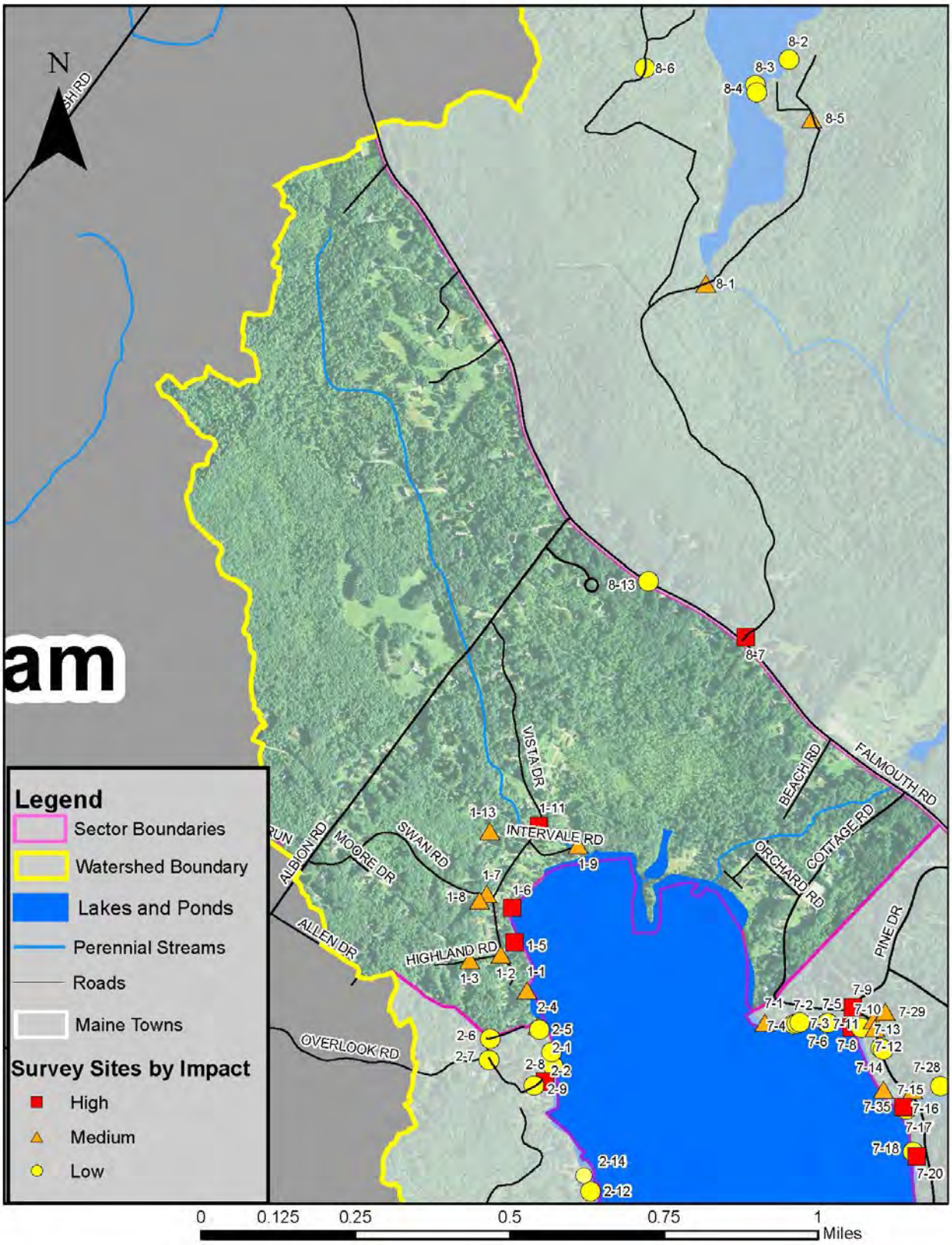
Appendix B1



Appendix B2

Sector 1: Documented NPS Sites

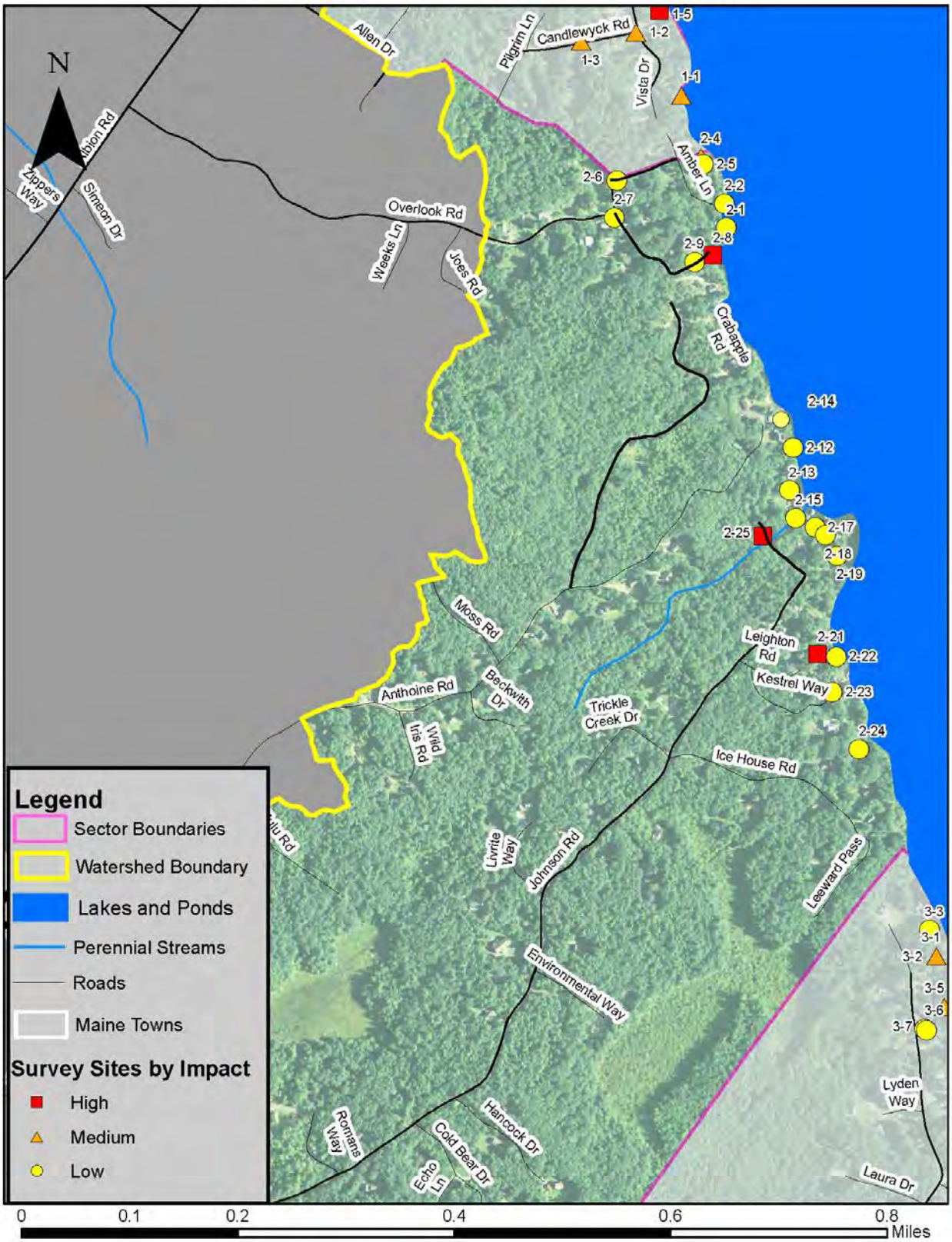
2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B3

Sector 2: Documented NPS Sites

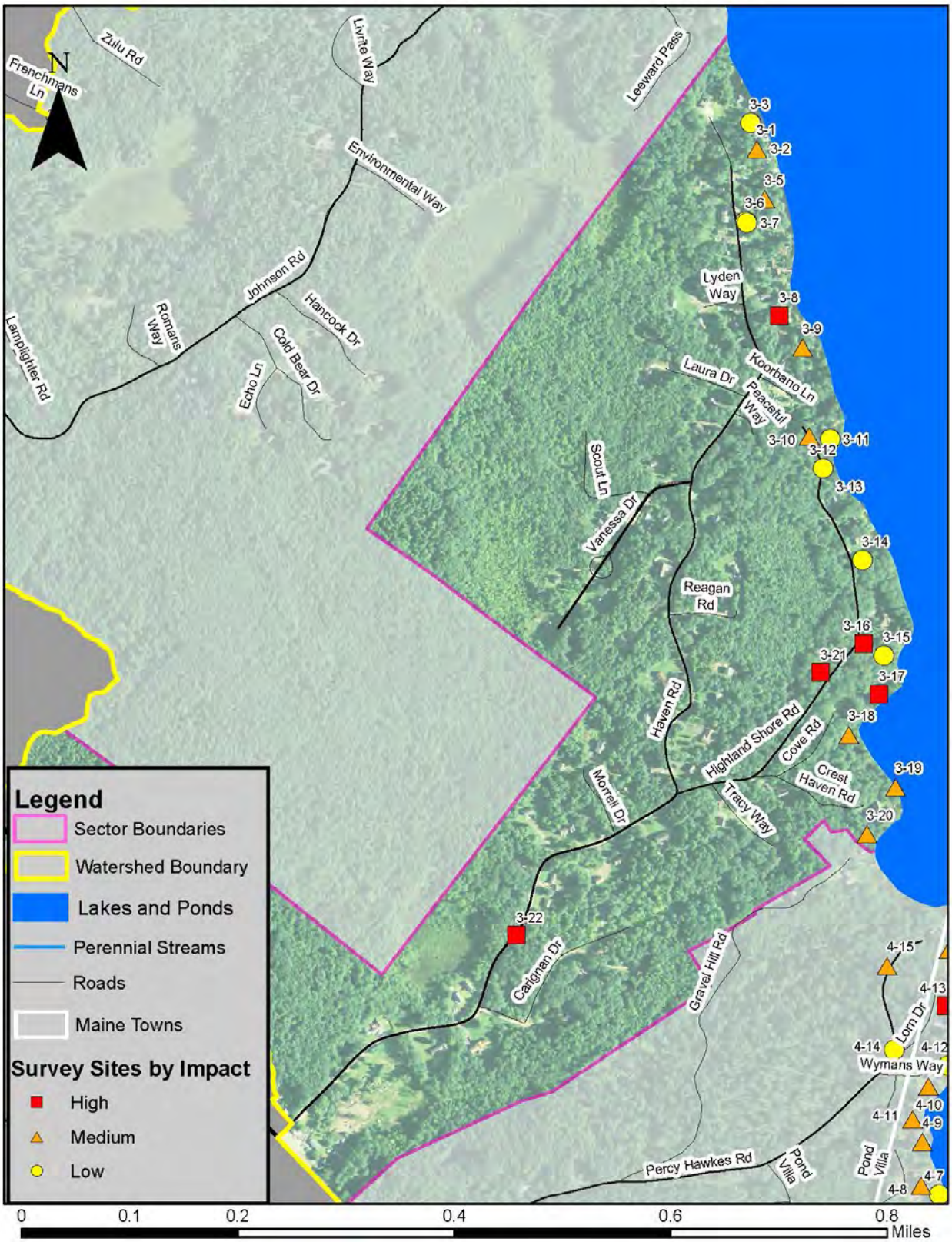
2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B4

Sector 3: Documented NPS Sites

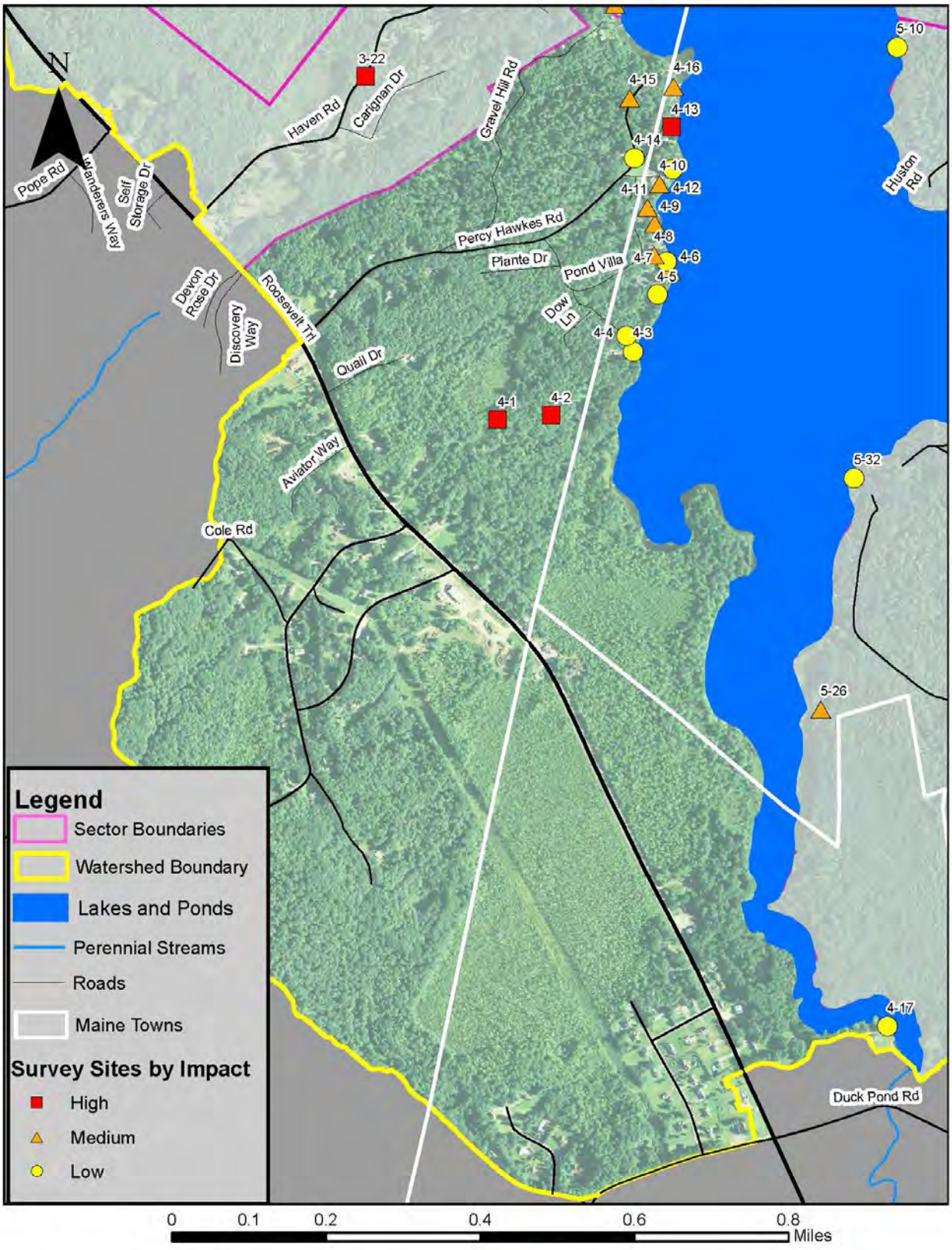
2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B5

Sector 4: Documented NPS Sites

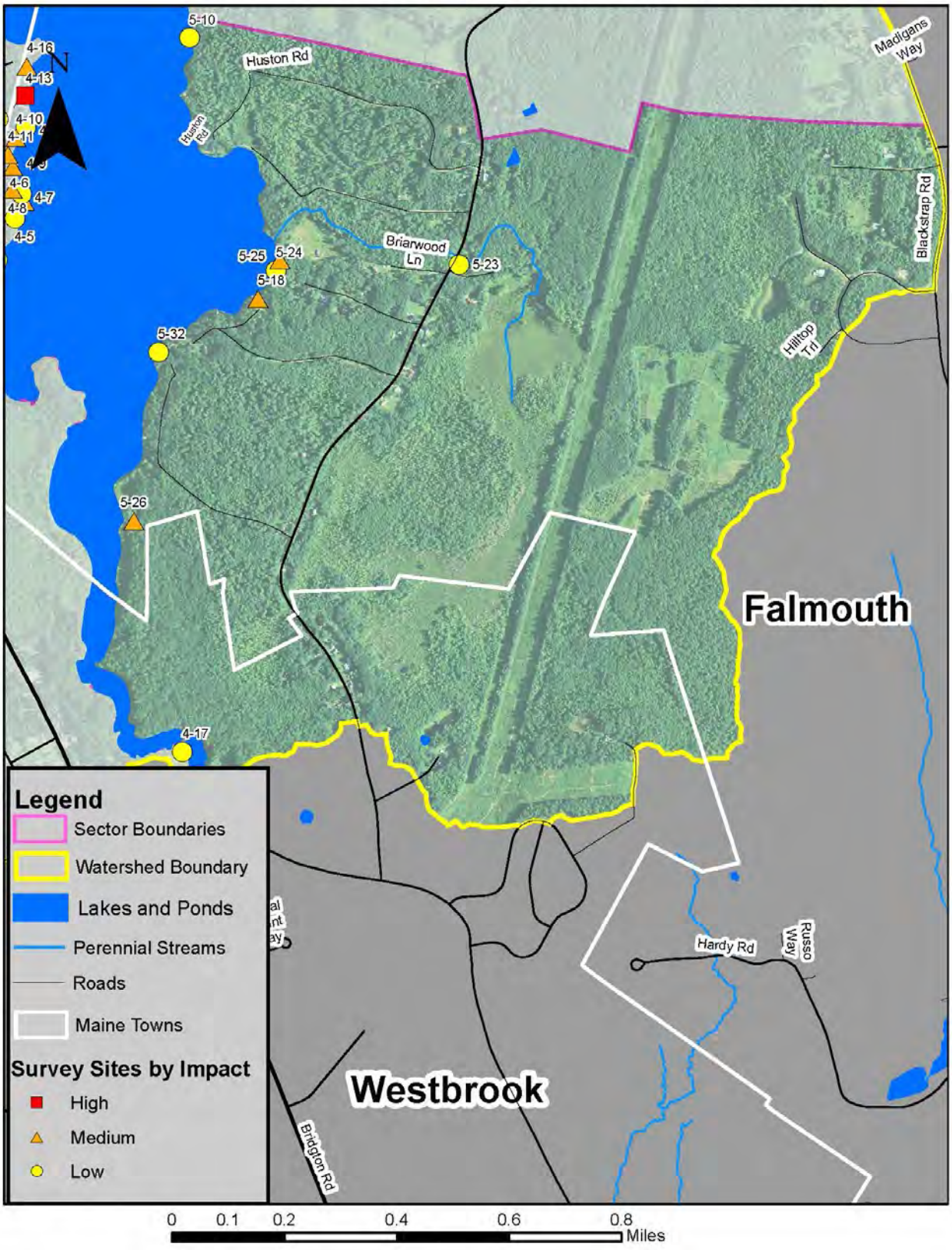
2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B6

Sector 5: Documented NPS Sites

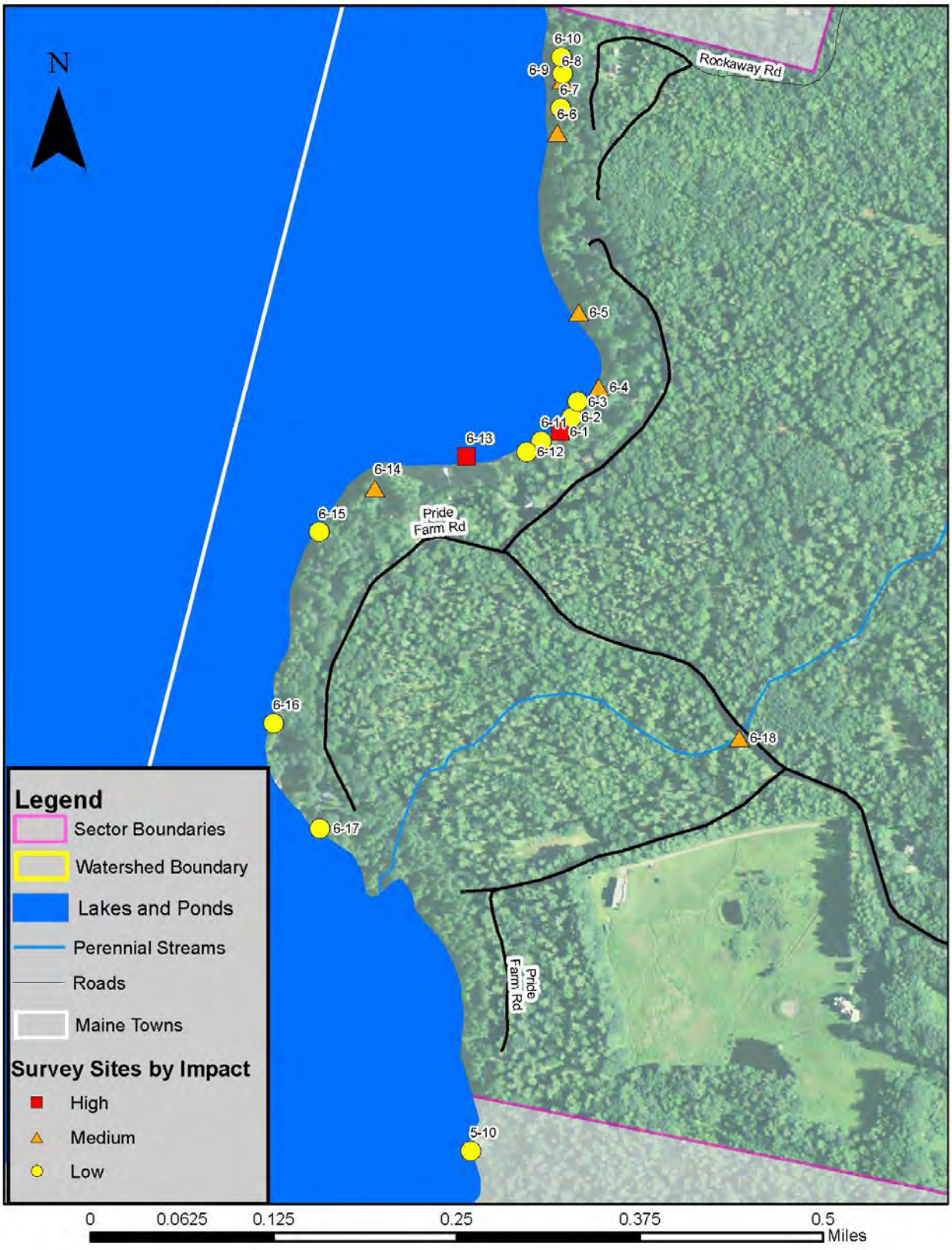
2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B7

Sector 6: Documented NPS Sites

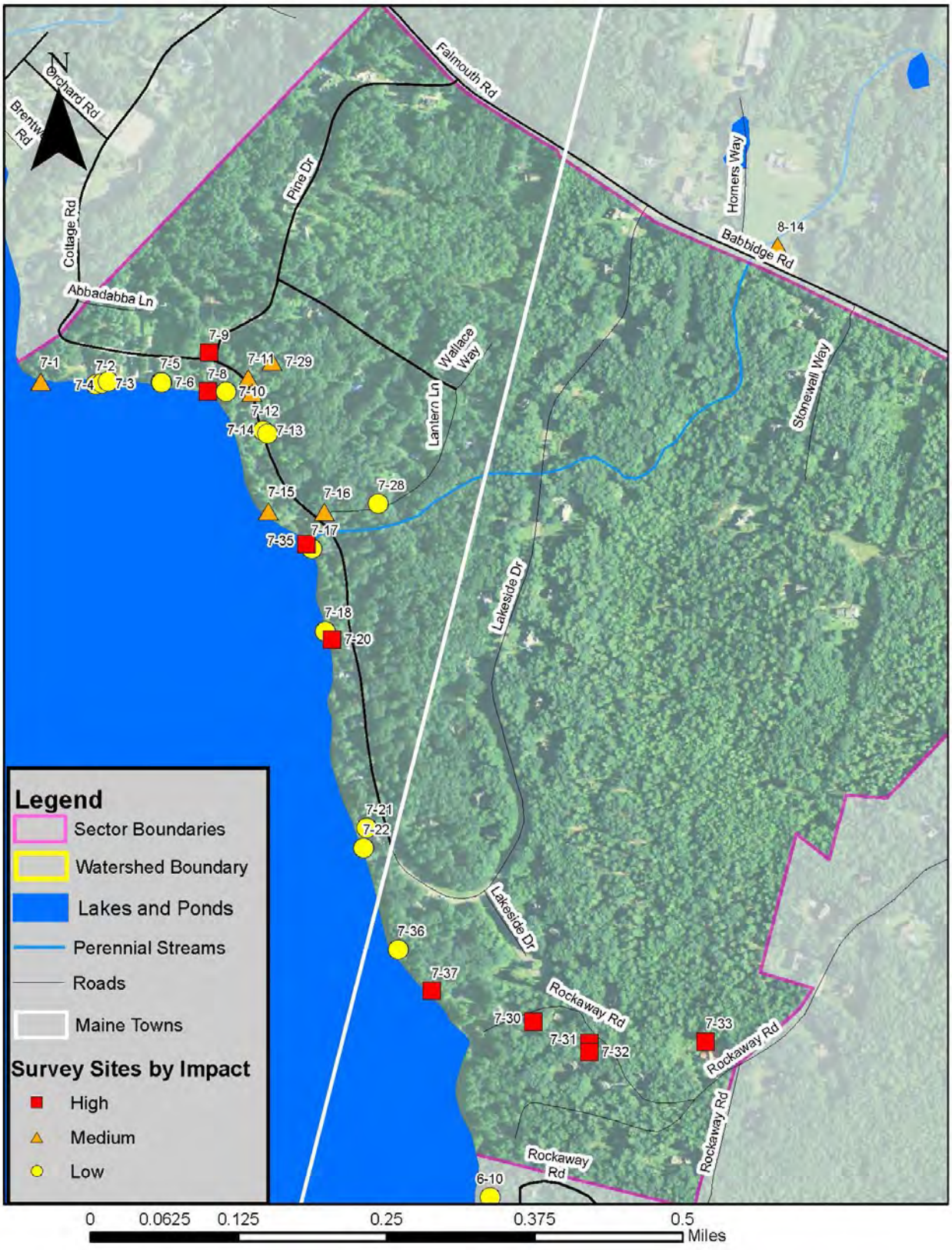
2018 HIGHLAND LAKE WATERSHED SURVEY



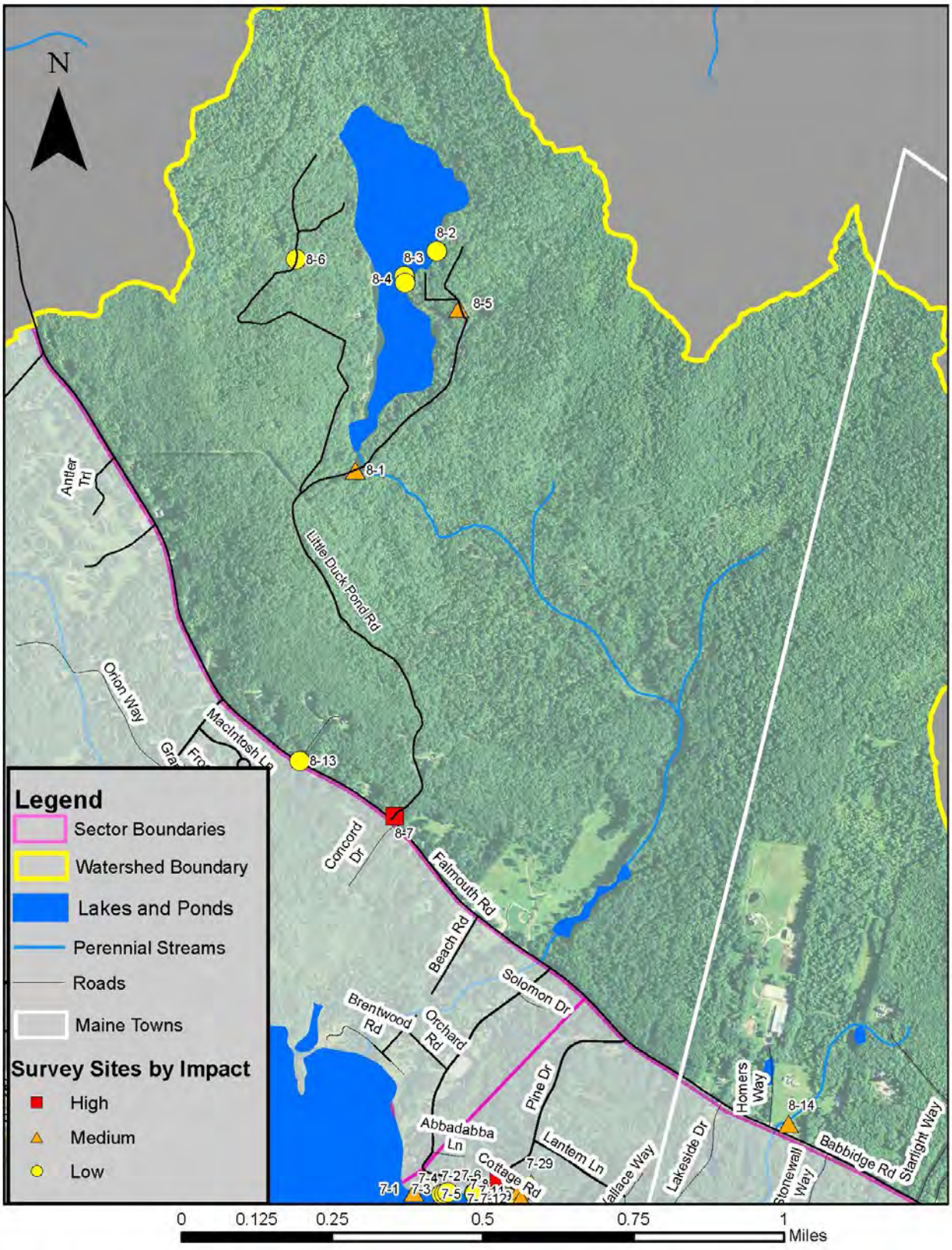
Appendix B8

Sector 7: Documented NPS Sites

2018 HIGHLAND LAKE WATERSHED SURVEY



Appendix B9


Sector 8: Documented NPS Sites
2018 HIGHLAND LAKE WATERSHED SURVEY
N
8-1
8-2
8-3
8-4
8-5
8-6
8-7
8-13
8-14
7-1
7-3
7-4
7-5
7-6
7-12
7-29
Antler Trl
Little Duck Pond Rd
Orion Way
MacIntosh Ln
Concord Dr
Falmouth Rd
Beach Rd
Solomon Dr
Brentwood Rd
Orchard Rd
Pine Dr
Abbadabba Ln
Lantern Ln
Cottage Rd
Lakeside Dr
Homers Way
Babbidge Rd
Starlight Way
Stonewall Way
Legend
Sector Boundaries
Watershed Boundary
Lakes and Ponds
Perennial Streams
Roads
Maine Towns
Survey Sites by Impact
High
Medium
Low
0
0.125
0.25
0.5
0.75
1
Miles

Appendix C: Survey Data Detail

Highland Lake Watershed Survey Data
May and June 2018

Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
1	1	1-1	Beach Access	Surface Erosion - Rill; Soil - Bare;	1100	Roads/Driveways - Remove Grader/Plow Berms; Roads/Driveways - Install Runoff Diverters; Paths & Trails - Define Foot Path; Other - Install Runoff Diverter (waterbar); Other-Mulch/Erosion Mix; Other - Rain Garden	Medium	Medium	Winter sand pile at end of road. Evidence of sediment washing to lake. Algae growth across from house 137, owned by 133.
1	2	1-2	Private Road	Soil- Winter Sand;	6000	Roads/Driveways - Plow Berms	Medium	Low	Sediment Berm on shoulder; water running across road; sweep winter sand.
1	3	1-3	Private Road	Surface Erosion- Gully; Ditch - Rill Erosion; Ditch - Gully Erosion; Road Shoulder Erosion - Rill	100	Roads/Driveways - Pave; Roads/Driveways- Vegetate Shoulder	Medium	Low	Remove grader berm; Also noted Algae but no location pinpointed.
1	5	1-5	Private Road	Ditch - Gully Erosion; Ditch - Undersized;		Ditch - Armor Ditch with Stone; Ditch-Install Sediment Pools	High	Medium	Add filtration at culvert outlets on Vista. Noted two pipes with steady flow with iron content; Sediment Delta in Lake
1	6	1-6	Boat Access	Surface Erosion - Rill; Surface Erosion - Gully; Shoreline - Erosion; Shoreline - Unstable Access	800	Roads/Driveways - Build Up; Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape Crown; Roads/Driveways - Install Runoff Diverters (Waterbar)	High	Medium	Note to install waterbar at top and at intervals into adjacent ditch. Noted that DEP has been involved per Al. Also noted that new landowner may help with match. Entire area shows erosion
1	7	1-7	Private Road	Soil - Winter Sand	4000	Roads/Driveways - Remove Grader/Plow Berms	Medium	Medium	Heavy Sediment running into Basin; Pavement Erosion; Sand Berm causing Erosion; Sweep and Disposal of sand on Swan Road and clean out sediment basin
1	8	1-8	Construction Site	Surface Erosion - Sheet; Soil - Bare	1875	Construction Site - Mulch; Construction Site - Seed/Hay	Medium	Low	Erosion Control to prevent runoff; add crushed stone across entrance
1	9	1-9	Private Road	Surface Erosion - Sheet; Soil - Bare; Soil - Uncovered Pile	1500	Roads/Driveways - Remove Grader/Plow Berms; Vegetation - Add to Buffer	Medium	Low	Evidence of snow bank remnants at stream bank. Consider alternate snow storage at end of road away from stream

Highland Lake Watershed Survey Data
May and June 2018

Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
1	11	1-11	Private Road	Culvert - Unstable Inlet/Outlet	100	Culvert - Armor Inlet/Outlet; Culvert - Enlarge	High	High	Road over major culvert is collapsing. Stone cribbing failed on downstream side. Replace stone cribbing. Analyze site for cause of collapse. Peter says John Ricci can likely fix road; Peter will talk to Rosie about 2018 Windham Application Funds
1	13	1-13	Private Road	Culvert - Clogged;	200	Culvert - Remove Clog	Medium	Low	At bend in road, culvert output is filled with branches, logs and debris. If clog not removed, overtopping and road washout potential.
2	1	2-1	Residential	Shoreline - Undercut	12	Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Add to Riprap
2	2	2-2	Residential	Surface Erosion - Sheet; Soil - Bare	495	Paths & Trails - Stabilize Foot Path; Other - Mulch/Erosion Control Mix	Low	Low	
2	4	2-4	Boat Access	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	1000	Roads/Driveways - Add New Surface Material; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Medium	Medium	Note to add crushed stone to driveway
2	5	2-5	Residential	Surface Erosion - Sheet; Soil - Bare	850	Roads/Driveways - Add New Surface Material; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix	Low	Low	Note to add crushed stone in parking area
2	6	2-6	Driveway	Surface Erosion - Rill; Road Shoulder Erosion - Rill	2400	Road/Driveways - Build Up; Add New Surface Material - Gravel; Add New Surface Material - Recycled Asphalt; Roads/Driveways - Reshape (Crown)	Low	Medium	
2	7	2-7	Private Road	Culvert - Unstable Inlet/Outlet; Culvert - Clogged; Culvert - Crushed/Broken	Intersection Ditches	Culvert - Armor Inlet/Outlet; Culvert - Remove Clog; Ditch - Vegetate; Ditch - Install Sediment Pools	Low	Low	Note 3 culverts

Highland Lake Watershed Survey Data
May and June 2018

Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
2	8	2-8	Private Road	Surface Erosion - Gully; Road Shoulder Erosion - Gully; Soil - Bare; Soil - Delta in Stream/Lake; Soil - Winter Sand; Shoreline - Erosion	75	Roads/Driveways - Add New Surface Material; Roads/Driveways - Reshape (Crown); Roads/Driveways - Vegetate Shoulder; Roads/Driveways - Install Runoff Diverters (Waterbar); Vegetation - Add to Buffer	High	Medium	Note to remove winter sand and reclaim delta
2	9	2-9	Residential	Surface Erosion - Sheet; Culvert - Clogged; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Erosion	2000	Culvert - Remove Clog; Roads/Driveways - Build up; Roads/Driveways - Add New Surface Material; Driveways/Roads - Reshape (Crown); Driveway/Roads - Install Runoff Diverters (Rubber Razor or Waterbar); Other - Mulch/Erosion Control Mix; Other-Rain Garden; Vegetation - Add to Buffer	Low	Medium	Rain garden at top of rock borders slope to lake.
2	10	2-10	Private Road	Surface Erosion - Gully; Ditch - Gully Erosion; Ditch - Undersized; Road Shoulder Erosion - Gully	600	Culvert - Install Culvert; Ditch - Reshape Ditch; Ditch - Install Ditch; Ditch - Remove debris/sediment; Roads/Driveways - Pave; Roads/Driveways - Reshape (Crown)	High	High	Note Ditch is filled with road material and construction debris
2	11	2-11	Private Road	Ditch - Gully Erosion	100	Ditch - Install Ditch; Roads/Driveways - Add New Surface Material; Roads/Driveways - Reshape (Crown)	High	High	Combine Site 2-11 with 2-10
2	12	2-12	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	400	Paths & Trails - Stabilize Foot Path; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Low	Low	
2	13	2-13	Residential	Surface Erosion - Sheet; Soil Bare; Shoreline - Inadequate Shoreline Vegetation	160	Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer	Low	Low	Pine Needle Berms are good. Erosion control mix berms would be even better
2	14	2-14	Driveway	Surface Erosion - Sheet	200	Roads/Driveways - Build Up; Roads/Driveways - Add New Surface Material	Low	Low	Suggest crushed stone
2	15	2-15	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Unstable Access	90	Paths & Trails - Stabilize Foot Path; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer	Low	Low	Lack of stream side buffer

Highland Lake Watershed Survey Data
May and June 2018

Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
2	17	2-17	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	150	Roads/Driveways - Add New Surface Material (Gravel); Vegetation - Establish Buffer	Low	Low	
2	18	2-18	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	30	Vegetation - Add to Buffer	Low	Low	Bare areas have been seeded and mulched since the survey. Landowner using organic methods for fertilizing and pest control.
2	19	2-19	Boat Access	Surface Erosion - Sheet; Soil Bare	300	Roads/Driveways - Build Up; Roads/Driveways - Add New Surface Material; Other - Mulch/Erosion Control Mix	Low	Low	Suggest adding large crushed stone
2	21	2-21	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	1500	Paths & Trails - Define Foot Path; Other - Mulch/Erosion Control Mix; Other - Infiltration Trench; Vegetation - Establish Buffer	High	Medium	Landowner has plans for buffer plants and defined path above rock line. Infiltration trench uphill of bare area. Old boat access on site. Large area contributing to runoff.
2	22	2-22	Residential	Surface Erosion - Rill; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	12	Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Low	Low	
2	23	2-23	Boat Access	Surface Erosion - Sheet	400	Roads/Driveways - Vegetate Shoulder	Low	Low	Landowner is installing landscape timbers on bank along boat ramp
2	24	2-24	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Unstable Access	50	Paths & Trails - Define Foot Path; Other - Mulch/Erosion Control Mix; Other - Rain Garden; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Landowner has seeded slope directly in front of house.
2	25	2-25	Stream Crossing	Surface Erosion - Sheet; Surface Erosion - Gully; Road Shoulder Erosion - Sheet; Soil - Bare	Several	Ditch - Armor with Stone; Ditch - Install Sediment Pools; Roads/Driveways - Vegetate Shoulder; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - No Raking	High	Medium	Also stream crossing on site. Note to armor Ends of Bridge

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
3	1	3-1	Residential	Surface Erosion -Sheet; Soil - Bare; Roof Runoff Erosion	Entire Lot	Paths & Trails - Define Foot Path; Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Paths & Trails - Install Runoff Diverter (waterbar); Roof Runoff - Infiltration Trench @ roof dripline; Roof Runoff - Drywell @ gutter downspout; Other - Install Runoff Diverter (waterbar); Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	See also Site 3-2 Consider limiting path to one side of house rather than both sides
3	2	3-2	Construction Site	Surface Erosion - Sheet; Soil - Bare	Entire Lot	Construction Site - Mulch; Construction Site - Silt Fence/EC Berms	Medium	Low	Same as Site 3-1. Under construction and erosion potential now is severe, needs eventual shore buffer, plantings.
3	3	3-3	Trail or Path	Surface Erosion - Rill; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	120	Vegetation - Establish Buffer	Low	Low	
3	5	3-5	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	500	Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown); Roads/Driveways - Install Runoff Diverters (Rubber Razor); Paths & Trails - Infiltration Steps; Other - Install Runoff Diverter (waterbar); Other - Rain Garden; Vegetation - Add to Buffer; Vegetation - Reseed bare soil and thinning grass	Medium	High	Very Steep Slope - about 45 degrees for 15 meters to shore Terrace the steep slope going from house to shore
3	6	3-6	Driveway	Surface Erosion - Sheet	1440	Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown)	Low	Medium	Surface of drive is already reclaimed asphalt. Water runs into adjacent driveway (Site 3-5)
3	7	3-7	Trail or Path	Surface Erosion - Sheet; Soil - Bare	200	Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix	Low	Medium	Steep 20-degree slope
3	8	3-8	Residential	Ditch - Gully Erosion; Ditch - Bank Failure; Ditch - Undersized; Soil - Delta in Stream/Lake	600	Ditch - Armor with Stone; Ditch - Install Check Dams; Ditch - Remove debris/sediment	High	High	Ditch is on north side of lot. Sediment trap needs maintenance/cleanout
3	9	3-9	Trail or Path	Surface Erosion - Sheet; Soil - Bare	400	Paths & Trails -Infiltration Steps; Other - Mulch/Erosion Control Mix; Vegetation - No Raking	Medium	Low	Right of Way

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
3	10	3-10	Private Road	Surface Erosion - Sheet; Surface Erosion - Rill; Road Should Erosion - Rill; Soil - Bare	800	Ditch - Vegetate; Ditch - Install Ditch; Ditch - Remove debris/sediment; Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Vegetate Shoulder	Medium	High	Also, a Ditch that has sand build up. Road is as much as 10-degree slope.
3	11	3-11	Residential	Surface Erosion - Sheet; Soil - Bare	750	Paths & Trails - Define Foot Path; Paths & Trails - Stabilize Foot Path; Paths & Trails - Install Runoff Diverter (waterbar); Roof Runoff - Infiltration Trench @ roof dripline; Other - Rain Garden	Low	Medium	
3	12	3-12	Residential	Surface Erosion -Sheet; Soil - Bare	1000	Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	
3	13	3-13	Residential	Surface Erosion - Sheet; Soil - Bare	120	Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	
3	14	3-14	Private Road	Surface Erosion - Gully; Culvert - Unstable Inlet/Outlet; Ditch - Rill Erosion	600	Ditch - Armor with Stone; Ditch - Install Check Dams; Ditch - Install Sediment Pools	Low	Low	Spreads into buffer before reaching lake.
3	15	3-15	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion	1000	Roof Runoff - Infiltration Trench @ roof dripline; Other - Rain Garden; Vegetation - Reseed bare soil & thinning grass	Low	Low	Landowner plans to terrace and install raingarden. Vegetation is thin, not bare because of shading.
3	16	3-16	Private Road	Ditch - Gully Erosion; Soil - Bare	600	Ditch - Armor with Stone; Ditch - Install Sediment Pools	High	High	Ditch is from plunge pool on opposite side of road. Runs between 53 and 49 Highland Shore
3	17	3-17	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Erosion; Shoreline - Unstable Access	1/8 - Acre	Paths & Trails - Define Foot Path; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Medium	Medium	Also, rubber razors in driveway need to be repaired/replaced. Since survey, landowner has put some crushed stone by lake
3	18	3-18	Driveway	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Inadequate Shoreline Vegetation	3600	Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown); Roads/Driveways - Install Runoff Diverters (Rubber Razor); Vegetation - Add to Buffer	Medium	Medium	There is some recycled asphalt now. Driveway is as much as 10-degree grade

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
3	19	3-19	Beach Access	Surface Erosion - Rill; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Erosion	200	Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - No Raking	Medium	Low	Beach Access is also dock storage area. Pictures don't match report & GPS coordinates
3	20	3-20	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation	800	Other - Install Runoff Diverter (waterbar); Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Medium	Low	In Sector 4
3	21	3-21	Private Road	Surface Erosion - Gully; Culvert - Unstable Inlet/Outlet; Culvert - Clogged; Road Shoulder Erosion - Sheet	4800	Culvert - Armor Inlet/Outlet; Culvert - Remove Clog; Ditch - Install Ditch; Ditch - Install Check Dams; Roads/Driveways - Pave	High	High	Slope as much as 8-degree grade.
3	22	3-22	Town Road	Ditch - Sheet Erosion; Road Shoulder Erosion - Gully; Soil - Bare; Soil - Winter Sand	550	Ditch - Install Check Dams; Ditch - Install Sediment Pools	High	Medium	Other suggestions. Riprap road shoulders at stream crossing
4	1	4-1	Private Road	Surface Erosion - Gully; Ditch - Bank Failure; Soil - Bare; Shoreline - Undercut	2400	Ditch - Vegetate; Ditch - Armor with Stone; Ditch - Install Turnouts	High	High	
4	2	4-2	Private Road	Surface Erosion - Gully; Ditch - Bank Failure; Soil - Bare	2400	Ditch - Vegetate; Ditch - Armor with Stone; Ditch - Remove debris/sediment	High	High	Note about stream habitant
4	3	4-3	Beach Access	Surface Erosion - Sheet; Soil - Bare; Shoreline - Undercut; Shoreline - Unstable Access	100	Paths & Trails - Define Foot Path; Paths & Trails - Infiltrations Steps; Paths & Trails - Install Runoff Diverter (waterbar); Vegetation - Establish Buffer	Low	Low	
4	4	4-4	Driveway	Surface Erosion - Sheet; Surface Erosion - Rill; Soil - Bare	600	Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown); Roads/Driveways - Install Runoff Diverters (Broad-based Dip); Roads-Driveways - Install Runoff Diverters (Open Top Culvert); Roads/Driveways - Install Runoff Diverters (Waterbar); Roof Runoff - Rain Barrel; Other - Rain Garden; Vegetation - Add to Buffer	Low	Medium	Suggestion for rain garden -gutters. As an alternative just use upper parking area and convert lower driveway into mulched footpath.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
4	5	4-5	Beach Access	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Unstable Access	600	Paths & Trails - Infiltration Steps; Paths & Trails - Install Runoff Diverter (waterbar); Other - Install Runoff Diverter (waterbar); Other-Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	
4	6	4-6	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	1200	Roof Runoff - Rain Barrel; Other - Mulch/Erosion Control Mix; Other - Rain Garden; Other - Water Retention Swales; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Low	
4	7	4-7	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	400	Roof Runoff - Infiltration Trench @ roof dripline; Roof Runoff - Drywell @ gutter downspout; Roof Runoff - Rain Barrel; Other - Mulch/Erosion Control Mix; Other - Water Retention Swales; Vegetation - Add to Buffer; Vegetation Reseed bare soil & thinning grass	Low	Low	
4	8	4-8	Residential	Ditch - Gully Erosion; Soil - Bare	300	Ditch - Armor with Stone; Ditch - Install Check Dams; Ditch - Remove debris/sediment; Ditch - Install Sediment Pools;	High	Medium	Other Suggestions - Rip Rap to slow water; Compact new soil at top; check other side of road & rip culvert inlets, put check dam in ditch above rip rap across road
4	9	4-9	Residential	Surface Erosion - Sheet; Surface Erosion - Gully; Soil - Bare	800	Culvert- Install Plunge Pool; Other - Rain Garden; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	Upper part of property exhibits sheet and lower part, gully. Recommendations suggest rain garden at lower part.
4	10	4-10	Boat Access	Surface Erosion - Sheet; Soil - Bare; Shoreline - Unstable Access	500	Road/ Driveways - Pave; Road/Driveways - Vegetate Shoulder; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	Suggested to widen ramp and use concrete pavers rather than pave

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
4	11	4-11	Residential	Surface Erosion - Rill; Ditch - Rill Erosion; Soil - Bare; Shoreline - Erosion	24	Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix; Vegetation - Reseed bare soil & thinning grass	Medium	Low	suggest crushed stone rather than EC Mix
4	12	4-12	Residential	Surface Erosion- Sheet; Soil - Bare	2100	Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	Low	Low	Divert along steps to lake or mulch
4	13	4-13	Driveway	Ditch - Sheet Erosion; Ditch - Gully Erosion	200	Ditch - Armor with Stone; Ditch - Install Check Dams; Ditch - Remove debris/sediment	High	Medium	Note there is a delta formation on shoreline
4	14	4-14	Private Road	Culvert - Unstable Inlet/Outlet; Ditch - Sheet Erosion; Ditch - Rill Erosion; Roadside Plow/Grader Berm; Soil - Bare; Soil - Winter Sand	80	Culvert - Install Plunge Pool; Ditch - Install Sediment Pools	Low	Low	
4	15	4-15	Private Road	Culvert - Unstable Inlet/Outlet; Ditch - Rill Erosion	Large area downhill of clogged culvert	Culvert - Install Plunge Pool; Ditch - Remove debris/sediment; Roads/Driveways - Remove Grader/Plow Berms	Medium	Medium	No inlet to culvert
4	16	4-16	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	1200	Other - Install Runoff Diverter (waterbar); Other - Mulch/Erosion Control Mix; Other - Rain Garden; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	
4	17	4-17	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Inadequate Shoreline Vegetation	50	Vegetation - Add to Buffer	Low	Low	Note to ask landowner not to mow to the lake
5	10	5-10	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion	10	Other - Mulch/Erosion Control Mix	Low	Low	Bare soil near the boat barn. Gutters would reduce roof runoff erosion.
5	18	5-18	Residential	Surface Erosion - Sheet; Ditch - Sheet Erosion; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	Medium	Paths & Trails - Install Runoff Diverter (waterbar); Roof Runoff - Rain Barrel; Other - Mulch/Erosion Control Mix; Other - Infiltration Trench; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	Beach is bare, with steps going down to it. Stone wall holds sand in place. Owner not thinking of grassing this area. It has been this way for three generations.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
5	23	5-23	Town Road	Culvert - Clogged	Culvert opening	Culvert - Remove Clog	Low	Low	Partial blockage on one of three barrels. Easily cleared.
5	24	5-24	Beach Access	Surface Erosion - Rill; Soil - Bare	160	Roads/Driveways - Add New Surface Material (Gravel); Other - Install Runoff Diverter (waterbar)	Low	Low	
5	25	5-25	Residential	Shoreline - Lack of Shoreline Vegetation; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	500	Vegetation - Establish Buffer; Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	Mowing too close to lake.
5	26	5-26	Boat Access	Surface Erosion - Rill	1300	Roads/Driveways - Add New Surface Material (Gravel); Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown); Roads/Driveways - Install Runoff Diverters (Rubber Razor); Paths & Trails - Stabilize Foot Path	Medium	Low	Hand carry path to lake is the primary area of concern. Road and parking area show erosion from 1-inch thunderstorm prior night, but sediment is trapped in basin before entering lake. Three rubber razors need maintenance.
5	32	5-32	Residential	Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Erosion	400	Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	Low	Low	Bare soil in yard and down to lake. Lack of shoreline vegetation is not a significant factor. Shoreline erosion is a product of wash from prior night's 1-inch thunderstorm.
6	1	6-1	Boat Access	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	500	Road/Driveways - Install Runoff Diverters (Rubber Razor)	High	Low	Suggest adding crushed stone to last 50' of ROW (lake end). Add one more rubber razor toward lake end and repair others.
6	2	6-2	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion; Shoreline - Unstable Access	100	Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix	Low	Low	Erosion occurring at two locations.
6	3	6-3	Residential	Surface Erosion - Sheet; Surface Erosion - Rill; Soil - Bare; Roof Runoff Erosion; Shoreline - Lack of Shoreline Vegetation	250	Paths & Trails - Stabilize Foot Path; Roof Runoff - Infiltrations Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - No Raking	Low	Low	Stream bank appears to be unstable, continue to monitor.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
6	4	6-4	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion	100	Ditch - Vegetate; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - No Raking	Medium	Medium	Stream bank appears to be unstable. Add vegetation to area where bank is eroding. Continue to monitor. Erosion control mix for bare soil around trees. Retaining wall is failing. Cost to Fix is high if retaining wall is included.
6	5	6-5	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion	Most of lot including behind house	Roads/Driveways - Install Runoff Diverters (Rubber Razor); Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Roof Runoff - Infiltrations Trench @ roof dripline; Roof Runoff - Drywell @ gutter downspout; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - No Raking	Medium	Medium	Gutter and downspout would reduce roof runoff erosion. Steps and retaining areas need maintenance to hold back soil. Recommend rubber razor be installed opposite from shed. Infiltration steps need upgrading.
6	6	6-6	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Erosion	800	Paths & Trails - Define Foot Path; Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Roof Runoff - Drywell @ gutter downspout; Roof Runoff - Rain Barrel; Other - Mulch/Erosion Control Mix; Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	Medium	Medium	Gutter would reduce roof runoff erosion. Add some type of retaining wall halfway up slope.
6	7	6-7	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	450	Paths & Trails - Define Foot Path; Paths & Trails - Stabilize Foot Path; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - No Raking	Low	Medium	
6	8	6-8	Residential	Surface Erosion - Sheet; Culvert - Unstable Inlet/Outlet; Roof Runoff Erosion; Shoreline - Inadequate Shoreline Vegetation	230	Culvert - Armor Inlet/Outlet; Paths & Trails - Define Foot Path; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Medium	Low	Erosion occurring at culvert outlet; add large rip rap. Get rid of barberry.
6	9	6-9	Beach Access	Shoreline - Undercut	20		Low	Low	Shoreline concrete is cracking and falling into water. Add rip rap in front of concrete or replace concrete.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
6	10	6-10	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	200	Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Plant garden in front of deck to intercept runoff.
6	11	6-11	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	200	Paths & Trails - Infiltration Steps; Roof Runoff - Rain Barrel; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Low	Low	Fireplace ash on beach; remove and dispose of properly. Place stone behind existing timbers.
6	12	6-12	Trail or Path	Surface Erosion - Sheet; Soil - Bare; Shoreline - Erosion; Shoreline- Unstable Access	96	Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix	Low	Low	Erosion Control Mix on path may be preferred because of shallow roots.
6	13	6-13	Beach Access	Surface Erosion - Rill; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion; Shoreline - Unstable Access Other - Road runoff redirected into French drain causing erosion on beach	900	Ditch - Install Sediment Pools; Paths & Trails - Define Foot Path; Paths & Trails - Infiltration Steps; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	High	Medium	Road runoff redirected into French Drain causing erosion on beach. Investigate French Drain and if plugged, consider converting it to an Open Top Culvert and directing discharge to a Sediment Pool. For bare soil, choose Mulch/Erosion Control Mix or Reseed bare soil depending on preferred ground cover.
6	14	6-14	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Unstable Access	680	Path & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - No Raking	Medium	Low	Have a really nice buffer although it is short circuited by the footpath straight through it. Other suggestions for slowing water down include adding waterbars and/or adding gravel or crushed stone.
6	15	6-15	Residential	Surface Erosion - Sheet; Soil - Bare; Other - Lots of hardscaping	100	Path & Trails - Stabilize Foot Path; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	A lot of existing hardscaping. Consider adding crushed stone at bottom of steps to lake. Mulch/Erosion Control Mix could be placed above and below steps.
6	16	6-16	Residential	Soil - Bare	400	Other - Mulch/Erosion Mix; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Either adding Mulch/Erosion Control Mix or Reseeding bare soil & thinning grass would reduce erosion at end of driveway.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
6	17	6-17	Boat Access	Soil - Bare	200	Other - Mulch/Erosion Control Mix	Low	Low	Currently crushed stone on boat access. Old boat house foundation is caving in, but no erosion was observed. Mulch/Erosion Control Mix should be added to boat access side slopes.
6	18	6-18	Private Road	Culvert - Unstable Inlet; Shoreline - Undercut	50	Culvert - Armor Inlet/Outlet; Culvert - Install Plunge Pool	Medium	Low	Erosion is occurring where the road ditch intersects with the culvert. Install plunge pool at intersection.
7	1	7-1	Residential	Surface Erosion - Sheet; Surface Erosion - Rill; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation	200	Paths & Trails - Stabilize Foot Path; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - Reseed bare soil & thinning grass	Medium	Low	
7	2	7-2	Residential	Surface Erosion - Sheet; Soil - Uncovered Pile; Shoreline - Lack of Shoreline Vegetation	100	Paths & Trails - Infiltration Steps	Low	Low	Uncovered pile is sand mixed with debris. Likely a result of raking beach. Pile should be moved away from lake. Suggest no new sand brought in. One infiltration step could be added at bottom of existing steps.
7	3	7-3	Residential	Surface Erosion - Sheet; Soil - Bare; Soil - Uncovered Pile; Shoreline - Inadequate Shoreline Vegetation	72	Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer	Low	Low	Remove sand/debris pile.
7	4	7-4	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Undercut; Shoreline - Erosion	10	Paths & Trails - Infiltration Step	Low	Low	Bare soil at beach. One infiltration step could be added at bottom of existing steps.
7	5	7-5	Residential	Soil - Bare; Roof Runoff Erosion	140	Paths & Trails - Define Foot Path; Paths & Trails - Stabilize Foot Path; Roof Runoff - Drywell @ gutter downspout; Other - Mulch/Erosion Control Mix; Vegetation - Reseed bare soil & thinning grass	Low	Low	Add Drywell along edge of existing pavers.
7	6	7-6	Residential	Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Unstable Access	150	Construction Site - Silt Fence/EC Berms; Paths & Trails - Define Foot Path; Path & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Soil in side yard and in front yard had been reseeded at the time of the QA/QC. According to owner, Dripline Infiltration Trench, Buffer, and Reseeding is a work in progress. One infiltration step could be added at bottom of existing steps.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
7	7	7-7	Residential	Soil - Bare; Soil - Uncovered Pile; Shoreline - Inadequate Shoreline Vegetation	400	Roof Runoff - Infiltration Trench @ roof dripline; Other - Rain Garden; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	Remove sand/debris pile.
7	8	7-8	Boat Access	Surface Erosion - Rill; Soil - Delta in Stream/Lake; Shoreline - Unstable Access	1200	Roads/Driveways - Build Up; Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Install Runoff Diverters (Waterbar)	High	High	Delta in lake is from boat ramp and adjacent stream. Stream outlet and end of boat ramp merge.
7	9	7-9	Town Road	Culvert - Unstable Inlet/Outlet; Culvert - Clogged; Road Shoulder Erosion - Rill	900	Culvert - Armor Inlet/Outlet; Culvert - Remove Clog; Ditch - Remove debris/sediment	High	Medium	Algae in ditch from a possible nutrient source such as septic? Remove winter sand and vegetate back slopes.
7	10	7-10	Residential	Surface Erosion - Rill; Soil - Bare	200	Vegetation - Add to Buffer; Vegetation - No Raking; Vegetation - Reseed bare soil & thinning grass	Low	Low	Plant Pachysandra ground cover. Owner prefers shrubs over mulch.
7	11	7-11	Construction Site	Soil - Bare	900	Construction Site - Mulch; Construction Site - Silt Fence/EC Berms; Construction Site - Seed/Hay	Medium	Low	Close proximity to stream. Also recommend removing accumulated dirt from driveway and installing culvert under driveway.
7	12	7-12	Town Road	Culvert - Clogged; Road Shoulder Erosion - Rill; Roadside Plow/Grader Berm; Soil - Bare; Soil - Winter Sand	720	Culvert - Remove Clog; Ditch - Reshape Ditch; Ditch - Install Check Dams; Ditch - Remove debris/sediment; Roads/Driveways - Remove Grader/Plow Berms	Medium	Medium	Winter sand accumulation is due in part to the Site 7-11 construction site blocking road drainage. Installing a culvert under the driveway will alleviate backup.
7	13	7-13	Driveway	Surface Erosion - Rill; Soil - Bare	105	Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape Crown	Low	Low	Work with neighbor to extend garden.
7	14	7-14	Residential	Soil - Bare	140	Ditch - Vegetate; Other - Mulch/Erosion Control Mix; Vegetation - Reseed bare soil & thinning grass	Low	Low	Culvert under driveway is too high resulting in poor drainage. Road ditch backslope is bare ground. At time of QA/QC, owner has seeded bare area and grass has started to grow.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
7	15	7-15	Residential	Surface Erosion - Rill; Soil - Bare; Shoreline - Lack of Shoreline Vegetation; Shoreline - Unstable Access	2000	Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Medium	Low	Area above lake bank is flat and path to dock is steep.
7	16	7-16	Private Road	Surface Erosion - Rill; Road Shoulder Erosion - Rill; Roadside Plow/Grader Berm; Soil - Winter Sand	800	Roads/Driveways - Remove Grader/Plow Berms; Roads/Driveways - Add New Surface Material (Pave); Roads/Driveways - Reshape (Crown); Vegetation - Reseed bare soil & thinning grass	Medium	High	Surface erosion in road is due to broken pavement. Rill erosion on bare inslope. Engineering needed for road improvements. Add Asphalt curb.
7	17	7-17	Residential	Surface Erosion - Rill; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	100	Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Vegetation - Establish Buffer; Vegetation - Reseed bare soil & thinning grass	Low	Low	
7	18	7-18	Residential	Surface Erosion - Sheet; Soil - Bare	48	Other - Mulch/Erosion Control Mix; Vegetation - Establish Buffer	Low	Low	Bare soil in sitting area. Remove light sand. Establish buffer along edge of area.
7	20	7-20	Residential	Surface Erosion - Rill; Soil - Bare; Shoreline - Undercut	840	Paths & Trails - Stabilize Foot Path; Paths & Trails - Infiltration Steps; Roof Runoff - Infiltration Trench @ roof dripline; Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer; Vegetation - No Raking	High	Medium	Sediment washed up against patio fence. Infiltration Trench should be installed along porch edge too. Erosion Control Mix berm along edge of fenced patio would reduce sediment migration into lake.
7	21	7-21	Residential	Surface Erosion - Sheet; Soil - Bare	320	Paths & Trails - Infiltration Steps; Other - Mulch/Erosion Control Mix	Low	Low	
7	22	7-22	Residential	Surface Erosion - Sheet; Soil - Bare	600	Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	Low	Low	Bare soil in lawn close to lake.
7	28	7-28	Private Road	Soil - Winter Sand	0.2-mile X 15'	Roads/Driveways - Remove Grader/Plow Berms; Roads/Driveways - Reshape (Crown)	Low	High	Excessive winter sand accumulation on the road surface.
7	29	7-29	Residential	Soil - Winter Sand	150	Vegetation - Establish Buffer	Medium	Low	Sand dumped on stream bank. Stop dumping sand onto bank. Plant ground cover on exposed sand.
7	35	7-35	Beach Access	Soil - Bare; Shoreline - Lack of Shoreline Vegetation	2400	Vegetation - Establish Buffer.	High	Medium	Delta in lake at stream outlet. Plant vegetation after removal of delta.
7	36	7-36	Trail or Path	Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	225	Paths & Trails - Install Runoff Diverter (waterbar); Vegetation - Add to Buffer	Low	Low	Add/replace rubber razors on path to shoreline.

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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
7	37	7-37	Trail or Path	Surface Erosion - Rill; Shoreline - Undercut; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	150	Paths & Trails - Stabilize Foot Path; Paths & Trails - Install Runoff Diverter (waterbar); Other - Mulch/Erosion Control Mix; Vegetation - Add to Buffer	High	Medium	Large contributing area from boat storage area. Construct Water Bar crossing in front of boat racks to existing rip rap slope under docks on bank. Crushed stone would be appropriate in high traffic areas.
8	1	8-1	Private Road	Surface Erosion - Sheet; Culvert - Unstable Inlet/Outlet	12' for over 250 yds length	Culvert - Armor Inlet/Outlet; Culvert - Lengthen; Ditch - Install Turnouts; Ditch - Install Ditch; Roads/Driveways - Add New Surface Material (Pave); Roads/Driveways - Install Runoff Diverters (Waterbar)	Medium	Medium	Resident says road does not erode badly. Unstable culvert outlets at two stream crossings. Southwest of culverts, road is at 10 to 15 degrees slope. Install large rip rap at culvert outlets. Recycled Asphalt could be used as an alternative to paving.
8	2	8-2	Residential	Surface Erosion - Sheet; Soil - Bare; Roof Runoff Erosion; Shoreline - Lack of Shoreline Vegetation	120	Paths & Trails - Infiltration Steps; Roof Runoff - Rain Barrel; Vegetation - Establish Buffer	Low	Low	Over 20-degree slope exposed at shoreline.
8	3	8-3	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Lack of Shoreline Vegetation	1500	Vegetation - Add to Buffer; Vegetation - No Raking	Low	Low	Thin grass cover over bare soil at time of QA/QC.
8	4	8-4	Residential	Surface Erosion - Sheet; Soil - Bare; Shoreline - Inadequate Shoreline Vegetation; Shoreline - Erosion	100	Vegetation - Establish Buffer; Vegetation - No Raking	Low	Low	
8	5	8-5	Private Road	Surface Erosion - Sheet; Surface Erosion - Rill; Road Shoulder Erosion - Rill; Soil - Bare	60 yds	Culvert - Armor Inlet/Outlet; Culvert - Lengthen; Ditch - Install Turnouts; Roads/Driveways - Add New Surface Material (Recycled Asphalt); Roads/Driveways - Reshape (Crown)	Medium	Medium	Road slope is as much as 10-degree grade. Much of upper Little Duck Pond Rd is steep and eroding, but I don't see sediment is getting into the pond during QA/QC. Reshape road shoulders. Paving could be used as an alternative to Recycled Asphalt.
8	6	8-6	Private Road	Culvert - Unstable Inlet/Outlet; Culvert - Undersized; Road Shoulder Erosion - Rill	100	Culvert - Replace; Culvert - Enlarge; Culvert - Lengthen; Ditch - Armor with Stone	Low	Medium	Much of Libby Hill Road is surfaced by reclaimed asphalt and is stable, but North end is gravel, steep in spots, showing erosion, but I don't see that sediment is getting into Little Duck Pond during QA/QC. Low traffic volume.

Highland Lake Watershed Survey Data
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Sector	Surv. Site	Mapsite #	Land Use	Type of Problem	Area	Recommendations	Impact	Cost	Notes
8	7	8-7	Private Road	Surface Erosion - Rill; Ditch - Rill Erosion; Road Shoulder Erosion - Rill Other - Road needs to be ditched and paved up to asphalt	1440	Roads/Driveways - Add New Surface Material (Pave); Roads/Driveways - Install Runoff Diverters (Waterbar)	High	High	Sand from erosion on Little Duck Pond Road is filling up roadside ditch of Falmouth Road going South, on West side. Little Duck Pond Road is 10-degree slope. This section of Little Duck Pond Road needs to be ditched and paved to Falmouth Road. Recycled Asphalt was laid down last week of May, according to an owner on Little Duck Pond Road.
8	13	8-13	Private Road	Surface Erosion - Sheet	1500	Ditch - Remove debris/sediment; Ditch - Install Sediment Pools; Road/Driveways - Install Runoff Diverters (Waterbar)	Low	Low	Bimmer Drive is very steep at approximately 15-degree grade. Road surface is compacted Recycled Asphalt. Sand is accumulating in ditch alongside of Falmouth Road.

Appendix D: Best Management Practice Glossary

Following are brief descriptions of best management practices for protecting water quality. Website addresses for sources of information on each BMP are contained in **Tables 7, 8, and 9** of the Survey Report.

Best Management Practice	Description
CONSTRUCTION SITE	
Mulch	Temporary mulching is the application of hay, straw, erosion control mix, chemical mulches and soil binders, or erosion control blankets and mats to the soil surface. Its purpose is to prevent erosion by protecting the exposed soil surface and to aid in the growth of vegetation by conserving available moisture, controlling weeds, and providing protection against extreme heat and cold. The choice of materials for mulching is based on soil and site conditions, season, and economics.
Seed/Hay	Seed/Hay is used to establish either a temporary (up to 12 months) or permanent vegetative cover to stabilize the soil and reduce damage from sediment runoff. The hay is used as mulch to protect the seed until growth is established. Temporary vegetative cover stabilizes disturbed areas that will not be brought to final grade for a year or less. Annual plants that sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover whereas long-lived plants are necessary for permanent vegetative cover.
Silt Fence / EC Berms	Silt fence and Erosion Control Mix (EC) berms are temporary sediment barriers installed across a slope to retain small amounts of sediment from disturbed or unprotected areas. Silt fence is a synthetic filter fabric and is designed for situations in which only sheet or overland flows are expected. Generally, pre-manufactured silt fencing with posts attached is used. EC berms consist of primarily organic material including shredded bark, stump grindings, or composted bark. They are placed in a berm along a contour and are especially useful where frozen ground, outcrops of bedrock, and very rooted areas make installation of silt fence impractical.
CULVERTS	
Armor Inlet/Outlet (7)	Material, typically stone, is installed to protect the immediate area around the inlets and outlets of culverts from scour and deterioration. At stream crossings, stone should not be placed across the entire stream channel; it should be limited to the culvert inlet/outlet and banks of the stream around the crossing only.
Enlarge	Replacement of an undersized culvert which is contributing to overtopping and/or erosion of road surfaces with a larger culvert.
Install Culvert	A culvert is installed in order to convey water under a road from one side to the other. They are installed where a stream, brook, or seasonal runoff intersects a road, where runoff accumulates to volumes that are difficult to contain (without eroding) in a roadside ditch and needs to be turned out to the opposite side of the road, or where driveway crossings intercept a road ditch.

Install Plunge Pool	Plunge pools are installed where there is a need to dissipate the flow of high velocity water exiting a culvert in order to prevent channel erosion at the culvert outlet. They are typically armored with stone. Plunge pools should NOT be installed in a stream channel without first obtaining a permit. 
Lengthen	Culverts should be lengthened where a road is too wide for an existing culvert and road material is spilling over a culvert inlet or outlet and into a channel.
Remove Clog	Culverts can sometimes become clogged with winter sand and other debris and need to be cleaned out in order to return them to their original capacity. Sometimes local fire departments will flush culverts if requested.
Replace	Culverts that are crushed, heavily corroded, or are undersized need to be replaced.
DITCHES	
Armor with Stone	Ditches should be lined with non-woven geotextile fabric and covered with stone where the runoff velocities are too high for a vegetated lining. This can occur in ditches on steeper slopes (greater than 5%) where a ditch is subject to rill and/or gully erosion. Stone (riprap) must be sized based on the anticipated flow velocities.
Install Check Dams	Check dams are small stone dams constructed across a swale or ditch to reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. Although check dams also trap small amounts of sediment generated in the ditch itself, they are not considered a sediment trapping practice. They are not to be used in a stream.
Install Ditch	Ditches should be installed wherever runoff from roads and/or runoff intercepted by roads is negatively impacting the downstream environment. Some factors to be considered prior to ditch construction include the watershed area draining to the ditch, degree of slope, width of right-of-way, ditch size and shape, and native soil type. Parabolic or trapezoidal shaped ditches are preferred over V-shaped ditches because of the reduced potential for erosion of the ditch bottom.
Install Sediment Pools	A sediment pool or basin is a water impoundment constructed to collect and store sediment by constructing a dam or embankment and/or excavating a pit or dugout pond for water storage. They are typically located on flatter slopes where sediment would collect at the downhill end of a ditch. Several factors, including the watershed area draining to the sediment pool, should be considered during design in order to prevent damage to the sediment pool and downstream resources.
Install Turnouts	Turnouts are basically openings in the backslope of a ditch and constructed at intervals so as to divert ditch water into vegetated buffers. Installing turnouts will disperse water that accumulates in the ditch, resulting in less ditch erosion and the associated discharge of sediment into downstream resources. The concentrated flow in the ditch is converted into sheet flow by a level spreader located at the end of a turnout. Water and nutrients can then be effectively filtered and absorbed by the vegetated buffer.

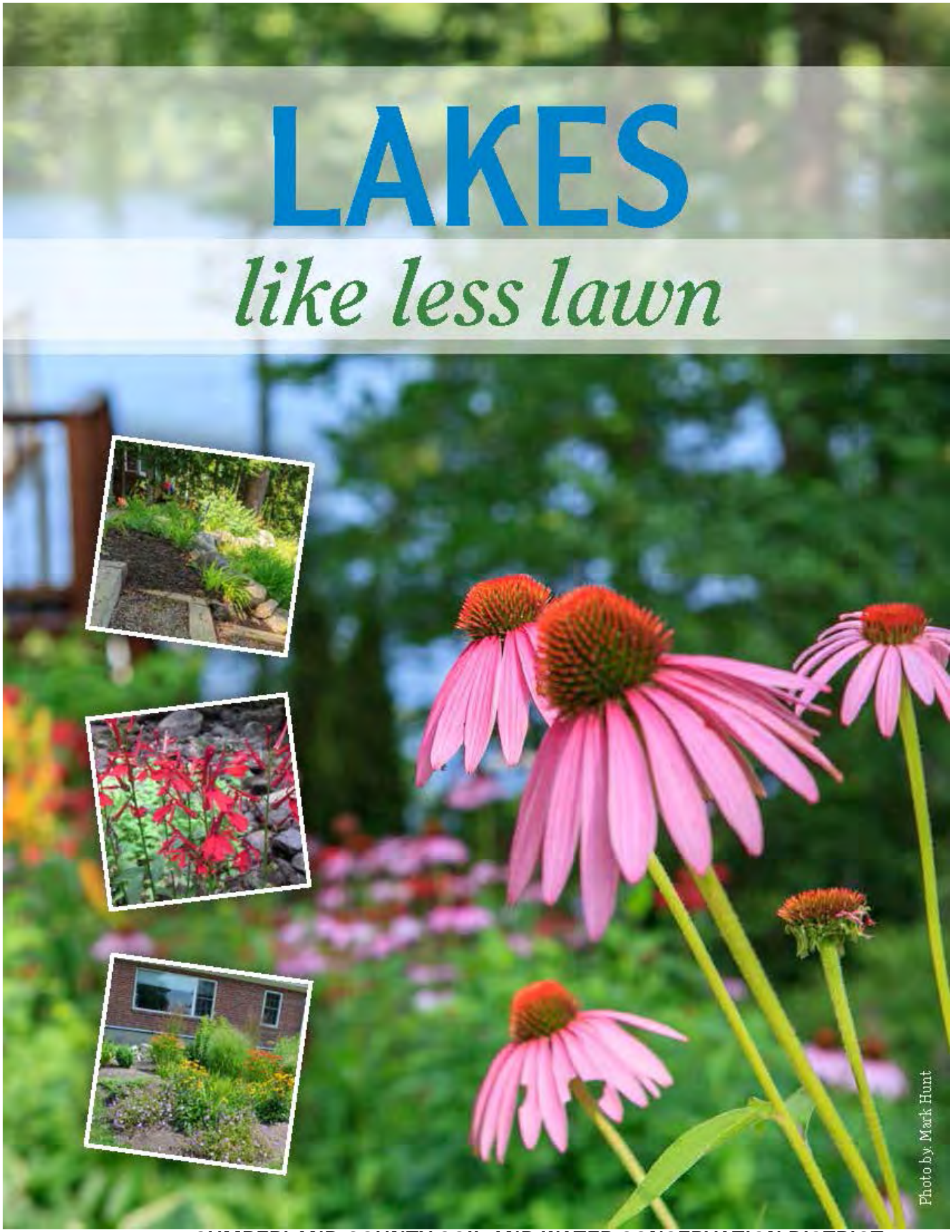
Reshape Ditch	A ditch should be reshaped when it appears that a ditch is too narrow or the side slopes too steep and severe erosion is the result. Parabolic or trapezoidal ditches are preferred over V-shaped ditches. The flatter bottoms of parabolic and trapezoidal ditches spread water over a wider surface area, which slows water down and greatly reduces its erosive potential. Ditch side slopes should be no steeper than 2:1 (horizontal: vertical).
Remove Debris/Sediment	Debris and sediment accumulating in a ditch can eventually reduce its carrying capacity and potentially result in the ditch banks being overtopped and causing severe erosion of the road and surrounding area. Sediment that accumulates could also be remobilized and discharge to downstream resources in a large storm event.
Vegetate	Vegetated ditches are preferred over stone ditches where flow velocities allow. The vegetation is better at filtering out sediment and nutrients from the water and allowing some of the water to infiltrate. It also reduces the thermal load in ditch water that stone can sometimes produce on hot days. If erosion control blankets or mats are placed over a newly excavated and seeded ditch, the grass will become intertwined in the blanket or mat and will help to anchor the grass in place.
DRIVEWAYS/ROADS/ BOAT LAUNCH	
Add New Surface Material (Gravel)	Gravel should be added to a road surface if the road has experienced erosion from traffic and/or runoff, causing the road to lose its crown (high point in the middle of the road). Rebuilding the crown allows water that accumulates on the road to flow to the edge of the road and into a ditch, as opposed to a flat or sunken road where the water sits on the road and creates potholes. A crushed, well-graded gravel should be used.
Add New Surface Material (Pave)	Although the cost of paving can be prohibitive for a driveway or private road, it can be the best option on a particularly steep, high-use, or intersection portion of a road. Paving a chronically eroding section of a road can be the best method of stabilizing it.
Add New Surface Material (Recycled Asphalt)	Recycled Asphalt can be used as an alternative to Gravel (see above). It is old pavement which has been run through a grinder. It looks similar to Gravel but it is more granular and darker because of the residual asphalt. Once installed and compacted, the residual asphalt and fines bind the material into a very erosion-resistant road surface. It can be more effective than Gravel for repairing road sections with chronic erosion problems.
Buildup	Road Buildup should be considered if a road is sunken relative to the surrounding landscape and it is practical and economical to bring road material in and raise the road. This would allow runoff that accumulates on the road and in the ditches to shed into the surrounding landscape during major storms and reduce the potential for severe erosion occurring on the road and in the ditches.
Remove Grader/Plow Berms	Grader/Plow Berms can occur as a result of road grading and snow plowing activities that push road material or winter sand into small berms along the edge of the road. These little berms defeat the purpose of road crowning by catching water before it can drain off the road and channels it along the outer edge of the road surface. The berms should be removed by using the grader blade to smooth the edges and bringing material back toward the center of the road.
Reshape (Crown)	Roads should be reshaped if a road surface has been flattened by vehicular traffic, snow plowing, and and/or runoff and water cannot drain to the side of the road and into ditches. Rebuilding a crown is essentially reestablishing the high point in the middle of the road either through adding more surface material or regrading, or a combination of both.

Runoff Diverters (Broad-Based Dip)	A Broad-Based Dip can be used to divert runoff flowing down a road into ditches and/or the surrounding landscape. They are most useful on long, continuous slopes and are built by cutting into the road surface to create a shallow depression diagonally across the road at an approximate 30-degree angle and using that material to raise the road surface on the downhill side of the depression. The transition through the Broad-Based Dip should be smooth enough so that the road can be plowed during the winter. They are best used on shallow angle hills and not steep hills.
Runoff Diverters (Open Top Culvert)	Open Top Culverts can be used on seasonal roads and driveways to divert runoff flowing down a road into ditches and/or the surrounding landscape. They are constructed by assembling rot resistant lumber into a cross-sectional square trench shape, excavating a trench of the same outside dimensions as the culvert at an approximate 30-degree angle into the road surface, and placing the culvert into the road with the top of the culvert flush with the road surface.
Runoff Diverters (Rubber Razor)	Rubber Razors can be used on seasonal roads and driveways to divert runoff flowing down a road into ditches and/or the surrounding landscape. They are constructed by sandwiching a rubber bar (typically new or used conveyor belt) between rot resistant lumber, excavating a trench of the same outside dimensions as the Rubber Razor at an approximate 30-degree angle into the road surface, and placing the Rubber Razor into the road with the rubber bar portion protruding above the road surface.
Runoff Diverters (Unspecified Type)	Runoff Diverters can be any of the types listed in this section, depending on a number of factors including location (shallow or steep hill), use (year-round or seasonal), traffic (heavy or light), maintenance requirements (equipment), and resources (financial and manpower).
Runoff Diverters (Waterbar)	A Waterbar can be used to divert runoff flowing down a road into ditches and/or the surrounding landscape. They are built by cutting into the road surface to create a depression diagonally across the road at an approximate 30-degree angle and using that material to create a bump on the downhill side of the depression. The result is a ridge, or speed bump, that runs across the road. The transition over the Waterbar is not as smooth as that of a Broad-Based Dip, so may not be appropriate for roads that will be plowed.
Vegetate Shoulder	Road shoulders can be vegetated in order to help prevent erosion of road edges and to filter runoff from the road surface. However, road shoulders should be maintained to prevent the buildup of sediment which could create small berms that would block runoff.
OTHER	
Infiltration Trench	Infiltration Trenches can be used to collect and infiltrate runoff from paved driveways, rooftops, and other areas. They work best in well drained-soils like sands and gravels. They are not suitable for areas that receive large amounts of sediment as they will fill in quickly. They are constructed by excavating a trench, preferably lining the trench with non-woven geotextile fabric, and backfilling the trench with crushed stone.
Install Runoff Diverter (Waterbar)	Waterbars can be used to divert runoff from roads, footpaths, and trails but materials and construction are very different for those used on roads versus those used on footpaths and trails. For roads, refer to the description for Waterbars under the Roads/Driveways/Boat Launch section above and for other applications, refer to the description under the Paths & Trails section below.
Mulch/Erosion Control Mix	Mulching is the application of an organic cover over exposed soil to protect its structure from the impact of raindrops, to reduce the potential for erosion, and to maintain soil permeability and moisture for vegetation uptake. Erosion Control Mix is a type of mulch made of partially composted bark, sand, gravel, stone, and wood fragments. It is much heavier than other types of mulch and its mixture of elongated fibers, gravel, and soil lock together to protect the underlying soil from erosion.

Rain Garden	Rain Gardens can be used to capture and filter stormwater from roofs, driveways, and other impermeable surfaces. They collect water in bowl-shaped, vegetated areas, and allow it to slowly soak into the ground. They are most effective when the Rain Garden area is 20-30% of the drainage area. The lowest point should be no lower than 6" below the surrounding land.
Water Retention Swales	Water Retention Swales can be used to capture and filter stormwater from roofs, driveways, and other impermeable surfaces. They collect water in a long, vegetated swale (shallow/wide ditch) built on a contour so that water spreads out evenly over the bottom of the swale. They work best in well-drained soils like sands and gravels.
PATHS & TRAILS	
Define Foot path	Foot paths are defined by limiting foot traffic to a path ideally 3' to 4' wide but no more than 6' wide. They should wind through the landscape and avoid straight sections on steep slopes. The path surface should not be lower than the surrounding landscape to avoid channeling of runoff. The path surface itself should be covered with an erosion resistant material.
Infiltration Steps	Infiltration Steps are steps built into slopes using timbers that retain crushed stone or pea stone. The crushed stone slows down and infiltrates runoff between the steps. They are effective on moderate slopes but consider building wooden stairways on 1:1 slopes (45°) or areas where rocks or surface roots make it difficult to set Infiltration Steps into the ground.
Install Runoff Diverter (Waterbar)	Waterbars intercept runoff flowing down paths and other areas and divert it into stable, vegetated areas. Waterbars should be spaced to evenly divide runoff between several receiving areas. Also, the steeper slope, the closer the spacing to keep runoff velocities low and help reduce the potential for erosion. They are constructed by excavating a trench at a 30-degree angle across the slope, inserting and securing a rot resistant timber or log into the trench, and backfilling the trench on the uphill side of the timber with crushed stone.
Stabilize Foot Path	Foot paths can be stabilized using any one or more of several erosion resistant materials. Choices include Erosion Control Mix, pine needles, bark mulch, crushed stone, and wood chips, to name a few. Material selection depends on a number of factors including volume of foot traffic, angle of slope, exposure to runoff, shoreland zone regulations, and aesthetics.
ROOF RUNOFF	
Drywell at Gutter Downspout	Drywells collect and infiltrate runoff at gutter downspouts and other places where large quantities of water flows off rooftops. These systems help reduce erosion that would otherwise occur if runoff was allowed to discharge onto erosion prone surfaces. They also reduce wear on house sidings by minimizing back splash. They are constructed by excavating a large hole at the end of the downspout, lining the hole with non-woven geotextile fabric, and backfilling the hole with crushed stone. They work best in sand and gravel soils that can quickly disperse large volumes of water.
Infiltration Trench at Dripline	On roofs without gutter systems, Dripline Trenches collect and infiltrate stormwater as it flows off the roof. These systems help reduce erosion that would otherwise occur if the runoff was allowed to fall directly onto the ground surface under the dripline. The trenches collect the roof runoff and stores it until it soaks into the surrounding soil. They also reduce wear on house sidings by minimizing back splash. They are constructed by excavating a linear trench under the dripline, lining the trench with non-woven geotextile fabric, and backfilling the trench with crushed stone. They work best in sand and gravel soils that can quickly disperse large volumes of water.

Rain Barrel	Rain barrels provide an innovative way to capture rainwater from roofs and store it for later use. Water collected from rain barrels can be used to water lawns, gardens, and indoor plants. This water would otherwise run off your roof directly onto the ground surface or through downspouts, potentially leading to erosion at the roof dripline or the downspout outlet, respectively. Using Rain Barrels can also lower your water bill, conserve well water in the dry season, and reduce polluted stormwater runoff.
VEGETATION	*Vegetated buffers are trees, shrubs and groundcover plants that catch sediment and other pollution before it reaches lakes or streams. Trees and shrubs also intercept raindrops and reduce their impact on the soil.*
Add to Buffer or Establish Buffer	Install additional plant material, especially in areas closest to the lake and other bodies of water. Select plants suitable to the growing zone, sunlight, and soil conditions of the planting area. Ideally, native plants should be selected since these are better adapted to local conditions, fit in with the natural landscape, and do not require fertilizers or pesticides.
No Raking	Avoid raking fallen leaves and other plant material which, if left in place, can act as a natural mulch and assist with erosion control.
Reseed Bare Soil / Thinning Grass	Using a suitable seed mixture for the conditions (e.g., sun or shade), seed bare areas at specified application rates and cover with mulch. A wide variety of blended seeds are available, including conservation mixes, which can provide quick growth in the short-term and hardy perennial plants in the long term.

Appendix E: Lakes Like Less Lawn Brochure



Why Do Lakes Like Less Lawn?

Whether you have lakefront property or live many feet from the lake, you can help protect lake water quality by reducing your lawn and making your property more beautiful and more valuable at the same time. The goal of this publication is to show you how!

When it rains, most of the water runs off smooth surfaces, such as lawns, instead of soaking in. And shallow grass root systems do little to prevent soil erosion. This means fertilizers and pesticides applied to lawns end up in the lake where they feed algae and degrade water quality. Eroded soil also feeds algae and too much algae in a lake can make the water murky and green. Studies have shown that property values are lower on lakes with less clear water. Too much algae in a lake also lowers oxygen levels in the water which can threaten cold water fish species, other wildlife, and a healthy lake habitat.

By planting a variety of trees, shrubs, ground covers, and flowering perennials you can protect the lake. All of these have deeper root systems that hold soil in place, absorb more runoff, and filter out more pollutants than grass. Native plant species are the best to use because they are adapted to local conditions. This means they require little maintenance once established, so you'll have more time to relax and enjoy the lake. Plus, they provide important habitat and food for birds, butterflies, and other wildlife.

How do I install plants on my property?

Select plants suitable to the growing zone, light, and soil conditions of the planting area. Ideally, native plants should be selected since these are better adapted to local conditions, fit in with the natural landscape, and do not require chemical fertilizers or pesticides. Be sure to plant a mix of trees, shrubs, and groundcover plants. Fall and spring are ideal planting times, but anytime during the growing season is acceptable. Step by step planting instructions are described below (from www.odonalsnurseries.com). The materials you will need, such as plants and bags of compost and loam, can be purchased from local nurseries.

1. Water the plant while it is still in its container. Dig a hole 2 times the width of the container and as deep as the soil level in the container.
2. Remove the root ball from the container and loosen the outside layer of the root system either by scoring with a knife or pulling by hand.
3. Set the plant in the middle of the hole. The top of the root ball should be at or slightly below normal ground level. If not, remove the plant and adjust the hole. Keep in mind that planting too deeply can kill the plant.
4. Backfill 2/3 of the planting hole with soil. If the original soil is very poor and the plant requires better soil conditions, mix in no more than 25% loam and/or compost with the original soil.
5. Fill the planting hole with water. This will result in a "moat" around the soil ball. When this drains completely, re-fill with water again.
6. After the water has drained, backfill the rest of the hole to ground level, and gently press the soil down to remove air pockets.
7. Water thoroughly once more to remove any remaining air pockets.
8. Place no more than 2" to 4" of mulch around the plant, but keep the mulch a few inches away from the trunk or branches emerging from the root ball. For the first year after planting a tree or shrub, keep a mulch ring around the outer edge of the hole to allow water to soak into the soil. Cover leftover bare soil with additional mulch or move to areas where it will not erode into the lake.

How do I maintain plants once they're installed?

YEAR ONE

Deep, weekly watering is a must during the first year of planting. Most plants that die in the first season do so because of inadequate watering. Make sure the water reaches the depth of the root ball. Planting areas can be weeded, but should not be raked.

AFTER ONE YEAR

After the first year, you should only need to water if there is a lack of normal rainfall. Once the plants are well established, you can let the planted area naturalize so that you do not need to replenish mulch or weed. The "duff" layer of leaves and pine needles will serve as natural mulch.

SHOULD I APPLY FERTILIZER?

If plants appear to be growing well, they should not require fertilization. Fertilizer can actually harm newly developing roots, and summer/fall applications can prevent shrubs and trees from hardening off in time for winter. Applying compost is the best way to fertilize plants on shorefront properties.

Can I transplant plants rather than purchase them?

You can save money by transplanting native plants onto your property. Keep in mind, however, that mortality rates of transplants are relatively high. Here are some general transplanting guidelines:

1. Make sure to ask for landowner permission before harvesting and do not take too many plants from any one area. Do not remove plants next to lakes or streams.
2. Transplant in the early spring or late fall when the plants are dormant. This reduces trauma to their root systems.
3. Choose sturdy-looking plants. Dig up the root ball as much as possible (extend your digging area at least to the width of the plant's branches.)
4. Once your transplant has been replanted, water frequently until well established.

Native Plants of the Northeast
Vines and Groundcovers

BEARBERRY
(Arctostaphylos uva-ursi)

Evergreen foliage is bright green and glossy. Spreads to form a mat. Blooms with small pink flowers in spring followed by bright red berries in fall. Does well in poor, sandy soils.

WILD GINGER
(Asarum canadense)

Easy to grow ground cover with shiny, heart shaped leaves.

WINTERGREEN
(Gaultheria procumbens)

Evergreen leaves are fragrant when crushed. Bright red berries are edible.

CREEPING JUNIPER
(Juniperus horizontalis)

Evergreen, blue-green foliage. Easy to grow, spreading plant.

CRESTED IRIS
(Iris cristata)

This iris grows to 6 inches tall and spreads, but not rapidly. Showy, lilac-blue flowers in late spring.

HONEYSUCKLE
(Lonicera dioica)

Low climbing vine with pale yellow, orange, or purple flowers that bloom in late spring.

TRUMPET HONEYSUCKLE
(Lonicera sempervirens)

High climbing vine with red, tubular flowers that bloom in late spring/early summer. Attracts birds, hummingbirds, and butterflies.

VIRGINIA CREEPER
(Parthenocissus quinquefolia)

Climbing and spreading hardy vine that tolerates a wide range of conditions. Foliage turns maroon in fall.

VIOLET
(Viola labradorica)

Blooms with purple flowers in spring.

MOSS PHLOX
(Phlox subulata)

Easy to grow, mat forming ground cover with needle like foliage. Blooms in spring with pink, lavender, or white flowers.

LOWBUSH BLUEBERRY
(Vaccinium angustifolium)

Easy to grow, mat forming shrub with white bell shaped flowers in the spring followed by edible, blue fruit in late summer. Attractive red foliage in the fall.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Perennials

BIG BLUESTEM
(Andropogon gerardii)

Easy to grow ornamental grass, green foliage turns red in the fall.

COLUMBINE
(Aquilegia canadensis)

Blooms mid to late spring with orange to reddish bell shaped flowers.

BUTTERFLY WEED
(Asclepias tuberosa)

Blooms in the summer with clusters of bright orange flowers. Does not transplant well due to taproot. Attracts bees and butterflies.

NEW ENGLAND ASTER
(Aster novae-angliae)

Blooms in fall with daisy like purple or pink flowers.

MARSH MARIGOLD
(Caltha palustris)

Leaves are round in shape, blooms in the spring with bright yellow flowers.

PINK TURTLEHEAD
(Chelone lyonii)

Dark green foliage, blooms in late summer with pink flowers.

BUGBANE, BLACK COHOSH
(Cimicifuga racemosa)

Dark green foliage, blooms in mid summer with white bottlebrush-like flowers.

PURPLE CONEFLOWER
(Echinacea purpurea)

Blooms in summer with pink daisy-like flower that has an orange-brown center. Attracts bees and butterflies.

JOE PYE WEED
(Eupatorium maculatum)

Blooms in late summer with clusters of pink flowers. Attracts bees and butterflies.

WILD GERANIUM
(Geranium maculatum)

Blooms in late spring to early summer with rose purple flowers.

NORTHERN BLUE FLAG IRIS
(Iris versicolor)

Blooms in late spring with bluish-purple flowers. Thrives in wetland areas.

GAYFEATHER
(Liatris spicata)

Blooms in late summer with spikes of pinkish-purple flowers. Foliage is grasslike.

CARDINAL FLOWER
(Lobelia cardinalis)

Blooms in late summer to early fall with tall spikes of crimson flowers. Does best along the edges of wet areas. Attracts hummingbirds.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Perennials

BEE BALM
(Monarda didyma)

Blooms in summer with red showy flowers. Attracts bees, butterflies, and hummingbirds.

SWITCHGRASS
(Panicum virgatum)

Easy to grow ornamental grass, green foliage turns yellow in the fall. Provides winter interest.

BEARD TONGUE
(Penstemon digitalis)

Blooms in summer with white tubular, bell shaped flowers. Attracts bees and hummingbirds.

SOLOMON'S SEAL
(Polygonatum pubescens)

Blooms in spring with bell shaped white flowers. Graceful plant with arching stems.

BLACK EYED SUSAN
(Rudbeckia hirta)

Blooms in summer with daisy like golden yellow flowers with a dark brown center. Attracts butterflies.

BLOODROOT
(Sanguinaria canadensis)

Blooms in spring with a white flower with a yellow center.

LITTLE BLUESTEM
(Schizachyrium scoparium)

Easy to grow ornamental grass, green foliage turns bronze-orange in the fall.

INDIAN GRASS
(Sorghastrum nutans)

Easy to grow ornamental grass, blue-green foliage turns orange-yellow in the fall, feathery seed stalks.

FOAMFLOWER
(Tiarella cordifolia)

Blooms in spring with delicate white flowers.

Ferns

LADY FERN
(Athyrium filix-femina)

Easy to grow, ornamental fern with bright green, lacey fronds.

OSTRICH FERN
(Matteuccia struthiopteris)

Easy to grow fern with edible fiddleheads.

CINNAMON FERN
(Osmunda cinnamomea)

Easy to grow, cinnamon-colored fertile frond present in spring. Leaf fronds turn yellow-gold in the fall.

INTERRUPTED FERN
(Osmunda claytoniana)

Easy to grow, hardy fern that spreads well. Frond is "interrupted" by reproductive spore sacs.

HAYSCENTED FERN
(Dennstaedtia punctilobula)

Easy to grow, spreading fern with lacey, fragrant fronds.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Small Shrubs (Less than 6ft tall)

BLACK CHOKEBERRY
(Aronia melanocarpa)

White flowers in clusters, large, showy black berries, and excellent red fall foliage. Attracts birds.

BUTTONBUSH
(Cephalanthus occidentalis)

Deciduous shrub that grows best in wet areas. Blooms in the summer with fragrant white flowers that appear in dense spherical heads. Flower heads become ball-like fruits.

SWEET PEPPERBUSH
(Clethra alnifolia)

Deciduous shrub that blooms in late summer with fragrant white flowers. Flowers attract bees and butterflies.

SWEET FERN
(Comptonia peregrina)

Deciduous, hardy shrub with fragrant foliage. Does well in dry, sandy soil.

COMMON JUNIPER
(Juniperus communis)

Evergreen shrub that tolerates drought, cold temperatures, and windy sites. Produces small white berries that turn blue.

REDOSIER DOGWOOD
(Cornus sericea)

Deciduous shrub with attractive red stems in winter.

BUSH HONEYSUCKLE
(Diervilla lonicera)

Deciduous, hardy shrub with light and dark green foliage. Blooms in summer with yellow flowers in clusters.

SHEEP LAUREL
(Kalmia angustifolia)

Evergreen shrub that tolerates a range of soils but does best in acidic soils. Blooms in late spring with bright pink flowers.

SWEETGALE
(Myrica gale)

Deciduous shrub that is extremely hardy and has fragrant foliage and stems.

SHRUBBY CINQUEFOIL
(Potentilla fruticosa)

Deciduous shrub that blooms with bright yellow flowers late summer into fall. Foliage is blue-green to dark green in color.

FRAGRANT SUMAC – 'GRO-LOW'
(Rhus aromatica)

Deciduous shrub that is fast growing and has attractive red or orange fall foliage.

SNOWBERRY
(Symphoricarpos albus)

Deciduous shrub with large snow white berries.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Tall Shrubs (Greater than 6ft tall)

COMMON WITCH HAZEL
(Hamamelis virginiana)

Grows to 15 feet tall. Yellow flowers in October. Yellow fall foliage.

INKBERRY
(Ilex glabra)

Evergreen shrub with small greenish white flowers in early summer and black berries in fall.

WINTERBERRY
(Ilex verticillata)

Bright red berries persist into mid winter. Excellent wetland plant. Attracts birds.

SPICEBUSH
(Lindera benzoin)

Deciduous shrub with small yellow flowers in spring before the foliage emerges. Red fruit and yellow foliage provide color in fall.

NORTHERN BAYBERRY
(Myrica pensylvanica)

Glossy-green, aromatic foliage. Tolerates poor soils with its ability to fix nitrogen. Gray berries used to make candles; important food for the yellow rumped warbler.

BEACH PLUMB
(Prunus maritima)

Grows wider than tall. White flowers in spring, orange - red foliage in fall. Excellent stabilizer of dry, sandy soil. Edible fruit, attracts birds and bees.

HIGHBUSH BLUEBERRY
(Vaccinium corymbosum)

Deciduous shrub with white bell shaped flowers in early summer followed by edible, blue fruit in late summer. Attractive red foliage in fall.

NANNYBERRY
(Viburnum lentago)

Large, dense shrub or small tree is hardy and performs well in most soils. Shiny, dark green foliage turns purple and red in fall. White flowers in flat clusters about 4 inches wide in spring. Fruit initially pinkish turns bluish black on pinkish red stalks.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Trees

BALSAM FIR
(Abies balsamea)

Evergreen with aromatic leaves. Favored for Christmas trees and greens. Grows to 70 feet.

RED MAPLE, SWAMP MAPLE
(Acer rubrum)

Fall foliage ranges from yellow to brilliant red. Withstands wet soils. Grows to 60 feet.

SUGAR MAPLE
(Acer saccharum)

Foliage is orange-yellow. Best maple for syrup production. Avoid wet soils or where road salts are a problem. Grows to 80 feet.

YELLOW BIRCH
(Betula alleghaniensis)

Shiny, yellow-bronze bark. Foliage is golden-yellow in fall. Grows to 80 feet.

AMERICAN HORNBEAM, MUSCLEWOOD
(Carpinus caroliniana)

A small, slow-growing tree, often with leaning trunk. Foliage turns a brilliant scarlet in fall. Grows to 25 feet.

HAWTHORN
(Crataegus crus-galli)

Glossy green leaves, 2 inch thorns, persistent dark red fruits. Grows to 30 feet.

GREEN ASH
(Fraxinus pennsylvanica)

Fast grower, tolerates salty, dry, and alkaline soils. Grows to 60 feet.

TAMARACK
(Larix laricina)

Also called eastern larch or hackmatack. Our only native deciduous conifer, fast growing. Grows to 60 feet.

WHITE SPRUCE
(Picea glauca)

Good for windbreak. Does not tolerate shade. Grows to 60 feet.

BLACK SPRUCE
(Picea mariana)

Will grow rapidly on a good site. Grows to 70 feet.

RED PINE
(Pinus resinosa)

Fast-growing, good for screening/blocking wind. Also called Norway pine for its original finding in Norway, Maine. Grows to 80 feet.

SWAMP WHITE OAK
(Quercus bicolor)

Orange foliage in fall. Adapted to poorly drained soils but is drought tolerant as well. Ducks often feed on its acorns. Grows to 75 feet.

NORTHERN RED OAK
(Quercus rubra)

Fast growing oak. Prefers well drained, moist soil. Transplants readily. Good fall red leaf color. Grows to 75 feet.

NORTHERN WHITE CEDAR
(Thuja occidentalis)

Commonly used as hedge plant. Source of food for deer in winter. Grows to 60 feet.

EASTERN HEMLOCK
(Tsuga canadensis)

Partial shade preferred. Does not tolerate drought or windy sites. Grows to 75 feet.

KEY TO SYMBOLS:					
	Full Sun		Dry soil		Deer resistant
	Part Sun		Moist soil		Deciduous
	Shade		Wet soil		Evergreen

Plants to Avoid

From the Maine Invasive Species Network, University of Maine
https://extension.umaine.edu/invasivespecies/home/id-resources2/

AMUR MAPLE *(Acer ginnala)*
NORWAY MAPLE *(Acer platanoides)*
BISHOP'S WEED *(Aegopodium podagraria)*
TREE OF HEAVEN *(Ailanthus altissima)*
GARLIC MUSTARD *(Alliaria petiolata)*
FALSE INDIGO *(Amorpha fruticosa)*
PORCELAIN BERRY *(Ampelopsis glandulosa)*
COMMON MUGWORT *(Artemisia vulgaris)*
JAPANESE BARBERRY *(Berberis thunbergii)*
COMMON BARBERRY *(Berberis vulgaris)*
ASIATIC BITTERSWEET *(Celastrus orbiculatus)*
AUTUMN OLIVE *(Elaeagnus umbellata)*
WINGED EUONYMUS OR BURNING BUSH *(Euonymus alatus)*
CYPRESS SPURGE *(Euphorbia cyparissias)*
CHINESE BINDWEED *(Fallopia baldschuanica)*
JAPANESE KNOTWEED *(Fallopia japonica)*
GLOSSY BUCKTHORN *(Frangula alnus)*
DAME'S ROCKET *(Hesperis matronalis)*
ORNAMENTAL JEWELWEED *(Impatiens glandulifera)*
YELLOW IRIS *(Iris pseudacorus)*
COMMON PRIVET *(Ligustrum vulgare)*
JAPANESE HONEYSUCKLE *(Lonicera japonica)*
AMUR OR BUSH HONEYSUCKLE *(Lonicera maackii)*
MORROW'S HONEYSUCKLE *(Lonicera morrowii)*
TATARIAN HONEYSUCKLE *(Lonicera tatarica)*
PURPLE LOOSESTRIFE *(Lythrum salicaria)*
JAPANESE STILT GRASS *(Microstegium vimineum)*
PAULOWNIA *(Paulownia tomentosa)*
MILE-A-MINUTE WEED *(Persicaria perfoliata)*
AMUR CORK TREE *(Phellodendron amurense)*
WHITE COTTONWOOD *(Populus alba)*
BLACK LOCUST *(Robinia pseudoacacia)*
MULTIFLORA ROSE *(Rosa multiflora)*

Sebago Lakescaping Program

What is Sebago Lakescaping?

The Sebago Lakescaping Program helps you minimize the impact of runoff on lake water quality and enhance the value of your property at the same time.

Who can receive a Lakescaping Consultation and Grant?

You are eligible for a Lakescaping Consultation and Grant if you are in one of the 7 towns that border the lake (Standish, Sebago, Naples, Casco, Raymond, Windham, and Frye Island) and within 250 feet of Sebago Lake or one of the following rivers or streams: Crooked River, Songo River, Muddy River, North West River, Panther Run, Rich Mill Outlet, Smith Mill, Sticky River, or Standish Brook. Priority is given to those properties closest to the lake or a major tributary and projects that will do the most for water quality. Individuals, camps, road associations, businesses, municipalities, non-profit organizations, and other groups are encouraged to apply.

How much funding can I receive from a Lakescaping Grant?

Available funds will be awarded to qualifying applicants on a first-come, first-serve basis. Grant awards require a dollar for dollar match, meaning your project cost could be reduced by up to 50%. The amount of grant funding is determined as follows:

PRIVATE LANDOWNERS: The Portland Water District will contribute up to 50% of the total project cost for a grant of up to $1,000.

ASSOCIATIONS, MUNICIPALITIES, BUSINESSES, OR OTHER GROUPS: The Portland Water District will contribute up to 50% of the total project cost for a grant of up to $2,000.

Contact the Portland Water District to schedule a FREE consultation today!

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MEMO

TO: Amanda Pratt, Maine DEP

FROM: Heather Huntt, CCSWCD

DATE: 1/17/2020

RE: **Highland Lake Watershed Assessment Project (#2017PT16) Deliverable 3, Task 3**

Attached is the following deliverable for the Highland Lake Watershed Assessment Project (#2017PT16): Highland Lake BMP Inspection Survey Summary Report (Task 3, Deliverable 3). Rosie Hartzler, Highland Lake Association's President and member of the Highland Lake Watershed Management Plan Technical Advisory Committee took the lead in inspecting previously installed Best Management Practices (BMPs). Rosie worked off a list from Maine DEP of BMPs installed in Phase I, II, and III 319 implementation projects between 2000 and 2010. While reviewing these BMPs, Rosie also took note of the overall condition of each of the watershed's private roads themselves (maintenance, repairs, fixes needed). Rosie worked with Cumberland County Soil and Water Conservation District to record this information (see attached Table) listing the original BMPs installed, the road, the section of road Rosie surveyed, the condition of the road and the BMPs, recommendations, and current status. Prior issues on many of these of the roads had been identified in the 2018 Watershed Survey and some have been or are in the process of being addressed through cost share funding from the towns of Windham and Falmouth. Out of the 34 road sites reviewed, 19 did not need maintenance nor addressing. The remaining 15 have been designated for outreach to address either directly by the landowners/road associations (maintenance) or to be repaired or redone through a grant cost share.

Highland Lake Watershed Assessment Project
(#2017PT16) Task 3, Deliverable 3

2019 Highland Lake BMP Inspection Survey Summary Report Table

Road	HLA's Review	BMP(s)	BMP Condition	Remediation Recommended	Current Status
Albion Road	stream crossing at bottom of hill	ditches, turnouts, culvert installed in 2000	culvert in good condition	bird cage could be beneficial at culvert inlet	town responsibility to repair; question as to whether culvert is within the watershed
Amber Lane	from bottom of Hague Road to end of Amber Lane	road surface installed in 2007; HLA reviewed road including culvert and settling basin	culvert is in good condition (inlet and outlet recently re-riprapped); settling basin is in good condition (on private property being maintained by property owners)	improve road surface, crown, rip rap culverts (DONE: rehabbed in September 2019 by road association)	no maintenance nor repairs currently needed
Anthoine Road	last 300 feet; site not included the watershed survey 2018	ditches, turnouts, culvert installed in 2000	end of road has recently been regraded with compacted crushed gravel; ditching has been improved; large turnout has been improved and expanded	none	no maintenance nor repairs currently needed
Babbidge Road / Falmouth Road - town site	settling basin plus ditches and turnouts at MacIntosh Brook	settling basin installed in 2000	settling basin and ditches full of sediment	clean settling basin and ditches now and as needed	town road responsibility to repair, Gretchen Anderson (Town of Windham) is aware of this site
Beach Road ROW	ROW at end of Lower Beach Road; settling basin	ditches, culvert, swale/settling basin, road surface installed in 2000	good: rehabbed in August 2019	clean settling basin and replace/ upgrade rock dams (DONE: rehabbed in 2019 by Beach Road Association)	no maintenance nor repairs currently needed
Beach Road settling basin	at end of Beach Road - on private property (Rosie Hartzler and Dawn Baumer)	ditches, culverts, settling basin, spillway, road surface installed in 2000	good: basin is on private property and maintained by owners (Rosie and Dusty)	property owners responsible to clean regularly	settling basin is being maintained by property owners according to CCSWCD's recommendations
Brentwood Road - crossing of MacIntosh brook	at culvert installed on Brentwood for McIntosh Brook	2 large culverts installed in 2000	there was some instability at the inlet/outlet	install riprap at edge of Brentwood at MacIntosh Brook crossing (DONE: rehabbed by road association in 2018)	no maintenance nor repairs currently needed
Candlewyck	total length of road including settling basin	ditches, culverts, settling basin, road surface installed in 2007	ditches rated as C; culverts - D/F; settling basin - A; road surface - D (despite improvements having been made)	break down berms, clean out settling basin, regrade road surface (DONE: rehabbed in 2019 by road association)	no maintenance nor repairs currently needed
Cove Road	road leading down to Highland Lake - 3 rubber razors	turnouts, water diverters, road surface installed in 2000	all BMPs ranked as A as they were just updated	none needed - rehabbed with Windham Watershed Protection Funds in 2019 - new razors put in, new road surface and regrading	no maintenance nor repairs currently needed
Crest Haven	halfway point to end (section maintained by home owner)	ditches, water diverter (open top box diverter), plunge pool, road surface installed in 2001	water diverter filled in yet road recently improved with crushed gravel and a culvert installed half way down hill; Result: ditches - A, new culvert - A, water diverter - gone; plunge pool - gone; road surface A	none needed - recently rehabbed	maintained up to standard by CCSWCD
Owl's Head	at corner of Vista Drive, includes culvert under Critter Drive	culverts and road surface installed in 2007	Completely full, not functioning - undersized; Result: culvert - F, road surface - F	maintenance to restore site to original design is needed; not a site for 319 remediation	needs assistance, not 319
Falmouth Road / Lite Duck Pond Road	town road site at intersect of Little Duck Pond Road with Falmouth Road	no known past BMPs installed - need for settling basin which was installed in 2018	Town installed settling basin in 2018	DONE: install settling basin to capture runoff from hill	rehabbed in 2018
Gravel Hill Road	hill portion of road	ditches, turnouts, level-lip spreader, culvert, settling basin, broad-based dip, swales, road surface, all installed in 2004	road erosion, grader berms, filled in ditches	add road material, re grading, re ditching , cleaning and reshaping of turnouts (DONE: completed in 2019 through Windham Watershed Grant Funds)	rehabbed in 2019

2019 Highland Lake BMP Inspection Survey Summary Report

Road	HLA's Review	BMP(s)	BMP Condition	Remediation Recommended	Current Status
Haven Road	town road portion	culverts installed at stream crossing in 2007	unstable road shoulder adjacent to and at culvert's inlets and outlets (culvert appears to be too short)	needs riprap stabilization at culvert inlet and outlet and adjacent road shoulders	Town needs to address: Gretchen Anderson to review site
Haven Road	hill portion of road	ditches, turnouts, culvert, settling basin, plunge pool installed in 2000; pavement with revamped ditching and sediment basin installed in 2009	good condition	none needed	no maintenance nor repairs currently needed
Haven Road	intersection of Lyden Way	ditches, turnouts, level-lip spreader, culvert, settling basin, plunge pool installed in 2007	problem: ditch - F; culvert - F (full of sediment); turnout, level-lip spreader, settling basin, and plunge pool are not present	need to revamp site: clean out all BMPs of accumulated sediment and debris	needs assistance, unsure if 319 can assist
Hideaway Lane	off Mast Road, at end of road, at beach access point	ditches, culverts, plunge pool installed in 2003	erosion present at boat launch	beach needs new crushed gravel to prevent erosion	rehabbed with Falmouth Protection Grant funds in 2019
Highland Shore Road	end of the road	ditches, turnouts, culvert, settling basin, spillway, plunge pool, and road surface installed in 2007	ditches - C, turnouts non-existent, culverts - D (clogged), settling basin non-existent, spillway non-existent, one plunge pool - B, road surface - A	install improved drainage for entire area including ditching	included in list of sites to be remediated with 319 grant funds
Highland Shore Road	the hill	ditches, turnouts, settling basin	settling basin very well maintained, adequate ditching, adequate surface: paved road surface - A	upgrade road material, re-ditch	rehabbed 2018 with Windham Watershed Protection Grant Funds
Johnson Road	end of the road (privately owned by 3 owners)	turnouts, level lip spreader, infiltration trench, culverts, settling basin, plunge pools, swales, road surface installed in 2007	turnouts - D, level lip spreader non-existent, infiltration trench non-existent, culvert non-existent (must be filled in), settling basin - D, plunge pool non-existent, swales - B, road surface - A (recently resurfaced)	this is in regard to the portion of road about 400 yards long, a sloping hill, leading to a 90 degree turn (L) into privately owned section of Johnson road ; - re grade road and continue to pitch toward ditch, re store good ditch , re configure settling basin at 90 degree turn (bottom of the hill), and remove tree at corner	road association scheduled to rehab in 2020
Lantern Lane	entire road	ditches, culverts, settling basin, plunge pools, road surface, check dams installed in 2007	in terrible condition: no maintenance; ditches - D to F, culverts - D, settling basin non-existent, plunge pools non-existent, road surface breaking up - D to F), check dams (non existent)	install new road material, revamp ditching, re-do culverts as needed	road requires complete upgrade; recommended for 319 funding
Long Lane	adjacent to stream crossing (not included in 2018 Water shed survey)	culverts and road surface installed in 2007	culvert is breaking out of road, large hump present - needs resetting (deeper); road surface ok - not sure who maintains, put on Site Tracker watch list	reset culvert	culvert should be reset and this site should be added the Site Tracker watch list
Lowell farm Road	public boat launch	ditches, turnouts, culvert, settling basin, water diverters, plunge pools, swales, road surface installed in 2007	ditches and turnouts - B, culvert - unknown, settling basin - unknown, rubber razor water diverters - D to F, road surface - DE (it is starting to erode), swales are non-existent	upgrade razors, regrade road and add better road material	recommended for 319 funding (if possible) - site owned by Falmouth?
Overlook road - right fork	Right fork	ditches, turnouts, culverts, settling basins, spillway, plunge pools, road surface installed in 2007	ditches - F, turnouts - F, culvert - F, settling basin non-existent, spillway non-existent, plunge pool non-existent, road surface - F	needs total upgrading of road, ditches, etc.	recommended for remediation with 319 funding

Highland Lake Watershed Assessment Project
(#2017PT16) Task 3, Deliverable 3

2019 Highland Lake BMP Inspection Survey Summary Report

Road	HLA's Review	BMP(s)	BMP Condition	Remediation Recommended	Current Status
Overlook road- left fork	Left fork/Hague Road (very steep hill leading down to Highland Lake)	ditches, turnouts, culverts, settling basins, swales, road surface installed in 2007	ditches - C, turnouts - A, culvert is non-existent, settling basin - A (homeowner maintained), swale is non-existent, road surface - D	paved section broken down badly, needs improved drainage	recommended for remediation with 319 funding
Percy Hawkes -privately owned section of road at very end of Percy Hawkes	privately owned section at end of road	ditches, turnouts, culverts, water diverter, plunge pools, swales, paved road surface installed in 2000	ditches - A, turnouts - A, culverts - A, water diverter is non-existent yet not needed, plunge pool - A, swales are non-existent, road surface - A	rehab ditches, re-pitch road, add upgraded road material (DONE: rehabbed in 2019 with Windham Watershed Protection Grant funds)	no maintenance nor repairs currently needed
Pond Villa	total length of road	ditches, turnouts, culverts, water diverter, broad-based dip, swales, road surface installed in 2002	ditches - A, turnouts - A, culverts - A, water diverter (broad-based dip)- A, swales non-existent, road surface - A	add good road material, ditch where necessary, install culverts (DONE: rehabbed in 2019 by road association)	no maintenance nor repairs currently needed
Mast Road	at Suckfish Brook crossing	ditches, turnouts, culverts, settling basin installed in 2003	ditches - B, turnout - A to B, culvert - A, settling basin non-existent, spillway non-existent	partially clogged culvert needs maintenance	listed in NPS Site Tracker; Review site to determine future needs / possible 319 funds?
Rockaway Road	stream crossing near end of Rockaway	ditches, settling basin, paved road surface over stream crossing installed in 2000	ditching - D, culvert - A, settling basin non-existent, road surface - F	short culvert with narrow road - road shoulder erosion at crossing with erosion from road surface, road surface needs to be crowned	need to list into NPS Site Tracker
Sunset Road - Right fork	right fork	ditches, turnouts, level-lip spreader, culverts, settling basin, swales, road surface installed in 2007	everything was rated as an A after it had been rehabbed	upgrade road material, ditching , etc. (DONE: rehabbed by road association in 2018)	no maintenance nor repairs currently needed
Sunset Road Left fork	left fork	turnouts, level lip spreader, settling basin, spillway, plunge pools, road surface, check dams installed in 2007	everything was rated as an A after it had been rehabbed	upgrade road material, ditching , etc. (DONE: rehabbed by road association in 2018)	no maintenance nor repairs currently needed
Swan Road	last 600 feet and settling basin	ditches, turnouts, culverts, settling basin, plunge pools, swales, road surface installed in 2007	ditches - B, turnouts - B, culverts - one between the two settling basins needs to be replaced is failing / rusting, settling basin - A, plunge pools - A, swale - A, road surface - B to C	replace failing culvert, clean out ditches and turnouts	to be addressed by road association with Windham Watershed Protection Grant Funds
Vista Road	stream crossing up to Albion Road	ditches, turnouts, culverts, settling basin, plunge pools, swales, road surface installed in 2007	road surface - C, ditches - D, turnouts non-existent, culverts - D, settling basin non-existent, plunge pool - A, swale - C	site needed work, this part of Vista Road was remediated in past grant cycle	road is fair to good condition; evidence of residents doing basic upkeep of the road
Vista Swan Road ROW	ROW at end of Swan road	road surface installed in 2007	recently rehabilitated with new crushed gravel	rehabbed in 2018 with Windham Protection Grant Funds: installed trench drain, install rock lined turnouts, added new crushed gravel	no maintenance nor repairs currently needed

Assessment of Highland Lake Tributary Road Crossings for Geomorphological Impacts

June 24, 2019

Surveyors – Jeff Dennis, Amanda Pratt (DEP Watershed Management Unit)

Summary

All of the tributary stream road crossings in the Highland Lake watershed were visited. Only five had notable issues that likely contribute to channel instability and bank and/or channel erosion during significant runoff events.

1. Tributary I – Albion Road Culvert (between Vista Drive and Long Lane)
   Description: A large and very effective debris dam below the culvert diverts high flows to a newly formed and unstable side channel is causing significant bank erosion and likely discharge of sediment downstream.

Site 1. View of debris dam looking upstream

Site 1. Side channel looking upstream

Site 1. View downstream from Albion Road. Side channel is to the right of the debris dam.

2. Tributary I – Vista Drive Culvert

Description: Lots of sediment deposition in stream channel below culvert. The culvert is not likely the cause of this sediment load, but the magnitude f the sediment in the channel suggest significant instability of the stream channel at some point upstream of the culvert.

Site 2. Sediment deposition in over-widened channel looking downstream.

Site 2. Looking upstream to culvert.

3. Tributary D – Below Lakeshore Drive crossing

   Lakeshore Drive ditches collect runoff from a watershed that is much larger than the natural watershed of Tributary D at the point where it crosses Lakeshore Drive resulting in significantly higher flows in this channel than if the original drainage patterns on site had been maintained by including more culverts on the road and ditch turnouts on the north side of the road. An instream dam in the stream several hundred feet below Lakeshore Drive creates a detention basin that has resulted very deep sediment accumulation in the stream channel and significant blockage of the culvert in the base of the dam. During major storm events it is likely that turbulence resuspends much of this sediment which is then discharged downstream to the lake.

Site 3. View of detention basin dam and culvert outlet looking upstream from below the dam.

4. Tributary A – Pride Farm Road Crossing

   Four small culverts have caused significant over widening of stream channel. Channel is somewhat unstable but recovers quickly downstream.

Site 4. Looking upstream at four culverts and over-widened somewhat unstable channel.

5. Tributary G (Macintosh Brook) – Little Duck Pond Road Crossing below Duck Pond Outlet
While the culverts did not seem to be causing channel instability, there is a lot of sediment deposition in the stream channel downstream of the crossing. This is likely the result of severe erosion of the steep road "ditches" leading down to the crossing. Most of the fines and phosphorus associated with this sediment have likely been transported downstream to the lake, leaving the coarser material in the stream channel.

A Technical Advisory Committee (TAC) was formed within the Highland Lake Leadership Team (HLLT) to draft a new Highland Lake Watershed Management Plan ('the Plan'). The Plan must be accepted and approved by the Department of Environmental Protection (DEP) to be eligible to apply for future DEP funding to assist with water quality improvement efforts throughout the watershed. The process to incorporate all required elements and ultimately draft the Plan is time-intensive and requires participation from multiple entities (municipalities, lake association, conservation district, DEP, etc.).

As part of compiling known data of potential pollutant and phosphorus inputs into the lake, the Towns of Windham and Falmouth surveyed the potential impact of septic systems to Highland Lake's water quality. The Towns used different methods when conducting the system prioritization.

Windham

Based on discussions with DEP, systems located within the shoreland zone (250 feet from Highland Lake) and on sensitive soils areas, could inadvertently impact water quality even though they appear to be functioning properly. Windham established metrics based on these discussions to evaluate the systems. The metrics are as follows:

- System Age – If a system is older than 1975, then it will be given a 'Yes' rating. If the system is not older then 1975, then it will be a 'No' rating. If there is no information, then it will be given a 'Yes' rating.
- Distance to Lake – If a system is less than 100 feet to the lake, then it will be given a 'Yes' rating. If the system is greater than 100 feet to the lake, then it will be given a 'No' rating. If there is no information, then it will be given a 'Yes' rating.
- Sensitive Soils – If a system is located on sensitive soils, then it will be given a 'Yes' rating. If a system is not located on sensitive soils, then it will be given a 'No' rating.

Each system then had three metrics from which a priority/nonpriority ranking could be assessed. The priority ranking guidelines are as follows:

- None-Priority System - 0 of 3 metrics are 'Yes'.
- Priority System - If 1 of 3 metrics or greater are 'Yes'.

The priority systems were then ranked High, Moderate, & Low. The guidelines are as follows:

- High Priority – 3 of 3 metrics are 'Yes'.
- Moderate Priority – 2 of 3 metrics are 'Yes'.
- Low Priority – 1 of 3 metrics are 'Yes'.

Based on these ranking guidelines, the Town of Windham prioritized systems to determine the relative impact to the Lake's water quality. The results are shown in the following table.

System Priority	Windham
Non-Priority	120
Low	83
Moderate	77
High	10

Falmouth

The Town of Falmouth evaluated the entire Highland Lake watershed and used the following methodology based on conversations with DEP.

- **High Risk Parcels**
  - Parcel with home built before 1980 and overlaps poor soils
- **Moderate Risk**
  - Parcel with home built before 1980
  - Parcel with home built after 1980 and overlaps poor soils
- **Low Risk**
  - Parcel with home built after 1980
  - Vacant - Parcel with no building
  - Vacant/Soils - Parcel with no building and overlaps poor soils
  - Other - Roads, ROW, Water, Dedicated Open Space, Utility Corridors, etc.

System Priority	Falmouth
Low	4
Moderate	42
High	11

In total, there are 21 parcels (eleven in Falmouth and ten in Windham) with potentially high at-risk septic systems to Highland Lake's water quality. Next step will involve working with Maine's State Soil Scientist and DEP to see if landowners are willing to have their septic systems inspected to determine if they are in fact an impact to the lake's water quality. This will be a task to pursue in 2020. Based on findings, grant funding and incentives could be pursued to assist landowners in septic replacements and upgrades. For more information, please contact any of the following entities:

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Fish Barriers and Potential Barriers Identified By Maine Stream Habitat Viewer https://webapps2.cgis-solutions.com/MaineStreamViewer

Site ID	Crossing Type	Crossing Class	Survey Date	Stream	Town	Road	Lat	Long	Road Type	Road Class	Structure Type
8692	Culvert	Potential Barrier	7/22/2009	Unnamed	Windham	Albion Road	43.79336	-70.3689	Paved	Town	Round Culvert
8798	Culvert	Potential Barrier	8/3/2009	Unnamed	Windham	Vista Drive	43.78954	-70.3664	Unpaved	Town	Round Culvert
8299	Multiple Culvert	Potential Barrier	8/3/2009	McIntosh Brook	Windham	Lower Beach Road	43.78886	-70.3606	Unpaved	Town	Round Culvert

8699	Culvert	Potential Barrier	7/1/2009	Unnamed	Windham	Cottage Road	43.78328	-70.354	Paved	Town	Box Culvert
8694	Multiple Culvert	Barrier	7/22/2009	McIntosh Brook	Windham	Falmouth Road	43.79083	-70.3548	Paved	State	Round Culvert
8700	Multiple Culvert	Barrier	7/1/2009	Unnamed	Falmouth	Babbage Road	43.78682	-70.347	Paved	State	Round Culvert

8708	Multiple Culvert	Potential Barrier	7/1/2009	Unnamed	Falmouth	Mast Road	43.75871	-70.3425	Paved	Town	Round Culvert
D0394	Highland Lake Dam	Potential Barrier		Mill Brook	Westbrook						