Highland Lake Watershed Management Plan

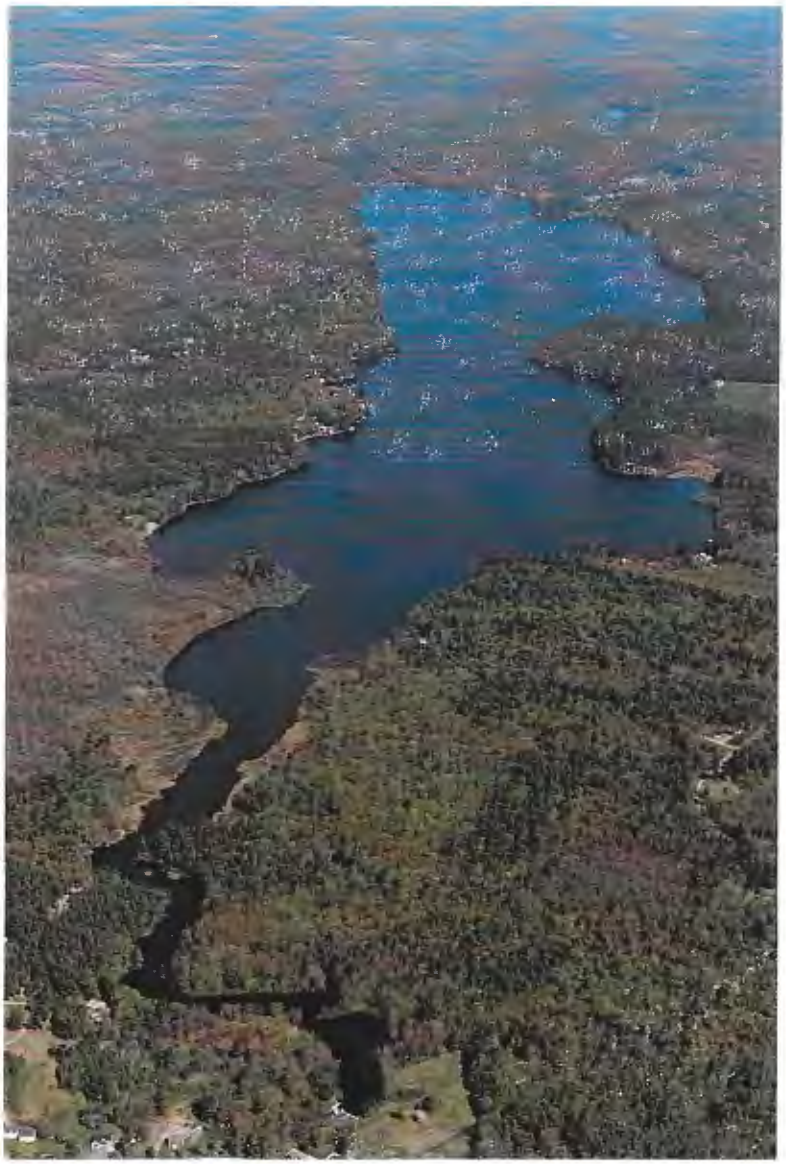

Photo Courtesy of
Waite Aerial Photography
Blackstrap Road, Falmouth

Highland Lake Watershed Steering Committee
Town of Falmouth, Town of Windham,
Highland Lake Association,
Cumberland County Soil & Water Conservation District

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EXECUTIVE SUMMARY

Lake and Watershed Description

Highland Lake is a 623-acre lake located in eastern Cumberland County in Southern Maine. The lake's watershed covers approximately 8.5 square miles in Falmouth, Windham and Westbrook (Figure 1).

Several perennial and intermittent streams drain into the lake from its surrounding watershed. The lake's sole outlet stream begins at the Highland Lake Dam as the headwaters of Mill Brook. Mill Brook, in turn, is a major tributary of the Presumpscot River, which ultimately flows into Casco Bay.

Highland Lake is highly valued by the area's seasonal and year-round residents for its seemingly pristine waters and sense of wilderness that it offers while still providing the conveniences of nearby Portland. It is a popular lake for winter activities such as snowmobiling and ice fishing and summer activities such as boating, kayaking and canoeing. The lake's public boat launch also makes it an accessible and popular destination for visitors from outside the watershed.

Water Quality in Highland Lake

Highland Lake has experienced a gradual decline in water quality over the past several years. The average annual secchi disk reading (a measure of water clarity) over the past decade is about one meter (three feet) less than it was in the previous decade, which signals an increase in algae and sediment in the lake. In addition, the average dissolved oxygen in the lake's bottom layer during September (when it is expected to be the lowest) has dropped to levels that threaten the lake's trout fishery.

Both problems can be attributed to polluted runoff, or nonpoint source pollution (NPS), that washes into the lake from its surrounding watershed. Phosphorus, which attaches to soil particles, poses the greatest NPS threat to Highland Lake. Phosphorus spurs excess algae growth, causing declines in water clarity and oxygen levels. Ultimately, high inputs of phosphorus can lead to a degradation of fish habitat, development of nuisance algae blooms and losses in lakefront property values.

The Maine Department of Environmental Protection (MDEP) has recognized Highland Lake's downward trend. In the 1996 *State of Maine Water Quality Assessment*, Highland Lake does not meet the state's water quality standards (MDEP, 1996). The MDEP has also placed Highland Lake on the state's "Priority Watersheds" list and list of lakes "Most at Risk from Development".

Local Involvement and Commitment

Local residents and municipal leaders have become increasingly active in the Highland Lake Watershed over the past several years. In particular, the Highland Lake Association, the

Town of Falmouth, the Town of Windham and the City of Westbrook have demonstrated a commitment to long-term watershed protection efforts.

The Highland Lake Association (HLA) has established itself as a leader in watershed education and monitoring efforts. The volunteer-run organization collects lake water quality data on a weekly basis from ice-in to ice-out, conducts bi-yearly aquatic vegetation surveys, distributes a semi-annual newsletter to all watershed households and coordinates activities such as Lake Festivals, Earth Day cleanups and annual meetings.

The lake's adjacent municipalities have also initiated and supported several projects in the watershed. The towns of Windham and Falmouth are developing a joint ordinance to limit phosphorus export from new single family home lots and private roads in the watershed. In 1995 Westbrook, Falmouth and Windham commissioned a study of the Highland Lake Watershed and formed the Highland Lake Study Committee to assess the condition of the lake and make recommendations for future protection and restoration.[1]

The Study Committee has since become a central motivating force in the watershed. The Committee completed the *Highland Lake Watershed Study* report in 1996. They then sought technical assistance from the Cumberland County Soil and Water Conservation District (CCSWCD) to carry out a watershed survey - a high priority recommendation in their report. After receiving a MDEP 604(b) grant in 1997, the CCSWCD and the Study Committee conducted a watershed survey and developed a watershed implementation plan. This plan was presented in several public meetings and accepted by the HLA, Falmouth Town Council and Windham Town Council. The same groups also endorsed this watershed management plan and the implementation grant proposal and committed funds and in-kind services to program efforts.

Watershed Action Plan

The *Highland Lake Watershed Survey and Implementation Plan* (CCSWCD, 1997) set one goal and several objectives for the watershed and outlined actions needed to meet these objectives. The Highland Lake Study Committee envisioned that the action plan would need to be implemented over a 10 to 15-year period to ensure project success.

Goal

- Improve or maintain water quality, and reduce symptoms of eutrophication in the Highland Lake Watershed.

Objectives

- Reduce the amount of phosphorus-loaded stormwater runoff from the watershed.
- Conduct systematic sampling of the water quality of the lake and its feeder streams.
- Build consensus on watershed management strategies and actions, and promote public stewardship and education about the watershed.

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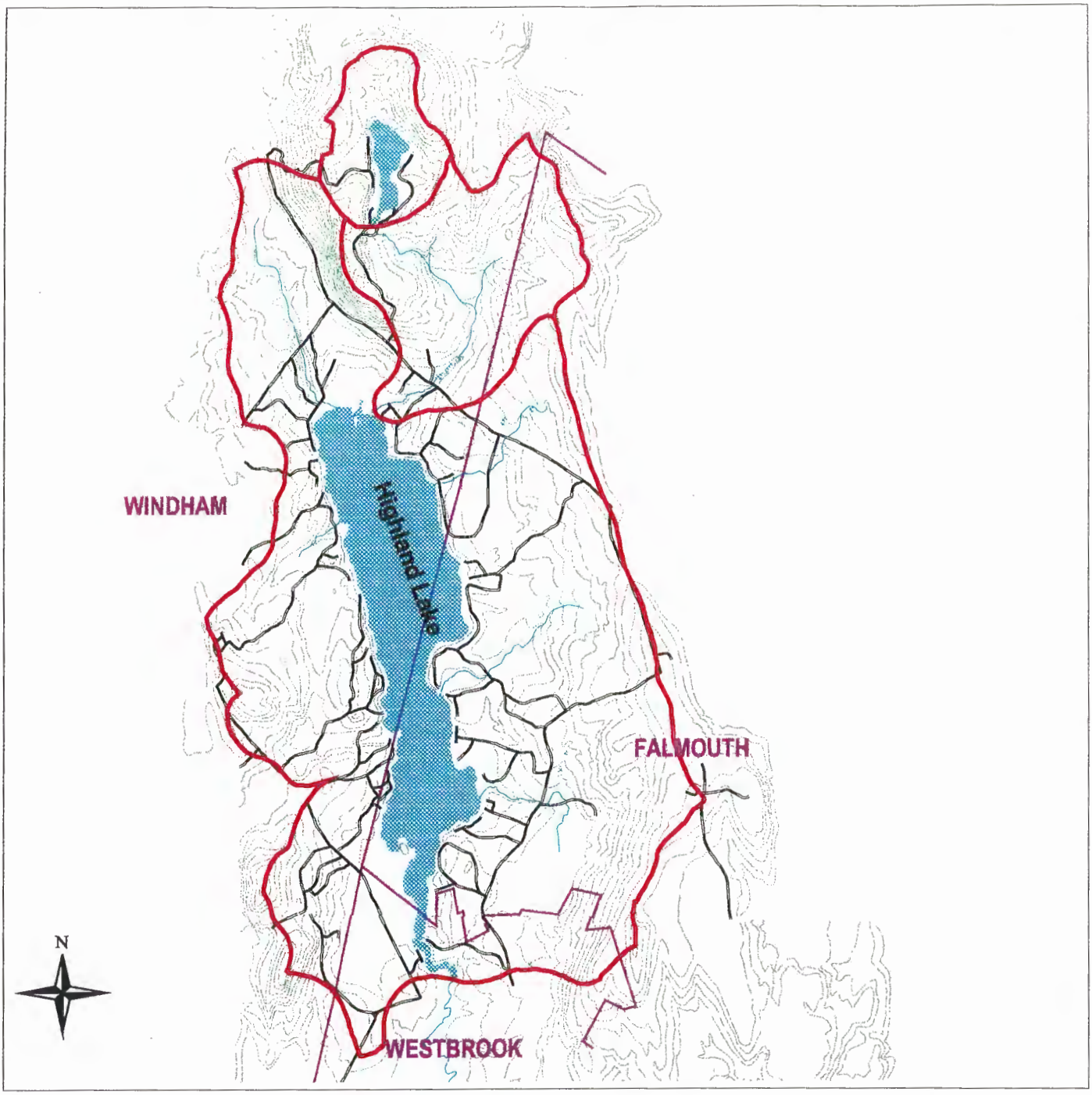
[1] The Study Committee included representatives from the HLA, town Planning Boards, Falmouth Conservation Commission, Windham Water Resources Committee and other interested citizens.



Highland Lake Watershed

Figure 1

Action Plan

Objective 1: Reduce the amount of phosphorus-loaded stormwater runoff from the watershed

Implement a Landowner Technical Assistance Program - Meet with landowners and provide site-specific recommendations and low cost Best Management Practices (BMPs) for residential NPS problems. **Cost:** $20,000/year

Implement a Roadside Erosion Control Program - Provide private road associations and Public Works Departments with technical and cost share assistance to address NPS road problems identified in the Highland Lake watershed survey. **Cost:** $50,000/year

Implement a Youth Conservation Corps (YCC) Program - Establish a summer YCC that provides watershed residents and road associations with labor to install simple, low-cost BMPs and teaches participants about watershed conservation. **Cost:** $20,000/year

Develop a Phosphorus Control Ordinance - Establish a joint ordinance in the Towns of Falmouth and Windham that limits phosphorus export from new single family lots and private roads in the Highland Lake Watershed. **Cost:** $12,000

Place Conservation Easements on Important Riparian Buffers – Identify properties that benefit lake and stream water quality or provide important wildlife habitat. Encourage landowners to protect these areas by donating conservation easements. **Cost:** Unknown

Establish a Septic System Pollution Prevention Program – Assess the level of pollution caused by watershed septic systems, disseminate educational materials and strengthen local monitoring and regulation. **Cost:** $15,000

Encourage Local Contractors to Become MDEP-Certified in Erosion Control – Publicize Nonpoint Source Training Center workshops and provide a list of certified contractors to municipalities and watershed residents. **Cost:** $1,000/year

Objective 2: Conduct systematic sampling of the water quality of the lake and its feeder streams.

Continue and Expand the Highland Lake Association's Volunteer Water Quality Monitoring Program - Continue lake and stream monitoring, volunteer quality control training, data management, and annual reporting. **Cost:** $2,500/year

- Continue to collect weekly seasonal measurements of secchi disk depth, dissolved oxygen and temperature.
- Increase monitoring frequency of total phosphorus and chlorophyll a.
- Monitor phosphorus cycling indicators and evaluate likelihood of significant cycling problems.

Objective 3: Build consensus on watershed management strategies and actions, and promote public stewardship and education.

Integrate Watershed and Water Quality Topics into K-12 Programs - Provide teachers with relevant curriculum, classroom assistance, community service projects and field trip opportunities. **Cost:** $10,000/year

Conduct a Comprehensive Campaign to Promote Sound Household Practices - Promote individual actions that play a role in lake protection. Conduct BMP demonstration workshops, create "table top tents" for rental properties and businesses and distribute educational materials. **Cost:** $10,000/year

Educate Recreational Users about Low-Impact Practices, Non-toxic Products and the Need to Protect Sensitive Habitats - Promote low-impact recreational practices in local media and participate in the Volunteer Lake Monitoring Program's Invasive Aquatic Plant Prevention Program. **Cost:** $5,000/year

Create Educational Sites Demonstrating Soil Erosion and Stormwater Runoff BMPs – Educate the public about BMPs by posting interpretive signs, leading guided tours and publicizing the benefits of existing BMP sites. **Cost:** $10,000/year

Hold Annual "State of the Lake" Meeting - Develop educational presentations, displays and project update reports for HLA's annual meeting. **Cost:** $4,000/year

Heighten Public Awareness of Watershed Boundaries - Place "Entering Highland Lake Watershed" signs on major roadways at the watershed border. **Cost**: $2400

Educate Residents and Municipal Officials about Watershed Development Trends and Associated NPS Impacts - Use the watershed build-out analysis (Highland Lake Study Committee, 1996) to develop additional GIS maps that effectively convey trends, guide planning efforts and educate the watershed community. **Cost:** $10,000

WATERSHED DESCRIPTION

General Description

The Highland Lake Watershed is a 8.5 square mile drainage basin located approximately 10 miles west of Portland in Cumberland County, Maine (Figure 1). The watershed lies mainly in Falmouth and Windham, although a small southern portion (about 7%) lies in the City of Westbrook. Several intermittent and perennial streams drain into the lake. The lake's single outlet stream, Mill Brook, begins at the Highland Lake Dam in Westbrook. Mill Brook then drains into the Presumpscot River, which, in turn, is part of the larger Casco Bay Watershed.

Natural Features

Topography

According to the *Casco Bay Land Use Inventory* (USDA NRCS, 1995), the Highland Lake Watershed is located in the Coastal Lowland region, which is characterized by rolling hills with small changes in elevation. Several parts of the watershed, however, have more

significant slopes. Libby Hill, located on the north end of the watershed, is very steep (with slopes greater than 25%), and areas immediately adjacent to the lake tend to be moderately steep (with 8-15% slopes).

Soils

Most of the Highland Lake Watershed (approximately 72%) is covered by glacial till. Nearly all of the watershed's soils are from the Paxton-Woodbridge-Hollis association (USDA NRCS, 1974). Paxton soils are deep, well-drained, fine sandy loams that formed in glacial till and have a compact layer at 17-25 inches. Woodbridge soils are generally found at lower elevations in less steep areas. Hollis soils are somewhat excessively drained, shallow to bedrock areas on crests of ridges or surrounded by Paxton soils.

The watershed's soils tend to be well drained to moderately well drained coarse-textured soils that range from fine to very stony sandy loams. About 18% of the watershed's soils are characterized as very poorly drained, or hydric, soils associated with wetlands adjacent to the lake and several streams.

Surface Water Resources

Highland Lake

Highland Lake, previously known as Duck Pond, covers 623 acres (nearly one square mile) and has a total volume of 14,000-acre feet (Table 1). It has a maximum depth of 67 feet, an average depth of 22 feet and a flushing rate of 0.7 flushes/year. The lake is dimictic; that is, it is deep enough to "turn over" twice per year.

The lake has about eight miles of shoreline, most of which is privately owned. There is a public launch located on Lowell Farm Road at the south end of the lake in the Town of Falmouth. The launch provides carry-in access for canoes and kayaks.

Aquatic plant surveys conducted by the Highland Lake Association indicate that there is a healthy diversity of plants in Highland Lake. In 1997, volunteers identified 63 different species. Among these is the floating plant, *Potamogeton pulcher* (spotted pond weed), which is listed as "Critically Imperiled" by the Maine Natural Areas Program (Williams, 1997).

Table 1 - Physical Characteristics of Highland Lake	
Watershed Area	8.5 square miles
Lake area	623 acres
Length of shoreline	8 miles
Maximum depth	67 feet
Average depth	22 feet
Volume	14,000 acre feet
Flushing rate	0.7 flushes/year

Streams

Several perennial streams flow into Highland Lake. The largest of these streams is McIntosh Brook, which begins north of Highland Lake at the outlet of Little Duck Pond. McIntosh Brook is the only inlet stream that is recognized on the US Geological Survey (USGS) topographic map. The following locally-named streams also drain into the lake: Johnson, Ridge, Vista, Pine, Haven, Percy Hawkes and Suckfish Brooks. The watershed also has several intermittent streams, many of which originate from wetland areas. In general, the streams have gravel or sand substrate and steep banks (Williams, 1998).

The lake's sole outlet stream is Mill Brook, which begins at the Highland Lake Dam on the southern end of the lake. The Highland Lake fishway, which is located at the dam, is managed to maintain at least six inches of year-round flow in Mill Brook.

Additional Watershed Features

Wetlands

There are several wetland complexes in the Highland Lake Watershed. The largest of these wetlands are located on the south and west edges of the lake. According to the *National Wetlands Survey* (US Fish and Wildlife Service, 1987), the watershed includes the following four types of wetlands: seasonally flooded wetlands with woody vegetation; permanently flooded wetlands; seasonally flooded wetlands with persistent emergent vegetation such as cattails; and seasonally flooded wetlands with shrub/scrub vegetation. Quaking bogs have also been identified in the watershed (Williams, pers. comm.).

Wetlands provide several important benefits to the Highland Lake Watershed. They mitigate flooding by absorbing excess water, filter pollutants from stormwater runoff and provide valuable habitat for moose, waterfowl and other wildlife.

Highland Lake Dam

The Highland Lake Dam, which is located on the southern end of the lake, controls the water levels of Highland Lake and Mill Brook. The City of Westbrook owns the dam. Lake water levels have historically been controlled cooperatively by the City of Westbrook and the Department of Marine Resources (DMR) to maintain year-round minimum flows in Mill Brook. The Highland Lake Association's Dam Committee also provides local input related to dam management and informally monitors water levels.

The Highland Lake Dam was partially breached during flooding in October 1996. The City of Westbrook quickly installed a temporary earthen dam to restore water levels. The City is currently planning more permanent repairs that will be funded through state and federal funds and contributions from Windham, Falmouth and Westbrook. Repairs are scheduled to begin in 1999.

Fisheries

According to the Maine Department of Inland Fish and Wildlife (IFW), there are 18 fish species in Highland Lake. This includes brown trout, brook trout, splake, smallmouth bass, largemouth bass, white perch, yellow perch, chain pickerel, brown bullhead (hornpout),

American eel, white sucker, splake, smelt, golden shiner, minnows, pumpkinseed sunfish, banded killifish and alewife. The IFW manages Highland Lake as a cold water fishery and stocks brown trout and splake annually.

In 1986 the DMR constructed a fish passage structure at the Highland Lake Dam. They then stocked the lake with alewives in 1987, 1989, 1990 and 1991. After the alewife run was established, the DMR managed the fishway to maintain minimum flow in Mill Brook and accommodate seasonal migration.

In October 1996 floods damaged the Smelt Hill Dam fishway on the Presumpscot River, thereby blocking fish migration between Highland Lake and the ocean. Central Maine Power, the dam's owner, has since resumed alewife stocking in Highland Lake. In 1997 they stocked 1000 adults, and in 1998 they stocked 2000 adults. They will continue annual stocking until the Smelt Hill Dam fishway is repaired or the dam is removed (dam removal is currently under consideration).

WATER QUALITY AND USES OF WATER BODIES

Water Quality Summary

Highland Lake

There has been a gradual decline in Highland Lake's water quality. Dissolved oxygen readings recorded in 1996 and 1997 were the lowest readings observed since record keeping began in 1955. The average dissolved oxygen in the hypolimnion (bottom layer) during September has dropped from a high of 3.0 parts per million (ppm) in 1975 to 2.5 ppm in 1980; 1.6 ppm in 1990; 0.5 ppm in 1995; and, most recently, 0.3 ppm in 1997.

Trout and other coldwater fish require oxygen levels greater than 4 ppm to survive and even higher levels to grow and reproduce. Since levels in Highland Lake's hypolimnion fall far below this level in most summers, it is assumed that the lake has experienced a moderate reduction in coldwater fish habitat.

A gradual decline in water clarity has also been documented. Based on Highland Lake's trend analysis, it appears there has been a negative trend in Highland Lake's mean and seasonal minimum secchi disk values (MDEP, 1997). The average annual secchi disk reading for the eleven-year period from 1985 to 1995 was 5.5 meters, whereas from 1975 to 1984 the average was 6.4 meters (Figure 2). This average overall decline of nearly one meter corresponds to the decline in dissolved oxygen and signals an increase in algae populations and sediment.

The USGS, MDEP, Portland Water District (PWD), HLA and University of Maine-Orono have periodically measured additional water quality parameters including pH (acidity), chlorophyll a (a rough measure of algae), nutrients and alkalinity. The chlorophyll a, phosphorus and secchi disk values have been used to determine Highland Lake's productivity, or Trophic State Index (TSI). According to these data Highland Lake has moderate algal production usually associated with average transparency and average chlorophyll a.

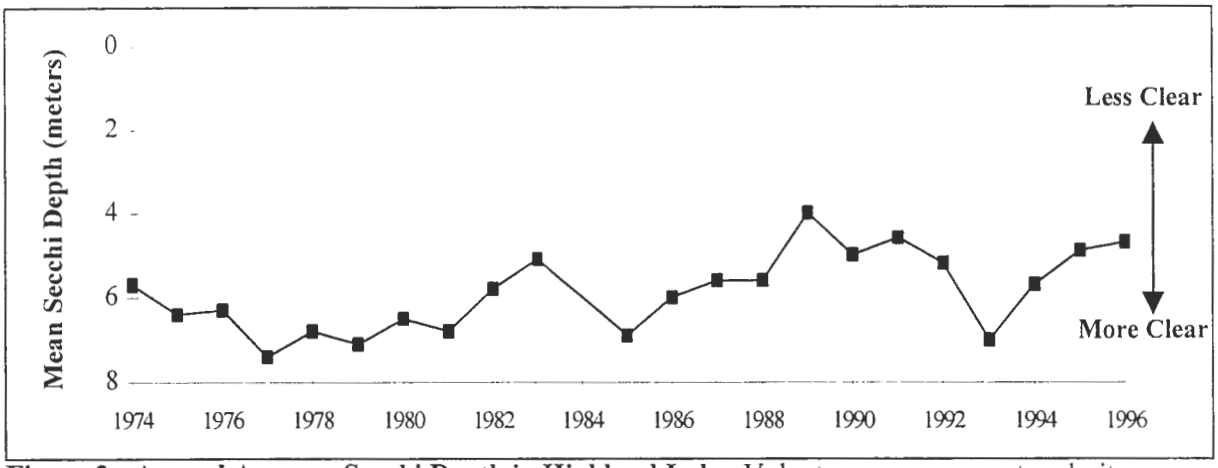


Figure 2 - Annual Average Secchi Depth in Highland Lake. Volunteers measure water clarity from May - September using a secchi disk. Deeper measurements indicate clearer water and better quality. MDEP analysis suggests a negative trend in water clarity.

Highland Lake's Inlet Streams

Eight of the lake's feeder streams have been sampled periodically at 13 locations. Most of this data was collected by the USGS in 1975 and 1976 and by the HLA in 1995, 1996 and 1997. In general, the data are within the typical range for Maine streams (Williams, 1998).

Principal Uses of Highland Lake

Recreation

Highland Lake receives heavy year-round recreational use from local residents and visitors from outside the watershed. The lake has a public access in Falmouth that is best suited for carry-in use. As such, kayaking and canoeing are popular summer activities. Other summer activities on the lake include swimming, fishing, water-skiing, windsurfing, boating and jet skiing. The lake is also used heavily in the winter for ice fishing and snowmobiling.

Cold and Warmwater Fishery

The lake supports a diverse cold and warm water fishery. According to the IFW this includes brown trout, brook trout, splake, smallmouth bass, largemouth bass, white perch, yellow perch, chain pickerel, brown bullhead (hornpout), American eel, white sucker, splake, smelt, golden shiner, minnows, pumpkinseed sunfish, banded killifish and alewife. IFW manages Highland Lake as a cold water fishery and stocks brown trout and splake annually. The DMR also oversees alewife runs.

Level of Impairment and Threats to Water Quality

NPS pollution, particularly the nutrient phosphorus, is the primary threat to Highland Lake's water quality. Algae, which are common microscopic plants in lakes, need phosphorus to grow. When phosphorus is abundant in lake water, algae populations soar in numbers, causing a decline in water transparency. In extreme cases algae blooms may occur, which, in turn, causes further depletion of the lake's dissolved oxygen, degradation of fish habitat, and losses in shorefront property values.

At this point, Highland Lake's trophic status indicates that the lake has only moderate algal production, and impairment has been limited to declines in water clarity and deep-water dissolved oxygen. However, if current trends continue without mitigation, it is only a matter of time before the lake's water quality is further degraded.

The MDEP has acknowledged Highland Lake's tenuous status and its need for immediate attention. The 1996 *State of Maine Water Quality Assessment* reports that Highland Lake does not meet the state's water quality standards due to its low dissolved oxygen levels and organic enrichment (MDEP, 1996). The report states that the source of the problem was attributed to shoreline development, and the magnitude of the problem was listed as high. The MDEP has also placed Highland Lake on Maine's "Priority Watershed" list and list of lakes "Most at Risk from Development". The MDEP has strongly supported the 1997 watershed survey project and the development of this watershed management plan through grants and technical assistance.

WATER QUALITY GOALS AND OBJECTIVES

The Highland Lake Study Committee developed the following set of goals and objectives for watershed implementation efforts. The group based their work on recommendations generated in their 1996 report, results from the 1997 watershed survey and input gathered at public meetings.

Goal:

- Improve or maintain water quality, and reduce symptoms of eutrophication in the Highland Lake Watershed.

Objectives:

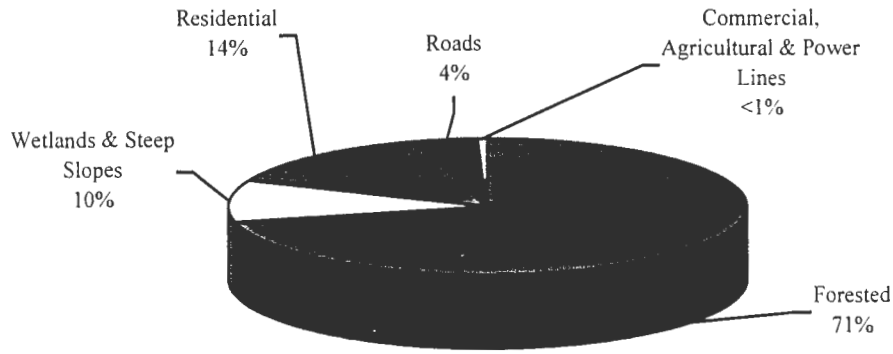
- Reduce the amount of phosphorus-loaded stormwater runoff from the watershed.
- Conduct systematic sampling of the water quality of the lake and its feeder streams.
- Build consensus on watershed management strategies and actions, and promote public stewardship and education about the watershed.

LAND USE INVENTORY AND NPS ASSESSMENT

Watershed Land Use

According to the Highland Lake Study (Highland Lake Study Committee, 1996), the watershed land use is 71% forested land, 14% residential development, 10% wetlands and steep slopes and 4% roads (Figure 3). Less than 1% of the watershed is classified as commercial, agricultural or power lines.

Figure 3 - Land Use in the Highland Lake Watershed (Highland Lake Study Committee, 1996)



Much of the watershed's early development occurred at the turn of the century as seasonal, lakeside cottages with private, gravel access roads. Over time, however, many of these small cottages were converted to larger, year-round homes; new houses were constructed adjacent to the lake; and private camp roads received year-round use and higher traffic volumes.

At this point, there are approximately 700 homes within the watershed, and roughly 50% of these homes are seasonal. Since there is no public sewer available, most sites are served by septic tanks and leach fields. Although public water is available to some Windham homes, many households receive their water supplies through hand-dug and drilled private wells. Some seasonal camps pump water directly from the lake for their non-drinking water supplies.

Despite its relatively low area at present, residential areas and roads are the land uses of greatest concern in the watershed. Many existing roads and residential sites are located close to the lake, and pollution from these land uses poses a significant threat to the lake's water quality. In addition, it is projected that 23% of the existing forestland will be developed in the next 50 years (Highland Lake Study Committee, 1996). This conversion from forest to residential developments and roads will place additional strain on Highland Lake. Without progressive erosion and sediment controls, the amount of soil erosion and stormwater runoff will increase and deliver additional pollutants to the lake.

NPS Threats

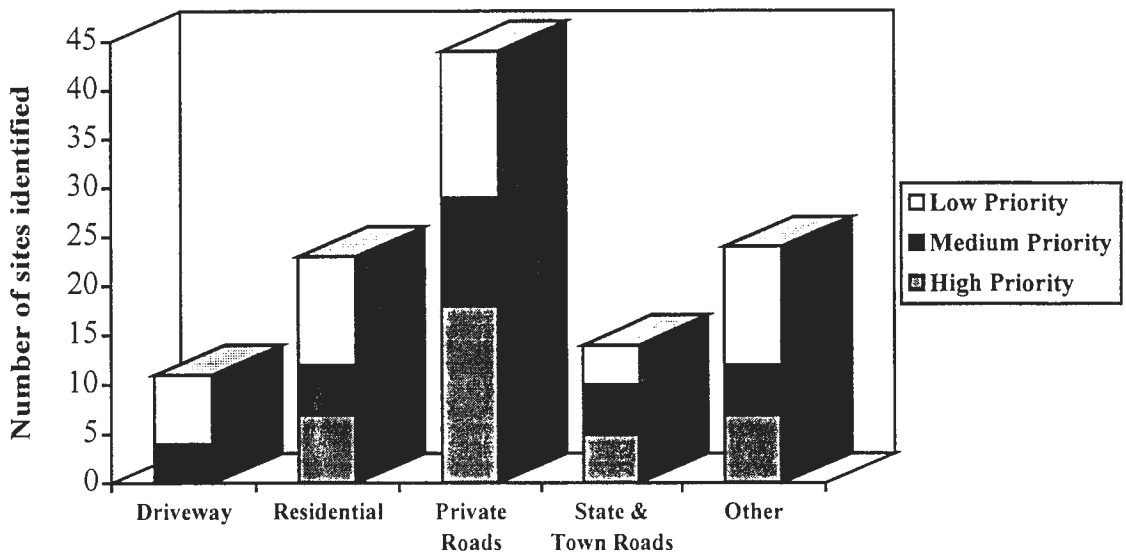
Phosphorous, carried to Highland Lake through soil erosion, is the most significant source of NPS pollution to Highland Lake. Phosphorous is a nutrient that adheres to soil particles and spurs lake algae growth. Algae, in turn, can impair water clarity, lead to nuisance algae blooms and further deplete oxygen levels as it decays.

The Highland Lake Study Committee and CCSWCD coordinated a survey to identify potential sources of NPS pollution (primarily in the form of soil erosion) in the watershed. After receiving a MDEP 604(b) grant in 1997, 27 trained volunteers conducted an initial watershed survey, and technical staff later confirmed their findings through follow-up visits.

In total, 104 sites were identified as potential sediment and phosphorus sources to Highland Lake (Figures 4 and 5). It is expected that additional sites will arise over time; however, the survey results provided a "snapshot" of 1997 conditions and revealed some of the typical problems in the watershed.

All of these sites identified in the Highland Lake Watershed were associated with roads and residential land uses. Private roads accounted for nearly half of the problems (42%). Residential sites (24%) and state/town roads (13%) were also significant sources of pollution. The remaining sites (21%) were linked to other sources such as beaches, boat access, footpaths and parking areas.

Figure 4 - Results from the 1997 Highland Lake Watershed Survey



OTHER FACTORS AFFECTING WATER QUALITY

Septic System Failures

The Highland Lake Watershed has several characteristics that increase the likelihood of pollution from improperly maintained and aging septic systems. All 700+ homes in the watershed rely on private septic systems, and many of these homes are located on poor soils and small lots next to the lake.

During July and August 1994, the Town of Windham conducted a survey to assess the condition of the town's septic systems within 250 feet of Highland Lake (Gass, 1995). There were no apparent problems with 98% of the 205 surveyed homes, and most homes used septic tank/leach field systems (81%) or holding tanks (12%). However, 30% of the systems were over 16 years old and 10% were of unknown age. Since the typical life expectancy of septic systems is 20-25 years, it is likely that many systems may need replacement in the near future.

The Code Enforcement Offices in the towns of Windham and Falmouth have responded to complaints and worked with landowners to ensure replacement of failing systems. They have also helped landowners take advantage of grants through the MDEP Small Communities Program to fund system replacements. The municipalities should become even more proactive with their septic system programs, however. Further surveys could be conducted in Falmouth and repeated in Windham to better assess septic system impacts on Highland Lake. The towns could also increase monitoring, education and regulatory efforts.

Internal Phosphorus Cycling

Oxygen levels less than 1 ppm can promote the recycling of phosphorus from the sediments at the bottom of the lake. Once re-released into the lake, this phosphorus can further impair water quality and lead to prolonged algae blooms, fish habitat loss and property value declines. At this point, Highland Lake has not experienced any significant phosphorus cycling problems. However, oxygen levels indicate that Highland Lake is at medium risk for the development of a significant cycling problem in the future.

HLA should continue to measure summer dissolved oxygen and phosphorus levels in the lake and monitor the likelihood of internal phosphorus cycling problems.

NPS POLLUTION CONTROL MEASURES

Critical NPS Areas

Based on the 1997 watershed survey, there are at least 104 erosion sites in the Highland Lake Watershed that may impact water quality (Table 2 and Figure 5). These sites ranged in severity and were assigned priority ratings of high, medium or low based on the following criteria: proximity to lake, stream, ditch or other pathway to the lake; total area of the disturbed site; soil type; and slope (Figure 4). Of all the sites identified 30% were considered high impact, 28% were medium impact and 42% were low impact.

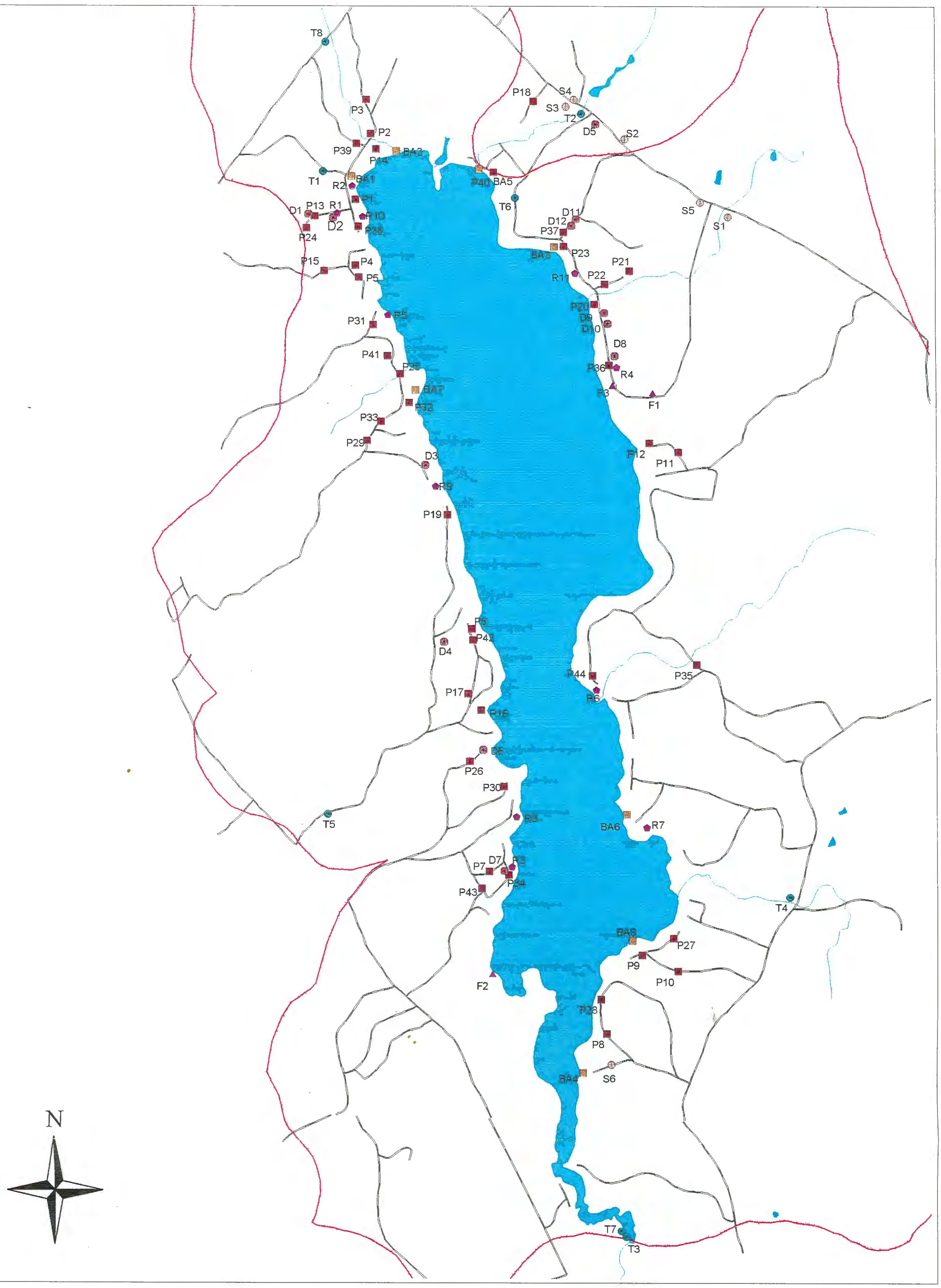
Table 2 – Critical Sites Identified in the Highland Lake Watershed Survey

Map ID	Land Use	Type of Problem	Priority
D1	Driveway	Corner of Oak and Highland Road-Direct flow to lake, surface erosion	Medium
D3	Driveway	Direct Flow to lake, moderate surface erosion	Medium
D4	Driveway	Surface erosion, severe ditch erosion, ditch is 50'x2'x2'	Medium
D5	Driveway	Babbidge Road-Direct flow to lake, surface erosion, poor shaping, poor surface material, direct flow to Highland Road	Medium

Map ID	Land Use	Type of Problem	Priority
D6	Driveway	Direct flow to lake, surface erosion, poor shaping and surface material, direct flow to lake	Low
D7	Driveway	Direct flow to lake, exposed bare ditch	Low
D8	Driveway	Cottage Road-Direct flow to lake, moderate surface erosion, poor shaping	Low
D9	Driveway	Surface erosion, poor surface material	Low
D10	Driveway	Surface erosion, poor shaping, poor surface material	Low
D11	Driveway	Pine Drive-Surface erosion, poor shaping and surface material	Low
D12	Driveway	Pine Drive-Surface erosion	Low
P1	Private Road	Vista Road-Direct flow to lake, severely eroded ditch between 2 houses, too much water for size of ditch	High
P2	Private Road	Vista Road-Direct flow to tributary and lake, ditch turnouts needed, unstable culvert outlet, existing ditch not functioning	High
P3	Private Road	Vista Road-Direct flow to tributary, moderate surface erosion, poor shaping, poor surface material, ditch turnouts needed	High
P4	Private Road	Overlook Road-Surface erosion, no ditch present, no turnouts	High
P5	Private Road	Right Fork of Overlook Road-Direct flow to lake, severe surface and ditch erosion, poor shaping and surface material	High
P6	Private Road	End of Haven Road-Direct flow to lake, surface erosion, poor shaping, no ditch, unstable culvert	High
P7	Private Road	Direct flow to lake, moderate surface erosion, poor shaping, poor surface material, water not getting into existing turnouts	High
P8	Private Road	Lowell Farm Road- Direct flow to lake, moderate surface erosion, poor shaping, ditch turnouts needed, water not getting to ditch	High
P9	Private Road	Sunset Road-Direct flow to lake, blocked culvert, moderate surface erosion, poor shaping and surface material	High
P10	Private Road	Sunset Road-Direct flow to lake, moderate surface erosion, poor shaping, poor surface material	High
P11	Private Road	Direct flow to tributary, surface erosion, poor shaping, poor surface material, poor maintenance practices	High
P12	Private Road	Direct flow to lake, moderate surface erosion, poor shaping, poor surface material	High
P13	Private Road	Highland Road-Direct flow to lake, severe surface erosion, poor surface material, severe shoulder erosion, banks of ditch on south side are slumping, water stays on surface, possible groundwater flow intercepted in south side ditch	High
P14	Private Road	Intervale Road-Direct flow to lake through public boat access, surface erosion and poor shaping	High
P15	Private Road	Overlook Road- Direct flow to tributary, surface erosion, poor shaping and surface material, water not getting to ditches, undersized culvert	High
P16	Private Road	Direct flow to lake, direct flow to tributary, delta of sediment in lake, severe surface erosion, poor surface material, severe shoulder erosion	High
P17	Private Road	Haven Road- Surface erosion, severe shoulder erosion	High
P18	Private Road	Beach Road- Direct flow to McIntosh Brook, moderate surface erosion, poor shaping and surface material, inadequate ditch for half the road	High

Map ID	Land Use	Type of Problem	Priority
P19	Private Road	Haven Road- Direct flow to lake, poor surface material, unstable culvert outlet	Medium
P20	Private Road	Cottage Road-Direct flow to lake, delta of sediment in lake approx. 200 cyd, unstable culvert outlet	Medium
P21	Private Road	Ridge Road-Poor shaping, ditch turnouts needed	Medium
P22	Private Road	Ridge Road-Surface erosion, poor shaping, poor surface material, shoulder erosion	Medium
P23	Private Road	Cottage Road-Direct flow to tributary, winter sand buildup, unstable culvert inlet/outlet. area recently paved with waterbar and drains flow from road into stream	Medium
P24	Private Road	Oak Road-Direct flow to lake, moderate surface erosion, poor shaping and surface material, poor placement of culvert, improperly sized culvert, no shoulder, cross culvert failed, water stays on road and does not make it to ditch, all water flows to Highland Road	Medium
P25	Private Road	Johnson Road-Direct flow to tributary, improperly sized culvert	Medium
P26	Private Road	Percy Hawkes Road-Direct flow to tributary, direct flow to lake, unstable culvert inlet, clogged culvert, ditch turnouts needed	High
P27	Private Road	Sunset Road-Direct flow to lake, moderate surface erosion, poor shaping, potentially high priority site if this continues to be a chronic problem	Medium
P28	Private Road	Lowell Farm Road-Poor surface material	Low
P29	Private Road	Johnson Road-Bare bank, direct flow to tributary and lake, ditch erosion	Medium
P30	Private Road	Percy Hawkes Road-Moderate surface and ditch erosion, direct flow to lake	Medium
P31	Private Road	Anthoine Road-Direct flow to tributary, surface erosion	Low
P32	Private Road	Johnson Road-Poor shaping and surface erosion, no ditch present	Low
P34	Private Road	Direct flow to lake, moderate surface erosion, poor shaping	Low
P35	Private Road	Pride Farm Road-Direct flow to tributary, moderate ditch erosion	Low
P36	Private Road	Cottage Road-Bare soil, exposed ditch, bank erosion	Low
P37	Private Road	Pine Drive-Shoulder erosion, water not getting into existing ditch, culvert clogged	Low
P38	Private Road	Lower Vista Road-Surface erosion, poor shaping, pot holes, washboarding	Low
P39	Private Road	Long Lake Road-Direct flow to lake - surface erosion	Low
P40	Private Road	Brook Road-Direct flow to lake, unstable fill next to pipe which flows into ditch	Low
P41	Private Road	Johnson Road-No ditch present	Low
P42	Private Road	Severe surface erosion, poor surface material, unstable culvert outlet	Low
P43	Private Road	Moderate surface erosion, could be a larger problem over time with sediment reaching stream	Low
P44	Private Road	Direct flow to lake, surface erosion, poor shaping and surface material	Low
T1	Town Road	Swan Road-Direct flow to lake, moderate surface erosion, poor shaping, poor surface material, turnout not shaped correctly	High
T2	Town Road	Cottage Road-Direct flow to tributary, shoulder erosion, ditch erosion, unstable culvert inlet and outlet, rip rap not functioning	High

Map ID	Land Use	Type of Problem	Priority
T3	Town Road	Access road to Dam-Bare soil	High
T4	Town Road	Mast Road-Direct flow to tributary, severe shoulder erosion	Medium
T5	Town Road	Haven Road-Shoulder erosion, unstable culvert	Medium
T6	Town Road	Cottage Road-Direct flow to tributary, unstable culvert inlet/outlet	Low
T7	Town Road	Access Road to Dam-Bare soil	Low
T8	Town Road	Albion Road-Direct flow to tributary, moderate shoulder erosion	Low
S1	State Road	Falmouth/Babbidge Road-Direct flow to tributary, severe shoulder erosion, unstable culvert inlet/outlet, crushed culverts	High
S2	State Road	Falmouth/Babbidge Road-Direct flow to tributary, moderate shoulder erosion, no ditch present	Medium
S3	State Road	Falmouth/Babbidge Road-Direct flow to tributary, old drainage ditch severely eroded down to clay	Medium
S4	State Road	Falmouth/Babbidge Road-Winter sand buildup, direct flow to tributary, sand has plugged culvert	Medium
S5	State Road	Falmouth/Babbidge Road-Bank and shoulder erosion, bare soil, winter sand buildup, unstable culvert inlet, clogged culvert	Low
S6	State Road	Direct flow to lake through public boat access, moderate surface erosion, poor shaping and surface material, water not getting into existing turnouts	High
B1	Beach	Shoreline erosion, beach enhancement	Low
B2	Beach	Bare soil	Low
BA1	Boat Access	Intersection of Vista and Swan Road-Direct flow to lake, delta of sediment in lake, poor surface material	High
BA3	Boat Access	Cottage Road-Direct flow to tributary, direct flow to lake, poor surface material, delta of sediment in lake	High
BA4	Boat Access	Public Boat Launch-Direct flow to lake, delta of sediment in lake, surface/rill erosion, poor surface material	High
BA5	Boat Access	End of Beach Road-Direct flow to lake, delta of sediment in lake, surface/rill erosion, poor surface material	Medium
BA6	Boat Access	Bare soil	Low
BA7	Boat Access	Bare Soil	Low
BA8	Boat Access	Culvert discharges road drainage onto boat access, delta of sediment in lake	Low
F1	Footpath	Cottage Road-Direct flow to lake, surface erosion, bank erosion	Medium
F2	Footpath	Bare soil	Low
F3	Footpath	Bare soil	Low
R1	Residential	Highland Road-Direct flow to lake, bare unstable trench 3' deep, 3' wide, 300' long, water silty and milk colored, lots of organics in trench	High
R2	Residential	Vista Road-Direct flow to lake, bare soil, beach enhancement, delta of sediment in lake, sand/gravel piles with a trench/ditch formed by stream	High
R3	Residential	Direct flow to lake, bare soil	Medium
R4	Residential	Severe surface erosion, bare soil	Medium
R5	Residential	Bare Soil	Medium
R6-R10	Residential	Bare soil	Low
R11	Residential	Poor surface material	Low



Critical Areas in the Highland Lake Watershed

Figure 5

NPS Control Strategies

Best Management Practices for NPS Sites

BMPs are structures or practices intended to minimize erosion, runoff and resulting water pollution. BMPs include, but are not limited to, structural and vegetative controls and maintenance procedures.

Technical staff from the MDEP and CCSWCD recommended BMPs for each site identified in the Highland Lake Watershed Survey (Table 2). Many of these BMPs can also be used to fix new NPS problems that arise in the watershed. Staff also made preliminary estimates about the level of technical expertise and funding needed to install these BMPs. A summary of these general trends is outlined in Table 3. In general, state, town and private road-related problems require more costly BMPs; whereas, residential and driveway sites involve lower cost BMPs.

Table 3 – BMPs for NPS Sites in the Highland Lake Watershed

Land Use	Proposed BMPs	Relative Cost[1]
State, town & private roads	Replace culvert.	High
	Install plunge pool or detention basin.	High
	Add new surface material. Reshape and crown road.	High/Medium
	Repair and stabilize culverts.	High/Medium
	Establish or reshape ditch.	High/Medium
	Install turnouts, broad-based dips and/or waterbars.	Medium/Low
	Stabilize ditch with stone.	Medium/Low
	Remove winter sand.	Low
	Seed and mulch ditch or banks.	Low
Residential and driveways	Add new surface material.	Medium
	Stabilize ditch or culvert with stone.	Medium/Low
	Install waterbars, broad-based dips or diversions.	Medium/Low
	Establish or enhance buffer	Medium/Low
	Seed and mulch bare soil.	Low

[1] Estimates include the level of technical assistance and construction costs. Low cost BMPs require only minimal technical assistance and cost under $500. Medium cost BMPs involve additional technical assistance, moderate cost and some equipment. Projects listed as high require engineering assistance and cost over $2500.

State and Town Road Management

Common problems associated with state and town roads include winter sand buildup, clogged or damaged culverts and ditch erosion. Many of these problems are maintenance issues and could be addressed by encouraging the towns and local road crews to adopt and adhere to annual maintenance schedules. Road crews could also receive training from the Maine Local Roads Center and the MDEP Nonpoint Source Training Center about the impacts of sediment on Highland Lake and road repair and maintenance techniques.

Private Camp Road Management

Private camp roads have their own set of problems. Most camp roads around Highland Lake were originally built as seasonal access roads and were not well designed or situated. Private road associations have dealt with the resulting chronic erosion problems by adding truckloads of new surface material to the washed-out roads each year. In general, they have not had the financial resources or expertise to fix the underlying problems causing this erosion.

These camp road problems could be addressed through several incentives. Private road associations could receive technical and financial assistance from state grants, towns or CCSWCD to encourage comprehensive road repairs. The associations could also receive education and training related to road construction, maintenance and the impacts of NPS on Highland Lake. This should build road associations' capacity to address their road problems independently.

Protection of Important Riparian Areas and Wildlife Habitat

Much of the lake's shoreline is already highly developed. However, there are still large parcels of forested, undeveloped land in the rest of the watershed. If possible, the towns of Falmouth and Windham should work with local land trusts, such as the Falmouth Conservation Trust, to protect critical undeveloped lands. These parties may want to encourage landowners to place voluntary conservation easements on important stream buffer areas or critical wildlife habitat[2].

Residential Property Management

The 1997 watershed survey documented numerous residential sites with bare soil and inadequate vegetated buffers. Based on this information, it is appears that there is a need for additional landowner education about "lake-friendly" home and yard care. Landowner education and outreach programs could help protect the existing buffers and promote restoration of inadequate buffers. Technical assistance and buffer workshops could also promote restoration.

Local shoreland zoning programs could also be strengthened to protect the lake's vegetated buffers. The towns of Windham and Falmouth and the City of Westbrook administer and

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[2] Conservation easements are legal agreements that permanently restrict the type and amount of development that may take place on a piece of land.

enforce Maine's Shoreland Zoning program that limits new development and vegetation removal adjacent to lakes and some streams. The municipalities and their code enforcement officers could minimize violations by helping with education and technical assistance programs or focusing on additional monitoring and enforcement.

Regulatory Approaches to Residential Development

The Maine Stormwater Management Law limits sediment and phosphorus export from new developments (with over 20,000 square feet of impervious area or over five acres of disturbed area). However, up to two-thirds of the watershed's development has occurred as single family dwellings, which are not subject to this law (Highland Lake Study Committee, 1996). Falmouth and Windham are developing a joint phosphorus ordinance to address this gap. This ordinance is an important step in the right direction, and the towns should persevere to ensure that this ordinance is enacted and enforced.

The Towns of Windham and Falmouth may also want to consider additional policy changes to limit the amount of NPS runoff from new developments. The *Falmouth Stormwater Management Plan* (Fogg, 1995) proposed two ways to use land more efficiently and limit the amount of land cleared for new development. Minimum lot sizes could be increased to decrease housing density. Alternately, the municipalities could promote cluster developments, whereby houses are built on smaller lots and important natural areas are permanently protected.

Septic System Pollution Prevention

The Town of Windham has been fairly proactive with septic system issues. They conducted a septic survey and distributed educational materials around Highland Lake in 1995. Both the Towns of Windham and Falmouth have implemented inspection and replacement programs and promoted grant programs such as the MDEP's Small Communities Program to help landowners finance new systems.

Additional measures may be needed, however, to protect Highland Lake from septic system pollution. Each municipality, including Windham, should consider conducting a comprehensive inventory of watershed septic systems (including pump out records), distributing educational materials to watershed landowners and requiring system inspections upon property sales.

Local Support

Highland Lake Association

The HLA formed in 1990 because of a general sense among property owners that the lake's water quality was deteriorating. The organization has since grown to nearly 200 members and established itself as a leader in watershed protection and monitoring efforts. With seed money from a Casco Bay Estuary Project (CBEP) grant, the HLA established a comprehensive water quality monitoring program. The group measures secchi disk level, temperature and dissolved oxygen in Highland Lake every week from ice-out to ice-in each

year; conducts periodic total phosphorus and chlorophyll a analysis; monitors the lake's feeder streams: and presents their findings in an annual water quality summary report.

In addition, the HLA also conducts bi-yearly aquatic vegetation surveys, distributes a semi-annual newsletter to each watershed household and coordinates activities such as Lake Festivals, Earth Day cleanups and annual meetings.

Municipal Support

The lake's adjacent municipalities have also demonstrated increasing interest and leadership in Highland Lake's protection and restoration. In 1993 the Falmouth Conservation Commission and Planning Department received a grant from the CBEP to study and make recommendations for improving the management of Highland Lake and the town's other watersheds. This study resulted in the *Falmouth, Maine Watershed Management Plan* (Fogg, 1993) and *Stormwater Management Plan* (Fogg, 1995). In addition, the Town of Windham conducted a 1994 septic system survey of over 200 homes around Highland Lake (Gass, 1994). These initial studies built momentum for more focused planning efforts in the Highland Lake Watershed.

The towns have since initiated several joint watershed projects. Windham, Falmouth and Westbrook commissioned a Highland Lake Watershed Study in 1995, and Windham and Falmouth are in the process of developing a phosphorus ordinance for the watershed. The Town of Windham has also dedicated funds in its 1999 budget for protection and restoration efforts in the Highland Lake Watershed.

Highland Lake Study Committee

In 1995 representatives from Falmouth, Windham, Westbrook, the HLA and other concerned citizens formed the Highland Lake Study Committee to assess the lake's condition and the potential threats to its water quality. In its final report, the *Highland Lake Watershed Study* (Highland Lake Study Committee, 1996), the Committee detailed its findings and presented five recommendations for action.

The Study Committee then moved ahead with its recommendation to conduct a watershed survey to identify existing sources of nonpoint source pollution in the Highland Lake Watershed. They enlisted project management assistance from the CCSWCD, submitted a 604(b) grant proposal to the MDEP in the fall of 1996 and received funding and technical assistance for the survey in 1997.

Over 27 volunteers assisted with the survey in the spring and summer of 1997 and helped identify 104 sources of NPS. The Highland Lake Steering Committee and CCSWCD used the survey information to develop water quality goals and objectives and outline action items for future implementation. The resulting *Highland Lake Watershed Survey and Implementation Plan* was released in June 1998 (CCSWCD, 1998).

Local Awareness and Level of Support

There is a high level of municipal and citizen awareness about the general problems in Highland Lake, and there is consensus about the need to take measures to protect the lake.

This support can be attributed to leadership from the HLA, town conservation commissions and planning boards and extensive press coverage by the Portland Press Herald (March, July, and August, 1998.)

Public support for lake protection and restoration has been expressed at several public meetings. At the HLA's 1998 annual meeting, the Highland Lake Implementation Plan and grant proposal were unanimously accepted by the 70 members in attendance. The Falmouth and Windham Town Councils have also formally accepted the plan and offered financial and in-kind support for implementation projects

It is clear that town leaders and the general public support protection efforts. However, there is still a need for education about the specific problems affecting water quality and the role that individuals, municipalities, schools and volunteer groups can play in lake stewardship. These gaps can be addressed by distributing the watershed management plan (or summary fact sheets) and holding public meetings, presentations and field tours to rally volunteer participation.

Table 4 - Timeline of Events in the Highland Lake Watershed

Summer 1990	Highland Lake Association formed.
1993-1995	Falmouth completed town-wide watershed and stormwater management plans that included an assessment of Highland Lake.
Summer-Fall 1994	Windham conducted a septic system survey around Highland Lake.
Fall 1995-Summer 1996	The Highland Lake Study Committee met for eight months to study the condition of Highland Lake. Their final report was released in July.
Fall 1996	The Highland Lake Study Committee and CCSWCD submitted a 604(b) grant proposal to the MDEP to fund a Highland Lake watershed survey.
Winter 1996	The CCSWCD received a 604(b) grant to fund its watershed survey proposal.
Spring-Fall 1997	Volunteers assisted with the watershed survey. Technical staff from MDEP and CCSWCD conducted a follow-up survey to verify sites and made BMP recommendations.
Summer 1998	CCSWCD and the Study Committee released the *Highland Lake Watershed Survey and Implementation Plan*.
Summer, 1998	HLA and Falmouth and Windham Town Councils accepted the watershed implementation plan and committed funds and in-kind services to the project.
Fall, 1999	The CCSWCD prepared the *Highland Lake Watershed Management Plan*.

IMPLEMENTING THE PLAN

Program Leadership

A watershed steering committee will oversee implementation efforts and conduct an annual evaluation of the program's effectiveness. The Steering Committee will be an extension of the Highland Lake Study Committee and include representatives from each town council, the

Windham Water Resources Commission, Falmouth Conservation Commission, HLA, CCSWCD, MDEP and other interested organizations and individuals.

Professional staff from CCSWCD will manage several elements of the watershed plan and conduct much of the work. However, several other organizations will lead or assist with specific monitoring, public outreach, technical assistance, and regulation and planning tasks. In addition, a youth conservation corps, which will be managed by an ad-hoc board of directors, will install BMPs for private landowners and some private road associations. The HLA, municipal leaders and residents will also donate time and services to help implement the plan.

Project Partnerships

Numerous partnerships have already been forged in the Highland Lake Watershed. Cooperating groups include the HLA, Town of Falmouth, Town of Windham, City of Westbrook, CCSWCD, MDEP, US EPA, CBEP and PWD. Once underway, the project will build upon these existing partnerships and develop new working relationships with the Maine Local Roads Center, private road associations, landowners, local businesses and schools.

Project Funding

The Watershed Steering Committee will develop annual fundraising plans to secure funding from diverse sources and create a sustainable watershed protection program. Initially, however, implementation projects will rely on state and federal grants such as the Maine Nonpoint Source Grants. The HLA, municipalities, CCSWCD and other organizations also plan to make financial and in-kind contributions toward implementation.

As the HLA, municipalities, road associations and other partners gain awareness and expertise with NPS treatment and prevention, it is expected that there will be less need for outside project funding. For example, the roadside erosion control program should help private road associations fix their more difficult road problems and become more active. Eventually, these groups should develop the confidence, experience and local support to address road maintenance and repair independently.

IMPLEMENTATION STRATEGY

Action Plan

The Highland Lake Study Committee developed an action plan to work toward the goals and objectives of this watershed management plan (Table 5). The plan was based primarily on information from the *Highland Lake Watershed Survey and Implementation Plan* (1998) and input gathered at several public meetings. CCSWCD also added some additional action items during the drafting of the final watershed plan. The watershed community should view the plan as a work in progress since it is expected to evolve as items are added, completed or deemed unnecessary.

The following section provides a general overview of the action plan. Additional information, such as candidate project sites, is detailed in the *Highland Lake Watershed Implementation Proposal*. Candidate sites will be selected from the watershed survey with preference given to high and medium priority sites. Final approval will be based on landowners' willingness to participate.

Objective 1: Reduce the amount of phosphorus-loaded stormwater runoff from the watershed

Implement a Landowner Technical Assistance Program - Meet with landowners and provide site-specific recommendations and low cost BMPs for residential NPS problems. **Cost:** $20,000/year

Implement a Roadside Erosion Control Program - Provide private road associations and Public Works Departments with technical and cost share assistance to address NPS road problems identified in the Highland Lake watershed survey. **Cost:** $50,000/year

- Conduct training workshops, publicize Maine Local Road Center courses and distribute road repair and maintenance publications to municipal officials, town road crews, contractors and private road associations.
- Work with towns to integrate adequate road maintenance, especially winter sand cleanup, into road crew budgets and work plans.
- Provide engineering assistance, cost sharing dollars and YCC crews to help road associations and towns repair high and medium priority road sites identified in the watershed survey.

Implement a Youth Conservation Corps Program - Establish a summer youth conservation corps that provides watershed residents and road associations with labor to install simple, low-cost BMPs and teaches participants about watershed conservation. **Cost:** $20,000/year

Develop a Phosphorus Ordinance - Establish a joint ordinance in the Towns of Falmouth and Windham that limits phosphorus export from new single family lots and private roads in the Highland Lake Watershed. **Cost:** $12,000

Place Conservation Easements on Important Riparian Buffers – Identify properties that benefit lake and stream water quality or provide important wildlife habitat. Encourage landowners to protect these areas by donating conservation easements. **Cost:** Unknown

Establish a Septic System Pollution Prevention Program – Assess the level of pollution caused by septic systems in the watershed, disseminate educational materials and strengthen local monitoring programs. **Cost:** $15,000

- Conduct a watershed-wide septic system survey (including pump-out records).
- Send landowners information about septic system maintenance and financing options for system replacement.
- Encourage contractors, code enforcement officers, plumbing inspectors and site evaluators to attend Department of Human Services courses and receive certification for septic system installation.
- Require landowners to obtain septic system inspections upon property sale.

Encourage Local Contractors to Become MDEP-Certified in Erosion Control – Publicize Nonpoint Source Training Center workshops, and provide a list of certified contractors to municipalities and watershed residents. **Cost:** $1,000/year

Objective 2: Conduct systematic sampling of the water quality of the lake and its feeder streams.

Continue and Expand the Highland Lake Association's Volunteer Water Quality Monitoring Program - Continue lake and stream monitoring, program planning and coordination, volunteer quality control training, data management and annual reporting. **Cost:** $2,500/year

- Continue to collect weekly seasonal measurements of lake secchi disk depth, dissolved oxygen and temperature.
- Continue stream monitoring and initiate macroinvertebrate sampling.
- Increase sampling frequency of total phosphorus and chlorophyll a.
- Monitor phosphorus cycling indicators, and evaluate likelihood of significant cycling problems.

Objective 3: Build consensus on watershed management strategies and actions, and promote public stewardship and education.

Integrate Watershed and Water Quality Topics into K-12 Programs - Provide teachers with relevant curriculum, classroom assistance, community service projects and field trip opportunities. **Cost:** $10,000/year

Conduct a Comprehensive Campaign to Promote Sound Household Practices - Promote individual actions and attitudes that play a role in lake protection. **Cost:** $10,000/year

- Participate in the MDEP non-phosphorus fertilizer campaign.
- Distribute existing publications and literature on residential BMPs.
- Conduct training workshops that demonstrate proper installation of vegetated buffers and other BMPs.
- Create "table top tents" for lake rental properties and businesses that provide tips about lake-friendly living.

Educate Recreational Users about Low-Impact Practices, Non-toxic Products, and the Need to Protect Sensitive Habitats - Cost: $5,000/year

- Submit articles to the HLA newsletter and local press that promote low-impact recreational practices.
- Participate in the Volunteer Lake Monitoring Program's (VLMP) Invasive Aquatic Plant Prevention Program. Deliver the VLMP's educational slide show at public meetings, post signs at boat launches and distribute educational articles to the HLA and local press.

Create Educational Sites that Demonstrate Soil Erosion and Stormwater Runoff BMPs – Educate the public about BMPs by posting interpretive signs, leading guided tours and publicizing the benefits of existing BMP sites. **Cost:** $10,000/year

Hold Annual "State of the Lake" Meeting - Develop educational presentations, displays and project update reports for HLA's annual meeting. **Cost:** $4,000/year

Heighten Public Awareness of Watershed Boundaries - Place "Entering Highland Lake Watershed" signs on major roadways at the watershed border. **Cost**: $2400

Educate Residents and Municipal Officials about Watershed Development Trends and Associated NPS Impacts - Use the watershed build-out analysis (Highland Lake Study Committee, 1996) to develop GIS maps that effectively convey trends, guide planning efforts and educate the watershed community. **Cost:** $10,000

EDUCATION AND OUTREACH

The future of Highland Lake rests in the hands of the watershed's citizens and local leaders. The success of virtually every action in the watershed management plan depends on public education, involvement and support. A citizenry that values the lake and its resources will support its restoration and protection. As such, public education and outreach elements have been incorporated into each action item in the plan.

Watershed education and outreach should serve several purposes:

- Help build community awareness and appreciation for Highland Lake Watershed's ecosystem, history and economic values.
- Promote understanding about issues facing the lake and watershed and demonstrate how these issues can be resolved.
- Foster a sense of stewardship for the lake and its watershed.
- Increase communication and cooperation.
- Promote dialogue and hands-on involvement.

Several approaches will be used to generate this interest and participation (Table 5). Educational articles and press releases will be offered for submission in the HLA newsletter and local newspapers. Lake stewardship practices and BMPs will be promoted through educational handouts, workshops, volunteer service projects, demonstration sites and tours, free technical assistance and cost sharing. The YCC will also provide labor to install BMPs on residential sites and private roads.

PROGRAM MONITORING AND EVALUATION

The following information will be used to track program progress and effectiveness and evaluate changes in water quality:

Water Quality Monitoring Data

It takes at least ten years of continuous data to accurately detect the program's effects on lake water quality. Nevertheless, the HLA should continue to collect and analyze annual secchi disk depth and dissolved oxygen information. As NPS pollution is reduced, the lake's water quality should eventually improve.

Table 5 – Highland Lake Watershed Action Plan

Watershed Action Items	Administered by[3]	Time	Funding Source/Cost
Reduce the amount of phosphorus-loaded stormwater runoff from the watershed			
Implement a Landowner Technical Assistance Program Provide landowners with site-specific recommendations for residential and driveway NPS problems. Provide YCC crews for installation.	**CCSWCD**, Windham, Falmouth	Ongoing	**Cost:** $20,000/year **Source:** NPS Grants, town and landowner contributions
Implement a Roadside Erosion Control Program Provide private road associations, town road crews and Public Works Departments with technical and cost share assistance to address road-related NPS problems.	**CCSWCD, Maine Local Roads Center, MDEP**, Falmouth, Windham	Ongoing	**Cost:** $50,000/year **Source:** NPS Grants, town match, road association contributions
Establish a Youth Conservation Corps (YCC) Program Establish a summer YCC that provides road associations and landowners with labor to install simple, low-cost BMPs.	**YCC Steering Committee, CCSWCD**, Windham, Falmouth	Ongoing	**Cost:** $20,000/year **Source:** NPS Grants, town match, local fundraising
Develop a Phosphorus Ordinance Establish a watershed phosphorus control ordinance for new single-family lots and private roads in Falmouth and Windham.	**Windham, Falmouth,** HLA	Year 1	**Cost:** $12,000 **Source:** Towns of Windham and Falmouth
Place Conservation Easements on Important Riparian Buffers Identify riparian properties that treat stormwater runoff or provide important wildlife habitat. Encourage donations of easements.	Windham, Falmouth, Falmouth Conservation Trust	Ongoing	**Cost:** Unknown **Source:** town and landowner contributions, private grants
Establish a Septic System Pollution Prevention Program Assess septic system pollution problems. Initiate monitoring program and educational campaign and investigate additional regulatory options.	Windham, Falmouth, **MDEP**, HLA, **DHS**	Ongoing	**Cost:** $15,000 **Source:** State grants, town contributions
Encourage Local Contractors to Receive MDEP Certification Publicize Nonpoint Source Training Center courses and encourage watershed community to use certified contractors.	**MDEP**, HLA, CCSWCD	Ongoing	**Cost:** $1,000/year **Source:** MDEP Nonpoint Training Center, NPS Grants

[3] Bold face indicates group(s) providing technical assistance.

Watershed Action Items	Administered by	Time	Funding Source/Cost
Conduct systematic sampling of the water quality of the lake and its feeder streams.			
Continue and Expand the HLA's Volunteer Monitoring Program Continue lake and stream monitoring, volunteer training, and annual reporting.	HLA, **MDEP**	Ongoing	**Cost:** $2,500/year **Source:** HLA due and services, NPS Grants
Build consensus on watershed management strategies and actions and promote public stewardship and education.			
Integrate Watershed and Water Quality Topics into K-12 Programs Provide teachers with water-related curriculum, classroom assistance, community service projects and field trip opportunities.	**Coop. Extension**, PWD, HLA, CCSWCD, AmeriCorps	Ongoing	**Cost:** $10,000/year **Source:** Town match, EPA Grants, private foundations
Conduct a Campaign to Promote Sound Household Practices Promote lake-friendly living through educational "table-top tents" and newsletter/newspaper articles and BMP demonstration workshops.	HLA, Falmouth, Windham, CBEP, CCSWCD, MDEP	Ongoing	**Cost:** $10,000/year **Source:** NPS Grants, HLA, business donations
Educate Lake Users about Low-Impact Practices/Habitat Protection Promote low-impact recreation and products through local press. Participate in VLMP Invasive Aquatic Plant Prevention Program.	**MDEP**, HLA, CCSWCD, IFW	Ongoing	**Cost:** $5,000/year **Source:** Outdoor Heritage Foundation, HLA
Create BMP Demonstration Sites Create educational sites demonstrating soil erosion and stormwater runoff BMPs. Post signs, lead tours and publicize BMP success stories.	HLA, **CCSWCD**, Windham, Falmouth	Ongoing	**Cost:** $10,000/year **Source:** NPS Grants
Hold Annual "State of the Lake" Meetings Develop educational presentations, displays and project updates for HLA's annual meeting.	HLA, CCSWCD	Annually	**Cost:** $4,000/year **Source:** NPS Grants, MDOT, HLA, towns
Heighten Awareness of Watershed Boundaries Heighten public awareness of the watershed's boundaries by placing signs on major roads at the watershed border.	HLA, **MDOT**, Windham, Falmouth	Year 1	**Cost:** $300/sign **Source:** NPS Grants, town match, local fundraising
Educate Residents and Town Officials about Development Trends Use watershed build out analysis to create maps of development trends.	Falmouth, Windham, GIS Consultant, CCSWCD	One Year	**Cost:** $10,000 **Source:** Town match, NPS Grants

Project Outreach and Participation

Project success can also be measured by the level of public participation, education and outreach. In particular, the following items will be documented each year:

- Amount of local contributions of money, materials or in-kind services.
- Number of BMPs installed.
- Number of requests for technical assistance.
- Decrease in the number of soil erosion sources (documented through watershed surveys).
- Number of people reached through newsletters, meetings, etc.
- Number of people involved in stewardship activities.
- Number of school programs or activities completed.
- Results of questionnaires and surveys.
- Compliance with Shoreland Zoning and Erosion and Sediment Control Laws.
- Improvements in municipal road maintenance.
- Number of articles published in local papers and newsletters

BMP Effectiveness

If possible, BMP performance and success should be assessed through the following measures:

- Documentation through before and after photos.
- Maintenance and performance of BMPs following installation.
- Calculations of soil loss equations.
- Changes in macroinvertebrate populations or other water quality parameters in adjacent streams.

LONG TERM PROGRAM FUNDING

The Steering Committee will develop a long-term funding strategy to increase local support as state support decreases. It is expected that as momentum for the program increases, there will be a similar increase in community support for the program and some of the following approaches will be viable options.

Local Transfer of Technology and Leadership

Over time the HLA, municipalities, road associations and other project partners will gain awareness and expertise with NPS treatment and prevention. As such, these groups can

eventually take the lead on several action items, and there will be less need for outside project funding. For example, the roadside erosion control program will encourage road associations to become more active and fix their road problems. It is anticipated that these groups will eventually have the confidence and local support to address road maintenance and repair independently.

Fundraising Campaigns

Some action items, such as the youth conservation corps, should attempt to secure funding through annual fundraising campaigns. The Belgrade Lakes Association has found great success using this approach, and they cover almost all of their annual Conservation Corps costs through contributions from local businesses, towns and residents.

State Revolving Funds

It is anticipated that State Revolving Funds (SRFs) will soon become available as a source of funding for NPS problems in Maine. The 51 Clean Water State Revolving Fund (CW-SRF) programs have over $24 billion in assets and currently issue approximately $3 billion in loans annually. SRF loans are issued at below market rates (0% to less than market), offering borrowers significant savings over the life of the loan.

The SRF programs work like banks (each state and Puerto Rico has one). Federal and state contributions are used to capitalize or set-up the programs. These assets are then used to make low-interest loans for important water quality projects. Repaid funds are then recycled to fund other important water quality projects. The CW-SRF can fund virtually any type or category of polluted runoff that is included in a state approved NPS management plan. Eligible loan recipients include communities, individuals, citizen groups and nonprofit organizations.

Although many organizations would rather receive grants than loans, SRF loans may be an attractive option for several reasons:

- **First, No Cash Up-Front.** Most grant programs require significant cost sharing (as much as 40% or more). An SRF loan can cover 100% of a project costs with no cash up-front.
- **Second, Significant Cost Savings.** SRF loans provide significant cost savings over the life of the loan. The total cost of a 0% SRF loan will be approximately 50% less than the same project financed by a commercial loan at 7.5%. Additionally, a 0% SRF loan is equivalent to receiving a 50% grant (where the matching 50% is financed at market rate).
- **Third, Streamlined Federal Requirements.** Financing a project with an SRF loan means fewer federal requirements than with a federal grant. Plus, the 51 CW-SRF programs help applicants through the loan application process and provide a variety of technical assistance services. Also, it may be possible to combine an SRF loan with grant dollars from other sources.

Many CW-SRF recipients have demonstrated a high level of creativity in repaying the loans. The source of repayment need not come from the project itself. Some possible sources include:

- Contributions from participating landowners or businesses
- Dedicated portion of local, county, or state taxes or fees
- Recreational fees
- Stormwater management fees, wastewater user charges
- Donations or dues made to nonprofit groups

In summary, the Clean Water State Revolving Fund provides a powerful funding resource for implementing clean water action strategies and should be considered as an option in the Highland Lake Watershed.

Charrettes

"Charrettes" describe a gathering of various groups of people in a community to solve problems with the assistance of outside experts. The charrette process, pioneered by the University of Maryland's Environmental Finance Center, uses an advisory panel of federal and state officials and private-sector financial and technical experts who provide local officials with solutions to their problems of financing environmental services and facilities. The charrette provides a forum for frank discussions between local officials and financial experts about financing difficulties experienced by communities in meeting the need for conservation efforts. The goal of the charrette is the creation of pertinent, realistic and achievable recommendations to finance specific projects.

This model approach to financing should be explored further for its applicability to the Highland Lake Watershed. The charrette process expands understanding of financing issues related to nonpoint source pollution, such as urban stormwater runoff or agricultural nutrient runoff. The charrette process also enables local communities to identify cost-effective and equitable financing solutions to environmental concerns that will not impede economic development in their community.

GLOSSARY

Algae: Small simple plants that naturally live in water. High algae populations impair water clarity and dissolved oxygen levels and indicate high concentrations of phosphorus.

Algae Bloom: A growth of algae resulting from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

Best Management Practices: (BMPs) Techniques to reduce nonpoint source impacts from construction, agriculture, timber harvesting, marinas, and stormwater.

Buffer (vegetated buffer): Areas of vegetation, left undisturbed or planted between a developed area and a water body. Buffer vegetation can include trees, shrubs and ground cover plants.

Culvert: A conduit through which surface water can flow under or across roads and driveways. Culverts are usually a pipe and can be made of metal, wood, plastic, or concrete.

Dissolved Oxygen (DO): Oxygen dissolved in the water is essential for all plants and animals living in the water. DO is a measurement of the amount of oxygen in the water that is available to these plants and animals. The amount of DO is used as an indicator of water quality and the level of life that the water can support.

Ditch Turnout: A Best Management Practice used to direct runoff in a ditch into a vegetated buffer. This shortens the distance that runoff travels in a ditch, thus reducing volume and speed of the water traveling in the ditch and preventing ditch erosion. A turnout prevents runoff in a ditch from reaching a stream or other body of water by directing water into a vegetated buffer.

Diversion: A Best Management Practice used to intercept and direct surface runoff. Diversions are usually channels or depressions with a supporting ridge on the lower side, constructed across or at the bottom of a slope.

Driveway: A private access and parking area for a residence.

Erosion: Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces. Human activities can greatly speed this process.

Eutrophication Enrichment of water by fertilizer, sewage or nutrient-rich substance. Eutrophication leads to the uncontrolled growth of nuisance algae, which can indirectly deplete oxygen and kill aquatic life.

Intermittent Stream: A stream that flows during part of the year.

Leach Field: The part of a septic system where the liquid (effluent) from the septic tank disperses into the soil.

Mulch: A layer of hay of other material covering the land surface that holds soil in place. It aids in the establishment of vegetation by preventing erosion, conserving moisture, and minimizing temperature fluctuations.

Phosphorus: An element found throughout the environment; it is a nutrient essential to all living organisms. Phosphorus binds to soil particles, is found in fertilizers, sewage, and motor oil, and is found in high concentrations in stormwater runoff. The amount of phosphorus present in a lake determines the lake's production of algae. A very small change in phosphorus levels can dramatically increase algae growth.

Nonpoint Source Pollution (NPS): Runoff that has picked up contaminants or nutrients from the landscape (or air), as it flows over the surface of the land to a body of water.

Runoff: Water that drains or flows across the surface of the land.

Sediment: Mineral and organic soil material that is transported in suspension by wind or flowing water, from its origin in another location.

Septic System: An individual sewage treatment system that typically includes a septic tank and leach field that area buried in the ground. The septic tank allows sludge to settle to the bottom and a scum of fats, greases and other lightweight materials to rise to the top. The remaining liquid flows to the leach field where it disperses through soil to reduce the number of bacteria and viruses.

Tributaries: Streams or rivers that flow to a larger body of water.

Turnover: Describes the process of mixing of the thermal layers in a lake that occurs from changes in temperature and wind action.

Vegetated Buffer: Areas of vegetation, left undisturbed or planted between a developed area and a waterbody that are used to capture pollutants from surface water and groundwater. Buffer vegetation can include trees, shrubs, bushes, and ground cover plants.

Water Quality: Pertaining to the presence and amount of pollutants in water.

Waterbar: A diversion ditch and/or hump installed across a trail or road to divert runoff from the surface before the flow gains excessive volume and velocity.

Watershed: The geographic region within which water drains into a particular river, stream, or body of water. A watershed includes hills, lowlands, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of land separating watersheds.

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