# PHOSPHORUS CONTROL ACTION PLAN

**and Total Maximum Daily (Annual Phosphorus) Load Report**

# PLEASANT (Mud) POND

Kennebec and Sagadahoc Counties, Maine

## Pleasant Pond PCAP-TMDL Report

**Maine DEPLW 2003 - 0626**

**Maine Department of Environmental Protection**

**COBBOSSEE WATERSHED DISTRICT and**

**Maine Association of Conservation Districts**

**Final EPA Review Document — May 7, 2004**

# PLEASANT (Mud) POND Phosphorus Control Action Plan (PCAP)

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### Total Maximum Daily (Annual Phosphorus) Load



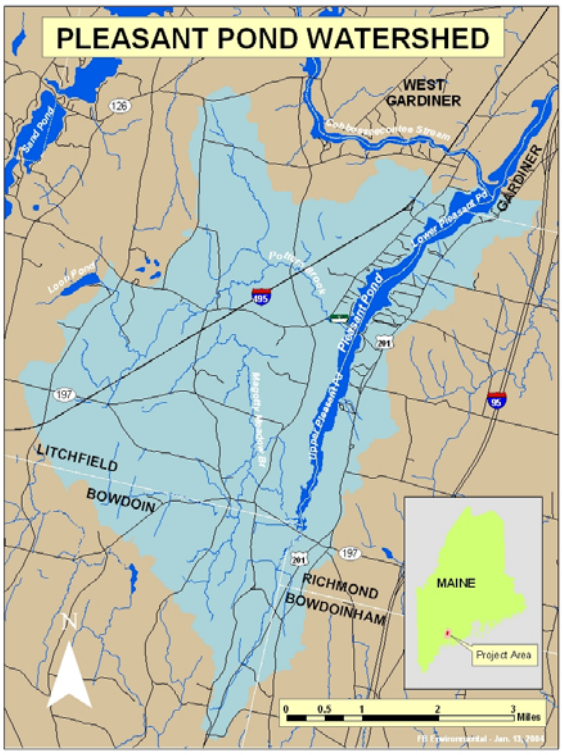

**ACKNOWLEDGMENTS**

*In addition to Maine DEP and US-EPA New England Region I staff, the following individuals, groups and agencies were instrumental in the preparation of this combined Pleasant Pond Phosphorus Control Action Plan-Total Maximum Daily (Annual Phosphorus) Load report: Cobbossee Watershed District staff (Bill Monagle and Wendy Dennis); Maine Association of Conservation Districts staff (Jodi Michaud Federle, Forrest Bell and Tim Bennett); Towns of Litchfield and Richmond; Kennebec County Soil and Water Conservation District (Nate Sylvester and Dale Finseth); Natural Resource Conservation Service (Dick Ferland); Four Towns Watershed Association and VLMP Monitors; Friends of the Cobbossee Watershed (Bob Moore); Maine Department of Inland Fish and Wildlife (Jim Lucas, Region B, Sidney Office); and Maine Department of Marine Resources (John Perry, Hallowell Office).*

# Pleasant Pond Phosphorus Control Action Plan
# Summary Fact Sheet

## Background

**PLEASANT POND** is a 749-acre waterbody situated within the Towns of Litchfield and Richmond and, to a much lesser extent, the City of Gardiner, in Kennebec and Sagadahoc Counties in central Maine. Pleasant Pond has a direct **watershed** (see map) area of 15,340 acres (24 square miles), and is located within the towns of Litchfield, Richmond, Bowdoin, Bowdoinham and the City of Gardiner. This pond has a maximum depth of 31 feet, a mean depth of 7 feet; and a **flushing rate** of 5.6 times per year, much higher than the average for Maine lakes (1.5 times per year). Pleasant Pond flows directly into water quality impaired [303(d) TMDL listed] Cobbossee Stream, which then drains into the Kennebec River.




Pleasant Pond has a history of supporting excessive amounts of algae in the late summer, due in large part to the contribution of **phosphorus** that is prevalent in area soils and has accumulated in the lake bottom sediments. Continued soil erosion in the Pleasant Pond watershed can have far-reaching consequences, as soil particles effectively transport phosphorus, which serves to "fertilize" the lake and decreases water clarity. Excess phosphorus can also harm fish habitat and lead to nuisance algae blooms—floating mats of green scum—or dead and dying algae. Studies show that as lake water clarity decreases, lakeshore property values also decline.

## Stakeholder Involvement

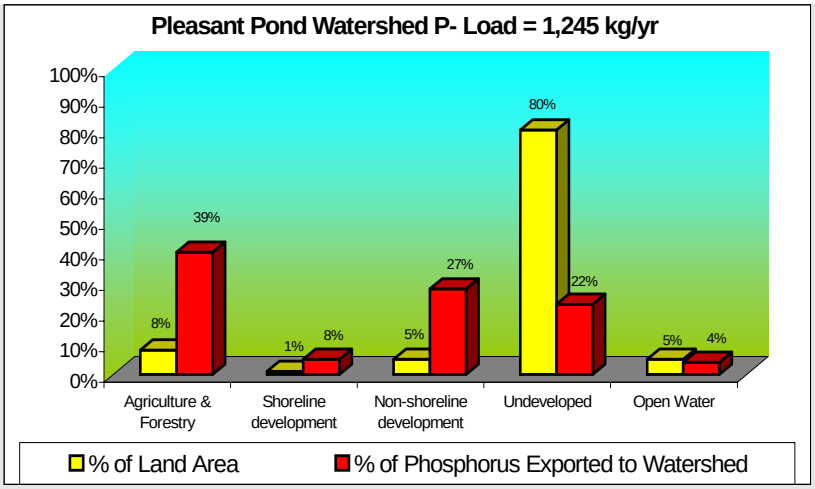
Federal, state, county, and local groups have been working together to effectively address this **nonpoint source water pollution** problem. In 2001, the Maine Department of Environmental Protection contracted with Cobbossee Watershed District to cooperate with the Kennebec County Soil and Water Conservation District, the Four Towns Watershed Association and the Maine Association of Conservation Districts, to identify and quantify potential sources of phosphorus and identify the **Best Management Practices** needed to be implemented in the Pleasant Pond watershed. A final report, completed in the spring of 2004, is entitled "Pleasant Pond Phosphorus Control Action Plan" and doubles as a **TMDL** report, that will be submitted to the US

*Typical Residential Development along the Pleasant Pond shoreline.*

Environmental Protection Agency for their final review and approval.

## What We Learned

A land use assessment was conducted for the Pleasant Pond watershed to determine potential sources of phosphorus that may run off from land areas during storm events and springtime snow melting. This assessment used numerous resources, including generating and interpreting maps, inspecting aerial photos and conducting field surveys.




An estimated 1,245 kilograms (kg) of phosphorus is annually exported to Pleasant Pond from its direct watershed. The bar chart illustrates the land area for each land use relative to its total phosphorus export load. This information, which is detailed in the full report, can help Pleasant Pond stakeholder groups to effectively prioritize future BMP projects for NPS pollution mitigation in the watershed.

## Phosphorus Reduction Needed

Pleasant Pond has a natural capacity to effectively process up to 727 kg of TP each year without harming water quality. This amount of phosphorus equates to an in-lake phosphorus concentration of 15 ppb. Pleasant Pond's actual average annual TP concentration is 21 ppb, equal to 1,027 kg TP. Taking into account a 25 kg allocation for future watershed development, the total amount of phosphorus needed to be reduced to maintain water quality standards (bloom-free conditions) in Pleasant Pond is estimated to be 325 kg.

## What You Can Do To Help!

As a watershed resident, there are many things you can do to protect the water quality of Pleasant Pond. Lakeshore owners can use phosphorus-free fertilizers and maintain natural vegetation adjacent to the lake. Agricultural and commercial land users and watershed residents can consult the Cobbossee Watershed District or the Kennebec County Soil and Water Conservation District for information regarding Best Management Practices (BMPs) for reducing phosphorus loads. Watershed residents can become involved by volunteering to help the Four Towns Watershed Association and participating in events sponsored by the Friends of the Cobbossee Watershed. Pleasant Pond stakeholders and watershed residents can learn more about their lake and the many resources available, including review of the Pleasant Pond Phosphorus Control Action Plan and TMDL report. Following final EPA approval, copies of this report, with recommendations for future NPS/BMP work, will be available online at www.state.me.us/dep/blwq/docmonitoring/tmdl2.htm, or can be viewed and/or copied (at cost) at Maine DEP offices in Augusta (Hospital Street, Ray Building, Bureau of Land & Water Quality).

### *Key Terms*

- ***Watershed*** *is a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.*
- ***Flushing rate*** *refers to how often the water in the entire lake is replaced on an annual basis..*
- ***Phosphorus*** *is one of the major nutrients needed for plant growth. It is naturally present in small amounts and limits the plant growth in lakes. Generally, as phosphorus increases, the amount of algae also increases.*
- ***Nonpoint Source Pollution*** *is polluted runoff that cannot be traced to a specific origin or starting point, but appears to flow from many different sources.*
- ***Best Management Practices*** *are techniques to reduce sources of polluted runoff and their impacts. BMP's are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.*
- ***TMDL*** *is an acronym for Total Maximum Daily Load which represents the total amount of a pollutant (e.g., phosphorus) that a waterbody can receive on an annual basis and still meet water quality standards.*

## Project Premise

This project, funded through a 319-grant from the United States Environmental Protection Agency (EPA), was directed and administered by the Maine Department of Environmental Protection (Maine DEP) under contract with the Cobbossee Watershed District (CWD) and the Maine Association of Conservation Districts (MACD), from summer 2001 through spring 2004.

The objectives of this project were twofold: First, a comprehensive land use inventory was undertaken to assist Maine DEP in developing a Phosphorus Control Action Plan (PCAP) and a Total Maximum Daily Load (TMDL) report for the Pleasant Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with the assistance of the CWD and MACD Project Team, will address and incorporate public comments before final submission to the US EPA. *(For more specific information on the TMDL process and results, refer to the Appendices or contact Dave Halliwell at the Maine DEP Augusta office at 287-7649 or at David.Halliwell@maine.gov*).

Secondly, watershed survey work, including a shoreline survey and agricultural land use evaluation, were conducted by CWD staff to assess applicable **total phosphorus** reduction techniques that would be beneficial for the Pleasant Pond watershed. Watershed survey work included assessing direct drainage **nonpoint source (NPS) pollution** sites from public (state and town) roadways that were not identified during the CWD's Nonpoint Source Pollution Survey of agricultural lands and town and state roadways within the immediate watershed in 1999/2000 and of camp/private roads conducted in the spring of 2000 in cooperation of Kennebec County Soil & Water Conservation District (SWCD) and the Four Towns Watershed Association (FTWA). The results of this assessment include recommendations for future conservation work in the watershed to help citizens, organizations, and agencies restore and protect Pleasant Pond.

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

***Nonpoint Source (NPS) Pollution*** *- is polluted runoff that cannot be traced to a specific origin or starting point, but appears to flow from many different sources.*

**Note:** *To protect the confidentiality of landowners in the Pleasant Pond watershed, site-specific information has not been provided as part of this report.*

This Phosphorus Control Action Plan (PCAP) compiles and refines land use data derived from various sources, including the municipalities of Litchfield, Richmond and Gardiner, the Four Towns Watershed Association, and the Kennebec County SWCD. Local citizens, watershed organizations, and conservation agencies should benefit from this compilation of data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Pleasant Pond stakeholder groups to effectively prioritize future BMP work projects in order to obtain the funding resources necessary for NPS pollution mitigation work in their watershed.

## Study Methodology

Pleasant Pond background information was obtained using several methods, including a review of previous studies of the lake and watershed area, numerous phone conversations and personal interviews with municipal officials, regional organizations and state agencies, and several field visits of the watershed, including boat reconnaissance of the pond and shoreline.

> ***GIS**—or **geographic information system** combines layers of information about a place to give you a better understanding of that place. The information is often represented as computer generated maps.*

Land use data in the Pleasant Pond watershed were determined using several methods, including: (1) **Geographic Information System (GIS)** map analysis; (2) analysis of topographic maps; (3) analysis of town property tax maps and tax data; (4) analysis of aerial photographs (1998 and 1992); and (5) field visits. Much of the undeveloped land use area (i.e., forest, wetland, grassland) was determined using GIS maps utilizing data from the Maine Gap Program/MRLC compiled by Maine DEP. The developed land use areas were obtained using the best possible information available through analysis of methods 2 through 5 listed above. Necessary adjustments to the GIS data were primarily made using best professional judgment.

Roadway data were gathered by taking actual road width measurements of the various types of roads (state, town, private/camp) in the watershed. Roads were measured between the two outer edges of the roadside ditches or berms. An average width was used for each of the three road types (state, town, camp/private). Final measurements for all roadways within the watershed were extrapolated using GIS and USGS topographical maps. The roadway area was determined using linear distances and average widths for each of the three main road types.

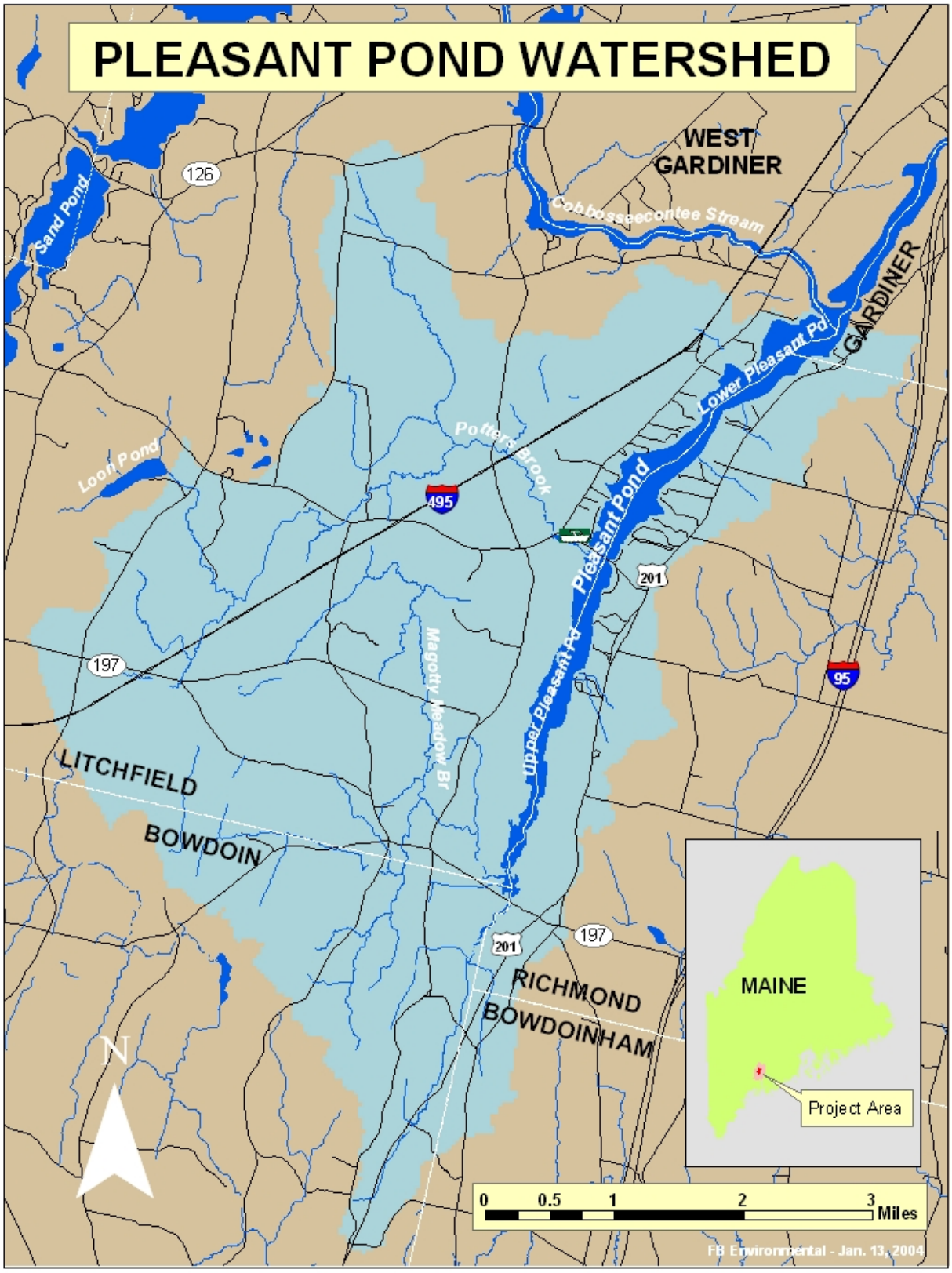
Additional land use data (i.e. non-shoreline residential, parks/cemeteries) were determined using GIS cover mapping, aerial photos, topographic and property tax maps as well as personal consultation and, when necessary, field visits.

The agricultural survey was conducted by CWD and Kennebec County SWCD. The survey included field inspections of farm lands, personal interviews with the farmers and consultation with Natural Resources Conservation Service (NRCS) staff. The goal of this survey was to gain information regarding herd size, cropland and crop practices, fertilizer use, manure storage and livestock access to streams.

## Study Limitations

Land use data gathered for the Pleasant Pond watershed is as accurate as possible given available information and resources utilized. However, the final numbers for the land use analysis and phosphorus loading numbers are approximate at best, and should be viewed as carefully researched estimations only.

# Figure 1. Map of Pleasant Pond Direct Watershed



# PLEASANT (Mud) POND Phosphorus Control Action Plan

## DESCRIPTION of WATERBODY (MIDAS Number 5254) and WATERSHED

**PLEASANT POND** is a 749-acre dual basin waterbody situated within the towns of Richmond and Litchfield and, to a much lesser extent, the city of Gardiner (DeLorme Atlas, Map 12), in Kennebec and Sagadahoc Counties, located in south-central Maine. Pleasant Pond has a **direct watershed** area (see Figure 1) of 15,340 acres (24 square miles) and is located within the towns of Litchfield, Richmond, Bowdoin, Bowdoinham and the City of Gardiner. Pleasant Pond has a maximum depth of 31 feet (9.5 meters), an overall mean depth of 6.6 feet (2 meters) and has a flushing rate of 5.6 times per year (CWD files).

*The **direct watershed** refers to the land area that drains to the lake without first passing through another lake or pond.*

**Drainage System** – Pleasant Pond generally flows from the southern "upper" basin into the larger, northern "lower" basin. The two basins are connected by several culverts located under the Thorofare Road in Litchfield and no identified indirect drainages are accounted for in this report. Pleasant Pond has two main tributaries - 303(d) listed Potters Brook, which flows from the southwest and enters the pond at its southern-most end, and Maggotty Meadow Brook which flows from the west and enters the pond about midway between the upper and lower basins. Pleasant Pond outlets at the northern tip into the Cobbossee Stream, which receives drainage from 27 upstream lakes and ponds, eventually draining into the Kennebec River in Gardiner. During times of heavy rainfall, there may be some non-determined amount of backflow from the Cobbossee Stream into Pleasant Pond (Bill Monagle, CWD, personal communication).

The towns of Richmond and Litchfield and the City of Gardiner cooperatively own the New Mills Dam that controls the pond water level. The dam is operated through an agreement with Consolidated Hydro, Inc.

### Water Quality Information

Pleasant Pond is listed on the Maine DEP's 303(d) list of lakes that do not meet State water quality standards as well as the State's Nonpoint Source Priority Watersheds list; hence the need for preparation of a Phosphorus Control Action Plan (and TMDL), which was prepared, publicly reviewed, and completed in the late spring of 2004.

***Secchi Disk Transparency**—a measure of the transparency of water (the ability of light to penetrate water) obtained by lowering a black and white disk into water until it is no longer visible.*

Water quality data for Pleasant Pond has been collected by Maine DEP and CWD since 1976. Based on continuous **Secchi disk transparencies,** measures of both total phosphorus (TP) and **chlorophyll-a**, the water quality of Pleasant Pond is considered to be poor and the potential for nuisance summertime algae blooms is high since algal blooms have occurred routinely during the summer months for the past 20 years (VLMP 2002). Together, these data

***Chlorophyll-a** is a measurement of the green pigment found in all plants including microscopic plants such as algae. It is used as an estimate of algal biomass; the higher the Chl-a number, the higher the amount of algae in the lake.*

document a trend of increasing **trophic state,** in direct violation of the Maine DEP Class GPA water quality criteria requiring a comparatively stable or decreasing trophic state.

***Trophic state—****the degree of eutrophication of a lake. Transparency, chlorophyll-a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion can be used to assess trophic state.*

Nonpoint source (nutrient) pollution is the main reason for declining water quality in Pleasant Pond. During storm events, nutrients such as phosphorus, naturally found in Maine soils, drain into the lake from the surrounding watershed by way of streams and overland flow.

Phosphorus is naturally limited in lakes and can be thought of as a fertilizer, a primary food for plants, including algae. When lakes receive excess phosphorus from NPS pollution, it "fertilizes" the lake by feeding the algae. Too much phosphorus can result in algae blooms, which can damage the ecology and natural aesthetics of a lake, as well as the economic well-being of the entire watershed community.

**Principal Uses:** The dominant human uses of the Pleasant Pond shoreline are residential (seasonal and year-round occupancy) and recreational (boating, fishing, swimming/beach) use.

**Public Access:** Peacock Beach State Park is located on the eastern shore of Pleasant Pond off of Route 201. The park has a beach and picnic area, with approximately 3,000 visitors a year (Maine Bureau of Parks and Lands 2003). The Thorofare Road in Litchfield runs between the upper and lower basins of the pond. Along this road there are two boat launch/public access sites, one for the lower basin and one for the upper basin. There is also a commercial campground located on the east side of the pond in Gardiner that has limited lake access for swimming, boating and fishing.

**Human Development:** The shoreline of Pleasant Pond is moderately to highly developed in comparison to other regional lakes and ponds managed by the CWD. The northern basin, lower Pleasant Pond, is much more intensely developed than the smaller and shallower upper basin. There are 166 residential dwellings located along the approximate 9-mile shoreline. Of these, 58 percent are seasonal camps and 42 percent are year-round dwellings (CWD project staff 2001).

*Waterbodies within designated **NPS priority watersheds** have significant value from a regional or statewide perspective and have water quality that is either impaired or threatened to some degree due to NPS water pollution. This list helps to identify watersheds where state and federal agency resources for NPS water pollution prevention or restoration should be targeted.*

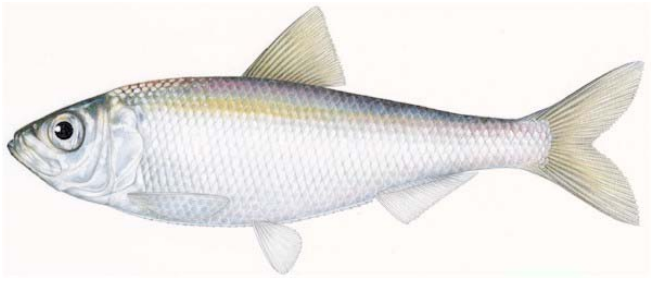
Pleasant Pond is noted as a high priority on the State's **Nonpoint Source Priority Watersheds** list due primarily to algal blooms and high population growth rates in the watershed. Notably, Litchfield's population has increased by 17% for the 1990-2000 time period (US Census 2000). According to Maine Municipal Association, the 2001 year-round populations of the municipalities with frontage on the pond are Gardiner - 6,268; Litchfield - 3,110; and Richmond - 3,485. The vast majority of these populations reside outside the watershed of the pond and the urban commercial centers of Gardiner and Richmond are completely outside of the watershed. The Town of Litchfield is a rural suburban town 16 miles southwest of Augusta and Gardiner is located 6 miles south of Augusta, which is the major commercial and employment center in this area.

# Pleasant (Mud) Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and a recent conversation with fish biologist Jim Lucas (Region B, Sidney DIFW office), **Pleasant Pond** (towns of Litchfield, Richmond, and West Gardiner, Cobbossee Stream - Kennebec River drainage) is currently managed as a warmwater fishery (largemouth bass) and was last surveyed in 1963 (report revised in 2000 and fish list updated 2003). A total of **16** fish species are listed, including: **12** native indigenous fishes (brook trout, rainbow smelt, American eel, golden shiner, banded killifish, ninespine stickleback, white sucker, brown bullhead, chain pickerel, redbreast sunfish, pumpkinseed, and yellow perch); and **4** previously introduced fishes (white perch, black crappie, smallmouth and largemouth bass). MDIFW note that "an occasional brown trout may be caught in Pleasant Pond, dropping down from the stocking of upstream Cobbossee Lake. Historically, Pleasant Pond provided an excellent smallmouth bass fishery, but excessive shoreline siltation and the abundant growth of invasive aquatic vegetation (variable-leaf milfoil) have severely altered aquatic habitats, to the benefit of largemouth bass and chain pickerel. Introduced rudd, an exotic minnow species closely resembling golden shiner - with which it is capable of hybridizing, have been recorded from nearby Cobbossee Stream and may also reside in Pleasant Pond. Rudd are commonly utilized as a baitfish species in other parts of the United States, but are prohibited from sale in Maine.

**Pleasant Pond** has historically been plagued with annually occurring severe summertime algal blooms. Working on the premise that reducing algal productivity will help restore/maintain suitable water quality conditions and fishery habitat conditions, then a significant reduction (325 kg TP/year) in the external (watershed) loading of total phosphorus to Pleasant Pond (1,245 kg TP/year) can lead to maintaining in-lake nutrient levels - within the assimilative capability of this lake (727 kg TP/year) to effectively process available phosphorus and enhance/protect existing warmwater fisheries.

The Maine Department of Marine Resources (Maine DMR) has been stocking Pleasant Pond with alewives since 1997 as part of the Cobbosseecontee Watershed Restoration Plan. This plan seeks to restore historical diadromous fish species to the watershed. Presently, DMR is in the process of stocking alewives in Pleasant Pond at the rate of approximately 6 fish/acre. Table 1 outlines the annual extent of anadromous alewife stocking in Pleasant Pond by Maine DMR.



**Alewife (*Alosa pseudoharengus*)**

**Table 1.** *History of Alewife stocking in Pleasant Pond*

| YEAR | # ALEWIVES STOCKED |
|---|---|
| 1997 | 4,540 |
| 1998 | 4,572 |
| 1999 | 4,724 |
| 2000 | 4,517 |
| 2001 | 3,514 |
| 2002 | 4,559 |
| 2003 | 5,573 |

**Invasive Aquatic Plants** - The presence of the non-native invasive aquatic plant, variable-leaf watermilfoil (*Myriophyllum heterophyllum*) was confirmed in Pleasant Pond in 2001. The shallow, upper Pleasant Pond basin was determined to be heavily infested by this species (Maine DEP Invasive Species Program 2003).

**Watershed Topography and Characteristic Soils** (Sources: USDA SCS 1978 Soil Survey for Kennebec County and USDA SCS 1970 Soil Survey for Androscoggin and Sagadahoc Counties):

The western portion of the Pleasant Pond watershed (Kennebec County) is dominated by the **Buxton-Scio-Scantic soil association**. These soils are characterized as deep, moderately well drained to poorly drained, nearly level to sloping, medium textured soils; in flat areas and near waterways. This association is characterized by wetness and slow infiltration rates (hydrologic soil groups C and D with infiltration rates less than 2.54 cm/hr). These soils have a very slow rate of water transmission and a high runoff potential. Soil erodibility is also high.

Parts of the far western reaches of the watershed (Kennebec County) contain the **Hollis-Paxton-Charlton-Woodbridge soil association.** The major soils in this association were formed in glacial till. Hollis, Paxton, and Woodbridge soils have a high runoff potential (hydrologic soil group C) due to shallowness to bedrock and high water table conditions; Charlton soils have a moderate runoff potential (hydrologic soil group B). All except Hollis have infiltration rates of less than 2.54 cm/hr. Soil erodibility is high.

The eastern portion of the watershed (Sagadahoc County) is dominated by the **Charlton-Sutton-Paxton soil association .** These are deep, medium-textured and moderately coarse textured, well drained and moderately well drained, nearly level to steep soils, on hills and ridges. This association (hydrologic soil groups B and C) generally has moderate to slow infiltration rates.

## Land Use Inventory

Results of the Pleasant Pond watershed land use inventory are depicted in Table 2 (following page). The various land uses are categorized by developed land vs. non-developed land. The developed land areas comprise approximately 15% of the watershed and the non-developed land areas, including the water surface area of Pleasant Pond, comprise the remaining 87% of the watershed. These numbers may be used to help make future planning and watershed conservation decisions relating to the Pleasant Pond watershed. The land use and phosphorus loading information in Table 2 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

### Descriptive Land Use and Phosphorus Export Estimates

**Agriculture:** The CWD has been working with various farmers in the Pleasant Pond watershed since the 1970's. During this time period, three dairy farms, one beef cattle operation and three poultry farms have ceased operation. On some of these farms, land is hayed by some of the remaining seven active farms. Of these, three of the farms are dairy farms, one is a dairy replacement farm, two are beef operations, and the seventh is a deer farm.

Pasture for four of the seven farms totals 220 acres, 15 of which are also manured. Total acreage for all pasture land in the watershed is estimated at 362 acres. There are approximately 300 acres of hayland in the watershed that is known to be manured (fertilized), and 20 acres that

## Table 2. PLEASANT (Mud) Pond Direct Watershed - Land Use Inventory and Phosphorus Loads.

| LAND USE CATEGORY | Total Land Area Acres | Total Land Area % | TP Export Total % |
|---|---|---|---|
| **Agricultural & Forested Land** | | **Pleasant Pond** | |
| Hayland (Manured) | 482 | 3.1 | 19.4 |
| Low-Intensity Hayland | 203 | 1.3 | 4.2 |
| Manure Storage | 0.60 | 0.0 | 4.3 |
| Pasture | 362 | 2.4 | 9.5 |
| Operated Forest Land | 114 | 0.7 | 1.5 |
| **Sub-Totals** | **1,161** | **8%** | **39%** |
| **Shoreline Development** | | **Pleasant Pond** | |
| Low Impact Residential | 9 | 0.1 | 0.4 |
| Medium Impact Residential | 11 | 0.1 | 0.5 |
| High Impact Residential | 19 | 0.1 | 1.0 |
| Residential Septic Systems | — | 0.0 | 3.3 |
| Camp and Private Roads | 31 | 0.2 | 2.0 |
| Recreational (State Park) | 7 | 0.0 | 0.3 |
| **Sub-Totals** | **77** | **0.5%** | **8%** |
| **Non-Shoreline Development** | | **Pleasant Pond** | |
| State Roads | 239 | 1.6 | 11.7 |
| Town Roads | 62 | 0.4 | 3.0 |
| Low Density Residential | 454 | 3.0 | 7.4 |
| Commercial Property | 4 | 0.0 | 0.2 |
| Institutional (Public) | 6 | 0.0 | 0.3 |
| Parks, Cemeteries | 50 | 0.3 | 1.4 |
| Exposed Earth | 110 | 0.7 | 3.5 |
| Gravel Pits | 109 | 0.7 | 0.0 |
| **Sub-Totals** | **1,034** | **5%** | **27%** |
| **Total: DEVELOPED Land** | **2,272** | **15%** | **74%** |
| **Non-Developed Land** | | **Pleasant Pond** | |
| Inactive/Passively Managed Forest | 9,642 | 62.9 | 12.5 |
| Wetlands | 722 | 4.7 | 0.5 |
| Scrub Shrub | 189 | 1.2 | 0.6 |
| Grassland/Reverting Fields | 1,766 | 11.5 | 8.6 |
| **Total: NON-DEVELOPED Land** | **12,319** | **Pleasant 80%** | **22%** |
| **Total: Surface Water (Atmospheric)** | **749** | **5%** | **4%** |
| **TOTAL: DIRECT WATERSHED** | **15,340** | **Pleasant 100%** | **100%** |

are known to be non-manured. The presence or absence of manure application on the remaining 365 acres of hayland is undetermined. For the purpose of this study, at least half of the acreage was assumed to be manured and half of the acreage was assumed to be non-manured. Hen manure is imported from a local egg farm for hayfields on at least one of the dairy farms. Three of the dairy farms have nutrient management plans.

On the three dairy farms, active milkers total 170 cows. The three milking dairy farms all utilize constructed manure storage facilities. One of these pits, known to be of inadequate size, requires retrofitting in order to reduce manure runoff to an adjacent tributary to Pleasant Pond. Barnyard runoff from this farm also enters the tributary. The replacement dairy farm has over 100 cows and manure is hauled to a field stacking site in winter. One of the beef herds has about 50 head, while the larger herd size is unknown. Manure storage on the other farms involves either mixing with sawdust and stacking at edge of a barnyard or is unknown.

On five of the operational farms, cows have unfettered access to tributary streams (Potters Brook, Maggotty Meadow Brook, Ashford Brook). Only one of the dairy farms has recently fenced cows from a tributary stream (CWD observation).

In summary, the extent of land used for agricultural purposes in the Pleasant Pond watershed remains substantial when compared to other culturally-based land uses. The amount of land used for agriculture in the watershed of Pleasant Pond accounts for 7% of the total direct watershed area and 37% of the total phosphorus loading to the lake based on land use based phosphorus export coefficients. Of the various agricultural practices, hayland is estimated to contribute the most phosphorus, with pasture and manure storage contributing the remainder of the annual total phosphorus load.

**Forestry Practices:** Generally, poorly managed forestry operations have the potential to negatively impact a waterbody by erosion and sedimentation from logging sites.

The estimated “operated forestland” acres for Pleasant Pond, based on GIS cover mapping, averages 114 acres per year. The operated forestland area within the watershed approximates less than 1% of the total land area and an estimated 1.5% of the total phosphorus load to Pleasant Pond.

**Shoreline Residential (House and Camp Lots):** In order to evaluate the impact of lakeshore dwellings, CWD project staff conducted a Pleasant Pond shoreline survey in the summer-fall of 2001. This survey was conducted by boat and the results represent subjective determinations of potential impact ratings based on best professional judgment. To determine phosphorus loading estimates, each developed shoreline lot was assigned an NPS pollution impact rating, ranging from 1 to 5, with 1 being low impact (natural - best case scenario) and 5 being high impact (unnatural – worst case scenario). Table 3 (following page) outlines the impact ratings assigned to each shoreline lot during the survey. Lots receiving a rating of 1 have a full, naturally vegetated buffer. Conversely, a lot given a score of 5 would have little or no vegetative buffer and support bare (eroding) soil – a visible source of phosphorus input to the lake. A grass-covered mowed lawn leading down to a rip-rapped shoreline or beach would receive a rating of 4 – but, only if there was no evidence of bare soil, in which case a rating of 5 would be assigned.

In addition to the impact rating, project staff did a house structure tally as well as estimated the residency status of the dwelling (seasonal vs. year-round), the distance of the dwelling to the lake, the percent slope of the lot, the presence or lack of vegetated buffers, presence of bare soils, existing rip-rap, and other notable features such as retaining walls or boat launches. A similar rating system for vegetated buffer status was established. A summary of the findings of the shoreline survey on Pleasant Pond appears below.

**Table 3: Results of the 2001 Pleasant Pond Shoreline Survey**

| NPS Pollution Potential Severity Score | Impact rating characterized by one or more of the following: | Number of shoreline sites identified within each category | % of sites within each category |
|---|---|---|---|
| 1 = low impact | All natural vegetated buffer; good setback from lake | 39 | 23% |
| 2 | Good natural vegetation; good setback from lake | 21 | 13% |
| 3 = moderate impact | Lack of adequate buffer; close to lake | 25 | 15% |
| 4 | Lack of buffer; steep slopes; close to lake | 45 | 27% |
| 5 = high impact | Lack of buffer; steep slopes; close to lake; bare soils | 36 | 22% |

Overall, more than one-half of the developed shoreline lots on Pleasant Pond have a moderate to high impact due to inadequate or nonexistent vegetative buffers and/or moderate to severe soil erosion. Along the 9-mile long shoreline, there were an estimated 70 linear feet of shoreline considered moderately to severely eroded, suggesting that inadequate wooded shoreline buffers contribute most to the high number of sites categorized as moderate to severe (i.e., 3 to 5 rank) nonpoint source phosphorus contributors.

Of the 166 dwellings, 69 are year-round residences and 97 are seasonal. The more developed lower basin has 147 dwellings (61 year-round, 86 seasonal); and the smaller upper basin has a total of 19 dwellings (8 year-round, 11 seasonal).

To estimate the phosphorus load to Pleasant Pond derived from shoreline dwellings, the shoreline survey data were condensed into three categories - low, medium and high impact, and each lot was subjectively assigned a phosphorus export coefficient corresponding to a residential lot with clearing limits of 10,000 square feet and situated on HSG-C soils as presented in **PHOSPHORUS CONTROL IN LAKE WATERSHEDS:** *A Technical Guide to Evaluating New Development* (Maine DEP 1992). These values were then subjected to buffer treatment factors based on whether they were high, medium, or low impact lots.

Seasonal and year-round camp and home lots on Pleasant Pond comprise less than 1% of the land area and an average of 24 kg of total phosphorus annually, which approximates 1.9% of the estimated total phosphorus load.

**Shoreline Septic Systems:** It is important to consider the potential for phosphorus loading from malfunctioning septic systems around the immediate shoreline of Pleasant Pond. Export coefficients were taken from Dennis and McPhedran (1991), and applied to this recent shoreline survey. These include an estimate of 2.7 persons per household and export coefficients of 0.05 and 0.15 kg of phosphorus per capita for seasonal and year-round residences, respectively.

Estimates of the loading from residential septic systems on Pleasant Pond is 41 kg TP annually, approximating 3.3% of the total watershed phosphorus load.

*View of Peacock Beach State Park from the footbridge.*

**Recreational (Shoreline):** Included in this category is Peacock Beach State Park which has approximately 3,000 visitors a year. The park area consists of a picnic and swim area and parking lot, approximately 7 acres (Steve Curtis, Maine BPL, personal communication). A commercial campground located in Gardiner is not included in this shoreline analysis since the actual campsites are located 400 yards from the water's edge . Estimates of loading from recreational (shoreline) development on Pleasant Pond approximates an average TP export of 0.3% or about 4 kg of TP annually.

**Private/Camp Roadways:** There is a network of 49 private/camp roads that provide access to Pleasant Pond. Actual camp and private road widths were measured by CWD project staff and road lengths were determined by Kennebec County SWCD using GIS. The average road width for private roads is 16.8 ft and there are roughly 14 miles of camp roads within the watershed. Multiplying the average width by length, camp roads cover 30.5 acres in the watershed. Overall, camp roads contribute an estimated 25 kg of TP to the total phosphorus load to Pleasant Pond. Total phosphorus loading from private camp roads comprises only 0.2% of the land area and approximates 2% of the total watershed TP export annually (Table 2).

**Shoreline Development Summary:** Overall, shoreline development comprises 0.5% of the total watershed area and contributes an average of 94 kg of total phosphorus annually which approximates 8% of the estimated phosphorus load (Table 3) to Pleasant Pond.

## Other Development and Land Uses

**Non-Shoreline Development** consists of all lands outside the immediate shoreline area of Pleasant Pond, including state and town roadways, residential areas and other land uses, such as commercial, institutional (public) areas, parks/cemeteries and gravel pits. These land use areas

were calculated using GIS land use coverage provided by the Maine DEP as well as aerial photos, CWD files and field visits (ground-truthing).

**Public Roadways** are divided into two categories - state public highway and town public roadway. There are approximately 32 miles of state highway, which includes the Maine Turnpike (I-495) and US Route 201, and 24 miles of town roadways. The average road width for the turnpike is 82' and 41' and 22' for state and town roads, respectively. There are 239 acres of state roadways and 62 acres of town roads within the watershed. Public roadways account for a much greater percentage of the phosphorus load (15%) versus its land area (2%) in the Pleasant Pond watershed (Table 2).

**Non-Shoreline Residential Areas** in the watershed contribute 92 kg or approximately 7% of the total phosphorus load to Pleasant Pond. Phosphorus loading coefficients were developed using information on residential lot stormwater export of algal available phosphorus (Dennis et al. 1992).

**Other Land Uses** include several cemeteries, public areas, and a few commercial enterprises. The total phosphorus loading of these other uses is 22 kg or about 2% of the total phosphorus loading to Pleasant Pond.

Overall, non-shoreline development accounts for 5% of the total land area and contributes 27% of the total phosphorus load to Pleasant Pond.

## Phosphorus Loading from Non-Developed Lands and Surface Water

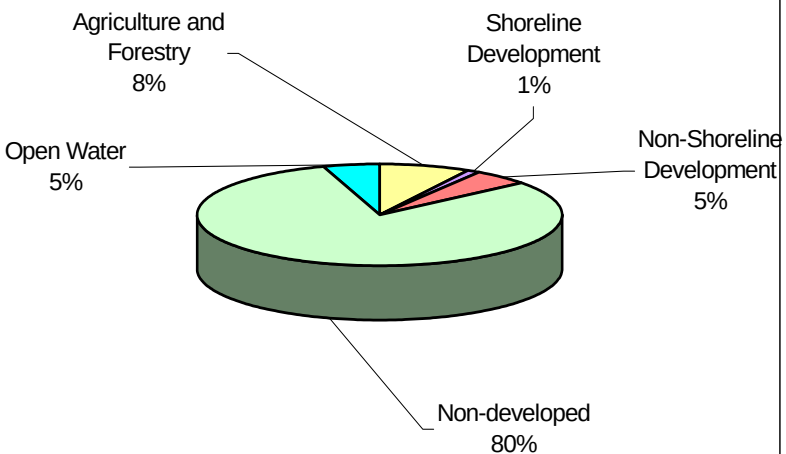
**Inactive/Passively Managed Forests:** Of the total land area within the Pleasant Pond watershed, 63% (9,642 acres) is forested. About 12.5% of the phosphorus load is estimated to be derived from non-commercial forested areas within the Pleasant Pond direct drainage area (Table 2).

**Other Non-Developed Land Areas** include wetlands, grassland/reverting fields and old field scrub shrub to account for the remaining 17% of the land area and about 10% of the non-developed total phosphorus export load to Pleasant Pond.

**Atmospheric Deposition (Open Water):** Surface waters (749 acres) comprise 5% of the total watershed area (15,340 acres), contribute 48 kg TP/yr and represent 4% of the total phosphorus load entering Pleasant Pond.

**Figure 2** (right) depicts the percentage of total land area covered by each land use category.

***Figure 2: Total Land Area - Pleasant Pond Watershed***



## PHOSPHORUS LOADS – Watershed, Sediment and In-Lake Capacity

Supporting documentation for the phosphorus loading analysis for Pleasant Pond include the following: water quality monitoring data from Cobbossee Watershed District, Maine DEP and the Volunteer Lake Monitoring Program, and the development of a phosphorus retention model (see TMDL report Appendices for detailed information).

- Total phosphorus loadings to Pleasant Pond originate from a combination of external (watershed) and internal (pond sediment) sources. External (direct) watershed TP sources approximating 1,245 kg have been identified and accounted for by land use (Table 2).

- The relative contribution of internal sources of total phosphorus within Pleasant Pond - in terms of pond sediment total phosphorus recycling - approximate 86 kg (2001 phosphorus profile monitoring data, CWD).

- The load allocation (lake assimilative capacity) for all existing and future non-point pollution sources for Pleasant Pond is 727 kg of total phosphorus per year, based on a target goal of 15 ppb.

- A change of 1 ppb in phosphorus concentration in Pleasant Pond is equivalent to 50 kg and the difference between the target goal of 15 ppb and the measured average annual epilimnetic phosphorus concentration (21 ppb) is 6 ppb (6 x 50), equivalent to 300 kg.

- Given a 25 kg allocation for future development (0.5 x 50), the total amount of phosphorus needed to be reduced to attain suitable water quality in Pleasant Pond is about 325 kg.

# PLEASANT (Mud) POND

## PHOSPHORUS CONTROL ACTION PLAN

### Recent and Current NPS/BMP Efforts

Since the 1970's, Pleasant Pond has had a consistent and well-documented history of supporting nuisance algal blooms. The earliest watershed survey conducted for Pleasant Pond was a land use study conducted by the Cobbossee Watershed District (CWD) and the Southern Kennebec Valley Regional Planning Commission (SKVRPC) in 1974 (SKVRPC 1976; Sage and Moran 1977). This study was part of a regional watershed-wide effort to address the major lakes and ponds of the Cobbossee Stream drainage that were displaying signs of eutrophication.

As part of a water quality management plan for Southern Kennebec Valley region, CWD conducted a land use/water quality study of Pleasant Pond in 1974 to determine phosphorus sources to the pond and strategies for phosphorus reduction (Sage and Moran, 1977). The study revealed that nonpoint sources of phosphorus from primarily agricultural based (e.g., manured fields/pasture), sources must be reduced by approximately 50 percent in order to achieve water quality goals.

In 1977, CWD was awarded a Clean Lakes Program grant to support lake restoration efforts, with implementation to begin in 1978. The program included a nutrient inactivation (i.e., alum) treatment in upstream Annabessacook Lake to reduce the internal phosphorus recycling in the lake and to reduce phosphorus export from agricultural lands throughout the watersheds of Annabessacook and Cobbossee lakes and Pleasant Pond, primarily by way of improved animal waste management.

In 1999, CWD was awarded a Section 319 Nonpoint Source Pollution Grant (#ME-2000-09). The purpose of the project, conducted in cooperation with the Kennebec County Soil and Water Conservation District (SWCD) and the Four Towns Watershed Association (FTWA), was to conduct a survey of road and agricultural related sources of phosphorus, develop recommendations for phosphorus mitigation and outline strategies for implementation.

The road portion of the Section 319 watershed survey targeted camp roads around the perimeter of the pond and the town and state roads in the immediate vicinity of the pond. Camp roads were surveyed by trained volunteers of the FTWA, while the improved state and town roads were surveyed by CWD and Kennebec County SWCD staff. Forty-nine camp roads in the immediate vicinity of Pleasant Pond were surveyed and results were tallied and photo-documented. Of the 49 camp roads, 11 were found to be free of NPS-related problems; 10 were considered to be of high NPS priority; 16 were medium; and 12 were of low priority. Common problems included erosion of the road surface, insufficient road crown, and presence of shoulder berms. Staff from CWD and Kennebec County SWCD conducted follow-up visits to the roads to develop recommendations for mitigation. Common recommendations included road crowning, removal of shoulder berms, and armoring of culvert inlets/outlets. Landowners were encouraged to contact

CWD for site-specific recommendations. Results of the survey can be viewed on the FTWA website, www.FTWA.org.

In the summer 2002, CWD began a coordinated effort with the newly formed non-profit organization, Friends of the Cobbossee Watershed (*Friends*), to expand current education and outreach to lakeshore owners and boaters. The *Friends'* mission is to support programs and projects offered by CWD and related lake associations within the Cobbossee watershed, as well as to promote public awareness and educate about water quality issues. In 2002 the *Friends* launched the E/V (education vessel) Otter on several of the lakes of the Cobbossee watershed, including Pleasant Pond, to disseminate lake education material and to educate citizens about vegetated buffers, proper camp road maintenance and erosion control. In its first season working with the *Friends*, AmeriCorps completed one rip-rap job on Pleasant Pond during the summer of 2003. The *Friends* plan to continue to facilitate this type of conservation work within the Cobbossee watershed, which includes Pleasant Pond, in future years.

In the fall/winter of 2003-2004, as a result of a collaborative effort between a local farmer, the Four Towns Watershed Association, the CWD, the *Friends* and the NRCS, an upgrade (new roof and sides) to a manure storage pit was completed, helping to effectively reduce the amount of phosphorus run-off from this agricultural site.

## Recommendations for Future Work

Pleasant Pond is a waterbody that has impaired water quality due mostly to nonpoint source (NPS) pollution and the resultant accumulation and internal sediment recycling of phosphorus. Specific recommendations regarding recent and current efforts in the watershed, Best Management Practices (BMPs), and actions to reduce external watershed total phosphorus loadings in order to improve water quality conditions in Pleasant Pond are as follows:

**Watershed Management:** There are many active agencies/organizations involved with the protection and restoration of Pleasant Pond's water quality. The Cobbossee Watershed District (CWD) has been involved with water quality monitoring as well as documenting and mitigating nonpoint source (NPS) pollution sites throughout the Pleasant Pond watershed. The Four Towns Watershed Association has also taken an active role with documenting and mitigating NPS pollution in conjunction with the Kennebec County SWCD. The *Friends* has recently taken efforts to facilitate implementation of BMPs and has begun other education and outreach efforts in order to reduce/eliminate NPS pollution in the Pleasant Pond watershed. With so many active organizations, it is important to communicate and inform all interested stakeholders about current water quality issues and future watershed management actions.

| **Action Item # 1: Coordinate Existing Watershed Management Efforts** | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Develop a Pleasant Pond Leadership Team | FTWA, CWD, *Friends*, KC-SWCD, MDEP, municipalities, local business, watershed citizens | Annual Roundtable Meetings beginning in 2004—**minimal cost** |

**Shoreline Residential** areas have the potential to negatively impact the water quality of Pleasant Pond. The 2001 shoreline survey conducted by CWD found that nearly half of all of the residential shoreline lots have inadequate or nonexistent vegetative buffers, which are necessary to decrease and slow run-off from shore land sites.

An increased effort should be undertaken to encourage landowners to establish adequate and effective vegetated buffers along the shoreline of Pleasant Pond. The availability of free technical assistance by CWD, KC-SWCD, and Maine DEP, as well as free labor provided by the *Friends* Americorps, should be well-publicized to all shoreline landowners.

| **Action Item # 2: Expand Buffer Awareness Campaign** | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Expand Buffer Awareness and Planting Campaign | FTWA, *Friends*, CWD, municipalities, KC-SWCD, local nurseries, watershed citizens | Immediately—cost varies |

**Shoreline Septic Systems** – Antiquated and/or poorly designed and installed septic systems within the shoreland zone may contribute to the annual total phosphorus load to adjacent lake water, adding to the cumulative phosphorus load to Pleasant Pond. While most septic systems – when properly sited, constructed, maintained, and set back from the water – should have a minimal effect on lake water quality, systems that do not meet all of these criteria have the potential to contribute phosphorus and other contaminants to lake water. Systems around Pleasant Pond which are sited in coarse, sandy soils with minimal filtering capacity, and which are situated in zones where groundwater in-seepage is significant, are especially likely to contribute nutrients to lake waters. This is particularly true for old systems which pre-date Maine's 1974 Plumbing Code.

Available options for reducing septic system-related phosphorus loading to Pleasant Pond include seeking the replacement of pre-plumbing code septic systems and other poorly functioning systems within the shoreland zone of Pleasant Pond. Identification of potential problem systems can be accomplished through a combination of shorefront property owner questionnaire surveys and/or formal sanitary surveys (e.g., dye testing). Educational efforts should make residents aware of impending problems and possible cost-effective solutions.

| **Action Item # 3: Promote Public Education About Septic System Impacts** | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Distribute Educational Materials for shoreline residents re: septic systems and water quality | FTWA, *Friends*, CWD, Maine DEP, KC-SWCD, municipalities, shoreline residents | Beginning in 2004—**$1,500** |

**Roadways:** Generally, camp roads are poorly designed and not maintained properly and can be a major source of erosion and sedimentation to lakes. There has been substantial information gathered regarding the condition and potential NPS influence of the roadways in the watershed of

Pleasant Pond, particularly in close proximity to the pond itself. The majority of this information was gathered as part of the Pleasant Pond watershed survey project.

Much of the information regarding camp road problems and recommendations has been made available to the camp road owners, especially through the posting of results and specific camp road information on the Four Towns Watershed Association web site (www.ftwa.org), as well as through individual site visits by CWD upon request by road owners. It is anticipated that the concern for pond protection and desire on the part of camp road owners to improve their respective roads will continue. For a free copy of the Camp Road Maintenance Manual or for free technical assistance about proper camp road maintenance and/or potential cost-share funds, contact CWD in Winthrop (377-2234), Kennebec County SWCD in Augusta (622-7847 x 3) or the Maine DEP in Augusta (287-2111).

State and Town roads also were determined to contribute NPS pollution to Pleasant Pond. Two town roads and one state road (Route 201/Rte.197 intersection) were deemed to represent high priority sites. The MDOT Division 5 and Maine Department of Transportation Office of Environmental Services staff were consulted in fall of 2000. Some work has been done, but more work needs to be encouraged in order to address these problems. The municipalities of the Pleasant Pond watershed, Litchfield in particular, have cooperated with the CWD in the past on town road-related problems as they become apparent. The CWD will continue to seek municipal cooperation when erosion or drainage related problems arise on town roads in the watershed**.**

In general**,** the CWD has, and will, continue to make available to local camp road associations and member municipalities, technical advice on proper road design and maintenance. Provided recommendations generally include the installation of typical roadside BMPs such as reshaping of ditches, culvert maintenance, proper crowning of roads, and installing plunge pools and turnouts.

| **Action Item # 4: Implement Roadway Best Management Practices** | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Continue to Implement Roadside BMPs watershed-wide | CWD, FTWA, KC-SWCD, Maine DEP, watershed municipalities and road associations | Annually beginning in 2004 **$10,000/yr** |

**Agriculture** – Since the late 1970's the CWD, the USDA Natural Resources Conservation Service (NRCS) and the Kennebec County SWCD have worked cooperatively to educate farmers about the relation between agricultural practices and water quality and to install agricultural conservation practices in the watershed. Based on the most recent agricultural land use assessment, the following recommendations were made: The CWD should notify the NRCS of the need for assessment and/or technical assistance regarding overgrazed pastureland and manure management. Other recommendations include: continued modification/retrofitting of outdated manure pits and adherence to a cleanout schedule; installation of fencing to prevent access by

cows to tributaries to Pleasant Pond. Additional recommendations will be developed after further farm-specific information is gathered by CWD.

| Action Item # 5: Continue to work with Watershed Farmers | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Continue to encourage watershed farmers to use of phosphorus control measures | CWD, KC-SWCD, NRCS, FTWA, and agriculture community | Annually beginning in 2003 **$1,000/yr** |

**Forestry:** Landowners, loggers and foresters working within the Pleasant Pond watershed should contact the Maine Forest Service (1-800-367-0223) for a copy of Forestry BMP guidelines and other forest management assistance. Special attention should be given to forest access roads and proper erosion control measures should be utilized.

**All Watershed Residents and Commercial** areas must be considered as potential problem areas, especially areas near watershed brooks and streams. The CWD has for years offered technical assistance to the planning boards of District towns regarding the review of proposed subdivisions and commercial uses. Little need has arisen in recent years in the City of Gardiner and/or Town of Richmond to scrutinize new development with respect to phosphorus export to the pond. Of the three District towns in the Pleasant Pond watershed, the CWD has been called on most frequently by Litchfield to review phosphorus control plans as required by the town's planning board. The low frequency of technical review is reflected in the few subdivisions and commercial operations in the watershed - the CWD is poised, however, to provide technical oversight to support local planning board review of these projects.

All Pleasant Pond watershed residents should be encouraged through continued education and outreach efforts, including: use of non-phosphate cleaning detergents, establishing or maintaining vegetated buffer strips down-gradient of developed areas, changing lawn practices to include the use of phosphorus-free fertilizer, proper maintenance of septic systems, and practicing proper erosion control during any construction activities, however minor.

The educational campaign conducted by CWD and *Friends* (see above) should be expanded to include a watershed-wide outreach program as all residents within the watershed will benefit from improved water quality in Pleasant Pond.

| Action Item # 6: Expand Homeowner Education & Technical Assistance Programs | | |
|---|---|---|
| **Activity** | **Participants** | **Schedule & Cost** |
| Increase outreach and education efforts to **ALL** watershed citizens and businesses including technical assistance to landowners | FTWA, *Friends*, KC-SWCD, CWD, Maine DEP, watershed residents and businesses | Annually beginning in 2004 **$1,500/yr includes printing of educational materials** |

**Municipal Action:** Should include ensuring public compliance with local and state water quality laws and ordinances (Shoreland Zoning, Erosion and Sedimentation Control Law, plumbing code) through education and enforcement action, when necessary.

**In-Lake Nutrient Inactivation**: Phosphorus release from Pleasant Pond sediments during brief periods of thermal stratification and low dissolved oxygen in lake bottom waters appear to be substantial on a relative basis. Phosphorus release from anoxic sediments in Pleasant Pond is also likely to be contributing. The 86 kg of TP presumably released from Pleasant Pond sediments during the summer of 2001 resulted in a near two-fold increase in the in-lake total phosphorus.

Applying aluminum compounds to Pleasant Pond sediments in an effort to reduce the internal release of phosphorus during periods of anoxia may offer some reduction in the internal loading component, but the physical and hydrological characteristics of the pond all but eliminate its candidacy for this technique. Successful treatment of shallow, polymictic lakes has been thought to be unlikely (Cooke et al. 1986), although some success stories do exist. Longevity of the success of nutrient inactivation in shallow lakes is uncertain. In any event, a nutrient inactivation treatment would be an unwise approach to eliminating algae blooms in Pleasant Pond until significant progress has been made in reducing the external loading of phosphorus from the direct watershed.

## WATER QUALITY MONITORING PLAN

Historically, the water quality of Pleasant Pond has been monitored intensively since 1976 during open water months via measures of Secchi disk transparencies (CWD-VLMP). The monitoring program has been augmented through the effort of local volunteers who provide frequent Secchi disk transparency data (CWD-VLMP). Continued long-term water quality monitoring of Pleasant Pond will be conducted from May to October through the routine efforts of the CWD. Under this planned, post-TMDL water quality-monitoring scenario, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in Pleasant Pond water quality. A post-TMDL adaptive management status report will be prepared five to ten years following EPA approval.

## PLEASANT POND PCAP CLOSING STATEMENT

The Cobbossee Watershed District (CWD) has worked diligently since the early to mid-1970's addressing nonpoint source pollution in the watershed of Pleasant Pond and associated upstream lakes. The CWD partnered with the recently formed Four Towns Watershed Association to assess and correct NPS pollution problems in the Pleasant Pond watershed. Technical assistance by CWD is available to all District towns to mitigate phosphorus export from existing NPS pollution sources and to prevent excess loading from future sources through the CWD's technical advice to local planning boards. CWD Towns, including Litchfield, Richmond, and the City of Gardiner have long recognized the value of their water resources and its link to the local way of life in the respective communities as well as the local economies by providing strong support to lake restoration and protection efforts. These towns should be commended for their continued support of and cooperation with CWD in the pursuit of regional lake protection and improvement.

Since 2002, CWD has worked closely with the newly-formed Friends of the Cobbossee Watershed - a watershed made up of 28 waterbodies, of which Pleasant Pond is one. This regional watershed group is taking an aggressive and innovative approach to water quality education and outreach which includes a newsletter, a web site, an *Education Vessel*, educational workshops for kids and a conservation corps. The CWD also works closely with the Natural Resources Conservation Service to collaboratively address agriculturally-based nutrient loading. The Kennebec County SWCD regularly joins forces with the CWD and NRCS to identify NPS sites and develop effective mitigation strategies.

This teamwork approach by regional and local groups, in conjunction with the continued water quality protection efforts of CWD, lends a high probability that NPS awareness and NPS-BMP implementation within the watershed will increase, helping to improve Pleasant Pond's water quality over time.

# APPENDICES

## PLEASANT (Mud) POND

### Total Maximum Daily (Annual Phosphorus) Load

## Introduction to Maine Lake TMDLs and Phosphorus Control Action Plans (PCAPs)

**You may be wondering** what the acronym 'TMDL' represents and what it is all about. TMDL is actually short for 'Total Maximum Daily Load.' This information, no doubt, does little to clarify TMDL's in most people's minds. However, when we think of this as an annual phosphorus load (*Annual Total Phosphorus Load),* it begins to make more sense.

**Simply stated**, excess nutrients or phosphorus in lakes promote nuisance algae growth/blooms - resulting in the violation of water quality standards as measured by water clarity depths of less than 2 meters. A lake TMDL is prepared to estimate the total amount of total phosphorus that a lake can accept on an annual basis without harming water quality. Historically, development of TMDLs was first mandated by the Clean Water Act in 1972, and was applied primarily to *point sources* of water pollution. As a result of public pressure to further clean up water bodies, lake and stream TMDLs are now being prepared for watershed-generated *Non-Point Sources* (NPS) of pollution.

**Nutrient enrichment of lakes** through excess total phosphorus originating from watershed soil erosion has been generally recognized as the primary source of NPS pollution. Major land use activities contributing to the external phosphorus load in lakes include residential-commercial developments, roadways, agriculture, and commercial forestry. Statewide, there are 32 lakes in Maine which do not meet water quality standards due to excessive amounts of in-lake total phosphorus—the great majority of which are located in south-central Maine (Kennebec County).

**The first Maine lake TMDL** was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and US-EPA. TMDLs have also been approved by US-EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered Ponds (Kennebec County), and Mousam and Highland lakes in southern Maine. PCAP-TMDLs are presently being prepared by Maine DEP, with assistance from the Maine Association of Conservation Districts (MACD) and County Soil and Water Conservation Districts (SWCDs) - for Pleasant Pond and Annabessacook Lake (under contract with CWD), Sabattus, Unity, and Toothaker ponds, and Highland Lake (Bridgton - with assistance from Lakes Environmental Association). PCAP-TMDL studies have also been initiated for Togus and Lovejoy ponds, Little Cobbossee Lake and Upper Narrows Pond (under contract with CWD) and Long Lake (Bridgton - with assistance from LEA). Duckpuddle and Lily ponds in Knox-Lincoln County SWCD will be studied next, along with Herman and Hammond ponds, and the remaining seven 303(d) listed PCAP-TMDL waterbodies in Aroostook County.

**Lake PCAP-TMDL reports** are based in part on available water quality data, including seasonal measures of total phosphorus, chlorophyll-a, Secchi disk transparencies, and dissolved oxygen-water temperature profiles. Actual reports include: a lake description; watershed GIS assessment and estimation of NPS pollutant sources; selection of a total phosphorus target goal (acceptable amount); allocation of watershed/land-use phosphorus loadings, and a public participation component to allow for stakeholder review.

**PCAP-TMDLs are important tools** for maintaining and protecting acceptable lake water quality and are designed to 'get a handle' on the magnitude of the NPS pollution problem and to develop plans for implementing Best Management Practices (BMPs) to effectively address the lake's water pollution problem. Landowners and watershed groups are eligible to receive technical and financial assistance from state and federal natural resource agencies to reduce watershed total phosphorus loadings to the lake. **Note:** for non-stormwater regulated lake watersheds, the *development of phosphorus-based lake PCAP-TMDLs are not generally intended by Maine DEP to be used for regulatory purposes*.

For further information, contact Dave Halliwell, Maine Department of Environmental Protection, Lakes PCAP-TMDL Program Manager, SHS #17, Augusta, ME 04333 (287-7649).

**Water Quality Monitoring:** (Source: CWD) Water quality data for Pleasant Pond has been collected annually since 1973, primarily on a monthly basis during ice-free conditions (May – Oct) at the deeper, northern (lower) basin. This water quality assessment is based on 26 years of Secchi disk transparency (SDT) measures, combined with 22 years of epilimnion core total phosphorus (TP) and 17 years of chlorophyll-a monitoring data, and associated water chemistry monitoring data.

**Water Quality Measures:** (Source: CWD and VLMP 2002) Pleasant Pond, a lightly colored lake (29 CPU apparent color), has a historical range of SDT measures from 1.3 to 5.7 meters, with an average of 3.3 m, an epilimnion core TP range of 15 to 28 (100 ppb in 1982) with an average of 26 parts per billion (ppb), and chlorophyll-a measures ranging from 1.3 to 32.1, with an average of 9.7 ppb. Recent dissolved oxygen (DO) profiles indicate low levels of DO in deep areas of the lake. Late summer dissolved oxygen levels in 2001 remained fairly low (0-3 ppm) with up to 50% of the water column (lower 5 meters — deep hole) unsuitable for salmonid species (e.g., brown trout). The potential for total phosphorus to leave the bottom sediments and become available to algae in the water column (internal loading) is high, since algal blooms have occurred routinely during the summer months for the past 20 years (Maine DEP 2002). Together, these data generally show a trend of increasing trophic state for Pleasant Pond, in violation of the Maine Class GPA water quality criteria requiring a stable or decreasing trophic state.

The water quality data for Pleasant Pond (2001) show that total phosphorus concentrations in the pond ranged from 14 ppb (June 25) to 26 ppb (September 5). During this period, the in-lake total phosphorus increased from 91 kg TP to 177 kg TP. The source of this increase (86 kg TP) is likely internal recycling from anoxic sediments, and possibly, and to a lesser degree, oxic sediments, as there was very little precipitation (2.74", CWD weather station, Winthrop) and, hence, runoff during the interim period (July - August). Dissolved oxygen began to decline at depth in late May, and gradually ascended to the 4 to 5 meter depth interval by late August. This upward migration of the anoxic boundary coincided with an increase in total phosphorus and chl-*a*, and a decline in transparency (SDT). On August 21, chl-*a* reached the maximum concentration of 31 ppb, which coincided with a SDT of 1.6 m. During the 2001 season, the mean volume-weighted total phosphorus concentration was 20 ppb, and chl-a averaged 11.8 ppb. Nuisance algae blooms were prevalent during the summers of 2001 and 2002 in Pleasant Pond.

**Priority Ranking, Pollutant of Concern and Algae Bloom History:** Pleasant Pond is listed on Maine's 1998 303(d) list of waters in non-attainment of Maine state water quality standards and was moved up in the priority development order due to stakeholder interest and need to complete an accelerated approach to lakes TMDL development. The Pleasant Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in freshwater lakes in Maine.

**Natural Environmental Background Levels** for Pleasant Pond were not separated from the total nonpoint source load because of the limited and general nature of available information. Without more and detailed site-specific information on nonpoint source loading, it is very difficult to separate natural background from the total nonpoint source load (US-EPA 1999). There are no known point sources of pollutants to Pleasant Pond.

## WATER QUALITY STANDARDS & TARGET GOALS

**Maine State Water Quality Standard** for nutrients which are narrative, are as follows *(July 1994 Maine Revised Statutes Title 38, Article 4-A*): "Great Ponds Class A (GPA) waters shall have a stable or decreasing trophic state (based on appropriate measures, e.g., total phosphorus, chlorophyll a, Secchi disk transparency) subject only to natural fluctuations, and be free of culturally induced algae blooms which impair their potential use and enjoyment."

Maine DEP's functional definition of nuisance algae blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<26 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Pleasant Pond is a lightly colored lake (average color 29 SPU), with an average SDT of 3.3 m (9.9 feet), in association with elevated average chlorophyll a levels of 9.7 ppb (1976 -2002). Pleasant Pond does not meet water quality standards due to annual summertime nuisance algae blooms, hence a continued trend of increasing trophic state. This water quality assessment uses historic documented conditions as the primary basis for comparison. Given the context of "impaired use and enjoyment," along with a realistic interpretation of Maine's goal-oriented Water Quality Standards (WQS), Maine DEP has determined that episodic, non-cyanobacteria based algae blooms (e.g. diatoms), limited to the fall or spring periods only, are in WQS attainment for GPA waters.

**Designated Uses and Antidegradation Policy:** Pleasant Pond is designated as a GPA (Great Pond Class A) water in the Maine DEP state water quality regulations. Designated uses for GPA waters in general include: water supply; primary/secondary contact recreation (swimming and fishing); hydro-electric power generation; navigation; and fish and wildlife habitat. No change of land use in the watershed of a Class GPA water body may, by itself or in combination with other activities, cause water quality degradation that would impair designated uses of downstream GPA waters or cause an increase in their trophic state. Maine's anti-degradation policy requires that "existing in-stream water uses, and the level of water quality necessary to sustain those uses, must be maintained and protected."

**Numeric Water Quality Target:** The water quality goal for Pleasant Pond is to halt its trend of increasing productivity, so that it meets the Maine DEP standard of stable or decreasing trophic state. To meet this goal, the numeric (in-lake) water quality target for Pleasant Pond is set at 15 ppb total phosphorus (727 kg TP/yr). Since numeric criteria for phosphorus do not exist in Maine's water quality regulations - and would be less accurate targets than those derived from this study - we employed best professional judgment to select a target in-lake total phosphorus concentration that would attain the narrative water quality standard. Spring-time (epilimnion core) phosphorus levels in Pleasant Pond averaged 15.1 ppb in 16 of the 25 years for which data was available, representative of non-bloom springtime baseline conditions. In direct contrast, the average annual epilimnetic phosphorus concentration (within the deep hole basin of Pleasant Pond) based on water quality data from 1998 to 2001, was calculated to be 21 ppb (Maine DEP 2004).

In summary, the numeric water quality goal of 15 ppb for total phosphorus in Pleasant Pond was based on available water quality data corresponding to non-bloom conditions, as reflected in suitable (water quality attainment) measures of both Secchi disk transparency (> 2.0 meters) and chlorophyll-a (< 8.0 ppb).

Notably, the development of the Pleasant Pond TMDL and selection of the numeric water quality target is protective of downstream uses in Cobbossee Stream, which also is water quality impaired and 303(d) listed. In that the water quality impairment to Cobbossee Stream is due primarily to pollutants (I.e. total phosphorus) from Pleasant Pond (Maine DEP 2004), then the in-lake target of 15 ppb will provide for the attainment and maintenance of the water quality standards in both waters. Hence, following approval of the Pleasant Pond PCAP-TMDL report, Cobbossee Stream may also be effectively off-ramped from the 303(d) list to category 4A (TMDL approved).

## ESTIMATED PHOSPHORUS EXPORT BY LAND USE CLASS

Table 4 (following page) details the numerical data used to determine external phosphorus loading for the Pleasant Pond watershed

## Table 4. PLEASANT Pond Direct Watershed - Phosphorus Export by Land Use Class

| LAND USE CLASS | Land Area Acres | Land Area % | TP Coeff. Range kg TP/ha | TP Coeff. Value kg TP/ha | Land Area Hectares | TP Export Load kg TP | TP Export Total % |
|---|---|---|---|---|---|---|---|
| **Agricultural and Forested Land** | | | **Pleasant** | **Pond** | | | |
| Hayland (Manured) | 482 | 3.1% | 0.65 - 1.81 | 1.24 | 195 | 241.9 | 19.4% |
| Low Intensity Hayland | 203 | 1.3% | 0.35 - 1.35 | 0.64 | 82 | 52.6 | 4.2% |
| Manure Storage | 0.60 | 0.0% | 21.0 - 795 | 224 | 0.24 | 53.8 | 4.3% |
| Pasture | 362 | 2.4% | 0.14 - 4.90 | 0.81 | 146 | 118.7 | 9.5% |
| Operated Forest Land | 114 | 0.7% | 0.20 - 0.60 | 0.40 | 46 | 18.5 | 1.5% |
| **Sub-Totals** | **1,161** | **8%** | **Pleasant** | **Pond** | **470** | **485** | **39%** |
| **Shoreline Development** | | | | | | | |
| Low Impact Residential | 9 | 0.1% | 0.25 - 1.75 | 1.24 | 4 | 4.5 | 0.4% |
| Medium Impact Residential | 11 | 0.1% | 0.40 - 2.20 | 1.50 | 4 | 6.7 | 0.5% |
| High Impact Residential | 19 | 0.1% | 0.56 - 2.70 | 1.66 | 8 | 12.8 | 1.0% |
| Residential Septic Systems | **Pleasant** | **Pond** | **Septic** | **Model** | | 41.0 | 3.3% |
| Camp and Private Roads | 31 | 0.2% | 0.60 - 10.0 | 2.00 | 13 | 25.1 | 2.0% |
| Recreational (State Park) | 7 | 0.0% | 0.25 - 1.75 | 1.50 | 3 | 4.2 | 0.3% |
| **Sub-Totals** | **77** | **0.5%** | **Pleasant** | **Pond** | **31** | **94** | **8%** |
| **Non-Shoreline Development** | | | | | | | |
| State Roads | 239 | 1.6% | 0.60 - 10.0 | 1.50 | 96.7 | 145.1 | 11.7% |
| Town Roads | 62 | 0.4% | 0.60 - 10.0 | 1.50 | 25.1 | 37.6 | 3.0% |
| Low Density Residential | 454 | 3.0% | 0.25 - 1.75 | 0.50 | 183.7 | 91.9 | 7.4% |
| Commercial | 4 | 0.0% | 0.80 - 4.20 | 1.50 | 1.6 | 2.4 | 0.2% |
| Institutional | 6 | 0.0% | 0.80 - 4.20 | 1.50 | 2.2 | 3.3 | 0.3% |
| Parks, Cemeteries | 50 | 0.3% | 0.25 - 0.98 | 0.80 | 20.2 | 16.2 | 1.3% |
| Exposed Earth | 110 | 0.7% | 0.25 - 1.75 | 0.98 | 45 | 43.6 | 3.5% |
| Gravel Pits | 109 | 0.7% | 0.00 - 0.00 | 0.00 | 44 | 0.0 | 0.0% |
| **Sub-Totals** | **1,034** | **5%** | **Pleasant** | **Pond** | **418** | **340** | **27%** |
| **Total: DEVELOPED LAND** | **2,272** | **15%** | **Pleasant** | **Pond** | **919** | **920** | **74%** |
| **Non-Developed Land** | | | | | | | |
| Inactive/Passively Managed Forest | 9,642 | 62.9% | 0.01 - 0.04 | 0.04 | 3902 | 156.1 | 12.5% |
| Wetlands | 722 | 4.7% | 0.00 - 0.05 | 0.02 | 292 | 5.8 | 0.5% |
| Scrub Shrub | 189 | 1.2% | 0.10 - 0.20 | 0.10 | 76 | 7.6 | 0.6% |
| Grassland/Reverting Fields | 1,766 | 11.5% | 0.10 - 0.20 | 0.15 | 714.7 | 107.2 | 8.6% |
| **Total: NON-DEVELOPED Land** | **12,319** | **80%** | **Pleasant** | **Pond** | **4,985** | **277** | **22%** |
| **Total: Surface Water (Atmospheric)** | **749** | **5%** | 0.11 - 0.21 | 0.16 | **303.1** | **48** | **4%** |
| **TOTAL: DIRECT WATERSHED** | **15,340** | **100%** | **Pleasant** | **Pond** | **6,208** | **1,245** | **100%** |

## Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the **Pleasant Pond** direct watershed are presented in Table 4 representing the extent of current external phosphorus loading to the lake.

Total phosphorus loading measures are provided as a range of values to reflect the degree of uncertainty generally associated with such relative estimates (Walker 2000). The watershed total phosphorus loadings were primarily determined using literature and locally-derived export coefficients as found in Schroeder (1979), Reckhow et al. (1980), Dennis (1986), Dennis et al. (1992), and Bouchard et al. (1995) for residential properties, roadways, agriculture and other types of land uses (e.g., recreational, commercial).

In some cases (primarily roadways and non-shoreline residential) selected phosphorus loading coefficients were reduced (from total P values) to account for the estimated bioavailability of the soil runoff sources according to available literature (Lee et al. 1980 and Sonzogni et al. 1982) and to better account for algal available-P export values as reflected in Dennis et al. (1992) - realizing that direct delivery of phosphorus to the lake is not occurring in many cases. These adjustments accounted not only for the readily available SRP (soluble-reactive-phosphorus) in the runoff, but also a substantial portion of the particulate inorganic component, particularly the P which is weakly adsorbed on the surface of soil particles (relative to discussion in Chapra 1997, pg. 524). **Note:** *These adjustments in P-load coefficients did not effectively alter the overall conclusions and final recommendations of the Pleasant Pond PCAP-TMDL report regarding identified needs and NPS/ BMP implementation plans for the Pleasant Pond watershed.*

**Agricultural and Forest Operational Lands:** Phosphorus loading coefficients as applied to agricultural land uses were adopted, in part, from Reckhow et. al. 1980: manured hayland 1.24 kg TP/ha, pasture 0.81 kg TP/ha; and Dennis and Sage 1981: low-intensity hayland 0.64 kg TP/ha; and from past Maine DEP 1982 studies. The phosphorus loading coefficient applied to operated forestlands (0.40 kg TP/ha) was derived (best estimate) from the original Cobbossee Lake TMDL report (Monagle 1995).

**Shoreline Residential Lots (House and Camp):** The range of phosphorus loading coefficients used (0.25 – 2.70 kg ha/yr) were developed using information on residential lot stormwater export of algal available phosphorus as derived from Dennis et al (1992) .

**Private Camp Roads:** The total phosphorus loading coefficient for private camp roads (2.00 kg/ha) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997), as well as best professional judgment (Jeff Dennis, Maine DEP).

## Non-Shoreline Development

**Residential:** Non-shoreline residential areas in the watershed are best characterized as low density residential - reflected in the 0.50 TP loading coefficient.

**Public Roadways:** Town and state roadways (301 ha) were assigned a total phosphorus loading rate of 1.50 kg per hectare per year. This coefficient was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997).

**Total Developed Lands Phosphorus Loading:** A total of 74% (919 kg) of the total phosphorus loading to Pleasant Pond is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: agriculture and forestry (39% - 470 kg); non-shoreline development (27% - 340 kg) and shoreline development (8% - 94 kg), which includes septic systems (3.3% - 41 kg) and camp/private roads (2% - 25 kg) – as depicted in Table 4.

**Non-Developed Lands Phosphorus Loading:** The phosphorus export coefficient for forested land (0.04) is based on a New England regional study (Likens et al 1977). The lower total phosphorus loading coefficient chosen for atmospheric deposition (0.16 kg TP/ha) is similar to that used for the China Lake TMDL (Kennebec County), while the upper range (0.21 kg TP/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980). Other Non-Cultural Land Uses: Combined wetlands, reverting fields and old field scrub shrub account for the remaining 9.5% (121 kg) of the total non-cultural or non-developed land total phosphorus export load of 277 kg (Table 4).

**Atmospheric Deposition (Open Water):** Pleasant Pond surface waters (303 ha) comprise 5% of the total watershed area (15,340 ha) and account for an estimated 48 kg of total phosphorus, representing 4% of the total phosphorus load entering Pleasant Pond.

## Phosphorus Load Summary

It is our professional opinion that the selected export coefficients are appropriate for the Pleasant Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external (watershed generated) nonpoint source pollution approximates 1,245 kg TP/yr. This annual external watershed generated loading to Pleasant Pond closely equates to a total phosphorus loading modeled at 26 ppb (1,260 kg TP) - approximately 533 kg above the TMDL target goal of 15 ppb (727 kg TP/year). Internal (pond bottom sediments = 86 kg) sources of phosphorus are additional contributors to the existing nonpoint pollution related water quality problem in Pleasant Pond.

## LINKING WATER QUALITY and POLLUTANT SOURCES

**Assimilative Loading Capacity:** The Pleasant Pond TMDL is expressed as an annual load as opposed to a daily load. As specified in 40 C.F.R. 130.2(i), TMDLs may be expressed in terms of either mass per unit time, toxicity, or other appropriate measures. Although Pleasant Pond has a moderate flushing rate of 5.6 flushes/yr, (almost four times the average flushing rate for Maine lakes = 1.50), we believe it is appropriate and justifiable to express the Pleasant Pond TMDL as an annual load.

The Pleasant Pond basin lake assimilative capacity is capped at 727 kg TP/yr, as derived from the empirical phosphorus retention model based on a target goal of 15 ppb. This value reflects the modeled annual phosphorus loading responsible for current trophic state conditions, based on a long term goal of maintaining average phosphorus concentrations at or below 15 ppb.

**Future Development:** The Maine DEP water quality goal of maintaining a stable trophic state includes a reduction of current P-loading which accounts for both recent P-loading as well as potential future development in the watershed. The methods used by Maine DEP to estimate future growth (Dennis et al. 1992) are inherently conservative, as they provide for relatively high-end regional growth estimates and largely non-mitigated P-export from new development. This provides an additional non-quantified margin of safety to ensure the attainment of state water quality goals. Previously unaccounted P-loading from anticipated future development in the Pleasant Pond watershed approximates 25 kg annually (1 ppb change in trophic state = 49 kg; Future development = 0.5 x 1 ppb change in trophic state).

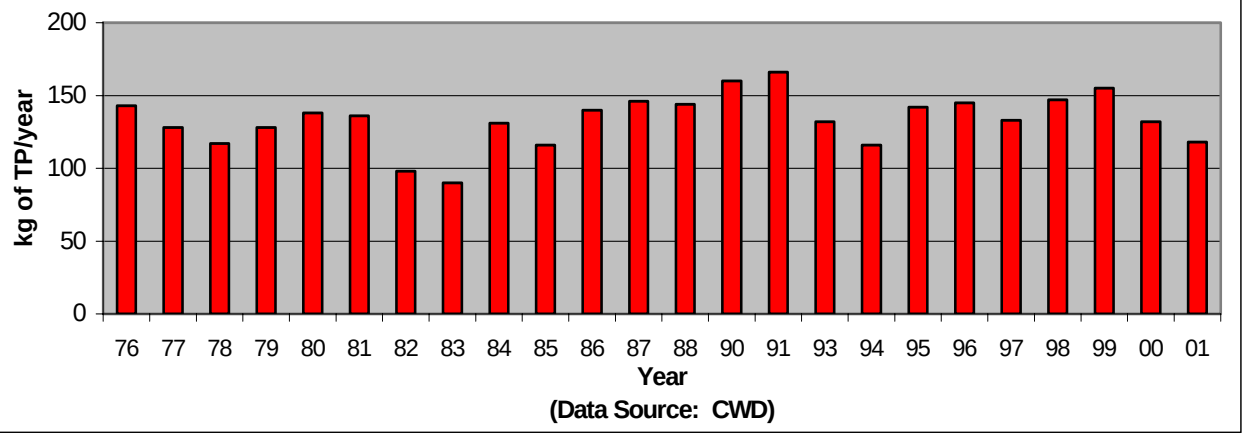
Undoubtedly, human growth will continue to occur in the Pleasant Pond watershed, contributing new sources of phosphorus to the lake. Hence, existing phosphorus source loads must be significantly reduced to allow for anticipated new sources of phosphorus to Pleasant Pond.

Overall, the presence of nuisance algae blooms in Pleasant Pond may be reduced, along with halting the trend of increasing trophic state, if the existing combined phosphorus loading is reduced by approximately 325kg TP. Reductions already underway in nonpoint source total phosphorus

loadings are expected from the continued implementation of best management practices - primarily from improvements to roadways and residential shoreline vegetative buffer plantings and updating agricultural BMPs (see NPS/BMP Implementation Plan and PCAP Summary).

**Internal Lake Sediment Phosphorus Mass:** The relative contribution of internal sources of total phosphorus within Pleasant Pond - in terms of sediment TP recycling - were analyzed (using lake volume-weighted mass differences between late spring and late summer/early fall) and estimated on the basis of water column TP data from 2001. During the summer of 2001, in-lake total phosphorus increased from 91 kg (June 25) to 177 kg (September 5). It is assumed that this increase (86 kg P) is attributed primarily to internal loading as July and August of 2001 were exceedingly dry. The combined internal (86 kg/TP/yr) and empirically modeled external total phosphorus loads to Pleasant Pond approximate 1,331 kg annually. Based on the 6 ppb difference between the 15 ppb target goal and the 21 ppb average annual epilimnetic P-concentration (300 kg), and inclusive of 25 kg allocation for future development, approximately 325 kg TP needs to be reduced to maintain suitable water quality standards. This reduction in total phosphorus loading may be achieved over time given decreased watershed load, which in turn, may lead to a reduction in the internal loading component through the continued annual flushing of Pleasant Pond.

**Figure 3: Pleasant (Mud) Pond Internal Load Sediment TP**




**(Data Source: CWD)**

**Linking Pollutant Loading to a Numeric Target:** The basin loading assimilative capacity for Pleasant Pond was set at 727 kg/yr of total phosphorus to meet the numeric water quality target of 15 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to numeric target.

**Supporting Documentation for the Pleasant Pond TMDL Analysis** includes the following: CWD and VLMP water quality monitoring data, and specification of a phosphorus retention model – including both empirical models and retention coefficients.

**Total Phosphorus Retention Model** (after Dillon and Rigler 1974 and others)

**L = P (A z p) / (1-R)** where,

**727** = **L** = external total phosphorus load capacity (kg TP/year)
15.0 = **P** = spring overturn total phosphorus concentration (ppb)
3.03 = **A** = lake basin surface area ($km^2$)
2.0 = **z** = mean depth of lake basin (m) **A z p = 33.94**
5.60 = **p** = annual flushing rate (flushes/year)
0.7 = **1- R** = phosphorus retention coefficient, where:
0.3 = **R = 1 / (1+ sq.rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenwieder (Dillon and Rigler 1974) type empirical model for Maine lakes, e.g., Cobbossee, Madawaska, Sebasticook, East Pond, China Lake, Webber, Threemile and Threecornered ponds, Mousam, and Highland lake TMDLs (Maine DEP 2000-2003) have shown this approach to be effective in linking watershed total phosphorus (external) loadings to existing in-lake total phosphorus concentrations.

**Strengths and Weaknesses in the Overall TMDL Analytical Process:** The Pleasant Pond TMDL was developed using existing lake water quality monitoring data, derived watershed export coefficients (Reckhow et al. 1980, Maine DEP 1981 and 1989, Dennis 1986, Dennis and McPhedran 1991, Dennis et al. 1992, Bouchard et al. 1995, Soranno et al. 1996, and Mattson and Isaac 1999, and Monagle 1995) and a phosphorus retention model which incorporates both empirically derived and observed retention coefficients (Vollenwieder 1969, Dillon 1974, Dillon and Rigler 1974 a and b, and 1975, Kirchner and Dillon 1975). Use of the Larsen and Mercier (1976) total phosphorus retention term, based on localized data (northeast and north-central U.S.) from 20 lakes in the US-EPA National Eutrophication Survey (US-EPA-New England) provides a more accurate model for northeastern regional lakes.

**Strengths:**

- Approach is commonly accepted practice in lake management
- Makes best use of available water quality monitoring data
- Based upon experience with other lakes in the northeastern U.S. region, the empirical phosphorus retention model was determined to be appropriate for the application lake.

**Weaknesses:**

- Inherent uncertainty of TP load estimates (Reckhow 1979, Walker 2000) and associated variability and generality of TP loading coefficients.

**Critical Conditions** occur in Pleasant Pond during late summer and early autumn, when the potential (both occurrence and frequency) of nuisance algae blooms are greatest. The loading capacity of 15 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide adequate protection throughout the year (see Seasonal Variation).

**LOAD ALLOCATIONS (LA's)** The load allocation for Pleasant Pond equals 727 kg TP on an annual basis and represents, in part, that portion of the lake's assimilative capacity allocated to non-point (overland) sources of phosphorus (from Table 4). Direct external TP sources (averaging 1,245 kg annually) have been identified and accounted for in the land-use breakdown portrayed in Table 2. Further reductions in non-point source phosphorus loadings are expected from the continued implementation of NPS best management practices (see summary pages 19-25). As previously mentioned, it was not possible to separate natural background from non-point pollution sources in this watershed because of the limited and general nature of the available information. As in other Maine TMDL lakes (see Sebasticook Lake, East Pond, China Lake, Webber, Threemile, Threecornered pond TMDLs), in-lake nutrient loadings in Pleasant Pond originate from direct external (watershed) and internal (lake sediment) sources of total phosphorus.

**WASTE LOAD ALLOCATIONS (WLA's):** There are no known existing point sources of pollution (including regulated storm-water sources) in the Pleasant Pond watershed, hence, the waste load allocation for all existing and future point sources is set at 0 (zero) kg/year of total phosphorus.

**MARGIN OF SAFETY (MOS):** An implicit margin of safety was incorporated into the Pleasant Pond TMDL through the conservative selection of the numeric water quality target, as well as the selection of relatively conservative phosphorus export loading coefficients for cultural pollution

sources (Table 4). Based on both the Pleasant Pond historical records and a summary of statewide Maine lakes water quality data for lightly-colored lakes (> 26 SPU) - the target of 15 ppb (727 kg TP/yr in Pleasant Pond) represents a highly conservative goal to assure attainment of Maine DEP water quality goals of non-sustained and non-repeated blue-green summer-time algae blooms due to NPS pollution or cultural eutrophication and stable or decreasing trophic state. The statewide data base for naturally colored Maine lakes indicate that summer nuisance algae blooms (growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 17 ppb or above. The 98 kg difference (49 kg change per ppb) between the in-lake target of 15 ppb (727 kg) and 17 ppb (825 kg) represents a 12% implicit margin of safety for Pleasant Pond ([(825-727)/825 = 11.9]. A non-quantified margin of safety for attainment of state water quality goals is also provided by the inherently conservative methods used by Maine DEP to estimate future growth in the Pleasant Pond watershed (see page 32).

**SEASONAL VARIATION:** The Pleasant Pond TMDL is protective of all seasons, as the allowable annual load was developed to be protective of the most sensitive time of year – during the summer and early fall, when conditions most favor growth of algae and aquatic macrophytes. With an average annual flushing rate of 5.6, the average annual phosphorus loading is critical to the water quality in Pleasant Pond. Maine DEP lake biologists, as a general rule, use more than six flushes annually (bi-monthly) as the cutoff for considering seasonal variation as a major factor (to distinguish lakes vs. rivers) in the evaluation of total phosphorus loadings in aquatic environments in Maine. Therefore, Pleasant Pond, with an average of 5.6 flushes per year, satisfies this criterion, albeit marginally. Nonpoint source best management practices (BMPs) implemented and proposed for the Pleasant Pond watershed have been designed to address total phosphorus loading during all seasons.

**PUBLIC PARTICIPATION:** Adequate ("full and meaningful") public participation in the Pleasant Pond TMDL development process was ensured through the following avenues:

1. On February 15, 2001, CWD Project Manager, Bill Monagle met with the Board of Directors of the Four Towns Watershed Association to explain the TMDL process, and the scope of services that the CWD would be providing in the preparation of a Pleasant Pond TMDL.
2. CWD Project Manager, Bill Monagle**,** explained the Pleasant Pond TMDL to the CWD Board of Trustees on February 20, 2001. The CWD Board of Trustees has three municipally appointed members from each of the three member Towns on Pleasant Pond, Gardiner, Litchfield and Richmond. The monthly CWD meeting was publicly noticed.
3. CWD Project Manager, Bill Monagle, was the guest speaker at the annual meeting of the Four Towns Watershed Association on July 7, 2001 18, 2001. Mr. Monagle addressed a couple of lake-related topics including the now, in-progress, TMDL effort for Pleasant Pond.
4. On July 18, 2001, CWD Project Manager, Bill Monagle provided the Litchfield Conservation Commission with an overview of CWD related efforts, among which, was the TMDL for Pleasant Pond.
5. On January 15, 2002, Mr. Monagle provided the CWD Board of Trustees with a progress report on the Pleasant Pond TMDL at the District's monthly, public noticed meeting.
6. On February 11, 2002, Mr. Monagle addressed the Litchfield Board of Selectmen to explain CWD's programs and current efforts regarding the Town's lake resources, including the Pleasant Pond TMDL.
7. On March 27, 2003, CWD Project Manager, Bill Monagle, addressed the Richmond Board of Selectmen to update them on the status of the TMDL and to explain other activities that the CWD was conducting to improve Pleasant Pond and increase public awareness of water quality issues.

8. On April 14, 2003, CWD Project Manager, Bill Monagle, addressed the Litchfield Board of Selectmen to update the Board on the TMDL, among other matters, including the CWD's plan for conducting watershed-wide public presentations on lake water quality related issues.

## STAKEHOLDER REVIEW COMMENTS

A preliminary stakeholder review draft Pleasant (Mud) Pond PCAP-TMDL report was provided to 16 interested individuals who received electronic or hard copy versions of the report on March 4, 2004, and were requested to comment by the end of the day on March 18 (two-week review period). No formal comments were received and only minor edits were incorporated in the report following the stakeholder review process.

## PUBLIC REVIEW COMMENTS

The Pleasant (Mud) Pond public review draft PCAP-TMDL report was advertised in weekend editions of three newspapers (*Kennebec Journal, Lewiston Sun Journal,* and the *Brunswick Times Record*) over two weekends and the (Winthrop) *Community Advertiser*, for a month long review period (March 26 to April 23) and was also posted on the Maine DEP website. During this time period, only US-EPA New England region I formal comments were received and were fully addressed in the final submission (May 10, 2004).

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