PHOSPHORUS CONTROL ACTION PLAN

and Total Maximum Daily (Annual Phosphorus) Load Report

Long Pond– Belgrade, Rome and Mount Vernon

Kennebec County, Maine

Long Pond PCAP - TMDL Report

Maine DEPLW - 0888

Maine Department of Environmental Protection

FB Environmental Consulting

EPA Final Review Document – April 2008

LONG POND - Rome, Belgrade, Rome and Mount Vernon

Phosphorus Control Action Plan (PCAP)

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LONG POND (Rome, Belgrade, Mount Vernon)

Total Maximum Daily (Annual Phosphorus) Load

Cover Photo: *View of Long Pond North from French's Mountain (Source: Peter Kallin, BRCA)*

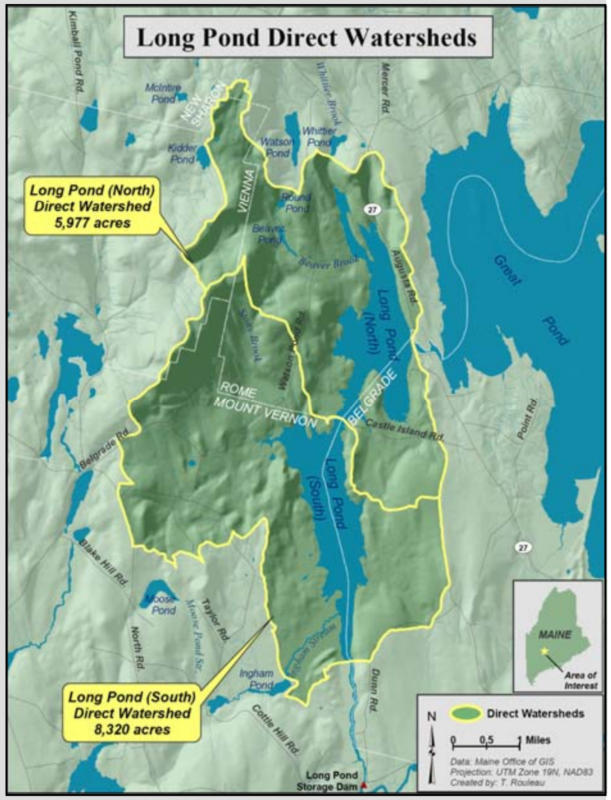
ACKNOWLEDGMENTS

In addition to Maine DEP (Division of Environmental Assessment - Lakes Assessment Section and Watershed Management Division- Augusta) and U.S. EPA New England Region I staff, the following individuals, groups and agencies were instrumental in the preparation of this Long Pond combined Phosphorus Control Action Plan and Total Maximum Daily Load report: FB Environmental staff (Jennifer Jespersen, Tricia Rouleau, Forrest Bell and Fred Dillon); Colby College (David Firmage and BI493 students); Belgrade Regional Conservation Alliance staff (Peter Kallin and Jason Bulay); Belgrade Lakes Association (Roger Shannon); Maine Department of Agriculture (David Rocque); Maine Forest Service (Chris Martin); Maine Department of Inland Fisheries and Wildlife (Bill Woodward); and Long Pond Volunteer Lake Monitors, and Belgrade Lakes Association Water Quality Monitors.

Long Pond - Rome, Belgrade, Mount Vernon Phosphorus Control Action Plan Summary Fact Sheet

Background

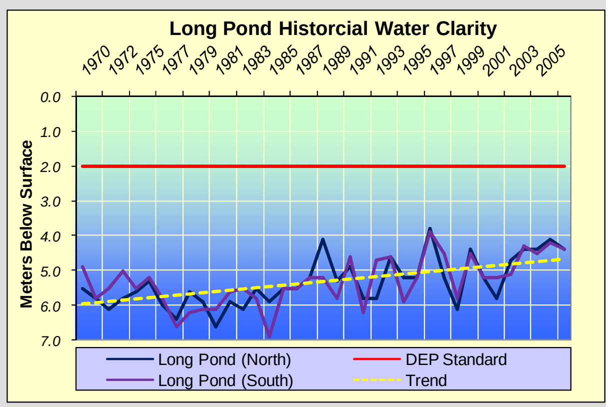
LONG POND (Midas No. 5272) is a dual-basin 2,666 acre, non-**colored** lake located in the towns of Rome, Belgrade, and Mount Vernon in Kennebec County, Maine. It is the sixth lake in the seven lake Belgrade Lakes Chain. Long Pond has a total combined direct **watershed** area of approximately 22 square miles (14,300 acres); a maximum depth of 105 feet (32 meters), and a mean depth of 35 feet (11 meters). The north basin of Long Pond has a slightly slower **flushing rate** (~ 3.0 times per year), than the south basin (3.5 times per year). The total Long Pond watershed drainage area, inclusive of the Great, Whittier, McIntire, Kidder and Ingham Pond indirect watersheds is approximately 75 square miles (47,740 acres).



Historical Information

The primary human uses of Long Pond are residential (both seasonal and year-round) and recreational – including boating, fishing, and swimming. The majority (77%) of the combined land area around the lake consists of non-developed land. The remaining land (7%) is utilized for residential development, agriculture, and to a lesser degree commercial development. Although they comprise a relatively small portion of the total combined watershed land area, these land uses represent a significant portion of the external **phosphorus** load to the lake.

From 1970 through the early 1980's, the water clarity of Long Pond, measured as Secchi disk transparency (SDT), appeared consistent, if not improving. The annual mean SDT in the lake generally ranged between 6 and 8 meters, and the maximum SDT even reached 9 meters. Since about 1982, however, the annual mean SDT has generally ranged between 5 and 7 meters, and the maximum SDT has been reduced, in some years to 5 meters. One of the poorest water quality years occurred in 2007 when the mean SDT was only 4.4 meters. Over the past three decades, the water clarity in Long Pond has declined by more than 1 meter. It was this downward trend in water clarity in Long Pond that prompted Maine DEP to assign "impaired" status to the lake and place it on the state's 303(d) list.



Minimum water clarity measurements have met DEP standards in all of the sampling years. Yet, the overall trend shows decreasing clarity since the mid 1970's.

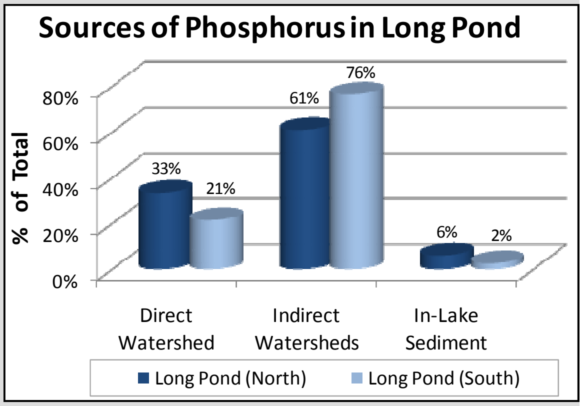
Key Terms

- ***Colored*** *lakes or ponds occur when dissolved organic acids, such as tannins or lignins, impart a tea color to the water, reflected in reduced water transparencies and increased phosphorus values.*
- ***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.*

Many factors may be contributing to the declining water quality in Long Pond, including soil erosion, fertilizers, upstream waterbodies, and accumulated phosphorus in bottom sediments. Soil erosion can have far reaching impacts, as soil particles effectively transport phosphorus, which serves to "fertilize" the lake and decreases water clarity. Nutrient rich bottom sediments can be a source of high phosphorus as a result of internal loading especially during the warm summer months. Excess phosphorus can also harm fish habitat and lead to nuisance blue-green algal blooms—floating mats of green scum—or dead and dying algae.

What We Learned

The land use assessment conducted by Colby College for the Long Pond watershed helped to determine the potential sources of phosphorus that may run off from land areas during storm events and springtime snow melting. This assessment utilized many resources, including generating and interpreting land cover maps, inspecting and verifying aerial photos, driving the watershed, and conducting both road and shoreline surveys for each respective watershed.



Upstream waterbodies are the largest contributor of total phosphorus to Long Pond.

An estimated **617 kg (1,360 lbs)** of phosphorus is exported annually to Long Pond North from the direct watershed. The natural capacity for in-lake phosphorus assimilation is 1,834 kg/ year (assuming a target goal of 8 ppb). The amount of total phosphorus being recycled internally from bottom sediments during the summer-time is approximately 108 kg/year. Similarly, an estimated **559 kg (1,232 lbs)** of phosphorus is exported annually to Long Pond South from the direct watershed. The natural capacity for in-lake phosphorus assimilation is slightly higher than Long Pond North at 1,947 kg/year (target goal of 8 ppb). The amount of total phosphorus being recycled internally from bottom sediments during the summer-time is lower in Long Pond South at approximately 65 kg/year. The bar chart (above) illustrates the large contribution of phosphorus from upstream sources compared to phosphorus from land uses in the direct watershed.

Phosphorus Reduction Needed

Long Pond's average summertime TP concentration approximates 8.3 ppb in Long Pond North, and 8.4 ppb in Long Pond South - equal to an additional 0.3 and 0.4 ppb more than the lake's natural capacity, respectively. Including a 172 and 182 kg allocation for future development in the north and south basins, the total annual amount of phosphorus needed to be reduced to support Maine water quality standards (algal bloom-free total phosphorus concentrations of 8 ppb or less) in Long Pond approximates 241 kg in Long Pond North and 279 kg in Long Pond South. Managing phosphorus levels in upstream waterbodies will be critically important to the health of Long Pond.

What You Can Do To Help!

As a watershed resident, there are many things you can do to protect the water quality of Long Pond, including maintaining natural shoreland areas, getting septic systems pumped regularly, and using phosphorus-free fertilizer. Under Maine law, effective January 2008, phosphorus fertilizers may only be used on new lawns or lawns that show a phosphorus deficiency on a soil test. Agricultural land users can consult the USDA/Natural Resources Conservation Service, the Maine Department of Environmental Protection, or the Maine Department of Agriculture, Food, and Rural Resources for information regarding **Best Management Practices** (BMPs) for reducing phosphorus loads. Watershed residents can always become involved by participating in events sponsored by State agencies, and by supporting local organizations such as the Belgrade Lakes Association and the Belgrade Regional Conservation Alliance. The estimated phosphorus loading to Long Pond originates from both shoreline and non-shoreline areas, so all watershed residents must take ownership for maintaining suitable water quality.

> ***Best Management Practices* (BMPs)** *are techniques to reduce sources of polluted runoff and their impacts. BMPs are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.*
>
> ***TMDL****, or Total Maximum Daily Load, 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.*

Lake stakeholders and watershed residents can learn more about their lake and the many resources available, including review of this Long Pond Phosphorus Control Action Plan and **TMDL** report. Following final EPA approval, copies of this detailed report, with recommendations for future BMP work, will be available online at www.maine.gov/dep/blwq/docmonitoring/tmdl2.htm, or can be viewed and/or copied (at cost) at the Maine DEP office in Augusta (Bureau of Land and Water Quality, Ray Building, AMHI Campus).

Project Premise

This lake's PCAP-TMDL project, funded by the United States Environmental Protection Agency (US-EPA), in cooperation with the Maine Department of Environmental Protection (Maine DEP), under contract with FB Environmental Consulting.

The objectives of this project were twofold: First, a comprehensive land use inventory was undertaken by the Colby College Environmental Assessment Team (CEAT) to assist Maine DEP in developing a Phosphorus Control Action Plan (PCAP) and a Total Maximum Daily Load (TMDL) report for the Long Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with assistance from FB Environmental staff, will fully 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 david.halliwell@maine.gov*).

Secondly, watershed assessment work was conducted by CEAT to help assess **total phosphorus** reduction techniques that would be beneficial for the Long Pond watershed. The results of this assessment include recommendations for future conservation work in the watershed to help citizens, organizations, and agencies restore and protect Long Pond. **Note:** *To protect the confidentiality of landowners in the Long Pond watershed, site-specific information has not generally been provided as part of this PCAP-TMDL report.*

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.*

This Phosphorus Control Action Plan (PCAP) report compiles land use data derived from color Digital Orthophoto-Quadrangles (DOQs) obtained from the Maine Office of Geographic Information Systems and prepared by CEAT, and analyzed by FB Environmental. Local citizens, active and/or developing watershed organizations, and conservation agencies will benefit from this compilation of both historical and recently collected data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Long Pond stakeholder groups to effectively prioritize future BMP work in order to obtain the funding resources necessary for further **NPS pollution** mitigation work in their watershed.

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

Aerial view of Long Pond North and Great Pond (background). Photo: CEAT

Study Methodology

Long Pond background information was obtained using several methods including review of several surveys of the lake and watershed, correspondence with municipal officials, regional organizations, Colby students and faculty, and state agencies.

__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.

__Ground-truthing__ involves conducting field reconnaissance in a watershed to confirm the relative accuracy of computer generated maps.

Members of the Colby Environmental Assessment Team (CEAT) conducting a road survey in the Long Pond watershed.

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of aerial photographs and (3) field verification. Watershed boundaries, as well as developed and non -developed land use area (i.e., forest, wetland) were initially determined using a combination of steps 2 and 3. The GIS land cover layer used for this analysis was created by CEAT (2007, 2008). It includes those classes in each layer which are best suited to calculating impermeability of watersheds. This land cover data was primarily derived from computer generated images (DOQs) made from aerial photographs taken in the spring of 2003. Land uses within these maps were further refined by CEAT based on field verification using **ground-truthing**, and reassessed by FB Environmental Consulting for the purposes of TMDL development.

A comprehensive road survey was conducted by CEAT in 2006 and 2007 to most accurately analyze the road land-use category. This entailed measuring the length and average width of every road in the direct watershed, thus allowing for calculation of total road area, and gathering information about different road types.

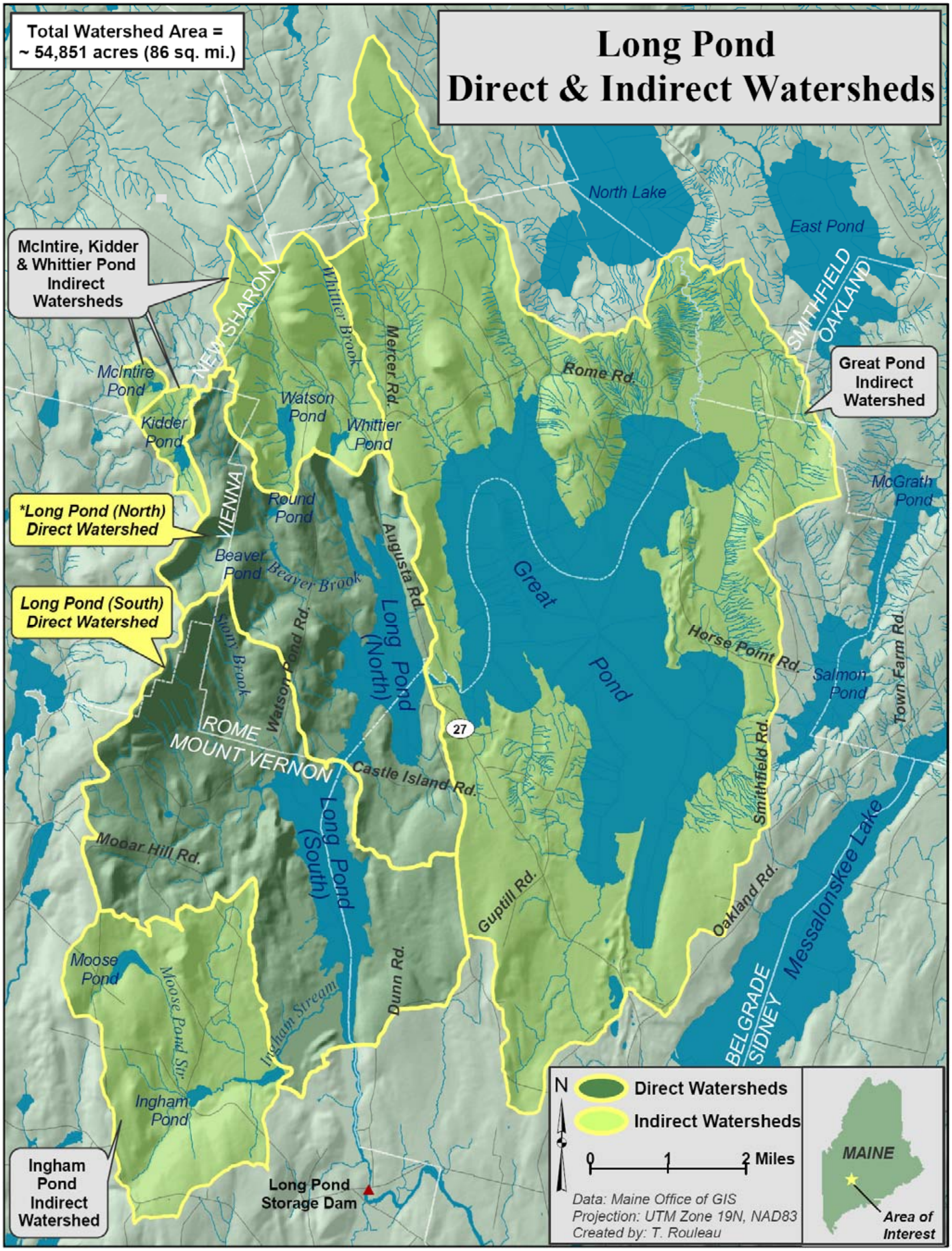
Similarly, manual house counts were performed by CEAT to improve accuracy in the number of commercial and residential properties in the watershed. To accurately quantify shoreline and non-shoreline residential areas, the number of residences pertaining to each category was multiplied by a lot size of one acre for non-shoreline and half and acre for shoreline residences. Ground-truthing was used to discriminate between commercial and residential land uses (CEAT 2007, 2008). Non-shoreline residences were counted during the road survey, while existing residences were counted by boat during the shoreline buffer survey.

Final phosphorus loading numbers (see Tables 7 & 8 on pages 37-38) were calculated in a spreadsheet, using estimated export coefficients, as found in Reckhow et al. (1980), Dennis et al. (1992), Monagle (1995), Dudley et al. (1997), Wagner et al. (1989) and Likens et al. (1977) for residential properties, agriculture, roadways, and other types of development (commercial, parks, and golf courses).

Study Limitations

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

Figure 1. Map of Long Pond Direct & Indirect Watersheds



** Long Pond North is an Indirect Watershed of Long Pond South.*
*** Total Watershed Area is inclusive of direct and indirect watersheds and their respective waterbodies.*

LONG POND Phosphorus Control Action Plan

DESCRIPTION of WATERBODY (MIDAS Number 5272) and WATERSHED

***Direct Watershed:** The direct watershed refers to the land area that drains to a waterbody without first passing through an associated lake or pond.*

LONG POND is a dual-basin 2,666-acre (1,079 hectare) lake situated in the towns of Rome, Belgrade and Mount Vernon (DeLorme Atlas, Maps 12 & 20), within Kennebec County, Maine. It is the sixth lake in the seven lake Belgrade Lakes Chain. The two distinct basins are divided by the narrows at Castle Island Road (see Figure 1, previous page). Long Pond North has a **direct watershed** area of approximately 5,977 acres (9.3 square miles) exclusive of lake surface area. The direct watershed of Long Pond North is located within three towns, including: Rome (62%), Belgrade (22%), and Vienna (16%). Long Pond North has a maximum depth of 60 feet (18 meters), a mean depth of 29 feet (8.9 meters); and a flushing rate of approximately 3.0 times per year. Long Pond North is an indirect watershed of Long Pond South.

Long Pond South has a larger direct watershed area at approximately 8,320 acres (13 square miles) exclusive of lake surface area and is located within four towns: Mount Vernon (64%), Belgrade (21%), Rome (13%) and Vienna (2%). Long Pond South has a maximum depth that is much deeper than that of Long Pond North at 105 feet (32 meters), yet the mean depth is slightly less than that of Long Pond North at 28 feet (8.4 meters). The flushing rate of Long Pond South is slightly faster than Long Pond North at 3.5 flushes per year. The total Long Pond watershed inclusive of both direct and associated indirect watersheds (Great, Whittier, Kidder, McIntire, and Ingham ponds) and their respective waterbodies is approximately 54,851 acres (86 square miles).

Aerial view of the narrows at Castle Island Rd. looking west. (Photo: CEAT 2007)

Drainage System: About 85% of the water flowing through Long Pond each year originates in the watersheds of its upstream lakes (Hardy 1977). The largest contribution is from Great Pond, which flows into Long Pond North from the east, crossing Rte. 27 just north of the Town of Belgrade. Great Pond accounts for more than 70% of the total indirect watershed area, and close to 50% of the entire Long Pond direct and indirect watershed area. In addition to Great Pond, water flows into Long Pond North through two primary tributaries. Watson Pond, to the north, flows through Whittier Pond, which enters Long Pond at the northern tip via Whittier Brook. To the west, McIntire Pond flows to Kidder Pond, which flows to Round Pond, to Beaver Pond, and finally to Long Pond via Beaver Brook. These ponds drain a large portion of the relatively undeveloped and partially protected area known as the Kennebec Highlands.

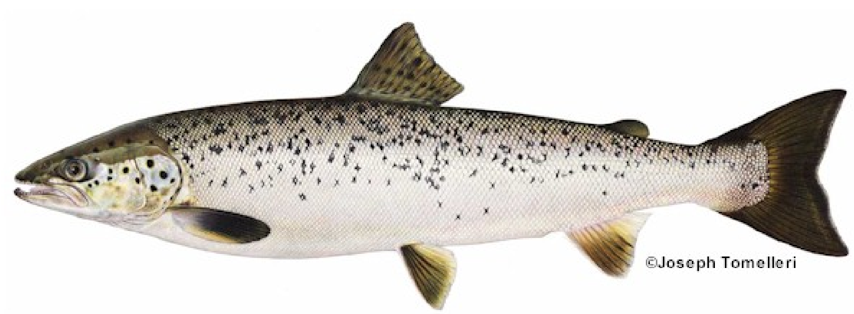
Long Pond North flows through the narrows under Castle Island Road into Long Pond South. Stony Brook flows into Long Pond South from the north-west, and Moose Pond flows through Ingham Pond to Long Pond via Ingham Stream. Long Pond drains through a dam at the south end of the lake. The dam is owned and operated by the Town of Belgrade through a cooperative agreement with the Towns of Rome and Mount Vernon. A state-owned public boat launch and parking area is located just south of the narrows at Castle Island.

<u>Long Pond</u> Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIF&W) and a recent conversation with fish biologist Bill (Woody) Woodward (Region B, Sidney, Maine DIF&W), **Long Pond** (towns of Rome, Belgrade, and Mount Vernon - Kennebec River drainage) is currently managed as a mixed cold/warm-water fishery (landlocked Atlantic salmon – brook trout and black bass) and was last field surveyed in 2007 (1940, revised 1967 and 1989). A total of **21** <u>fish species</u> are listed, including: **10** <u>native indigenous</u> fishes (brook trout, American eel, golden shiner, white sucker, brown bullhead, chain pickerel, pumpkinseed, redbreast sunfish, yellow perch, and slimy sculpin); **7** <u>introduced</u> (non-indigenous) fishes (brown trout, splake, white perch, <u>landlocked</u> rainbow smelt <u>and</u> Atlantic salmon, smallmouth and largemouth bass), and **4** <u>illegally stocked</u> fish species – northern pike, black crappie, landlocked alewife, and <u>walleye</u> – adults only, trap-netted and removed from Long Pond from 1996-2006.

Annual stockings of fall-yearling landlocked Atlantic salmon and spring-yearling brook trout sustain coldwater fisheries – because Long Pond and its tributaries lack sufficient amounts of salmonid spawning and nursery habitat to produce fishable numbers of wild fish. The limited brown trout and splake fisheries are emigrants from stockings done in either upstream or downstream waters. Principal warm water fisheries, in addition to black bass (large and smallmouth), include white perch, yellow perch and chain pickerel. Northern pike were originally <u>illegally stocked</u> into the Belgrade Lakes system (Little North Pond) in the late 1960's and have immigrated directly down into Long Pond via Great Pond in past years. An excellent state-owned boat launch and parking area is located on the lower (south) basin, just south of the narrows at Castle Island.

Northern pike (Esox lucius)



Landlocked Atlantic salmon (*Salmo salar***)**

Long Pond Water Quality Information

*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.*

***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.*

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

***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 all be used to assess trophic state.*

Long Pond is listed on the Maine DEP's 2006 303(d) list of lakes that do not meet State water quality standards as well as the State's **Nonpoint Source Priority Watersheds** list. Therefore, a combined Phosphorus Control Action Plan and TMDL report was prepared for Long Pond in the fall and winter of 2007-2008.

The water quality of both basins of Long Pond has been monitored by members of the Belgrade Lakes Association (BLA) since 1970. During this period, basic chemical information, including total phosphorus, **chlorophyll-a**, dissolved oxygen, pH, and total alkalinity was collected, in addition to **Secchi disk transparencies (SDT).** Sampling was performed primarily on a monthly basis during ice-free conditions (May – Oct) at the deepest portion of both lake basins.

While non-nuisance Gleotrichia blooms occur fairly regularly on Long Pond, results of long-term monitoring show that the water quality of Long Pond is considered to be above average. However, Secchi disk transparencies document a trend of increasing **trophic state** in Long Pond in direct violation of the Maine DEP Class GPA lakes water quality criteria requiring a stable or decreasing trophic state.

A variety of nonpoint sources of pollution may be contributing to the declining water quality in Long Pond. The water quality of Long Pond is influenced by runoff events from both the direct and indirect watersheds. The declining water quality of Great Pond is of special concern since it flows directly into Long Pond North. Nonpoint sources of pollution such as erosion from land uses such as residential development, agriculture, and roads in the watershed all contribute to the declining water quality in Long 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 and are deposited and stored in the lake, primarily in bottom sediments. Phosphorus can be released from sediment and re-suspended through biological or chemical means. 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 nuisance summertime blue-green algal blooms, which can damage the ecology and aesthetics of a lake, as well as the economic well-being of the entire lake watershed.

Principle Uses & Human Development:

Developed and managed land in the Long Pond watershed includes agricultural land, residential land (including septic systems), commercial areas, roads, parks, and a golf course. The most prevalent of these human uses in the Long Pond North watershed includes input from septic systems (33%), roads (17%) and residential land (16%). Long Pond South is heavily influenced by agriculture (20%) and roads (18%). The shoreline of Long Pond North has similar development to other regional lakes and ponds in the Belgrade Lakes Region, while Long Pond South is slightly less developed.

As discussed later in this report, a majority (56%) of residential structures in the watershed of Long Pond North are located along the shoreline. This is not the case for Long Pond South, where only 35% of residential dwellings are located on the shoreline. This is partly attributed to the large areas of wetlands on the south end of the lake which prohibit shoreline development. Both direct watersheds of Long Pond contain large areas of protected lands (approximately 2,155 acres throughout the direct watersheds), including the steeper and more erodible areas on the west and northwest edge of the watershed. Much of this land has been acquired or is currently under management by the State, or the Belgrade Regional Conservation Alliance (BRCA).

General Soils Description

The Long Pond watershed is characterized by the Dixfield-Colonel-Lyman-Brayton general soil association which consists of stony, loamy soils formed in glacial till (Ferwerda 1997). This soil association constitutes 100% of the land area in the Long Pond North watershed and over 50% of the Long Pond South watershed land area. Soils along the southwestern border of the Long Pond South watershed are typified by the Scantic-Lamoine-Buxton-Lyman general soil association - clayey and loamy soils formed in glaciomarine or glaciolacustrine sediments and loamy till (Ferwerda 1997).

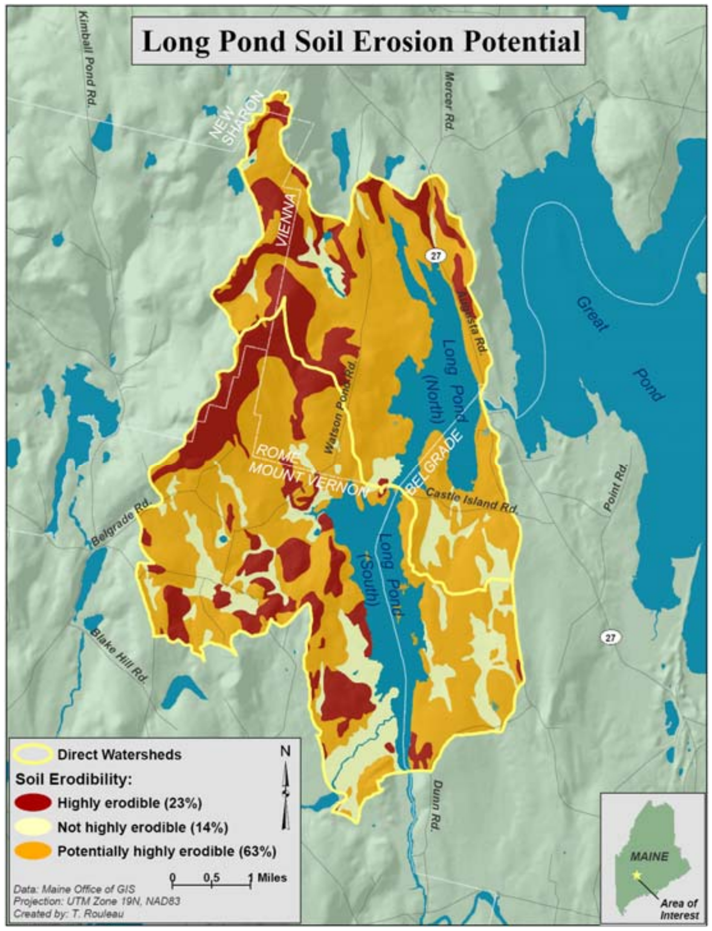


Figure 2. *If not properly managed, soils in the Long Pond watershed have the potential to be highly erodible.*

A number of factors, including soil texture, water infiltration rates, slope, and land use influence how soils may affect water quality. A Hydrologic Soil Group classifies soils in terms of their water infiltration rate, or how quickly water will be absorbed into soil during a rain event. In the Long Pond South watershed, the majority of the soils (54%) are classified as Group C. These soils have moderately fine textures, typically have limited recharge capacities for stormwater management and septic systems, and they generate significant amounts of runoff during storm events. The best-recharging soils (Group B) are concentrated in the Long Pond North watershed (52%). Group B soils are deep, moderately well-drained soils with relatively course textures. There are some areas of poorly recharging Group D soils located on the western side of the watershed, particularly at the southern end of Long Pond South.

Soil Group	Long Pond North	Long Pond South
A	-	1%
A/D	3%	3%
B	**52%**	12%
C	23%	**54%**
C/D	22%	24%
D	2%	6%

Table 1. *Hydrologic Soil Groups for the Direct Watersheds of Long Pond .*

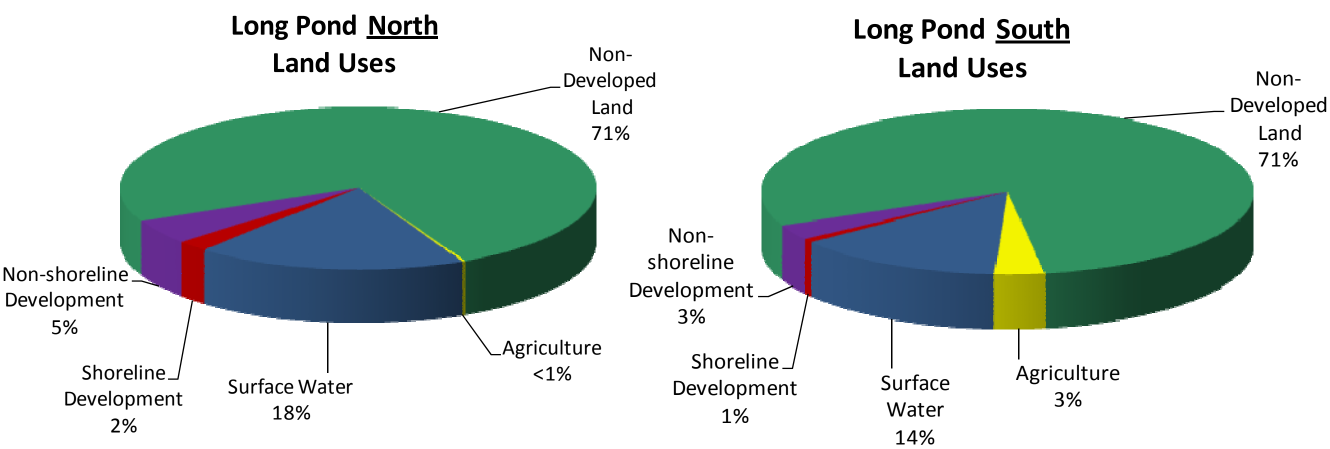
Based on soil types and slope, the majority of the Long Pond North watershed is suitable for septic system construction. In the Long Pond South watershed, despite the poor septic suitability of the soils, the majority of the watershed area is also suitable to septic system construction because of a low percent slope grade (CEAT 2008). There are, however, areas in both basins where existing septic systems should be maintained or replaced. These areas include the sections of the northwestern and southeastern shores of Long Pond South (CEAT 2008) and the southern shoreline of Long Pond North (CEAT 2007).

Overall, most of the watershed has a low to moderate erosion potential due to the combination of a high percentage of mature forest cover and soils with high water infiltration rates. However, if not properly managed 63% of the soils in the Long Pond watershed have the potential to be highly erodible. As such, particular attention should be paid to land uses on soils with steep slopes, and on land with exposed surface soils. Areas with a high erosion potential (23%) do exist throughout the watershed. Of particular concern are sections of the eastern shore of Long Pond North and the western shoreline of Long Pond South. Approximately 14% of watershed soils (located primarily in wetlands in the Long Pond South watershed) have little potential for erosion.

Land Use Inventory

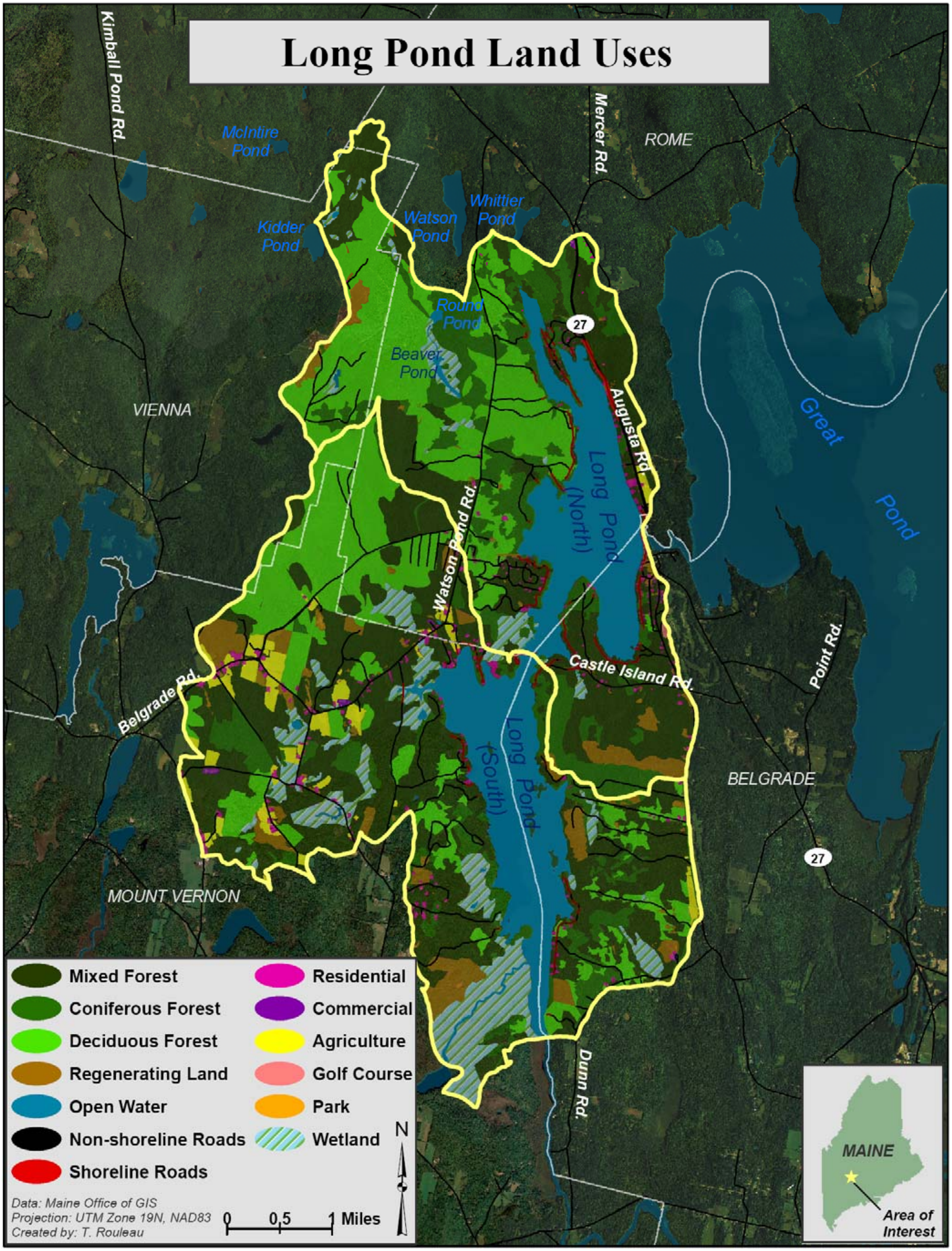
The results of the Long Pond watershed land use inventory are depicted in Figure 3 (below), as well as Figure 4 (next page) and Tables 2-4 (pp. 15-17). The majority of the watershed consists of non-developed land. The dominant human uses in the watershed are non-shoreline development (primarily non-shoreline roads and septic systems). The most significant land use change in the Long Pond North watershed has been the increase (~ 10%) in residential land area in just 12 years (1991-2003)(CEAT 2007). In this same time period, there was a 14% increase in forest land attributed a decrease in reverting land, cleared land and wetlands. A look at land use patterns over 30 years (1966-2003) in the Long Pond South watershed reveals a decrease in agricultural land and forest land. Some of this can attributed to increases in residential areas, regenerating land, and wetlands (CEAT 2008).

Figure 3. *Comparison of Land Uses in the Direct Watersheds of Long Pond.*



Future watershed development for Long Pond North is expected to focus less on construction of seasonal residences and more on year-round residences (CEAT 2007), while development for Long Pond South is predicted to occur in existing subdivisions in Rome, and along the eastern shoreline in Belgrade (CEAT 2008).

Figure 4. Long Pond Direct Watershed Land Uses



In Table 2 (below), watershed land uses for Long Pond North are categorized by developed land vs. non-developed land. The developed and managed land area comprises approximately 8% of the watershed and the undeveloped area, including the water surface area of Long Pond, comprises the remaining 92% of the watershed. This external watershed load is only a part of the total load which also includes the internal load and the indirect load (see Figure 8, p. 23). These numbers may be used to help make future planning and conservation decisions relating to the watershed of Long Pond North. The information in Table 2 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Table 2. Long Pond North Direct Watershed-
Land Use Inventory and External Phosphorus Loads

Long Pond North LAND USE CLASS	Land Area Acres	Land Area %	TP Export Load kg TP	TP Export Total %
Agricultural Land			**Long Pond North**	
Agriculture	16	<1%	6	1%
Sub-Totals	**16**	**<1%**	**6**	**1%**
Shoreline Development			**Long Pond North**	
Shoreline Residential	131	2%	53	9%
Shoreline Roads	26	<1%	21	3%
Shoreline Septic Systems			126	20%
Sub-Totals	**157**	**2%**	**200**	**32%**
Non-Shoreline Development			**Long Pond North**	
Commercial Land	<1	<1%	4	1%
Golf Course	9	<1%	5	1%
Park	<1	<1%	<1	<1%
Non-Shoreline Residential	212	3%	43	7%
Non-Shoreline Roads	143	2%	87	14%
Non-Shoreline Septics			83	13%
Sub-Totals	**365**	**6%**	**222**	**36%**
Total: DEVELOPED LAND	**538**	**8%**	**428**	**69%**
Non-Developed Land			**Long Pond North**	
Forest Land	5,016	69%	81	13%
Regenerating Land	239	3%	19	3%
Wetlands	179	2%	1	<1
Total: NON-DEVELOPED LAND	**5,434**	**74%**	**82**	**17%**
Total: Surface Water (Atmospheric)	**1,337**	**18%**	**87**	**14%**
TOTAL: DIRECT WATERSHED	**7,309**	**100%**	**617**	**100%**

In Table 3 (below), watershed land uses for Long Pond South are categorized by developed land vs. non-developed land. The developed and managed land area comprises approximately 7% of the watershed and the undeveloped area, including the water surface area of Long Pond, comprises the remaining 93% of the watershed. This external watershed load is only a part of the total load which also includes the internal load and the indirect load (see Figure 8, p. 23). These numbers may be used to help make future planning and conservation decisions relating to the watershed of Long Pond South. The information in Table 3 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Table 3. Long Pond (South) Direct Watershed-
Land Use Inventory and External Phosphorus Loads

Long Pond South LAND USE CLASS	Land Area Acres	Land Area %	TP Export Load kg TP	TP Export Total %
Agricultural Land			**Long Pond South**	
Agriculture	317	3%	110	20%
Sub-Totals	**317**	**3%**	**110**	**20%**
Shoreline Development			**Long Pond South**	
Shoreline Residential	63	<1%	25	5%
Shoreline Roads	7	<1%	6	1%
Shoreline Septic Systems			39	7%
Sub-Totals	**70**	**1%**	**70**	**13%**
Non-Shoreline Development			**Long Pond South**	
Commercial Land	14	<1%	11	2%
Non-Shoreline Residential	115	1%	23	4%
Non-Shoreline Roads	159	2%	97	17%
Non-Shoreline Septics			15	3%
Sub-Totals	**288**	**3%**	**146**	**26%**
Total: DEVELOPED LAND	**676**	**7%**	**326**	**59%**
Non-Developed Land			**Long Pond South**	
Forest Land	6,144	64%	99	18%
Regenerating Land	543	6%	44	8%
Wetlands	958	10%	4	<1%
Total: NON-DEVELOPED LAND	**7,644**	**80%**	**147**	**26%**
Total: Surface Water (Atmospheric)	**1,329**	**13%**	**86**	**15%**
TOTAL: DIRECT WATERSHED	**9,649**	**100%**	**559**	**100%**

In Table 4 (below), land uses for the Combined direct watersheds of Long Pond are categorized by developed land vs. non-developed land. The developed and managed land area comprises approximately 7% of the watershed and the undeveloped area, including the water surface area of Long Pond, comprises the remaining 93% of the watershed. This external watershed load is only a part of the total load which also includes the internal load and the indirect load (see Figure 8, p. 23). These numbers may be used to help make future planning and conservation decisions relating to the Combined direct watershed of Long Pond. The information in Table 4 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Table 4. Long Pond Combined Direct Watersheds- Land Use Inventory and External Phosphorus Loads

Long Pond Combined LAND USE CLASS	Land Area Acres	Land Area %	TP Export Load kg TP	TP Export Total %
Agricultural Land			Long Pond Combined	
Agriculture	334	2%	116	10%
Sub-Totals	**334**	**2%**	**116**	**10%**
Shoreline Development			Long Pond Combined	
Shoreline Residential	194	1%	79	7%
Shoreline Roads	33	<1%	26	2%
Shoreline Septic Systems			165	14%
Sub-Totals	**227**	**1%**	**270**	**23%**
Non-Shoreline Development			Long Pond Combined	
Commercial Land	19	<1%	15	1%
Golf Course	9	<1%	5	<1%
Park	<1	<1%	<1	<1%
Non-Shoreline Residential	327	2%	66	6%
Non-Shoreline Roads	302	2%	184	15%
Non-Shoreline Septics			98	8%
Sub-Totals	**657**	**4%**	**368**	**31%**
Total: DEVELOPED LAND	**1,218**	**7%**	**754**	**64%**
Non-Developed Land			Long Pond Combined	
Forest Land	11,160	65%	181	16%
Regenerating Land	782	5%	63	5%
Wetlands	1,137	7%	5	<1%
Total: NON-DEVELOPED LAND	**13,079**	**77%**	**249**	**21%**
Total: Surface Water (Atmospheric)	**2,666**	**16%**	**173**	**15%**
TOTAL: DIRECT WATERSHED	**16,963**	**100%**	**1,176**	**100%**

Descriptive Land Use and Phosphorus Export Estimates

- *To convert kilograms (kg) of total phosphorus to pounds - multiply by 2.2046*

Agriculture: In the past several decades the towns within the Long Pond watershed have changed from rural and agriculture-based communities to residential communities. Land once used for agriculture has reverted back to forest land or is now used for residential development. (CEAT 2007, 2008). A comparison between agricultural land area in Long Pond South between 1966 and 2003 revealed a 2.6% decrease (529 acres) in agricultural land use. Today, the main agricultural uses in the watershed are crops, pasture, hayland and tree farms.

The amount of land used for agriculture in the watershed of Long Pond North is much less than for Long Pond South, accounting for <1% of the total direct watershed area and just 1% of the total external phosphorus load to Long Pond North. Long Pond South has a larger agricultural land area, including a few large commercial farms (CEAT 2008), accounting for 3% of the total direct watershed area of Long Pond South and 20% of the total external phosphorus load to Long Pond South. Based on current land use combined total phosphorus load from the direct watersheds of Long Pond North and Long Pond South approximates just 2% of the total land area and 116 kg TP/yr (10%) of the total combined external phosphorus load. The extent of land used for agricultural purposes in the combined watershed is small compared to other culturally based land uses.

Shoreline Development consists of all developed lands within the immediate shoreland zone (250 feet) of Long Pond. A complete shoreline survey was conducted for Long Pond North in the fall of 2006, and for the Long Pond South in the fall of 2007 by the Colby Environmental Assessment Team (CEAT 2007, 2008) based on guidance provided by Maine DEP. These surveys were conducted via boat and the results represent subjective determinations of potential impact ratings based on best professional judgment.

The Buffer Survey included a residential structure tally along with an estimated buffer quality value for each property. CEAT surveyors evaluated the percent of vegetated buffer, buffer depth from shore, and slope rating. For each of these categories, point values were assigned according to the quality of that characteristic, with the higher values corresponding to higher quality. Scores for each characteristic were summed, and divided by the highest score possible to create a buffer strip index. Values between 0 and 25 percent were considered “poor” buffers, those between 26 and 50 percent considered “fair,” between 51 and 75 percent considered “acceptable,” and those 76 percent or above considered “good.” In addition to the impact rating, CEAT estimated the residency status of the dwelling (seasonal vs. year-round). Houses with a permanent foundation, a heat source such as a woodpile or an oil tank and a paved driveway were considered year-round residences.

Residential development, particularly in the shoreline zone can affect on the water quality of Long Pond. (Photo: CEAT)

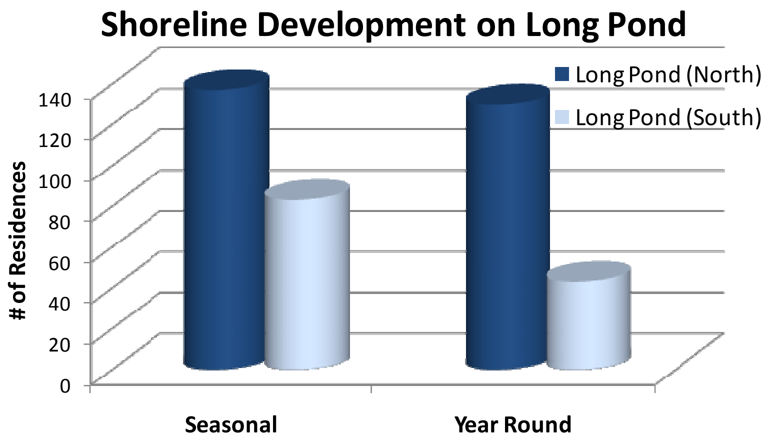


Figure 5. *Number and Residency Status of Shoreline Residences on Long Pond (Data Source: CEAT 2007, 2008).*

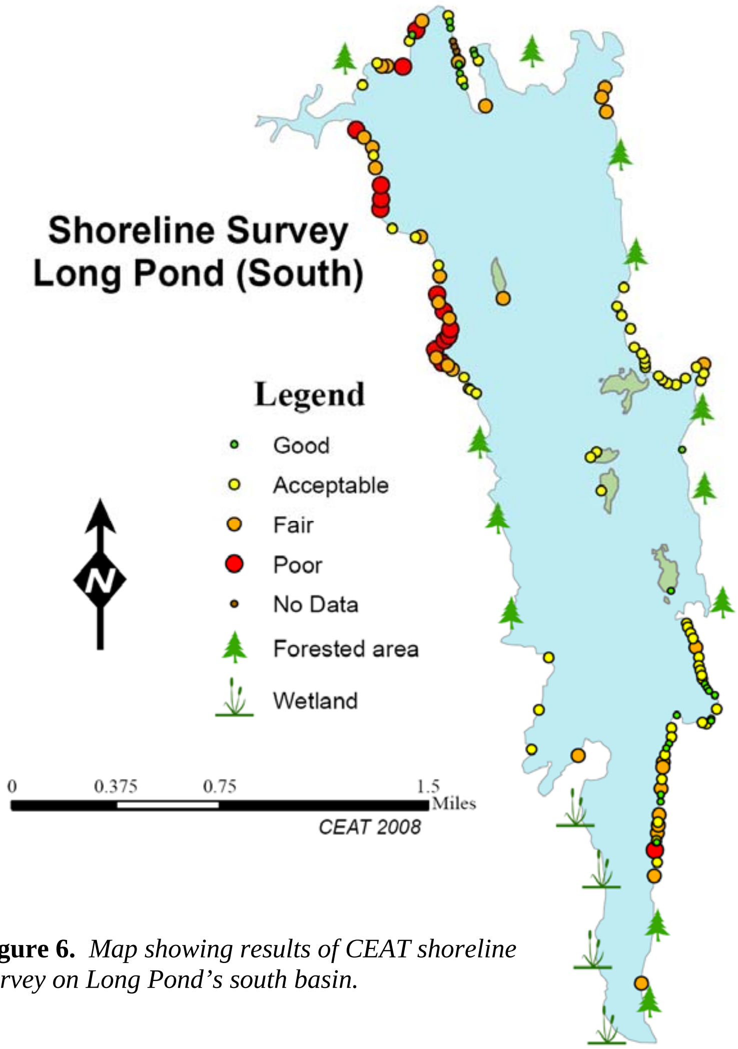


Figure 6. *Map showing results of CEAT shoreline Survey on Long Pond's south basin.*

The combined shoreline of Long Pond supports 393 dwellings. The majority of development occurs on the shoreline of Long Pond North (see Figure 5, left) with 137 seasonal and 130 year round dwellings spread evenly across the shoreline (CEAT 2007). This is 20 more shoreline residences than was documented in 1995 (CEAT 1995). With a current development density of 17.5 houses per shoreline mile (CEAT 2007), the shoreline of Long Pond North, exhibits similar development patterns to other local lakes.

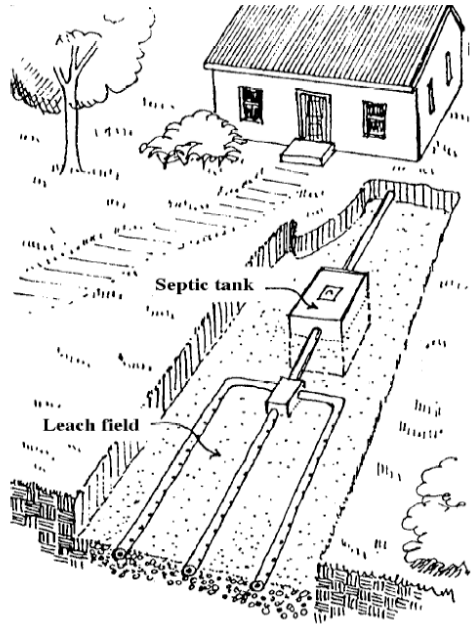
The shoreline of Long Pond South is less developed with 83 seasonal and 43 year round dwellings. As opposed to Long Pond North, dwellings on the shoreline of Long Pond South are not spaced evenly, and have a much lower development density of 9.2 dwellings per shoreline mile. The lower development density can be partly attributed to large areas of wetland, especially on the southern end of Long Pond South, that make the area unbuildable (see Figure 6, left).

The buffer survey revealed that Long Pond North has better buffer quality than Long Pond South (see Table 5, below). The most significant areas of fair and poor buffers exist in the highly developed northwest corner of Long Pond South, and around the Narrows in the southernmost portion of Long Pond North. Fair and Poor quality buffers were often associated with lots having 60 feet or less of distance between the house and the shoreline. The southeast corner of Long Pond South boasts exceptional buffer quality despite being highly developed, suggesting a higher degree of homeowner responsibility in this area (CEAT 2008).

Long Pond Shoreline Buffer Quality				
	Good	***Acceptable***	***Fair***	***Poor***
Long Pond (North)	48%	42%	9%	n/a
Long Pond (South)	18%	44%	24%	11%

Table 5. *A comparison of buffer quality on the shoreline of Long Pond North and South. (CEAT 2008).*

Shoreline Septic Systems: Total phosphorus export loading from residential septic systems within the Long Pond shoreline zone was estimated by CEAT using a septic suitability model (CEAT 2007, 2008). In the septic suitability model, an area indicated to have a high septic suitability has a low rating, indicating that the area is suitable for the installation of septic systems. The values for septic suitability in the watershed ranged from 3 to 8, on a scale from 1 to 9.



Many old septic systems in the Long Pond watershed may not meet current mandates that require a 100' setback from the high water mark (Image: Williams 1992 in CEAT 2007).

Export coefficients of 0.45 and 0.80 kg P per capita for seasonal and year-round residences were taken from Reckhow and Chapra (1983). Occupancy was estimated to be 2.6 persons per household, although the summer population increases to 3.8 persons per household (personal communication between CEAT and Rome CEO William Najpauer). Most of the watershed is suitable for septic system construction, yet there are a few notable exceptions along the developed shoreline of Long Pond South that may require future maintenance or replacement to ensure that septic systems in areas with low septic suitability continue to function properly. These areas include the northwestern shore opposite the most northern island, and the southeastern shore slightly south of the most southern island (CEAT 2008).

Based on these factors, the total phosphorus load to Long Pond from shoreline septic systems is estimated at 126 kg/yr for Long Pond North, and 39 kg/yr in Long Pond South. This represents approximately 20% of the annual land use-based total phosphorus load to Long Pond North, and 7% of the annual load to Long Pond South from the direct watershed area. The higher loading rate from Long Pond North is likely attributed to the greater number of shoreline residences. Combined, shoreline septic systems contribute 165 kg/yr TP (14%) to the combined direct watershed of Long Pond. With the exception of non-shoreline roads, shoreline septic systems have the potential to contribute the most total phosphorus to Long Pond's combined direct watershed, compared to all other types of development.

Shoreline Roads: NPS pollution associated with shoreline roads (roads within 250 feet of the shoreline) can vary widely, depending upon road type, slope, and proximity to a surface water resource. A NPS survey of the Long Pond watershed conducted by the BRCA (2002) concluded that private (camp) roads are potentially the most serious threat to the water quality of the lake because many were never constructed properly, and are currently used more often and for longer periods of time then they were in the past. The most common problems with this road type includes surface erosion, clogged culverts. If not properly constructed or maintained, these roads can channel runoff and associated pollutants directly to the lake.


Example of a camp road in the Long Pond south direct watershed with poor crowning. (Photo: CEAT)

Similar results were documented by CEAT in the fall of 2006 and 2007. A detailed road survey entailed documenting all of the roads in the direct watershed. This included road names, GPS coordinates of start and end locations, road width, total distance, road type, crown height, ditch shape and general road health. All of the camp roads were classified into categories including Good, Acceptable, Fair and Poor.

Results of the survey revealed that there are there are approximately 8 miles of camp and private roads within the shore zone of Long Pond. When multiplied by the average road width, these roads cover 33 acres and contribute an estimated 2% (26 kg/yr) to the total phosphorus load to Long Pond. A majority of these roads are located along the shore of Long Pond North (see Table 6 below). This corresponds with the higher development density in Long Pond North, which would require more roads for access. The greater number of roads would suggest more maintenance issues. Surprisingly, Long Pond North has a higher percentage of roads determined "Good" compared to roads along Long Pond South (see Figure 7 below).

Table 6. *Miles of Shoreline Roads in the Direct Watersheds of Long Pond.*

Condition	Long Pond North	Long Pond South
Acceptable	1.09	1.19
Fair	0.78	0.51
Good	3.32	0.012
Poor	0.43	0.16
Unknown (Paved)	0.03	0.12
Total	**5.7**	**2.0**

Overall, shoreline development comprises ~1% of the total combined watershed area, yet this type of development contributes approximately 270 kg of total phosphorus annually, accounting for 23% of the estimated phosphorus load.

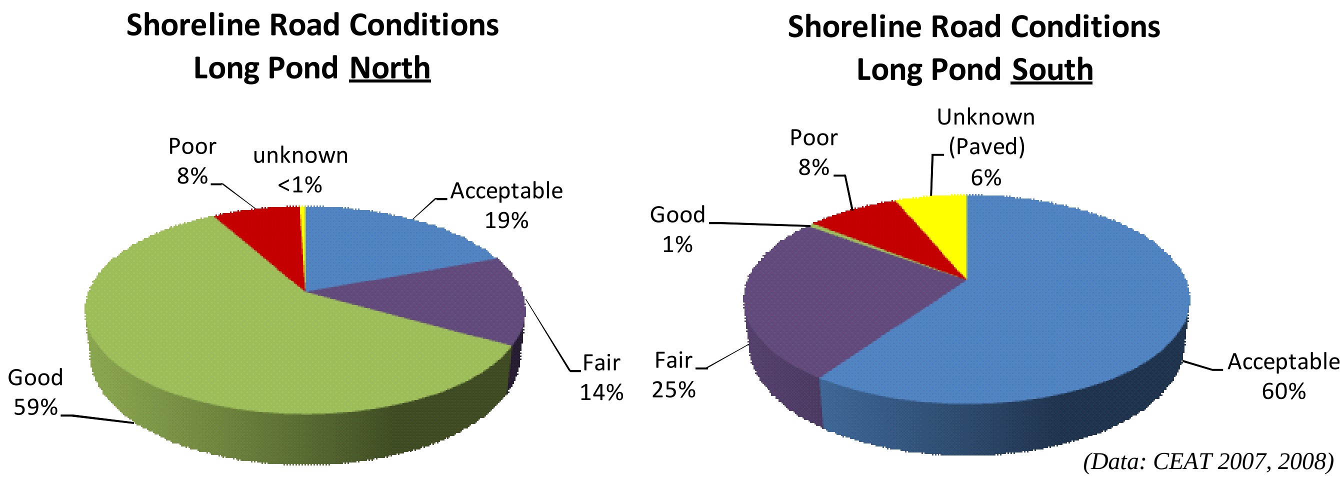


Figure 7. *Shoreline Road Conditions in the Direct Watersheds of Long Pond .*

While not considered part of the P loading calculation in the shore zone, non-shoreline roads associated with shoreline development may be more of a problem than shoreline roads from a management perspective, since they often run down hill in long runs with difficult drainage (Bouchard, personal communication).

Non-Shoreline Development and Land Uses

Non-Shoreline Development consists of all lands outside the immediate shoreline of Long Pond - including residential areas, commercial land, roads, parks, and golf courses. The total land area covered by these land-uses was calculated using a combination of GIS land use data and ground-truthing by the Colby Environmental Assessment Team (CEAT). Input from non-shoreline septic systems are included as part of the analysis.

Residential & Septics: Residential development approximates 212 acres and contributes an estimated 43 kg/year of the total phosphorus loading to Long Pond North, as well as 115 acres (23 kg/yr) to Long Pond South. Combined, non-shoreline residential land uses account for approximately 2% of the land area and approximately 6% of the total phosphorus load to Long Pond. Non-shoreline septic systems contribute 83 kg/year (13%) to Long Pond North, and an additional 15 kg/year to Long Pond South. Combined, non-shoreline septic systems contribute 8% of the total phosphorus load to Long Pond.

Commercial Land: Commercial development is limited to less than 1% of the land area in both direct watersheds of Long Pond. This accounts for less than 1% of the total land area in the combined watershed and just 1% (15 kg/year) of the total phosphorus load to Long Pond.

Roads: Roadway widths were estimated by CEAT using a combination of GIS based information and actual measurements for the various road types. The total P loading for non-shoreline roads in Long Pond North is 87 kg/yr (14%) of the total phosphorus load to Long Pond. This is the second largest contribution among the developed land classes for Long Pond North behind shoreline septic systems. The total P loading for non-shoreline roads in Long Pond South totals 97 kg/yr (17%) of the total phosphorus load to Long Pond. This is the second largest contribution among the developed land classes for Long Pond South behind agricultural land. Combined, non-shoreline roads contribute the most total phosphorus among the developed land classes at 15% of the total for all land use classes.

Other Developed Land Areas: The remaining developed land uses include a golf course and a park in the direct watershed of Long Pond North. The total Phosphorus loading from these uses is just over 5 kg/yr or approximately 1% of the total phosphorus loading to Long Pond North, and <1% of the combined direct watershed phosphorus load.

Phosphorus Loading from Non-Developed Lands and Water

Forest land: Of the total non-developed land area within the Long Pond North watershed, 5,016 acres are forested, accounting for 13% of the phosphorus load (81 kg/year). With a larger overall land area, Long Pond South contains 6,144 acres of forest land which accounting for approximately 18% of the phosphorus load (99 kg/year). Combined, forest land represents 65% of the total land area of Long Pond's direct watersheds and 16% of the total phosphorus load.

Other Non-Developed Land Areas: Regenerating lands and wetlands account for approximately 5% of the land area in the Long Pond North watershed, and 16% of the land area in the direct watershed of Long Pond South. Combined, approximately 68 kg/yr (5%) of the total phosphorus load to Long Pond is derived from these sources.

Atmospheric Deposition (Open Water): Surface waters in the direct watershed of Long Pond North comprise 18% of the total land area (1,337 acres) and account for an estimated 82 kg of total phosphorus per year, representing 14% of the total direct watershed load entering Long Pond North. Similarly, surface waters in the direct watershed of Long Pond South comprise 13% of the total land area (1,329 acres) and account for an estimated 82 kg of total phosphorus per year, representing 15% of the total direct watershed load entering Long Pond South. Combined, atmospheric deposition contributes 15% of the total phosphorus loading to Long Pond. The total phosphorus loading coefficient chosen (0.16 kg/ha) is similar to that used for central Maine lakes in Kennebec County. This value represents the median of a range of values from Reckhow (1980) of 0.11 kg/ha to 0.21 kg/ha.

PHOSPHORUS LOADS – Watershed, Sediment and In-Lake Capacity

Supporting documentation for the phosphorus loading analysis includes water quality monitoring data from Maine DEP/VLMP, and the development of a phosphorus retention model (see Appendices for detailed information). Please note that two methods were used in our total phosphorus loading analysis to assist with the preparation of this report: 1) a loading GIS-based export coefficient spreadsheet to provide a relative estimation of impacts from watershed land uses for the development of phosphorus reduction strategies by stakeholders; and 2) an in-lake phosphorus concentration model to determine the phosphorus reduction needed for the Long Pond TMDL. These two methods may yield different overall phosphorus loading results depending on the available water quality data and particular characteristics of the watersheds and water bodies being modeled.

1. GIS-Based Land Use and Indirect Load Method (Long Pond-North)

Watershed Land Uses (North): Total phosphorus loadings to Long Pond North originate from a combination of external watershed and internal lake sediment sources. Watershed total phosphorus sources, totaling approximately 617 kg (1,360 lbs) annually have been identified and accounted for by land use (See Table 7- page 37).

Internal Loading (North): Annual internal lake sediment P-loading of 108 kg was estimated from five years of recent data.

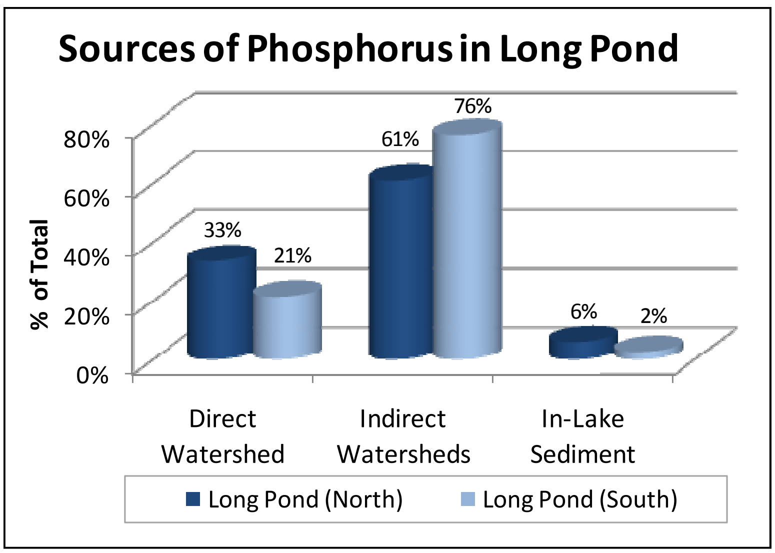


Figure 8. *Loading from the Indirect Watersheds of Long Pond represent a majority of the annual phosphorus load –far greater than inputs from land uses.*

Loading from the Indirect Watershed (North): Total phosphorus loading from the associated upstream watersheds of Great, Whittier, Kidder, and McIntire ponds accounts for an estimated indirect watershed average load of 1,123 kg annually to Long Pond North, determined on the basis of flushing rate x volume x TP concentration (see page 36 for more information).

The sum of these two potential sources of TP indicates that an estimated 1,740 kg/yr may be contributing to the current in-lake phosphorus levels of Long Pond North. However, these models do not take into account many of the complex factors that affect lake water quality. Instead, these figures provide stakeholders with relative estimates that should assist with targeting implementation measures in the watershed.

2. In-Lake Concentration Method (TMDL)- (Long Pond-North)

Lake Capacity (North): The assimilative capacity for all existing and future non-point pollution sources for Long Pond North is 1,834 kg of total phosphorus per year, based on a target goal of 8 ppb (See Phosphorus Retention Model - page 41).

Target Goal (North): A change in 1 ppb in phosphorus concentration in Long Pond North is equivalent to 229 kg of watershed loading. The difference between the target goal of 8.0 ppb and the measured average summertime total phosphorus concentration (8.3 ppb) is 0.3 ppb or 69 kg (0.3 ppb x 229 kg). The goal is to halt the decline in water quality and inhibit increases in the phosphorus concentration.

Future Development (North): The annual total phosphorus contribution to account for future development for Long Pond North is 172 kg (0.75 x 229) (see page 41 for more information).

Reduction Needed (North): Given the target goal and a 172 kg allocation for future development, the total amount of phosphorus needed to be reduced, on an annual basis, to restore water quality standards in Long Pond North approximates 184 kg (69 + 172).

1. GIS-Based Land Use and Indirect Load Method (Long Pond-South)

Watershed Land Uses (South): Total phosphorus loadings to Long Pond South originate from a combination of external watershed and internal lake sediment sources. Watershed total phosphorus sources, totaling approximately 559 kg (1,232 lbs) annually have been identified and accounted for by land use (See Table 8 - page 38).

Internal Loading (South): Annual internal lake sediment P-loading of 65 kg was estimated from five years of recent data.

Loading from the Indirect Watershed (South): Total phosphorus loading from the associated upstream watersheds of Long Pond North and Ingham Pond accounts for an estimated indirect watershed average load of 2,008 kg annually, determined on the basis of flushing rate x volume x TP concentration (see page 36 for more information).

The sum of these two potential sources of TP indicates that an estimated 2,567 kg/yr may be contributing to the current in-lake phosphorus levels of Long Pond South. However, these models do not take into account many of the complex factors that affect lake water quality. Instead, these figures provide stakeholders with relative estimates that should assist with targeting implementation measures in the watershed.

2. In-Lake Concentration Method (TMDL)- (Long Pond-South)

Lake Capacity: The assimilative capacity for all existing and future non-point pollution sources for Long Pond South is 1,947 kg of total phosphorus per year, based on a target goal of 8 ppb (See Phosphorus Retention Model - page 42).

Target Goal (South): A change in 1 ppb in phosphorus concentration in Long Pond South is equivalent to 243 kg of watershed loading. The difference between the target goal of 8.0 ppb and the measured average summertime total phosphorus concentration (8.4 ppb) is 0.4 ppb or 97 kg (0.4 ppb x 243 kg).

Future Development (South): The annual total phosphorus contribution to account for future development for Long Pond South is 182 kg (0.75 x 243) (see page 41 for more information).

Reduction Needed (South): Given the target goal and a 182 kg allocation for future development, the total amount of phosphorus needed to be reduced, on an annual basis, to restore water quality standards in Long Pond South approximates 279 kg (97 + 182).

The ultimate goal for Long Pond is to halt the decline in water quality and inhibit increases in phosphorus. Inevitably, development will continue to occur in the Long Pond watershed, and will need to be carefully managed in order to limit phosphorus increases to less than 0.5 ppb. Without watershed management and BMPs on new and existing development these goals will not be met, and declines in water quality will become apparent.

PHOSPHORUS CONTROL ACTION PLAN

Recent and Current NPS/BMP Efforts

For twenty years, the Belgrade Regional Conservation Alliance (BRCA) has been working with local lake associations, such as the Belgrade Lakes Association (BLA) whose mission, (for 100 years) has been to protect and improve the watershed of Great and Long Pond (BLA 2008). These two groups work closely with land owners in the Belgrade Lakes Region to protect and preserve the land around Long Pond and other nearby lakes including Great Pond. This cooperation has helped them support actions to reduce nutrient export from existing residential properties, roads and other land uses that have the potential to contribute phosphorus to Long Pond.

With funding from the Maine DEP's NPS Grants Program, BRCA has completed watershed surveys of all seven Belgrade Lakes (BRCA 2008). The survey for Long Pond was conducted in 2001 and completed in 2002. The survey objectives are to identify and prioritize NPS pollution sites within the watershed, increase public awareness of the effects of stormwater runoff and erosion on lake water quality, and recommend mitigation measures to help fix these problems (BRCA 2002). The NPS survey reported 206 problem sites, 135 were determined to have a measurable impact on water quality (BRCA 2002). The majority of these sites are directly associated with residential development.

In 1996, with support from local Towns and the BLA, the BRCA created the BRCA Conservation Corps. Since its initiation, the Conservation Corps has completed almost 500 erosion control projects in the Belgrade Lakes Region, with 89 of these projects occurring in the Long Pond watershed. The conservation corps enlists high school students to perform manual labor such as shoreline buffer plantings, bank and ditch stabilization, and installing drainage on unimproved camp roads free of charge to landowners that agree to pay for materials and any permit fees (BRCA 2008).

The BRCA assists Long Pond shoreline property owners with installing vegetated shoreline buffers consisting of native shrubs. (Photo: Jason Bulay)

The BRCA has been active in providing education and technical assistance to lake associations, municipal officials, code enforcement officers (CEO's) and planning board members of watershed towns. In 2007, the BRCA hosted a Watershed Forum to bring all of these groups together to discuss water quality issues in the Long Pond region. A particular focus of this meeting was to discuss the need for increased code enforcement in the watershed towns. The BRCA receives frequent communication from local landowners complaining of shoreline code violations that go unchallenged (Eliot, 2007; Kallin, personal communication).

The Town of Belgrade documented a need for increased hours for their CEO back in 1998 in their Comprehensive Plan (Town of Belgrade 1998). In March, 2008, the Board of Selectpersons approved hiring a CEO to work 18 hours per week, an increase from 12 hours per week (Stocco, personal communication).

Water quality is of high importance to the towns in the Long Pond watershed. Both the Town of Mount Vernon and the Town of Belgrade are in the process of updating their Comprehensive Plans. These plans will incorporate watershed protection strategies to ensure that the water quality of Long Pond will be protected into the future. Citizen participation in drafting these plans is a necessary step towards ensuring that water quality protections are carried out.

The BRCA Conservation Corps has actively installed BMPs in the Long Pond Watershed since 1996. A recent BRCA project (above) involved armoring a badly eroded ditch carrying large amounts of sediment from Rt. 27 into Long Pond (Photo: Jason Bulay).

Recommendations for Future NPS/BMP Work

Long Pond has impaired water quality primarily due to phosphorus inputs from nonpoint source (NPS) pollution, associated upstream sources, and resultant internal lake sediment recycling of phosphorus. Specific recommendations regarding recent and current efforts in the watershed, best management practices (BMPs), and actions to reduce (1) external watershed and (2) accumulated bottom sediment phosphorus total phosphorus loadings in order to improve water quality conditions in Long Pond are described below.

Action Item #1 : Support existing watershed management efforts		
Activity	**Participants**	**Schedule & Cost**
Resource agencies should continue to support the Belgrade Regional Conservation Alliance (BRCA) and the Belgrade Lakes Association (BLA)	BRCA, BLA, KC-SWCD, USDA/ NRCS, Maine DEP, Towns of Belgrade, Rome and Mount Vernon, interested watershed citizens-stakeholders.	Annual roundtable meetings—beginning in Summer 2008—minimal cost

Watershed Management: Several groups (i.e., primarily BRCA and the BLA, in addition to Maine DEP, KC-SWCD, watershed Towns) have been involved in attempting to restore and monitor the water quality of Long Pond and several of its contributing upstream waterbodies including Great Pond. This PCAP-MDL report will serve as a compilation of existing information about the past and present projects that have been undertaken in order to adequately assess future NPS BMP needs in the watershed.

Action Item # 2: Provide technical assistance to agricultural landowners		
Activity	**Participants**	**Schedule & Cost**
Recommend resource protection strategies for Moose Pond and other commercial agricultural sites.	BRCA, KC-SWCD, USDA/NRCS	Annually beginning in 2008 Variable cost depending on type of activities

Agriculture: The extent of agriculture has been reduced considerably in the Long Pond watershed. The majority of agricultural land today is more prominent in the direct watershed of Long Pond South (~317 acres), much of which is hayland, with a few commercial farming operations. The NPS survey for Long Pond (BRCA 2002) documented only one agricultural problem site involving livestock in the stream flowing into Moose Pond.

Action Item # 3: Educate watershed citizens about shoreline buffers		
Activity	**Participants**	**Schedule & Cost**
• Continue using BLA "Model Buffer Banner" in front of well-buffered camps • Work with local town clerks to provide education to new shoreline landowners • Target "Poor and Fair" shoreline properties for buffer plantings • Offer Erosion Control and Buffer Delineation Assistance similar to the Town of Bridgton	BRCA, BLA, Maine DEP, watershed citizens	Begin immediately - Cost is variable, depending on projects

Shoreline Residential: Shoreline residential sites have been determined to have a greater effect on the water quality of Long Pond North because there are more than twice the number of dwellings (267) than documented on Long Pond South (126). Combined, shoreline residences and shoreline roads are estimated to contribute 12% of the annual watershed-based phosphorus load to Long Pond North and 6% to Long Pond South (exclusive of septic systems). The NPS Survey for Long Pond reports that more than two-thirds of all identified problems in the watershed are residential (BRCA 2002).

In order to improve efforts to mitigate phosphorus export from shoreline residential lots, actions should be taken to encourage landowners to implement BMPs and adopt more responsible watershed behavior. This includes shoreline roads and driveways. The BRCA and the BLA will continue to work in a coordinated effort to expand current outreach to lakeshore owners and boaters by distributing informational material about lake protection and educating citizens about NPS best management practices. Based on the shoreline survey results from CEAT (2007, 2008), the most common BMP to be prescribed for shorefront-based protection should be the planting of shoreline buffer strips. With homes in close proximity to the water's edge, it is critical that adequate and effective vegetative buffers are in place to decrease and slow down run-off from shoreland sites.

An effort should be undertaken to encourage landowners to establish adequate and effective vegetated buffers along the shoreline by providing educational information, and continuing to provide technical assistance for installing these BMPs. The BRCA/BLA should continue efforts to meet with both seasonal and year-round shoreline property owners, with a goal of targeting shoreline properties receiving Buffer Quality ratings of "poor or fair". For a copy of The Buffer Handbook, contact the Maine DEP's Bureau of Land & Water Quality in Augusta (287- 2112) or for technical assistance regarding buffers, contact the BRCA or BLA.

Action Item # 4: Expand homeowner education & technical assistance programs		
Activity	**Participants**	**Schedule & Cost**
Provide stormwater management education to watershed residents.	BRCA, BLA, Maine DEP, watershed citizens	Begin immediately- Estimated $2-5,000 /yr

Non-Shoreline Residential Development: Non-shoreline development is estimated to contribute slightly less total phosphorus to Long Pond than shoreline residential development. The cumulative effects of non-shoreline development should also be regarded as a potential problem, especially in areas near brooks and streams. Actions that should be encouraged include establishing or maintaining vegetated buffer strips down-gradient of developed areas, changing lawn practices by encouraging compliance with a recently passed State law to ban high phosphorus fertilizers on non-agricultural lawns, installing BMPs on unimproved roadways, and practicing proper erosion control during any construction activities, however minor.

Action Item # 5: Continue to establish & maintain roadway BMP's		
Activity	**Participants**	**Schedule & Cost**
• Provide technical assistance to municipalities and camp road associations • Sponsor ME DOT "Local Roads" Workshops for contractors, town officials and camp road maintenance people • Inventory existing Road Associations and work with landowners to establish Camp Road Associations where they do not currently exist • Target road problem areas identified in NPS survey	BRCA, BLA, Towns of Belgrade, Rome and Mount Vernon, KC-SWCD, local Road Associations	Immediately & ongoing- Variable cost depending on extent of projects and assistance

Roadways: There has been substantial information gathered regarding the condition and potential NPS influence of the roadways in the direct watersheds of Long Pond, particularly in close proximity to the lake itself. This information was gathered as part of the Watershed Analysis by Colby College for both Long Pond North and Long Pond South, as well as the NPS survey conducted by the BRCA.

The NPS survey for Long Pond identified 13 sites on private roads, 11 on town roads, and one on State Rt. 27. The majority of problems on private roads involved maintenance issues such as surface erosion and clogged culverts. Problems on town roads were typically related to eroding shoulders and unstable culvert inlets and outlets (BRCA 2002).

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

Action Item # 6: Conduct septic system inspections and/or surveys		
Activity	**Participants**	**Schedule & Cost**
• Conduct septic system inspections/ surveys to identify any potential malfunctions and promote regular pumping to ensure proper septic system operation • Require septic upgrades upon sale or upgrade of property	Maine DEP, Towns of Belgrade, Rome and Mount Vernon, BRCA, BLA, and watershed citizens.	Annually beginning in 2008 Cost variable

Septic Systems: Antiquated and/or poorly designed and installed septic systems within the shoreland zone may contribute substantially to the annual total phosphorus load to adjacent lake water, adding to the cumulative phosphorus load to Long Pond. While Long Pond septic systems – when properly sited, constructed, maintained, and set back from the water – should have a minimal impact 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 Long Pond 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.

The shoreline survey conducted for Long Pond calculated a potential phosphorus load based on the number of residential dwellings, their estimated age (pre vs. post 1974) and their occupancy status. Both shoreline and non-shoreline septic systems were factored into the total phosphorus loading to Long Pond. Combined, septic systems have the potential to contribute 22% of the phosphorus load (14% shoreline, 8% non-shoreline). Areas where existing septic systems should especially be maintained or replaced include sections of the northwestern and southeastern shores of Long Pond South and the southern shoreline of Long Pond North.

Available options for reducing septic system-related phosphorus loading to Long Pond include seeking the replacement of pre-Plumbing Code septic systems and other poorly functioning systems within the shoreland zone of Long 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. Lakeshore residents who believe they may have problems with their septic systems are encouraged to contact their town office for possible technical and/or financial assistance.

Action Item # 7: Ongoing BMP training for municipal officials		
Activity	**Participants**	**Schedule & Cost**
• Municipal officials should continue to ensure compliance with local and State water quality laws and ordinances • Increase number of working hours for Town CEO's where needed • Inventory all shoreland lots using GPS indexed digital photos	Maine DEP, Maine DOT, BRCA, KC-SWCD, Towns of Belgrade, Rome and Mount Vernon, interested watershed citizens	Annually beginning 2008- Approximately $5,000/yr

Municipal Action: Ongoing training for municipal officials in current erosion and sediment control methods will ensure public compliance with local and state water quality laws and ordinances (Shoreland Zoning, Erosion and Sedimentation Control Law, plumbing code). This can be achieved through education and enforcement action, when necessary.

Increasing the resources available to CEO's of watershed towns should help reduce the number of violations that occur and go unnoticed in the shoreland zone. Efforts should focus on increasing the number of hours worked by CEO's where needed (Belgrade and Rome), inventorying all shoreland lots with GPS indexed digital photos for future reference. Towns should evaluate how to improve permits that are written and ensure better compliance.

Action Item # 8: Forest land conservation and management		
Activity	**Participants**	**Schedule & Cost**
• Provide technical assistance to forest land owners • Inform landowners of incentives, cost-share opportunities, management strategies, and relevant tax laws • Work with BRCA to continue to protect land in the watershed • Inventory managed vs. unmanaged forest land in the watershed	Maine Forest Service, BRCA, interested watershed citizens	Immediately & Ongoing - Minimal cost

Forest Land: Forest land in the combined direct watersheds of Long Pond make up 65% of the land area, representing the third largest phosphorus contribution to the lake. Still, compared to other developed land uses, undisturbed forest land can be a sink for atmospheric phosphorus and help infiltrate runoff before it can reach the lake. Landowners should be encouraged to retain forest land. Given that future development potential in the Long Pond watershed is expected to be relatively high, permanent land conservation easements or landowner incentives may provide additional water quality protection. Both the BRCA and the Maine Forest Service can provide on the ground technical assistance to get landowners started on long-term forest management strategies, cost-share opportunities, and information on current use tax laws including tree growth tax law (C. Martin, personal communication).

The recent land use analysis for Long Pond by CEAT did not assess the number of acres of actively managed forestland. As such, the estimated phosphorus loading from forest land may be underestimated. Future analysis should include managed versus unmanaged forest land in the watershed to determine the extent of phosphorus loading from this use.

Action Item # 9: Manage future watershed development		
Activity	**Participants**	**Schedule & Cost**
• Encourage building in existing developed areas • Modernize Comprehensive Plans to minimize the effects of future development • Ensure development meets 2007 phosphorus control standards • Manage development in the Great Pond Watershed	BRCA, BLA, Towns of Belgrade, Rome, and Mount Vernon, Maine DEP, interested watershed citizens	Immediately & Ongoing - Minimal cost

Future Development: Recent studies by the Colby Environmental Assessment Team (CEAT 2007, 2008) revealed that there are several hundred undeveloped buildable lots within 1000 feet of the shoreline of Long Pond North in the southwest corner of the watershed. In addition, there are 13 undeveloped shoreline lots on Long Pond North in Rome, and 11 undeveloped buildable lots in the direct watershed in the Town of Belgrade. There are an additional 50 undeveloped, buildable shoreline lots on the shoreline of Long Pond South. Large single family lots that exceed minimum lot size may be subdivided into multiple lots, thereby increasing the number of buildable lots in the future. Efforts should be made to encourage construction in existing developed areas, with all development subject to updated phosphorus control standards according to Maine DEPs 2007 revisions. In addition to new development, conversion of summer homes to year-round residences should be monitored.

Contributions of phosphorus from Great Pond far exceed the inputs from development in the direct watersheds of Long Pond. This means that declining water quality in Great Pond will ultimately lead to a decline in Long Pond. Any future watershed management plans for Long Pond should include restoration activities in the Great Pond watershed.

Future Development in the Long Pond Direct Watershed

There are a large number of small, already platted lots waiting to be developed along town and private roads in the Long Pond watershed with no safeguards requiring phosphorus load reduction (Bouchard, personal communication). As such, it is critically important that citizens be a part of drafting their Town's Comprehensive Plan. At this time, both Mount Vernon and Belgrade are working on updating their plans. Citizen input will help ensure that plans are modernized to incorporate phosphorus reduction strategies for all new development. It is imperative that each Town takes the initiative to follow through with these recommendations in order to keep P inputs at less than 0.5 ppb, and to halt the declining water quality of Long Pond.

WATER QUALITY MONITORING PLAN

Historically, the water quality of Long Pond (North and South basins) has been monitored on a monthly basis during open water periods since 1970. The Belgrade Lakes Association (BLA), through its water quality committee, has been active for several years in monitoring aspects of lake quality in conjunction with DEP and Colby College. The focus has been on Gloeotrichia but has included observations of general use regarding internal loading and lake currents. The monitoring program has been augmented through the effort of local volunteers who provide frequent Secchi disk transparency data (Maine DEP and VLMP). Some 20 BLA volunteers have contributed to water quality monitoring on both Long and Great ponds and will continue to do so in the future. Continued long-term water quality monitoring of Long Pond will be conducted between the months of May to October, through the continued efforts of the VLMP. Under this planned, post-TMDL water quality-monitoring scenario, sufficient data will be acquired to adequately track future seasonal and inter-annual variation and long-term water quality trends in Long Pond.

PCAP CLOSING STATEMENT

The Belgrade Lakes Association (BLA) and the Belgrade Regional Conservation Alliance (BRCA) have worked diligently to address nonpoint source pollution in the watershed of Long Pond and the other Belgrade Lakes. The BLA is the only organization in the region solely devoted to Great and Long ponds. Technical assistance by the BRCA is available to all watershed towns to mitigate phosphorus export from existing NPS pollution sources and the prevention of excess loading from future sources. The Maine Congress of Lakes Association (COLA) has been instrumental in the formation of a “Lake Trust” within BRCA that will be able to bring considerable professional expertise to bear on the PCAP initiative (Shannon, personal communication). In addition, watershed towns, including the Towns of Belgrade, Rome and Mount Vernon have long recognized the value of local water resources to the local way of life in the respective communities as well as the local economies, and provide strong support to lake restoration and protection efforts. These towns should be commended for their continued support of, and cooperation with the BRCA and the BLA in their pursuit of lake protection and improvement. The BRCA and BLA have worked to thwart the threat posed by invasive aquatic species and to promote education and outreach to Long Pond residents and recreational users. Based on the teamwork approach to lake improvement demonstrated over the past 20 years, there is a very high probability that the BRCA will continue to garner support from the local community, regional agencies, and the Maine DEP to advance restoration efforts in the Long Pond watershed. A Watershed-Based Management Plan for Long Pond, similar to the plan developed for nearby East Pond (McLean 2007), is forthcoming. In order to effectively reduce loading from the indirect watershed, which accounts for a majority of the P loading to Long Pond, the watershed-based management plan will need to incorporate management measures that include improvement of Great Pond, and should also consider other upstream Belgrade lakes.

APPENDICES

LONG POND (Belgrade, Rome and Mount Vernon)

Total Maximum Daily (Annual Phosphorus) Load

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' as historically applied to point-source pollutants. This information, no doubt, does little to clarify TMDLs 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, for nonpoint source pollution. Following EPA guidance (Spring 2006), we now report both daily and annual phosphorus loads.

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 33 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.

The first Maine lake TMDL was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and U.S. EPA. Recently (June 2006), Cobbossee Lake was officially removed from the TMDL listing of “impaired” waterbodies, in light of 9 years of above standard water clarity measures. TMDLs have been approved by U.S. EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered ponds (Kennebec County), Mousam Lake, the Highland lakes in Falmouth and Bridgton, Annabessacook Lake, Pleasant Pond, Upper Narrows Pond and Little Cobbossee Lake (under contract with CWD), Sabattus, Toothaker, Unity ponds, Long Lake (with assistance from Lakes Environmental Association), Togus Pond, Duckpuddle Pond, Lovejoy Pond, Lilly Pond, Sewall Pond, Cross Lake, Daigle Pond, Trafton Lake, Monson Pond, Echo Lake, Arnold Brook Lake, and Wilson Pond. A PCAP-TMDL study has also been initiated for Christina Reservoir, the last of the remaining 2006 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.

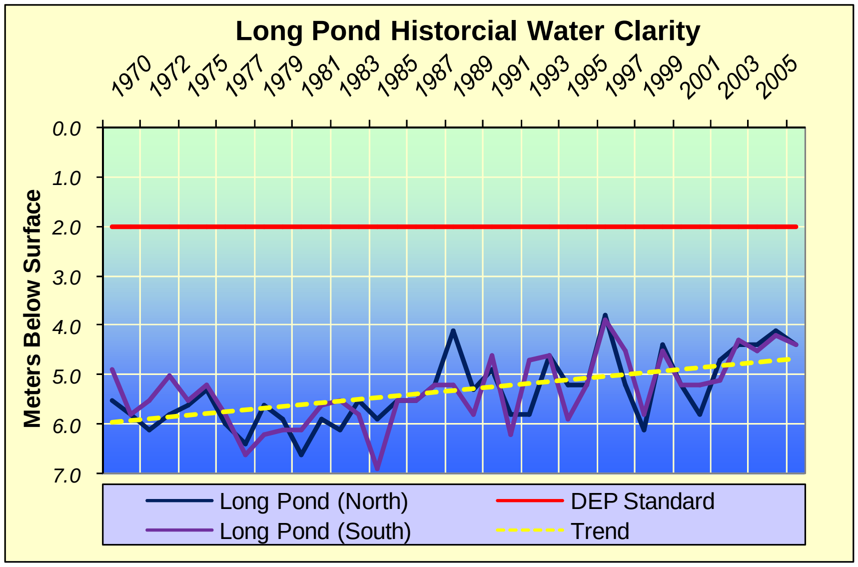
PCAP-TMDLs are important tools for maintaining and protecting acceptable lake water quality and are designed to 'get a handle' on the magnitude of the NPS pollution problem and to develop plans for implementing Best Management Practices (BMPs) to effectively address the lake’s water pollution problem. 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 (207-287-7649).
E-mail: david.halliwell@maine.gov

Water Quality, Priority Ranking, and Algae Bloom History

Water Quality Monitoring: (Source: Maine DEP and VLMP 2006) Water quality monitoring data for Long Pond (Stations 1 and 2, deep hole) has been collected annually since 1970 (with the exception of 1973). Hence, this present water quality assessment is based on thirty-six years of water quality data including 37 years of Secchi disk transparency (SDT) measures, combined with 22 years of epilimnion core and/or profile total phosphorus (TP) data, and 10 years of chlorophyll-a measures for Long Pond North, and 20 years of epilimnion core and/or profile total phosphorus (TP) data, and 8 years of chlorophyll-a measures for Long Pond South.

Water Quality Measures: (Source: Maine DEP and VLMP 2006) Historically, Long Pond North has had a range of SDT measures from 3.8 to 9.1 m, with an average of 6.5 m; an epilimnion TP range of 5 to 12 with an average of 8 parts per billion (ppb), and chlorophyll-a measures ranging from 2.0 to 9.6 ppb, with an average of 4.8 ppb. Long Pond South has similar water quality measures, with a range of SDT measures from 4.2 to 8.2 m, with an average of 6.3 m; an epilimnion TP range of 7 to 11 with an average of 9 parts per billion (ppb), and chlorophyll-a measures ranging from 2.6 to 9.0 ppb, with an average of 4.8 ppb.



Although consistently above minimum standards, the water clarity readings for Long Pond, have gradually declined since the 1980's. Over the past three decades, the water clarity in Long Pond has declined by an average of 1 meter.

Chlorophyll-a, an indicator of algal biomass, has generally been below the Maine State threshold of 8 ppb with notable exceptions in 2001 (9.6 ppb) and 2005 (9.0 ppb) in Long Pond North, and similarly as high as 9.0 ppb in Long Pond South in 2005. Since that time, the maximum value for Chl-a has exceeded 8 ppb during 11 of 14 years that Chl-a was monitored in the pond. During this same period, the annual average Chl-a exceeded the 8 ppb standard 4 times.

As Long Pond is a dimictic lake, it completely mixes, or "turns over", twice per year, once in the fall and once in the spring. Thermal stratification becomes established usually by the end of May and continues through October. During this period, oxygen commonly becomes depleted in the hypolimnion by August or September. Recent dissolved oxygen (DO) profiles show high DO depletion in deep areas of the lake. The potential for TP to leave the bottom sediments and become available to algae in the water column (internal loading) is moderate. Oxygen levels below 5 parts per million stress certain cold water fish, and a persistent loss of oxygen may eliminate or reduce habitat for sensitive cold water species (see Fish Assemblage & Fisheries Status - p.10).

Phosphorus, the nutrient that limits algal growth in the pond, has maintained a fairly consistent concentration since sampling began in 1970. Based on epilimnetic values, average springtime and summer concentrations are 8.8 and 8.4 ppb in Long Pond North and 8.3 ppb in Long Pond South (spring and summer averages are the same).

As indicated by the chart above, the water quality of both basins of Long Pond have generally declined over the historical monitoring period. The potential for nuisance blue-green algal blooms on Long Pond is currently considered moderate, while non-nuisance Gleotrichia blooms occur fairly regularly. Gleotrichia blooms are not at the nuisance level, but cause nuisance conditions that are both a concern to lake users, and an indicator of trophic stress on the lake system (Bouchard, personal communication).

Priority Ranking, Pollutant of Concern and Algae Bloom History: Long Pond is listed on the State's 2006 303(d) list of impaired waterbodies as well as the State's Nonpoint Source Priority Watersheds list. This Long Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algal growth in freshwater lakes in Maine.

Total phosphorus loading to Long Pond North from associated upstream sources, Great, Whittier, Kidder, and McIntire ponds (1,123 kg/year), accounts for loading from the indirect watershed, determined on the basis of flushing rate x volume x TP concentration, and 2,008 kg annually from the indirect watersheds of Long Pond South (Long Pond North and Ingham Pond).

Natural Environmental Background levels for Long Pond were not separated from the total non-point 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).

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 algal blooms which impair their potential use and enjoyment."

Maine DEP's functional definition of nuisance algal blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<30 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll-a levels (>8 ppb). Long Pond is a non-colored lake (average color 14 and 15 SPUs for Long Pond North and South, respectively), with declining minimum transparency measures. Currently, Long Pond does not meet water quality standards primarily due to increasing trophic state. This water quality assessment uses historic documented conditions as the primary basis for comparison.

Designated Uses and Antidegradation Policy: Long 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 numeric (in-lake) water quality target for Long Pond is set at 8 ppb total phosphorus (1,834 kg/yr for Long Pond North, and 1,947 kg/yr for Long Pond South). Since numeric criteria for phosphorus do not exist in Maine's state 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 allow for the attainment of the State's narrative standard by reversing the declining trend in Long Pond water quality. This goal is based on available lake-specific water quality data as Long Pond has at times attained this standard based on available historical water quality records.

ESTIMATED PHOSPHORUS EXPORT BY LAND USE CLASS

Tables 7 & 8 detail the numerical data used to determine external phosphorus loading for the Long Pond watershed. The key below the tables explains values in the columns, and the narrative that follows (p. 39) relative to each of the representative land use classes.

Table 7. Long Pond (North) Direct Watershed - Estimated Phosphorus Export by Land Use

LAND USE CLASS Long Pond North	Total Area Acres	Land Area %	TP Coeff. Avg. kg/TP/ha	TP Export Load kg TP	TP Export %
Agricultural Land				Long Pond North	
Agriculture	16	0.2%	0.91	6	1%
Sub-totals	**16**	**0.2%**		**6**	**1%**
Shoreline Development				Long Pond North	
Shoreline Residential	131	2%	1.00	53	9%
Shoreline Roads	26	0.4%	2.00	21	3%
Shoreline Septic Systems				126	20%
Sub-totals	**157**	**2%**		**200**	**32%**
Non-Shoreline Development				Long Pond North	
Commercial Land	0.1	0.1%	1.92	4	0.7%
Golf Course	9	0.1%	1.50	5	0.9%
Park	0.4	0.01%	0.80	0.1	0.02%
Non-Shoreline Residential	212	3%	0.50	43	7%
Non-Shoreline Roads	143	2%	1.50	87	14%
Non-Shoreline Septics				83	13%
Sub-totals	**365**	**6%**		**222**	**36%**
Total: DEVELOPED LAND	**538**	**8%**		**428**	**69%**
Non-Developed Land				Long Pond North	
Mixed Forest	1,718	23%	0.04	28	5%
Coniferous Forest	1,442	20%	0.04	23	4%
Deciduous Forest	1,856	25%	0.04	30	5%
Regenerating Land	239	3%	0.20	19	3%
Wetlands	179	2%	0.01	0.7	0.1%
Total: NON-DEVELOPED LAND	**5,434**	**74%**		**82**	**16%**
Total: Surface Water (Atmospheric)	**1,337**	**18%**	0.16	**87**	**14%**
Totals: DIRECT WATERSHED	**7,309**	**100%**		**617**	**100%**

Key for Columns in Table 7

Land Use Class: The land use category that was analyzed for this report.

Land Area in Acres: The area of each land use as determined by GIS mapping, and aerial photography.

Land Area %: The percentage of the watershed covered by the land use.

TP Coeff. Range kg/ha: The range of the total phosphorus coefficient values listed in the literature associated with the corresponding land use.

TP Coeff. Value kg/ha: The selected coefficient for each land use category. The total phosphorus coefficient is determined from previous research – usually the median value, if listed by the author.

Land Area in Hectares: Conversion, 1.0 acre = 0.404 hectares.

TP Export Load kg TP : Land area in hectares x TP coefficient value for the land use category.

TP Export Total %: The percentage of estimated phosphorus exported by the land use.

Table 8. Long Pond (South) Direct Watershed - Estimated Phosphorus Export by Land Use

LAND USE CLASS Long Pond South	Total Area Acres	Land Area %	TP Coeff. Avg. kg/TP/ha	TP Export Load kg TP	TP Export %
Agricultural Land				**Long Pond South**	
Agriculture	317	3%	0.91	110	20%
Sub-totals	**317**	**3%**		**110**	**20%**
Shoreline Development				**Long Pond South**	
Shoreline Residential	63	0.7%	1.00	25	5%
Shoreline Roads	7	0.1%	2.00	6	1%
Shoreline Septic Systems				39	7%
Sub-totals	**70**	**0.8%**		**70**	**13%**
Non-Shoreline Development				**Long Pond South**	
Commercial Land	14	0.1%	1.92	11	2%
Non-Shoreline Residential	115	1%	0.50	23	4%
Non-Shoreline Roads	159	2%	1.50	97	17%
Non-Shoreline Septics				15	3%
Sub-totals	**288**	**3%**		**146**	**26%**
Total: DEVELOPED LAND	**676**	**7%**		**326**	**59%**
Non-Developed Land				**Long Pond South**	
Mixed Forest	885	9%	0.04	14	3%
Coniferous Forest	1,730	18%	0.04	28	5%
Deciduous Forest	3,529	37%	0.04	57	10%
Regenerating Land	543	6%	0.20	44	8%
Wetlands	958	10%	0.01	4	0.7%
Total: NON-DEVELOPED LAND	**7,644**	**80%**		**147**	**26%**
Total: Surface Water (Atmospheric)	**1,329**	**13%**	0.16	**86**	**15%**
Totals: DIRECT WATERSHED	**9,649**	**100%**		**559**	**100%**

Key for Columns in Table 8

Land Use Class: The land use category that was analyzed for this report.

Land Area in Acres: The area of each land use as determined by GIS mapping, and aerial photography.

Land Area %: The percentage of the watershed covered by the land use.

TP Coeff. Range kg/ha: The range of the total phosphorus coefficient values listed in the literature associated with the corresponding land use.

TP Coeff. Value kg/ha: The selected coefficient for each land use category. The total phosphorus coefficient is determined from previous research – usually the median value, if listed by the author.

Land Area in Hectares: Conversion, 1.0 acre = 0.404 hectares.

TP Export Load kg TP: Land area in hectares x TP coefficient value for the land use category.

TP Export Total %: The percentage of estimated phosphorus exported by the land use.

Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the Long Pond watershed are presented on the previous pages in Tables 7 & 8. These tables represents the extent of the current direct watershed phosphorus loading to Long Pond North (617 kg/yr), and Long Pond South (559 kg/yr). Total phosphorus loading from Long Pond North's indirect watershed (Great, Kidder, McIntire and Whittier ponds –1,123 kg/yr), and for Long Pond South's indirect watershed (Long Pond North and Ingham Pond-2,008 kg/yr) was determined on the basis of *flushing rate x volume x TP concentration* representing typical area gauged stream flow calculations.

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 loading values were primarily determined using literature and locally-derived export coefficients as found in Reckhow et al. (1980), Dennis et al. (1992), Monagle (1995), Dudley et al. (1997), Wagner et al. (1989) and Likens et al. (1977) for residential properties, agriculture, roadways, and other types of development (commercial, parks, and golf courses).

Agriculture: Phosphorus loading coefficients as applied to agricultural land uses were adopted from: Reckhow et al. (1980): mixed agriculture (0.91 kg/ha/yr). Agricultural land included a tree farm with a loading coefficient of 0.40 kg/ha/yr, first used for Annabessacook Lake in 1977.

Residential Development: The phosphorus loading coefficients for residential land uses, including; medium impact residential (1.0 kg TP/ha/yr), and low density non-shoreline residential (0.5 kg/ha/yr), were developed from information on residential lot stormwater export of phosphorus as derived from Dennis et al (1992), and first implemented in the 1995 Cobbossee Lake TMDL.

Commercial: The phosphorus loading coefficient for commercial land (1.50 kg TP/ha/yr) is based on recommendations by Jeff Dennis (Maine DEP).

Roads: The total phosphorus loading coefficients for shoreline roads (2.0 kg/ha/yr) and for non-shoreline roads (1.5 kg/ha/yr) were chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997) and phosphorus research by Jeff Dennis (Maine DEP).

Other Developed Land Areas: The total phosphorus loading coefficient for other developed land areas including parks (0.80 kg TP/ha/yr) and golf courses (1.50 kg TP/ha/yr) are derived from research by Wagner et al. (1989) and phosphorus research by Jeff Dennis (Maine DEP).

Total Developed Lands Phosphorus Loading: A total of 69% (428 kg) of the phosphorus loading to Long Pond North, and 59% (326 kg) is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: *agriculture* (1% - 6 kg for Long Pond North and 20% - 110 kg for Long Pond South); *shoreline development* (32% - 200 kg for Long Pond North and 13% - 70 kg for Long Pond South); and *non-shoreline development* (36% - 222 kg for Long Pond North and 26% - 146 kg for Long Pond South) as depicted in Table 3.

Non-Developed Lands Phosphorus Loading: The phosphorus export coefficient for forest land (0.04 kg/ha/yr) is based on a New England regional study (Likens et al 1977) and phosphorus availability recommendation by Jeff Dennis (Maine DEP). The phosphorus export coefficient for regenerating land (0.20 kg/ha/yr) is based on research by Bouchard in 1995. The export coefficient for wetlands is based on research by Bouchard 1995 and Monagle 1995 (0.01 kg/ha/yr). The phosphorus loading coefficient chosen for surface waters (atmospheric deposition - 0.16 kg/ha/yr), was originally used in the China Lake TMDL (Kennebec County), and subsequent PCAP-TMDL lake studies in Maine.

Shoreline Erosion: Undeveloped areas of the lake shoreline that may be eroding due to natural causes (i.e., wind, wave and ice action) are not included as a source of phosphorus due to the difficulty in quantifying impact area and assigning suitable phosphorus loading coefficients.

Phosphorus Load Summary

It is our professional opinion that the selected export coefficients are appropriate for the direct watersheds of Long Pond. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external (direct and indirect drainages) nonpoint source nutrient pollution for Long Pond North approximates 1,740 (617 +1,123) kg/yr, and 2,567 (559 + 2,008) kg/yr for Long Pond South.

LINKING WATER QUALITY and POLLUTANT SOURCES

Annual/Daily Load Capacity: Total Phosphorus (TP) serves as a surrogate measure of Maine's narrative water quality standards for lake trophic status. The phosphorus-based TMDL is originally calculated as an annual load (kg TP/yr), which is based on an in-lake numeric water quality target (ppb or ug/l TP) and the annual flushing rate of the lake, using generally accepted response models for lakes. It is appropriate and justifiable to express the Long Pond TMDL as an annual load because the North and South basin's have annual flushing rates of 3.0 and 3.5, respectively (see discussion of seasonal variation on page 43). The annual flushing rate, or the theoretical rate at which water in a lake is replaced on an annual basis, is calculated as:

Flushes/year = (Watershed area * Runoff/year) / Lake volume

This TMDL also presents daily pollutant loads of TP in addition to the annual load. Daily flushing rates were determined by first calculating the monthly discharge from Dudley (2004). A number of parameters were required for input into these formulas including: Drainage area; % of significant sand and gravel aquifers; distance from the watershed to a predetermined line off the Maine coast; and mean annual precipitation. These parameters were determined using GIS (ArcGIS 9).

Once the monthly discharge was determined, this information was used to ascertain the following:

% Total Monthly Discharge = (Total monthly discharge/ Total annual discharge) *100

Flushes/month = (Total # of flushes/year * % of total monthly discharge)

Flushes/day = (Flushes/month)/(Days/month)

The majority of the parameters used for calculating the annual loading capacity (kg TP/yr) on page 46 (Dillon and Rigler 1974, where L= (Azp)/(1-R)), remain unchanged for use in calculating the daily loading capacity. The exception is p, where p now equals flushes/month. Thus, the monthly loading capacity is expressed as a proportion of the annual loading capacity, based on the discharge expected for that month. The daily loading capacity was then calculated as follows:

Daily Load Capacity (kg/day) = (Monthly Load Capacity)/(Days/month)

The daily loads for Long Pond (North and South basins) are presented on pages 44-45.

Assimilative Loading Capacity: The Long Pond basin lake assimilative capacity is capped at 1,834 kg TP/yr for Long Pond North and 1,947 kg TP/yr for Long Pond South as derived from the empirical phosphorus retention model based on a target goal of 8 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 8 ppb. This TMDL target concentration is expected to be met at all times (daily, monthly, seasonally, and annually). However, because the annual load of TP as a TMDL target is more easily aligned with the design of best management practices used to implement nonpoint source and stormwater TMDLs for lakes than daily loads of specific pollutants, this TMDL report recommends that the annual load target in the TMDL be used to guide implementation efforts. Ultimate compliance with water quality standards for the TMDL will be determined by measuring in-lake water quality to determine when standards are attained.

Future Development: An analysis of regional population trends in the Long Pond South direct watershed suggests an increase in total phosphorus concentration of five percent by 2020 and ten percent by 2030 (CEAT 2008). At this current rate of growth, phosphorus concentrations are expected to reach 9.7 ppb by 2030. In order to effectively meet the stated goal of decreasing the current trophic state conditions, further reductions in the existing watershed loading is necessary. Conversion of seasonal homes to year-round homes, development of remaining shoreline lots, and construction of new homes within existing subdivisions are the most likely patterns of growth in the Long Pond watershed. The unmitigated rate of increase in Long Pond's annual phosphorus load due to new development approximates 172 kg TP/yr for Long Pond North, and 182 for Long Pond South (Dennis et al. 1992 application).

The Maine DEP water quality goal of a decreasing trophic state includes a reduction of current P-loading which accounts for both current P-loading as well as potential future development in the watershed. The methods used by the 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.

Anticipated P-loading from future development in the Long Pond North watershed is 172 kg (1 ppb change in trophic state = (229 kg x 0.75), and 182 kg (1 ppb change in trophic state = 243 x 0.75). Hence, existing phosphorus load sources must be reduced by an additional 172 kg/yr in Long Pond North, and 182 kg/yr in Long Pond South to allow for anticipated new sources of phosphorus loading to the pond.

Internal Lake Sediment Phosphorus Mass: The relative contribution of internal sources of total phosphorus within Long Pond North – in terms of internal recycling of sediment-based phosphorus – were analyzed (using lake volume-weighted mass differences between late spring and late summer/ early fall) and estimated on the basis of five years of water column TP data (1992, 1998, 1999, 2001, 2003). Likewise, five years of water column TP data (1997, 1999, 2001, 2002, 2003) were used for calculating the internal sources of phosphorus in Long Pond South. It is assumed that this increase of 108 kg/yr for Long Pond North, and 65 kg/yr for Long Pond South is attributed primarily to internal recycling of phosphorus from phosphorus-rich sediments.

Linking Pollutant Loading to a Numeric Target: The basin loading assimilative capacity for non-colored Long Pond was set at 1,834 kg/yr for Long Pond North, and 1,947 kg/yr of total phosphorus for Long Pond South in order to meet the numeric water quality target of 8 ppb of total phosphorus. Phosphorus retention models, calibrated to in-lake phosphorus data for each basin, was used to link phosphorus loading to numeric target.

Supporting Documentation for the Long Pond TMDL Analysis includes the following: Maine DEP/ VLMP water quality monitoring data; watershed land use maps; literature derived phosphorus export coefficients; and specification of a phosphorus retention model - including both empirical models and retention coefficients.

Long Pond Total Phosphorus Retention Model - Long Pond North

(after Dillon and Rigler 1974 and others)

L = P (A z p) / (1-R) where, **1 ppb change = 229 kg**

1,834 = **L** = total phosphorus load capacity (kg TP/year)
8 = **P** = total phosphorus concentration (ppb) = Target Goal = **8 ppb**
5.41 = **A** = lake basin surface area (km^2) = 541 ha or 1,337 acres
8.9 = **z** = mean depth of lake basin (m) **A z p = 144**
3.0 = **p** = annual flushing rate (flushes/year)
0.63 = **1- R** = phosphorus retention coefficient, where:
0.37 = **R = 1 / (1+ sq. rt. p)** (Larsen and Mercier 1976)

<u>Long Pond Total Phosphorus Retention Model</u> - Long Pond <u>South</u>
(after Dillon and Rigler 1974 and others)

L = P (A z p) / (1-R) where, **1 ppb change = 243 kg**

1,947 = **L** = total phosphorus load <u>capacity</u> (kg TP/year)
8 = **P** = total phosphorus concentration (ppb) = <u>Target Goal</u> = **8 ppb**
5.38 = **A** = lake basin surface area (km^2) = 538 ha or 1,329 acres
8.4 = **z** = mean depth of lake basin (m) **A z p = 158**
3.5 = **p** = annual flushing rate (flushes/year)
0.65 = **1- R** = phosphorus retention coefficient, where:
0.35 = **R = 1 / (1+ sq. rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenweider (Dillon and Rigler 1974) type empirical model for Maine lakes, e.g., Cobbossee, Madawaska, Sebasticook, East, China, Mousam, Highland (Falmouth), Webber, Threemile, Threecornered, Annabessacook, Pleasant, Sabattus, Toothaker, Unity, Upper Narrows, Highland (Bridgton), Little Cobbossee, Long (Bridgton), Togus, Duckpuddle, Lovejoy, Lilly, Sewall, Cross, Daigle, Trafton, Monson, Echo, Arnold Brook, and Wilson Pond PCAP-TMDL reports (Maine DEP 2000-2007) have all 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 Long Pond TMDL was developed using existing water quality monitoring data, collected and compiled by the ME-DEP and VLMP; derived watershed phosphorus export coefficients (Reckhow et al. (1980), Dennis et al. (1992), Monagle (1995), Dudley et al. (1997), Wagner et al. (1989) and Likens et al. (1977); and a phosphorus retention model which incorporates both empirically derived and observed retention coefficients (Vollenweider 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 <u>US-EPA National Eutrophication Survey</u> (US-EPA-NES) 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.
- Export coefficients were derived from extensive databases, and were determined to be appropriate for the application lake.
- 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.
- Absence of TP loading coefficients for shoreline erosion contribution.

Critical Conditions occur in Long Pond during the late summer and early autumn, when the potential (both occurrence and frequency) of nuisance algaal blooms are greatest. The loading capacity of <u>8 ppb</u> 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 <u>Seasonal Variation</u>).

LOAD ALLOCATIONS (LA's) - The annual total phosphorus load allocation for Long Pond equals 1,834 kg for Long Pond North, and 1,947 kg TP for Long Pond South and represents, in part, that portion of the lake's assimilative capacity allocated to non-point (overland) sources of phosphorus. Direct external TP sources for Long Pond North and South (totaling 617 and 559 kg respectively, annually) have been identified and accounted for in the land-use breakdown portrayed in Tables 7 & 8. Further reductions in nonpoint source phosphorus loadings necessary to satisfy the load allocation will need to be produced from implementation of NPS best management practices for agricultural land in the Long Pond South watershed, road networks and septic systems in both watersheds, and improved overall "environmental housekeeping" practices by all watershed residents (see summary, pages 15-17). 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, and subsequent TMDLs), in-lake nutrient loadings in Long Pond North originate from a combination of direct and indirect (watershed + Great Pond + McIntire Pond + Kidder Pond + Whittier Pond) external and internal (lake sediment) sources of total phosphorus. Similarly, in-lake nutrient loadings in Long Pond South originate from a combination of direct and indirect (watershed + Long Pond North + Ingham Pond) external and internal (lake sediment) sources of total phosphorus.

WASTE LOAD ALLOCATIONS (WLA's): Since there are no existing point source discharges subject to NPDES permit requirements in the Long Pond direct watersheds, the WLA is set at 0 (zero), and all of the loading capacity is allocated as a gross allotment to the "load allocation".

MARGIN OF SAFETY (MOS): The TMDL expressed in terms of annual and daily loads includes an implicit MOS through the relatively conservative selection of the numeric water quality target (based on a state-wide database for lakes, supported by in-lake data). Based on both the Long Pond historical records and a summary of statewide Maine lakes water quality data for non-colored (< 30 SPU) lakes - the target of 8 ppb (1,834 kg/yr in Long Pond North and 1,947 kg/yr in Long Pond South) represents a highly conservative goal to assure future attainment of Maine DEP water quality goals of non-sustained and non-repeated blue-green summer-time algal blooms due to NPS pollution or cultural eutrophication and stable or decreasing trophic state.

SEASONAL VARIATION: The Long 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, when conditions most favor the growth of algae and aquatic macrophytes. With average flushing rates of 3.0 and 3.5 flushes/year, the average annual phosphorus loading to Long Pond North and South is most critical to the water quality in Long 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. Furthermore, non-point source best management practices (BMPs) proposed for the Long Pond watershed have been designed to address total phosphorus loading during all seasons.

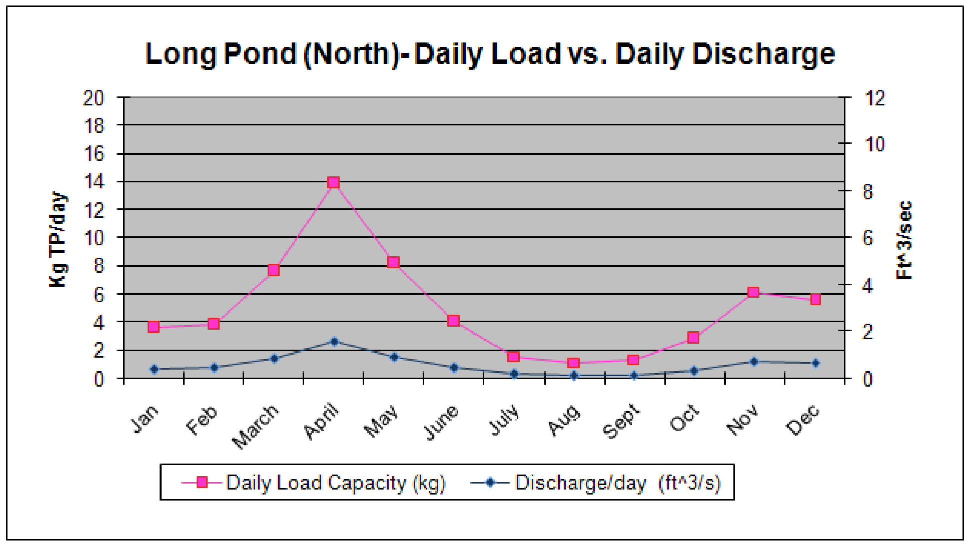
This variation is further accounted for in calculations of seasonal (May-October, November– April), monthly, and daily TP load calculations (pp. 44-45). These numbers are derived from formulas developed by Dudley (2004) for ungaged rivers in Maine, and are based on several physical and geographic parameters including: 1) drainage area of the waterbody, 2) percent of sand and gravel aquifers in the drainage area, 3) distance from a stationary line along the Maine coast, and 4) mean annual precipitation. Daily loading rates are then determined using variables from Dillon and Rigler (1974 - p. 46) for calculating the external total phosphorus load capacity (pp. 37-39) for the lake.

Daily TP Pollutant Loads for Long Pond (North)

Month	Discharge (ft^3/s)	% of Total	Flushes/month	Monthly Load Capacity (kg)	Discharge/day (ft^3/s)	Flushes/day	Daily Load Capacity (kg)
Jan	12.49	6%	0.18	111.2	0.40	0.006	3.59
Feb	12.08	6%	0.18	107.6	0.43	0.006	3.84
March	26.67	13%	0.39	237.4	0.86	0.01	7.66
April	46.70	23%	0.68	415.7	1.56	0.02	13.86
May	28.63	14%	0.42	254.9	0.92	0.01	8.22
June	13.70	7%	0.20	122.0	0.46	0.01	4.07
July	5.41	3%	0.08	48.2	0.17	0.003	1.55
Aug	3.90	2%	0.06	34.7	0.13	0.002	1.12
Sept	4.52	2%	0.07	40.3	0.15	0.002	1.34
Oct	9.90	5%	0.14	88.1	0.32	0.005	2.84
Nov	20.76	10%	0.30	184.8	0.69	0.01	6.16
Dec	19.44	10%	0.28	173.0	0.63	0.01	5.58

Season	% of Total	# Flushes
May -October	32%	1.0
November-April	68%	2.0

Vollenweider: L = P (Azp) / (1-R)	
L = external P load capacity (kg TP/yr)	**1834**
P = total P concentration (ppb)	8
A = lake basin surface area (km2)	5.41
z = mean depth of lake basin (m)	8.9
p = annual flushing rate	3.0
1-R = P retention coefficient	0.63
R = 1 / (1 + sq. rt. p)	0.37

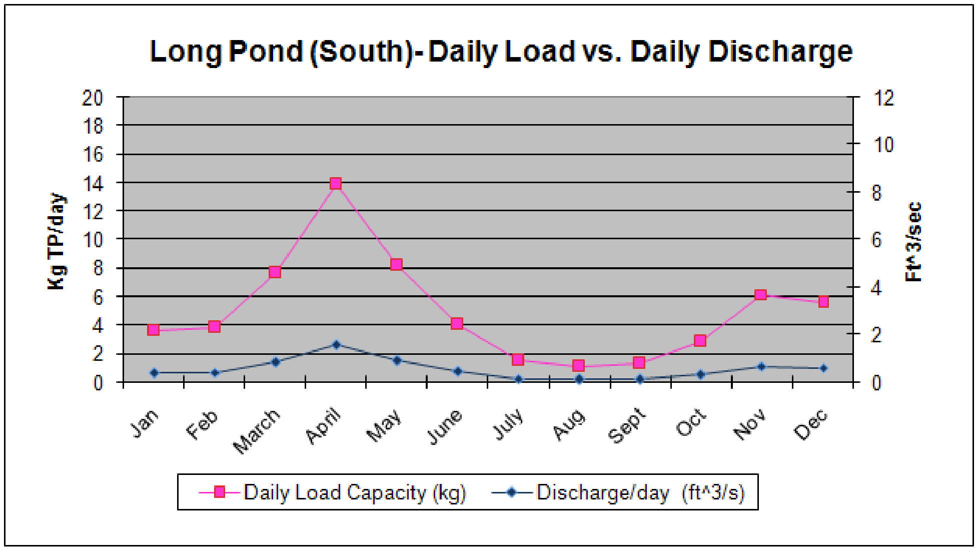


Daily TP Pollutant Loads for Long Pond (South)

Month	Discharge (ft^3/s)	% of Total	Flushes/month	Monthly Load Capacity (kg)	Discharge/day (ft^3/s)	Flushes/day	Daily Load Capacity (kg)
Jan	17.80	6%	0.22	121.2	0.57	0.007	3.91
Feb	17.15	6%	0.21	116.8	0.61	0.008	4.17
March	37.00	13%	0.45	251.9	1.19	0.01	8.13
April	65.13	23%	0.80	443.4	2.17	0.03	14.78
May	39.78	14%	0.49	270.8	1.28	0.02	8.74
June	19.26	7%	0.24	131.1	0.64	0.01	4.37
July	7.76	3%	0.10	52.8	0.25	0.003	1.70
Aug	5.56	2%	0.07	37.9	0.18	0.002	1.22
Sept	6.40	2%	0.08	43.6	0.21	0.003	1.45
Oct	13.73	5%	0.17	93.5	0.44	0.01	3.02
Nov	28.41	10%	0.35	193.4	0.95	0.01	6.45
Dec	27.22	10%	0.33	185.3	0.88	0.01	5.98

Season	% of Total	# Flushes
May -October	32%	1.1
November-April	68%	2.4

Vollenweider: L = P (Azp) / (1-R)	
L = external P load capacity (kg TP/yr)	1947
P = total P concentration (ppb)	8
A = lake basin surface area (km2)	5.4
z = mean depth of lake basin (m)	8.4
p = annual flushing rate	3.5
1-R = P retention coefficient	0.65
R = 1 / (1 + sq. rt. p)	0.35



Regression Equations Used for Calculating Daily Loads for Long Pond (from Dudley, 2004)

Table 7. Regression equations and their accuracy for estimating mean monthly streamflows for ungaged, unregulated streams in rural drainage basins in Maine

[ASEP, average standard error of prediction; PRESS, prediction error sum of squares; EYR, equivalent years of record; n, number of data points used in regression]

Regression equation	ASEP (in percent)	$(PRESS/n)^{1/2}$ (in percent)	Average EYR
$Q_{jan\ mean} = 36.36\ (A)^{1.007}\ (DIST)^{-0.771}$	-10.2 to 11.4	-11.1 to 12.5	29.9
$Q_{feb\ mean} = 46.79\ (A)^{0.991}\ (DIST)^{-0.829}$	-9.79 to 10.8	-12.0 to 13.7	41.2
$Q_{mar\ mean} = 109.10\ (A)^{0.924}\ (DIST)^{-0.807}$	-21.0 to 26.6	-22.4 to 28.8	7.27
$Q_{apr\ mean} = 1.362\ (A)^{1.006}\ 10^{0.013(pptA)}$	-15.6 to 18.4	-16.7 to 20.0	4.94
$Q_{may\ mean} = 0.350\ (A)^{1.035}\ (DIST)^{0.486}$	-15.8 to 18.8	-16.8 to 20.2	6.96
$Q_{jun\ mean} = 1.372\ (A)^{1.030}$	-14.6 to 17.1	-15.2 to 17.9	13.1
$Q_{jul\ mean} = 0.475\ (A)^{1.089}\ 10^{0.631(SG)}$	-19.3 to 24.0	-21.4 to 27.2	8.38
$Q_{aug\ mean} = 0.353\ (A)^{1.075}\ 10^{0.822(SG)}$	-22.0 to 28.2	-22.9 to 29.6	8.60
$Q_{sep\ mean} = 0.434\ (A)^{1.049}\ 10^{0.834(SG)}$	-19.9 to 24.9	-23.2 to 30.2	13.9
$Q_{oct\ mean} = 1.084\ (A)^{0.989}\ 10^{0.399(SG)}$	-19.3 to 24.0	-22.5 to 29.1	17.0
$Q_{nov\ mean} = 2.497\ (A)^{0.948}$	-18.6 to 22.9	-20.7 to 26.0	11.9
$Q_{dec\ mean} = 16.92\ (A)^{0.979}\ (DIST)^{-0.476}$	-12.4 to 14.1	-13.6 to 15.7	28.9

where,

Q — streamflow statistic of interest.

A — contributing drainage area, in square miles.

SG — fraction of the drainage basin that is underlain by significant sand and gravel aquifers, on a planar area basis, expressed as a decimal. For example, if 15 percent of the drainage area of a basin has significant sand and gravel aquifers, then $SG = 0.15$. Based on the significant sand and gravel aquifer maps produced by the Maine Geological Survey and maintained as GIS data sets by the Maine Office of GIS.

pptA — mean annual precipitation, in inches, computed as the spatially averaged precipitation in the contributing basin drainage area. Based on non-proprietary PRISM precipitation data spanning the 30-year period 1961-1990. Data maintained as GIS data sets by the Natural Resources Conservation Service (1998).

DIST —distance from the coast, in miles, measured as the shortest distance from a line in the Gulf of Maine to the contributing drainage basin centroid. The line in the Gulf of Maine is defined by end points 71.0W, 42.75N and 65.5W, 45.0N, referenced to North American Datum of 1983.

See the Regression Analyses section of this report for more details.

PUBLIC PARTICIPATION: Adequate ('full and meaningful') public participation in the Long Pond PCAP-TMDL development process was ensured - during which land use and phosphorus load reductions were discussed - through the following avenues:

1. **July 6, 2007:** FB Environmental staff met with Maine DEP, BRCA and the BLA to discuss the Long Pond TMDL process and to collect background information about the lake.

2. **July 13, 2007:** FB Environmental Staff contacted Colby Professor David Firmage to determine the schedule for the shoreline and septic survey and offer technical assistance.

3. **September 11, 2007:** FB Environmental staff Jennifer Jespersen and Maine DEP Biologist Dave Halliwell co-presented information about the TMDL process to Colby College students in preparation for the Shoreline and Septic Survey.

4. **October 19, 2007:** FB Environmental staff contacted watershed towns to collect information about Comprehensive Plan updates.

5. **December 6, 2007:** FB Environmental staff attended the CEAT Long Pond South public presentation in Belgrade, and spoke with staff from Maine DEP, BRCA and watershed towns.

6. **December 12, 2007:** MacGregor Stocco, Chair of the Belgrade Long Range Planning Committee contacted FB Environmental staff and provided information about the Comprehensive Plan.

7. **December 19, 2007:** FB Environmental staff Jennifer Jespersen met with BRCA Executive Director Peter Kallin and Charlie Baeder (Mount Vernon Comprehensive Planning Committee) to discuss code enforcement, and collect information about BRCA past and present projects.

8. **January 28, 2008:** FB Environmental staff Jennifer Jespersen met with Maine DEP staff Dave Halliwell and Roy Bouchard to discuss watershed boundaries.

9. **January 31, 2008**: FB Environmental staff Jennifer Jespersen contacted Peter Kallin and Jason Bulay at the BRCA to collect information about the Conservation Corps projects.

STAKEHOLDER AND PUBLIC REVIEW PROCESS

A two-week stakeholder review was distributed electronically on February 22, 2008 to the following individuals who expressed a specific interest, participated in the field work or helped develop the draft Long Pond PCAP-TMDL report: Belgrade Regional Conservation Alliance (Peter Kallin and Jason Bulay); Colby College (David Firmage and BI493 students); Town of Belgrade (Dennis Keschl, Gary Fuller, Mac Stocco); Town of Rome (Dennis Phillips, Bill Najpauer); Town of Mount Vernon (Charles Baeder, Russell Libby, Richard Marble); Belgrade Lakes Association (Roger Shannon, Kathy Lowell); KC-SWCD (John Blais); Maine Forest Service (Chris Martin); Maine Department of Inland Fisheries and Wildlife (Bill Woodward); and David Rocque (Maine Department of Agriculture). Responses were received from representatives of the BLA and the BRCA and incorporated into this Public Review document.

The following notification was advertised in the *Kennebec Journal* over the weekend of March 29-30, 2008.

LONG POND - Rome, Belgrade, and Mount Vernon, Maine

In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130 - the Maine Department of Environmental Protection has prepared a combined Phosphorus Control Action Plan (PCAP) and Total Maximum Daily Load (TMDL) nutrient report (DEPLW– 0888) for the **LONG POND WATERSHED**, located within the Towns of Rome, Belgrade, and Mount Vernon. This PCAP-TMDL report provides best estimates of non-point source phosphorus loads for all representative land use classes in the **LONG POND** direct watershed and the total phosphorus reductions required to restore and maintain acceptable water quality conditions. A Public Review draft of this report may be viewed at Central Maine DEP offices in Augusta (Ray Building, Hospital Street - Route 9, Land & Water Bureau) or on-line: http://www.maine.gov/dep/blwq/comment.htm. Please send all comments, in writing by April 11, 2008 to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333 or e-mail: david.halliwell@maine.gov.

PUBLIC REVIEW Comments Received

John Blais (KC-SWCD) reviewed the Public Review document and suggested that winter road maintenance should be considered as part of the phosphorus reduction plan.

RESPONSE- from Jennifer Jespersen, FB Environmental (Long Pond Project Manager)
Thank you for your comment regarding winter road maintenance in the Long Pond watershed. The phosphorus loading estimates used for roads in the TMDL are based on phosphorus loading coefficients from previous studies of rural Maine highways (Dudley et al., 1997), and phosphorus research conducted by Jeff Dennis at Maine DEP. You will find the reference for the 1997 report listed on page 50 of the TMDL. The consensus among staff at Maine DEP is that there is little to be gained by trying to separate out P inputs from winter maintenance because it is meant to be contained within the estimates currently used in the TMDL, (though it was not specifically evaluated in putting together P loading coefficients).

Road sand getting into streams and lakes is a very real issue and with too much accumulation can be damaging not only because of P input, but also because it is known to degrade fish habitat. Maine DOT installed catch basins to reduce bulk sand deposition along a road segment in the Long Pond North watershed. These catch basins effectively trap sand, but can be costly as well as a maintenance issue for the Town.

Because of the public safety concerns about slippery roads, the strong financial incentive to minimize sand use, and the level of precision of P loading estimates, BMP's for winter sanding may not profit from further investigation in the Long Pond watershed. That being said, on a dollar for dollar basis, more good would probably come from focusing efforts on other road BMPs as described on pages 28 and 29 of the TMDL, and in the surveys conducted by both the BRCA and Colby College. As a municipal resource, MDOT Local Roads Center has Salt/Sand workshops in the fall for any interested towns. These trainings provide an informative notebook which is available to towns upon request.

Pete Kallin (Executive Director, BRCA) reviewed the Public Review document and provided several comments making note of the large P loading inputs to Long Pond from Great Pond and other indirect watersheds. He suggested the need for a watershed-based implementation plan that extends to all of the Belgrade Lakes upstream of Long Pond. He also noted the importance of continual long-term water quality monitoring to ensure trophic status is in fact stabilizing or reversing. These comments have been addressed and incorporated into this final draft submittal.

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