Annabessacook Lake (Winthrop & Monmouth)
Watershed Based Plan

NPS Grant Project #2004R-30

Prepared for the
Maine Department of Environmental Protection
by Cobbossee Watershed District

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This plan complements and supplements the Annabessacook Lake Phosphorus Control Plan and Total Maximum Daily Load (TMDL) completed by the Maine Department of Environmental Protection (MDEP), Cobbossee Watershed District (CWD), and the Maine Association of Conservation Districts (MACD) in May of 2004. For more information, readers are encouraged to refer to the TMDL report available at: http://www.state.me.us/dep/blwq/docmonitoring/tmdl2.htm

Document Purpose

The purpose of the Watershed Based Plan, herein referred to as the "plan", is to lay out a strategy and schedule for NPS mitigation in the watershed to rehabilitate Annabessacook Lake. Completion of a Watershed-Based Plan is required to apply §319 funds to help restore and impaired (TMDL) waterbody. The EPA believes preparation of the plan is necessary to ensure that §319 funded projects make progress towards restoring NPS impaired waters. A Watershed-Based Plan must be designed to achieve the pollutant load reductions called for in a TMDL and address EPA's 9 mandatory elements for watershed planning.

Scope of Plan

The plan is designed to outline and describe actions that are expected to be implemented over the course of a ten-year period (2007 to 2016) in the Towns of Monmouth and Winthrop in the direct watershed of Annabessacook Lake. In the Annabessacook Lake (Monmouth & Winthrop) PCAP-TMDL (MDEP 2004), it is reported a need for an estimated reduction in annual loading from the current level of 332 kg/yr plus and additional 83 kg/yr to address future development. The total, or 415 kg, approximates a 15% of the current annual phosphorus load the Annabessacook Lake from all sources (the direct and indirect watersheds and internal loading). This plan is intended to incorporate measures in the watershed to realize an interim goal of an estimated 14% reduction (183 kg) in annual phosphorus loading from the direct watershed, which is estimated to contribute 1,315 kg/yr of TP to the lake.

Lake Water Quality Objective

In general, the main objective of this plan is to achieve a stable or decreasing trophic state, with the main goal to eliminate the occurrence of late summer or early fall nuisance algae blooms. It is anticipated that this could be accomplished by an estimated 14 % reduction in phosphorus loading from the direct watershed. In doing so, the lake could attain Class GP-A water quality criteria (38 MRSA 465-A(b)). By achieving these objectives, Annabessacook Lake could be removed from the §303(d) TMDL list ala Cobbossee Lake, 2006.

Acknowledgment: Funding for this project was provided by the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act. Section 319 grants are administered by the Maine Department of Environmental Protection in partnership with EPA.

Description of Watershed & Lake Water Quality

Annabessacook Lake is a 1,391 acre (563 ha) lake located in the Towns of Monmouth and Winthrop in Kennebec County, Maine. The lake has a direct watershed area of 13,543 acres, and is located primarily in the Towns of Monmouth and Winthrop, with a small portion located in the Town of Wales (Androscoggin County). A map of the watershed is depicted on Figure 1. There are also four lakes (Maranacook Lake, Lower Narrows Pond, Wilson Pond, and Cochnewagon Lake) immediately upstream of Annabessacook Lake that contribute to its hydrologic and nutrient budgets as well. The lake has a maximum depth of 47 feet and a mean depth of 17 feet, and has a flushing rate of 3.7 flushes per year. The lake is drained by its outlet, Jug Stream, which flows southeasterly into Cobbossee Lake.

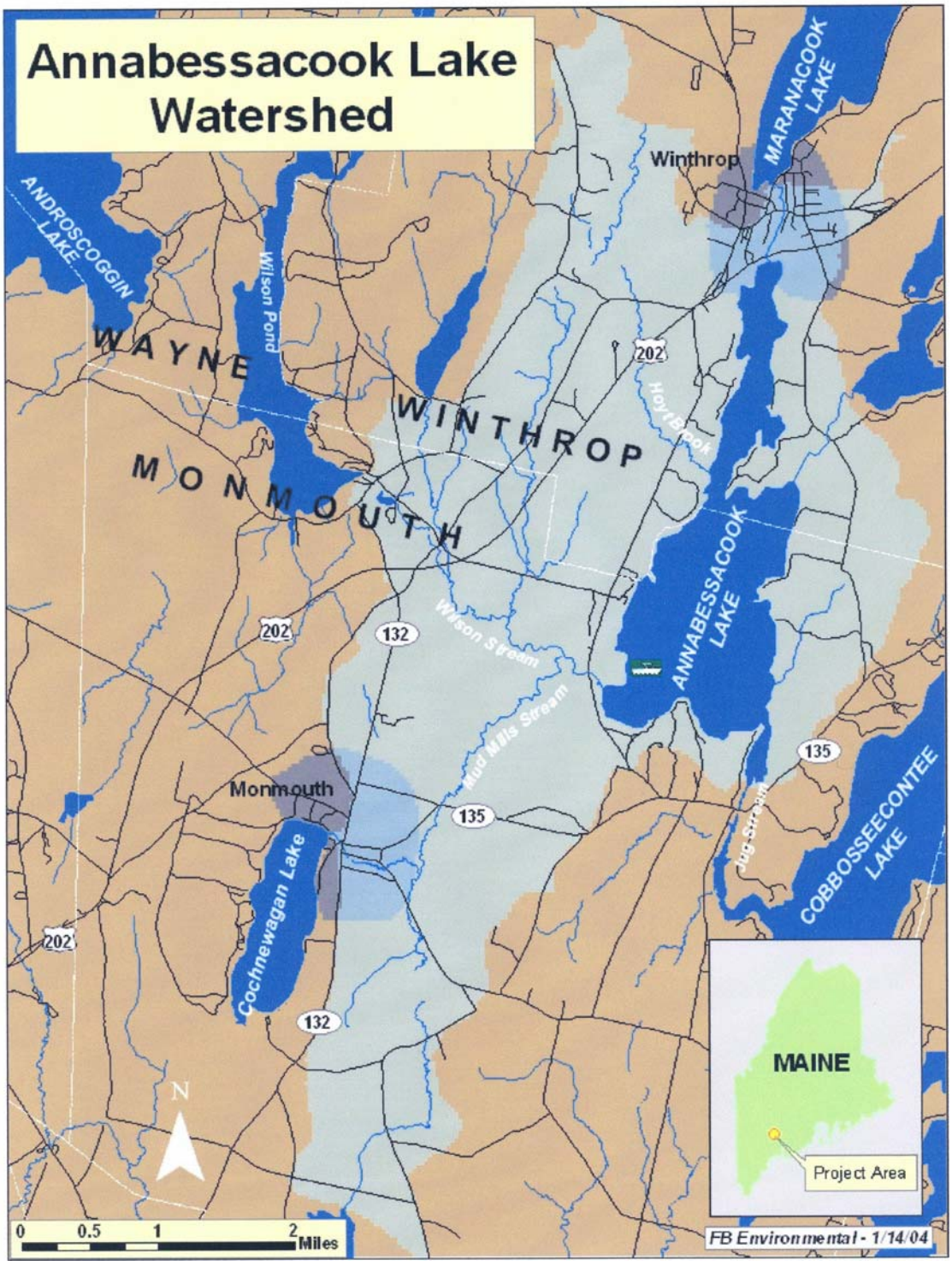
The Cobbossee Watershed District (CWD) has classified the lake as having poor/restorable water quality based on over thirty years of data collected by CWD staff. This classification, and concern, for the lake is due in large part to increases in total phosphorus concentration, reduced water clarity, and severe depletion of dissolved oxygen in bottom waters. The MDEP has placed Annabessacook Lake on its Nonpoint Source Priority Watersheds list and the list of Lakes Most at Risk from New Development under the state's Stormwater Law. Additionally, the lake is listed on Maine's §303d (TMDL) list, designating it as a lake that does not meet State water quality standards. As mentioned above, an EPA-approved Phosphorus Control Plan (and TMDL) was prepared by the MDEP, the CWD, and the MACD in 2004.

The lake's immediate shoreline is modestly developed, with 182 shorefront residences, of which, approximately one-half are year-round residences. The shorefront properties are serviced by a network of private camp roads, and there is a large campground with approximately 100 sites along the eastern shore in Winthrop. The urban center of Winthrop is located at the north end of the lake. The centers of Monmouth and North Monmouth are more distant from the lakeshore, but are located near or on major tributaries to the lake.

Anglers value Annabessacook Lake as a wonderful lake to fish for largemouth bass. The Maine Department of Inland Fisheries and Wildlife manage the lake as a warm water (largemouth bass) fishery. There are several bass tournaments held every year on the lake. There is only one public boat access facility on the lake. The lake is also enjoyed for swimming, boating, and general aesthetic beauty.

The lake has long history of supporting nuisance algae blooms, and the watershed community has through the years demonstrated a strong commitment to improving the lake. The CWD was formed in the early 1970's to direct activities to improve Annabessacook Lake and other lakes of the Cobbossee Stream drainage. The CWD began monitoring the lake's water quality in 1975, and immediately began working closely with the Annabessacook Lake Improvement Association (ALIA), the Maine DEP and the local citizens to correct problems in the lake and in the watershed. Nonpoint source pollution is, and has been, the main reason for water quality decline in Annabessacook Lake. A recent land use inventory associated with the 2004 PCP-TMDL suggests that NPS remains a major problem in the watershed.

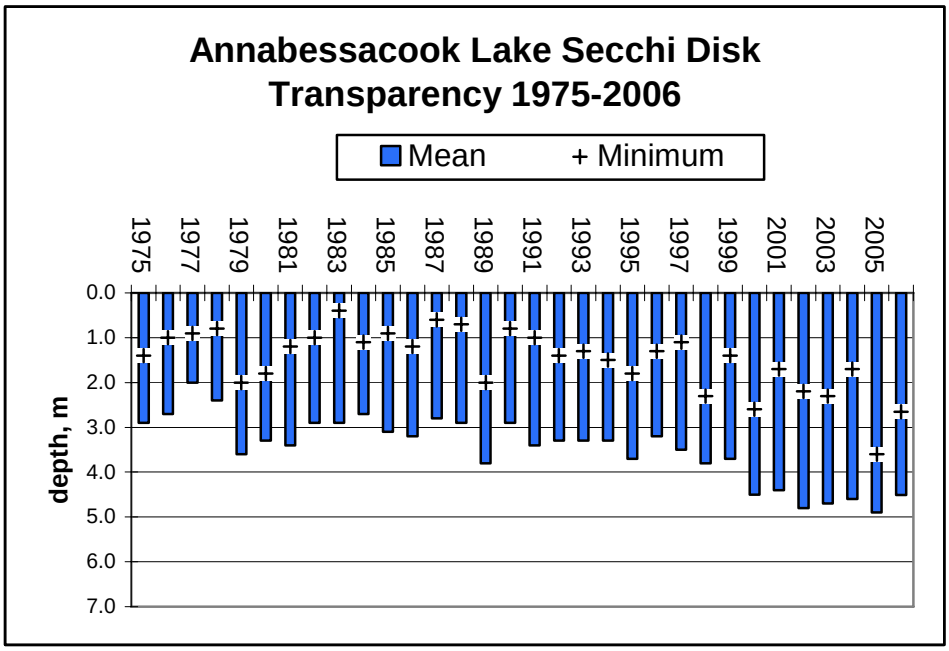
Figure 1. Map of Annabessacook Lake Direct Watershed



From: Annabessacook Lake (Monmouth & Winthrop) PCAP-TMDL (MDEP 2004)

The CWD has monitored Annabessacook Lake water quality for over 30 years. Since the late 1990's Annabessacook Lake has been exhibiting improved water clarity, expressed as Secchi disk transparency (SDT), throughout the summer period (Fig. 2). The year 2005 was particularly encouraging as the lake exhibited its best year, water clarity-wise, with a minimum SDT reading of 3.6 meters. In fact, over the 9-year period, 1998 – 2006, the SDT was not observed to be less than the 2.0 meter "nuisance algae bloom" level in 6 of those years. However, although the lake has shown signs of improvement over the past decade, the lake continues to exhibit stress (e.g., depleted oxygen and reduced clarity during late summer and early fall) but does appear to be approaching the point at which it could be removed from the §303d (i.e., TMDL) list.

Figure 2.



The lake's water clarity and dissolved oxygen problems are attributed primarily to nonpoint source (NPS) pollution that washes into the lake from the surrounding watershed. With agriculture on the wane throughout the watershed, and a deceleration in the internal recycling of phosphorus from Annabessacook Lake sediments (PCAP-TMDL 2004), soil erosion and stormwater runoff from the urbanized portions of Winthrop and Monmouth are considered to be two predominant sources of NPS pollution to Annabessacook Lake. The 2004 TMDL estimated that non-shoreline development was responsible for 45 percent of the annual phosphorus load to the lake, with residential and commercial contributing the majority of this fraction, or 40 percent of the total annual load. The network of camp roads around the perimeter of the lake, as well as numerous shorefront properties, has been identified as sources of eroding soil. Additionally, many of the shorefront properties examined during the 2004 PCAP-TMDL inventory effort were determined to have inadequate shorefront vegetation to buffer runoff from developed areas.

Prior Work

Annabessacook Lake has been the subject of lake restoration efforts for several decades. The lake began experiencing algae blooms as early as 1939, largely due to municipal and industrial discharges. In the mid-1960's residents responded to "pea soup" conditions and mats of rotting vegetation by treating the lake with copper sulfate, but to less than desired success. In 1967, it was determined that over 13,600 kilograms (30,000 pounds) of phosphorus per year were entering Annabessacook lake, 93 percent of which were from municipal and industrial discharges from the village areas of Winthrop, North Monmouth, and Monmouth Center (USEPA 1980). Fortunately, by 1972, a newly constructed trunkline sewer conveyed these discharges to the Augusta Sanitary District in Augusta, and by 1976, all point source discharges to the lake had been eliminated.

Following the sewage diversion, there was some improvement, but the high phosphorus concentrations continued along with nuisance algae blooms. Frustrated after decades of failure to improve the water quality of Annabessacook Lake, as well as several other lakes in the Cobbossee chain of lakes, the Cobbossee Watershed District was formed in 1972 to oversee and coordinate efforts to improve and protect the lakes of the CWD.

A 1975 Federal water quality management (§208) planning grant enabled the CWD to work with the Southern Kennebec Valley Regional Planning Commission to perform detailed diagnostic studies throughout the CWD and develop strategies for lake restoration. Annual phosphorus budgets for Annabessacook Lake resulting from these studies suggested that more than half of the phosphorus load to the lake was from agricultural runoff and from internal phosphorus recycled from highly enriched lake sediments. The CWD responded by pursuing a §314 (i.e., Clean Lakes Program) grant to address these sources. The grant, received by the CWD in 1977, supported major projects throughout the CWD including cost-sharing opportunities for local farmers to construct manure storage facilities, as well as a 1978 nutrient inactivation (i.e., alum) treatment of Annabessacook Lake sediments to arrest the internal release of phosphorus to overlying, surface waters.

The combination of agricultural best management practices and nutrient inactivation resulted in immediate improvements to Annabessacook Lake water quality. There was a dramatic decline in in-lake phosphorus concentration accompanied by a similarly dramatic increase in Secchi disk transparency. However, the improvements did not bring the lake water quality to approach the average water quality of other Maine lakes, and the lake continued to support a late summer or early fall nuisance algae bloom every year until the late 1990's, with the exception of 1989 (minimum SDT of 2.0 meters).

In 1990, the CWD received a §205j water quality planning grant to update the 1977 §208 water quality management plan for Annabessacook Lake. This project entailed monitoring the water quality in Mill Stream, the outlet of Maranacook Lake that flows through the downtown area of Winthrop prior to discharging into Annabessacook Lake, and also updating land use information throughout the lake watershed. This study concluded that there needed to be further reduction in nonpoint source pollution, particularly from residential and commercial development, roadways, and hayland, and that the Mill Stream urban watershed should be targeted for phosphorus export reduction.

In 1992, the Annabessacook Lake Improvement Association, with assistance from the CWD, conducted a survey of the watershed immediate to the lake, focusing on nearby town and state roads, and the camp roads that surround the lake. There were found to be 18 high priority road related sites in the watershed that needed improvements. One of these camp roads, Piney Heights Road, was determined to be a high priority NPS site. Piney Heights Road, due to its proximity to the outlet of Annabessacook Lake, was improved dramatically as part of 1995 §319 project for Cobbossee Lake (DEP #95-10), as it was recognized as a potential significant contributor to Cobbossee Lake.

In 2003, the CWD pursued funds from the Maine DEP that had been collected under the State's Stormwater Law. These funds, collected as compensation fees from land use developers unable to satisfy Stormwater Law standards for phosphorus runoff, were to be applied to the purchase a high-tech regenerative-air street sweeper that the Towns of Winthrop and Monmouth would jointly operate to clean in-town streets and those roads near stream crossings to reduce sediment and phosphorus pollution from these surfaces. The CWD was successful in securing $109,000 to purchase the street sweeper that the towns have been using since 2003.

In 2004, the Annabessacook Lake PCAP-TMDL Report, prepared by the Maine DEP with assistance from the CWD and Maine Association of Conservation Districts, was completed and approved by U.S. EPA.

Throughout these past few decades, the CWD has continued working with local citizens and town officials, including planning boards, code enforcement officers, and road crews, as well as the Annabessacook Lake Improvement Association, Kennebec County Soil and Water Conservation District, the Maine DEP, and other state and federal agencies to improve lake water quality further. Recently, the CWD has been teaming with the recently formed Friends of the Cobbossee Watershed to expand education and outreach and general watershed protection throughout the CWD.

Nine Mandatory Elements (A – I) of the Watershed Based Plan Required by EPA

A. Identify Causes and Sources of Water Quality Impairment

The occurrence of nuisance algae blooms and oxygen depletion in Annabessacook Lake are attributed primarily to historic point source discharges of municipal and industrial sewage, which still haunt the lake in the form of internal recycling of nutrient rich sediments, and nonpoint source pollution that washes in from the surrounding direct watershed. Two upstream lakes, Cochnewagon Lake and Wilson Pond, have experienced inconsistent water quality. Cochnewagon Lake received an alum treatment in 1986 to control internal recycling of phosphorus from lake sediments, and Wilson Pond began exhibiting a decline in water clarity in the late 1980's, and has recently been placed on the Maine DEP's list of impaired lakes (i.e., §303(d)). As a result, inputs from these lakes may have to some extent contributed negatively at some point in time to Annabessacook Lake water quality or have slowed its improvement. Point source discharges were eliminated in the early 1970's, but the lake has continued to support late

summer or early fall nuisance algae blooms, although these have occurred less frequently of late. Oxygen depletion in bottom waters is a constant annual occurrence, however. Phosphorus is considered the pollutant of primary concern. The 2004 Annabessacook Lake PCAP-TMDL report emphasized the need to correct erosion problems, encourage better land use practices in the shoreland zone as well as in the more urbanized centers of Winthrop and Monmouth, and improve road drainage design and maintenance practices on both private and public roadways.

In the development of the PCAP-TMDL Report for Annabessacook Lake, the DEP-CWD-MACD team determined the land use in the watershed using several methods including (1) Geographical Information System map analysis, (2) analysis of topographic maps, (3) analysis of town property tax maps and building permit records, (4) update of a 1990 Annabessacook Lake Watershed Land Use/Land Cover analysis of aerial photographs (with ground-truthing), (5) a 1990 National Wetlands Inventory for Monmouth, and (6) field visits. The CWD also conducted an in-depth survey of shorefront properties and shoreline conditions.

Of the 182 shorefront dwellings documented in the PCAP-TMDL, approximately 80%, or 145 properties, were deemed to have moderate to high NPS pollution impact due to a combination of inadequate buffers, close proximity to the shoreline, and the presence of bare and/or eroding soils.

In the May 2004 PCAP/TMDL Report, it states that an annual phosphorus load reduction of 415 kg/yr (or 15%) is required for Annabessacook Lake to attain bloom-free conditions. Of the 2,817 kg/yr that are currently estimated to enter the lake, only 1,315 kg/yr (47%) are estimated to originate as NPS pollution from the direct watershed. The bulk of the remainder is associated with upstream lakes (26%) and internal recycling from Annabessacook Lake sediments (16.5%). In order to achieve the necessary TMDL load reduction from the direct watershed of Annabessacook Lake alone (i.e., 32%), a very aggressive, long-term effort would be required. As this plan is intended to provide a schedule of actions over a ten-year timeframe, an interim target is needed.

An interim phosphorus loading reduction goal was set to target what most realistically can be accomplished over a ten-year timeframe. For this plan, the interim goal is a loading reduction sufficient to achieve a reduction of 1.0 ppb total phosphorus concentration in the lake as a result of NPS mitigation in the direct watershed of Annabessacook Lake. This would include accounting for 1.0 ppb from the direct watershed and a 0.5 ppb allowance to offset future development during this 10-year period. This would correspond to a load reduction of 182.6 kg/yr (14%) from the estimated direct watershed load of 1,315 kg/yr.

[**Note:** As reported in the PCAP-TMDL, 83 kg/yr was established to offset future development that would produce a 0.5 ppb increase in in-lake TP. The CWD currently reviews all new development in the two towns such that a 0.5 ppb increase would be realized over a 50-year period. For this plan then, 20% (16.6 kg/yr) of the 83 kg/yr are being accounted for.]

It is also worth noting that the internal recycling component of the annual phosphorus load to Annabessacook Lake has been gradually declining since the 1978 nutrient inactivation (i.e., alum) treatment. It is hypothesized that sediment stores of phosphorus that accumulated over many years prior to sewage diversion and the alum treatment, are gradually becoming exhausted as they are seasonally released and gradually purged , or flushed, from the lake. Regression analysis of internal loading in Annabessacook Lake for the 17 year period 1983 to 2001 suggests a rate of decline of approximately 17 kg/yr. At this rate, internal recycling would account for a predicted 224 kg/yr, or a reduction of 241 kg/yr by the year 2016. ***If this reduction in internal loading were to be realized, then the combined watershed loading reduction (i.e., interim goal of 183 kg/yr) and internal load reduction (241 kg/yr) would produce a net reduction of 424 kg/yr, or enough to achieve the goal set in the PCAP-TMDL.***

The interim target of reducing the annual phosphorus load to Annabessacook Lake by 183 kg/yr will require that several sources, identified and prioritized in the PCAP-TMDL Report, be addressed, including:

- Agricultural – all of the hayland known to be fertilized with manure will be addressed.
- Shoreline Development – Approximately 70 % of all residential properties and 100% of the camp and private roads will be addressed.
- Non-Shoreline Development – Approximately 50% of all state roads and 100% of all town roads will be addresses, and approximately 50% of all low density residential and 100% of high density residential issues will be addressed. And, 50% of commercial land uses will be addressed.

Based on the PCAP-TMDL Report, the above listed sources, or respective percentages thereof, account for approximately 34% (452 kg/yr) of the annual phosphorus load from the direct watershed of Annabessacook Lake. To reduce this amount by 183 kg/yr would require phosphorus removal rates from BMPs to average 40%.

B. Estimate Phosphorus Load Reduction to Result from Planned Management Measures

To estimate the reduction in annual phosphorus loading to Annabessacook Lake that might be realized through a ten-year period of watershed management efforts, we used "A Relational Method for Estimating Needed Phosphorus Load reductions for Lake Watershed", prepared by Jeff Dennis of the Maine DEP (see Attachments, Table 1). By using this method, land use and watershed survey information, gathered during the TMDL process, is reviewed to determine the relative fraction each land use type contributes to the watershed-based phosphorus load. To estimate the anticipated annual load reduction, the extent of BMP usage and BMP efficiency rates are applied to each category targeted for future (i.e., 10-year) watershed management efforts.

As stated earlier, the targeted interim phosphorus loading reduction goal is 14%. In the Attachment, the method and the results of the application of the "Relational Method" (see

above) to Annabessacook Lake watershed information are presented (Table 1). The land use information and phosphorus loading information are from the 2004 PCAP-TMDL Report for Annabessacook Lake.

It is not yet determined which BMPs will be assigned to individual properties within each land use, but it is clear that those that are prescribed must average 40% effectiveness in reducing phosphorus loading. Based on values described in various published stormwater BMP manuals (e.g., Dennis et al., 1992; Schueler, 1987; Reckhow et al., 1992; Maine DEP, 1995), assigning a BMP phosphorus removal efficiency across all categories that are to be addressed seems to be a conservative approach. Types of BMPs to be prescribed will include: vegetated buffers, infiltration practices, water quality swales, municipal street sweeping, fertilizer management (both agricultural and residential lawn), and proper roadway design and maintenance. Published ranges for BMP effectiveness for these BMPs bracket the mean 40% level required.

C. Description of Management Measures

The 2004 Annabessacook Lake PCAP-TMDL Report emphasized the need to correct erosion problems, encourage better land use practices in the shoreland zone as well as in the more urbanized centers of Winthrop and Monmouth, and improve road drainage design and maintenance practices on both private and public roadways. Based on these recommendations, the anticipated implementation scheme is as follows:

Shoreline Development – Residential

It is estimated that nearly two-thirds (70%) of shorefront properties will be addressed. This is roughly consistent with the results of the shoreline survey reported ion the 2004 PCAP-TMDL Report. The most efficient use of resources in this category will be to review the 145 shorefront properties and develop site-specific BMPs for the highest priority sites; that is, those that pose the greatest NPS threat, or the greatest likelihood of successful mitigation. Based on the survey results, the most common BMPs will likely be vegetated buffers, shoreline stabilization, stormwater diversion measures, rain gardens, and general better grounds-keeping practices (e.g., no lawn fertilization, etc).

Shoreline Development – Camp/Private Roads

Virtually 100% of the camp roads associated with shoreline development will need to be addressed. The CWD and the Annabessacook Lake Improvement Association have long recognized the impact that private camp roads in the shoreline area have on Annabessacook Lake. There are nearly two dozen camp roads surrounding the lake, several that are well designed and maintained. Most, however, would benefit greatly by improved drainage systems or surface modifications, and regular maintenance. Those roads which pose the greatest threat and/or the highest degree of successful implementation will be selected first. Publicly held demonstrations and promotion through the ALIA newsletter and other local publications will further serve to encourage participation by all private road associations or groups.

Non-Shoreline Development – State and Town Roads

Approximately 100% of town roads and 50% of state roads in the direct watershed will be addressed over the ten-year plan schedule. The CWD has a long history of working with the public works departments from the Towns of Winthrop and Monmouth, as well as with the Maine Department of Transportation throughout the CWD on road related projects to protect water quality. Some of the more pressing problems on state roads have received long-term remedies in the past decade, but other smaller, widespread problems exist. Problems exist on town roads as well, particularly in the more rural areas. Although some of town road related problems will require reconstruction or modifications that will require significant financial expenditures, most pertain to routine maintenance practices. The most common BMPs will be improved drainage through combinations of culverts, turnouts, proper ditching design and stabilization, and general surface improvements. The majority of in-town (urban) roads are relatively well maintained with engineered storm sewers. In 2003, the Towns of Winthrop and Monmouth began a robust street sweeping program, focusing on the majority of in-town roads and the more rural roads that are in proximity to tributaries and small drainages to Annabessacook Lake. The street sweeper, a high-tech regenerative air sweeper, was financed through a Stormwater Law Program grant from the Maine DEP. This BMP, which began after the 2001 TMDL project lake monitoring effort, is to continue indefinitely.

Non-Shoreline Development – Residential/Commercial

Of the residential component of the non-shoreline development, approximately 50% of low density residential and 100% of high density residential land uses will be addressed. Approximately 50% of the commercial land use will be addressed. The urban fractions of these land use components will be addressed both directly and indirectly *(e.g., municipal BMPs such as routine street sweeping).* The 2004 RCAP-TMDL estimated that these land uses collectively represented about 39% of the phosphorus load from the direct watershed, and the majority of the residential and commercial property resides within the more densely developed urban centers of Monmouth and Winthrop.

Within the urban areas, most properties lack the acreage to install wet ponds, buffers, etc. Therefore, it is anticipated that a public education and outreach program aimed at promoting responsible lawn care and erosion control practices, rain gardens, and pet waste management, among others, will be most appropriate here. It is worth noting is that in the 2004 PCAP-TMDL, the in-town roads were included in this category as supporting infrastructure. And it should be recognized that a portion of the phosphorus generated from the individual properties within the town centers contributes to the in-town roads as “wash-off”. Therefore, phosphorus mitigation that is accomplished by the street sweeping programs within this category addresses a portion of this phosphorus load.

In the more rural areas, there are likely to be more opportunities to install structural or vegetative BMPs. Depending on individual site-specific features, BMPs might include vegetated buffers, drainage swales (both grassed swales and dry swales, level spreaders),

and in some cases, stormwater ponds or engineered systems (e.g., StormTreat Systems). The education and outreach program noted above will also extend to these areas.

Agricultural

Hayland accounted for more than 22% of the annual phosphorus load to Annabessacook Lake as reported in the PCAP-TMDL. The vast majority of this was ascribed to non-manured hayland. However, it is anticipated that most of the effort to reduce this source of phosphorus will be aimed at the manured fields. Those farmers that manure hayfields will be encouraged to perform soil tests and make efforts to limit manure application according to phosphorus requirements of the soil and to spread only on those portions of fields that are away from drainage ways and are not subject to excessive runoff or erosion. Because of the magnitude of this general category, continued scrutiny of all hayfields should be continued to remain apprised of any newly adopted fertilization practices on hayfields.

D. Description of Technical and Financial Assistance

The cost of successfully implementing this 10-year watershed plan is approximately $1.7 million. This general, 'best guess' estimate is based on the following assumptions: municipal street sweeping ($400,000, or $40,000 per annum); 24 camp road repairs/upgrades ($240,000); residential shoreline development-based projects such as buffers, rip-rap, etc. ($72,500); watershed education ($150,000); lake water quality and BMP monitoring and assessment ($100,000); and miscellaneous public and private projects such as town and state road projects and in-town residential and commercial based projects ($750,000). The most likely sources of funding the program appear to be federally funded Section 319 projects, local cash and in-kind match. The soon-to-begin *Annabessacook Lake Rehabilitation Project-Phase I* is funded with $46,400 from Section 319, and $44,800 from non-federal match.

Cobbossee Watershed District will continue serving as the 319 grantee and will be responsible for the successful and complete implementation of all project activities. In non-319 related activities, the CWD will continue monitoring Annabessacook Lake water quality, managing lake water levels to control erosion and flooding, and providing technical assistance to watershed citizens and the Towns of Monmouth and Winthrop.

Maine Department of Environmental Protection will administer project funding and continue to provide technical support in lake water quality related matters.

US Environmental Protection Agency will provide project funding and guidance.

Annabessacook Lake Improvement Association will have representatives serving on the steering committee, and will continue to provide support to the CWD and other local lake groups to advance lake improvement and protective measure.

Friends of the Cobbossee Watershed will promote public education and information through a variety of programs aimed at all levels throughout the watershed, and will provide technical assistance to shorefront property owners seeking to implement BMPs.

Kennebec County Soil and Water Conservation District will provide technical assistance to property owners regarding erosion control, particularly on private camp roads and shorefront properties, and will serve on steering committees.

Towns of Winthrop and Monmouth will provide in-kind support through the continued aggressive program of street sweeping that began in 2003, and also providing labor and/or materials to address road-related NPS problems. The towns will also continue their strong enforcement of local and state ordinances that address lake water quality issues

E. Information & Education Outreach

An education and information program is expected to be central to any effort to reduce NPS in the Annabessacook Lake watershed. The program will address all levels of the community, including shoreline and non-shoreline related development as well as public school programs. The high concentration of non-shoreline residential and commercial land uses and the density of in-town streets in the urban centers of Winthrop, Monmouth, and North Monmouth,, in particular, lends to the anticipated success of an I&EO campaign to address this significant NPS source.

It is anticipated that public education in the watershed will be largely conducted by a relatively new organization, the Friends of the Cobbossee Watershed, the CWD, and the ALIA. Membership in the ALIA, one of the oldest lake associations in the state, is nearly complete around the shoreline. The ALIA serves as a great vehicle for dissemination of outreach materials. The CWD has for three decades provided public education through local publications, contributions to ALIA meetings and newsletters, and through project related demonstrations. The Friends of the Cobbossee Watershed (FCW) formed in the early 2000's to lend support to a common mission to protect area lakes. They (FCW) have developed top-notch watershed education programs including a LakeSmart Start Program to provide community-wide education, the Tadpole Patrol program, targeted to elementary school children, and a year-round watershed education program tailored to students, grades 4 through 7. Additionally, the FCW provides on-lake education via their education vessel, the pontoon boat, The Otter II. These three principal groups will coordinate their respective programs to provide a long-term E&O campaign that will reach all levels of the community to educate them about lake and watershed protection in general, and about project specific information, with the goal watershed-wide appreciation of lake issues and adoption of lake protective practices.

F. Implementation Schedule

2007-2009: Implement NPS Project #2007R-07 Annabessacook Lake Rehabilitation Project (Monmouth & Winthrop).

2010: The CWD will review lake water quality monitoring data to date, coupled with an assessment of the successful implementation of Project #2007R-07. Based on this assessment, a project grant proposal would be prepared and submitted to MDEP, and if funded, would commence in 2011.

2011 – 2013: Implement NPS Project – Annabessacook Lake Rehabilitation Project – Phase II (Monmouth & Winthrop).

2014: The CWD and MDEP will assess water quality data and previous implementation success to determine whether more watershed implementation work is required to meet stated goals, and if needed, develop a workplan and pursue funding for Phase III NPS project.

2007 – 2016: The Towns of Winthrop and Monmouth will maintain a vigorous street sweeping program within the respective urban centers and on high priority roads near stream crossings.

2007 – 2016: Cobbossee Watershed District and the Friends of the Cobbossee Watershed will continue programs to provide education and outreach to watershed citizens, municipal officials, and local schools.

G. Milestones to Measure Progress Implementing Management Measures

It is expected that by 2010 the 12 most severe camp road problems will be resolved (or about 50 percent of the camp roads surrounding the lake) as well as problems associated with 45 shorefront properties. Corrective measures on 10 sites along state and/or town roads are also expected to be performed. Approximately 150 non-shorefront residential and commercial properties will be addressed. All in-town roads and town roads near stream crossing will continue to be swept a minimum of 6 to 10 times per year (based on location). Towns will be encouraged to maintain strict adherence to local ordinance requirements pertaining to stormwater and phosphorus runoff. All schools will include lake and watershed protection in their educational curricula.

By 2016, an additional 12 camp roads and 10 town and/or state roads are expected to be addressed, as well as an additional 100 shorefront properties. Outside the shoreland area, approximately 200 additional residential and commercial properties will be addressed. The street sweeping program will continue. All agricultural (i.e., hayland) lands will have in place manure management programs aimed at preventing excessive application or mishandling of manure.

H. Criteria to Determine progress in Attaining WQ Standards & Load Reductions

Attaining Water Quality Standards

Maine water quality criteria require lakes have a stable or improving trophic state and be free of culturally induced algal blooms. Maine's functional definition of a nuisance algae bloom is an annual minimum Secchi disk transparency (SDT) of less than 2.0 meters (i.e., an algae bloom is declared if the SDT falls below 2.0 meters once during the year). The CWD, with support from Maine Volunteer Lake Monitoring Program, will continue monitoring the lake monthly for a host of parameters, including Secchi disk transparency and total phosphorus. The MDEP placed Annabessacook Lake on the 303(d) list primarily due to the occurrence of nuisance algae blooms (i.e., SDT < 2 m) at some point during the open water season. During six of the past nine years (1998 -2006), the lake has not exhibited such a bloom. It is anticipated that if this trend continues and the lake is deemed to attain water quality standards, then DEP could elect to remove the lake from the 303(d) list.

Load Reductions

Based on the Relational Method for Estimating Required and Projected Phosphorus Load Reduction (Attachment A), the BMPs that are proposed over the course of this plan are projected to provide a reduction in annual phosphorus loading to the lake of about 183 kg/yr. For the majority of major BMPs that are implemented, pollutant load reduction estimates will be made using methods approved and recommended by the EPA. (It is anticipated that there will be numerous BMPs implemented as a result of education and outreach and project related demonstrations that will evade scrutiny.

I. Monitoring Progress Compared to Criteria

CWD and DEP will periodically monitor progress as follows:

Attaining Water Quality Standards

The CWD will continue monitoring Annabessacook Lake water quality monthly from May through October each year. Water Quality parameters include Secchi disk transparency (SDT), temperature, dissolved oxygen, chlorophyll a, total phosphorus, and total alkalinity. The CWD's water quality database is augmented with monthly SDT readings from a volunteer monitor (VLMP). With this continued monitoring effort, short-term and long-term trends in water quality parameters, particularly SDT and total phosphorus, will be easily documented. These data will be particularly valuable in alerting the CWD of any needs to make adjustments in the watershed plan.

Load Reduction Estimates

Estimates of NPS pollutant load reductions and resources protected should be prepared as project work proceeds. Pollutant load reduction estimates should be developed and reported as follows. During design or installation of BMPs at NPS sites, appropriate filed measurements should be recorded to prepare written estimates of pollutant load reductions. Estimates should be prepared for NPS sites, unless there is no applicable estimation method for a given site. Methods to be used are the EPA Region 5 Load Estimation Model (see website http://it.tetratech-ffx.com/step1) and/or the federal WEPP

Road Model (http://forest.moscowfsl.wsu.edu/fswepp/). For BMPs that provide other means of treatment, such as infiltration or bio-retention, the CWD will review other publications (e.g., Dennis et al., 1992; Schueler 1987) for estimates of pollutant removal.

REFERENCES

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Attachments

- **A Relational Method for Estimating Needed Phosphorus Load Reductions for Lake Watersheds – Jeff Dennis, Division of Watershed Management, MEDEP**

- **Example Spreadsheet of relational Method – Jeff Dennis, MDEP**

- **Table 1. A Relational Method for Estimating Needed Phosphorus Load Reductions for Annabessacook Lake – Winthrop and Monmouth**

A Relational Method for Estimating
Required and Projected Phosphorus Load Reductions

Jeff Dennis, Division of Watershed Management, MEDEP

Given the nature of most Maine lake watersheds, which tend to be mostly forested, with most of the cultural activity being shoreline development accessed by a network of camp roads and rural, roadside residential development on a lower density network of town and state roads, it is difficult and often misleading to try to characterize phosphorus sources based on classic land use/export coefficient analysis. The development in these watersheds is anything but uniform, with phosphorus export being much more a function of the characteristics of each road segment and house lot than the areal extent of residential land use. Because of this, and also the fact that none of the residential export coefficients available in the literature were derived from data on this type of low density development, standard areal land use/export coefficient estimates of phosphorus load are likely to be inaccurate, or at least have a *very* wide margin of error.

In regard to phosphorus loading in impaired lakes in Maine, there are however two things that we can usually identify with some confidence. First, we usually have good enough information on in-lake phosphorus concentrations to define what the typical current phosphorus concentration (minus internal recycling issues) is in the lake and we also have a pretty good idea of what we would like that concentration to be. Since in lake concentration tends to be proportional to external phosphorus load once internal recycling has been factored out, we therefore know reasonably well what the target for percent reduction in external phosphorus load should be. Second, since we have usually completed a watershed survey to identify specific phosphorus sources, we have real information on what are probably the most important, actual, man-induced, nonpoint phosphorus sources to the lake. We do not know the absolute magnitude of any of these sources, but we do have a fairly good feel for their relative significance.

Since absolutes are so hard to quantify, we suggest working with percent reductions in various categories of phosphorus sources and BMPs.

1. Comparison of current lake P concentration (minus internal recycling consideration) and target P concentration gives best idea of necessary percent reduction in external load.
2. Use land use/watershed survey info to get a handle on the relative contribution of various types of phosphorus sources to the current load, expressed as a fraction of total load.
3. For each phosphorus source type that will be addressed (i.e. camp roads, town roads, agriculture, high export shoreline development, etc.) estimate what percent of that source type will be addressed by the project, expressed as a fraction of the total contributing "phosphorus sources".
4. For each phosphorus source type that will be addressed, make a best guess estimation of probable load reduction from the typical BMP systems that would be applied to a source, expressed as a fraction of the load from that source.
5. For each source type multiply the three fractions (from 2, 3,and 4) to get estimate of the portion of the total load that will be reduced by activities involving that land use.
6. Sum for all addressed source types to get an estimate of the expected reduction of total load, expressed as a fraction of the total load.
7. Compare to target percent reduction in 1.

EXAMPLE

Relational Method for Estimating Needed Phosphorus Load Reductins for Lake Watersheds - Jeff Dennis, Maine DEP

Source Type	Sub-type	fraction of total load	fraction addressed	expected BMP efficiency	load fraction reduced
Roads					
	high exp private	0.15	1	0.6	0.09
	low exp private	0.07	0	0.3	0
	high exp public	0.07	0.5	0.6	0.021
	low exp public	0.06	0	0.3	0
Residential					
	high exp shore	0.07	0.4	0.4	0.0112
	low exp shor	0.02	0	0.1	0
	high exp wshed	0.08	0.2	0.4	0.0064
	low exp wshed	0.03	0	0.1	0
Commer/Ind					
	high exp C/I	0.05	1	0.6	0.03
	low exp C/I	0	0	0.3	0
Forest					
	high exp forest	0.02	1	0.5	0.01
	low exp forest	0.38	0		0
		1			0.1686

Expected Load Reduction = 17%

Current Lake [P]	18
Target Lake [P]	15
Target fraction load reduction	0.1667
Target % load reduction	17%

Table 1. A Relational Method for Estimating Needed Phosphorus Load Reductions for Annabessacook Lake - Winthrop and Monmouth

Source Type	Sub-type	Fraction of Total Load	Fraction Addressed	Expected BMP Efficiency	Load Fraction Reduced
AG & Forestry	Hayland (manured)	0.014	1	0.5	0.007
	Low Intensity Hayland	0.213	0	0	0.000
	Orchard	0.003	0	0	0.000
	Pasture	0.031	0	0	0.000
	Manure Storage	0.003	0	0	0.000
	Operated Forest Land	0.015	0	0	0.000
Shoreline Development	Low Impact Residential	0.002	0.7	0.4	0.001
	Medium Impact Residential	0.006	0.7	0.4	0.002
	High Impact Residential	0.013	0.7	0.4	0.004
	Septic Systems	0.045	0	0	0.000
	Camp/Private Roads	0.012	1	0.4	0.005
	Recreational	0.004	0	0	0.000
Non-Shoreline Development	State Roads	0.023	0.5	0.4	0.005
	Town Roads	0.039	1	0.4	0.016
	Low Density Residential	0.132	0.5	0.4	0.026
	High Density Residential	0.124	1	0.4	0.050
	Commercial	0.127	0.5	0.4	0.025
	Cemeteries	0.001	0	0	0.000
	Closed Landfill	0.004	0	0	0.000
	Sand/Gravel Mining	0	0	0	0.000
	Recreational	0.002	0	0	0.000
Other	Inactive/Pass.Mangd. Fores	0.093	0	0	0.000
	Wetlands	0.005	0	0	0.000
	Scrub Shrub	0.009	0	0	0.000
	Atmospheric	0.07	0	0	0.000
		1			0.139

Expected Load Reduction = 14%