PHOSPHORUS CONTROL ACTION PLAN

and Total Maximum Daily (Annual Phosphorus) Load Report

Sewall Pond - Arrowsic

Sagadahoc County, Maine

Sewall Pond PCAP-TMDL Report

Maine DEPLW - 0735

Maine Department of Environmental Protection

and Maine Association of Conservation Districts

Final EPA Review Document - March 2006

SEWALL POND - Arrowsic

Phosphorus Control Action Plan (PCAP)

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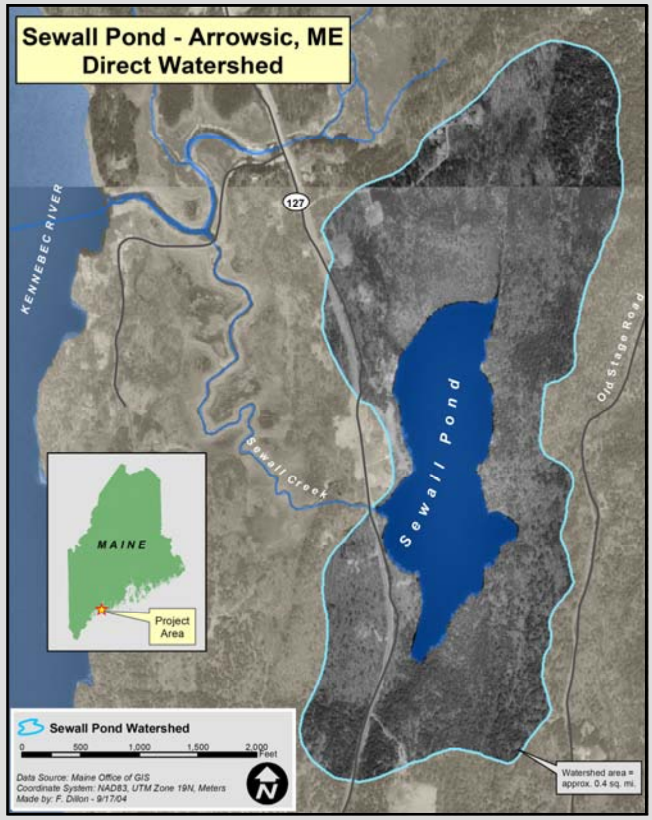
ACKNOWLEDGMENTS

In addition to Maine DEP (Division of Environmental Assessment - Lakes Assessment Section and Watershed Management Division) and U.S. EPA New England Region I staff, the following individuals, groups and agencies were instrumental in the preparation of this Sewall Pond combined Phosphorus Control Action Plan and Total Maximum Daily Load report: MACD staff (Forrest Bell, Fred Dillon, Jodi Michaud Federle, Jennifer Jespersen); Maine Department of Agriculture (David Rocque); Maine Forest Service (Chris Martin); Maine Department of Inland Fisheries and Wildlife (Bill Woodward); Maine Department of Marine Resources (Nate Gray); local Sewall Pond stakeholders including the Androscoggin Valley Soil and Water Conservation District, Town of Arrowsic, and the Maine Volunteer Lake Monitoring Program (William Blaiklock and Josephine Ewing, volunteer monitors).

SEWALL POND - ARROWSIC
PHOSPHORUS CONTROL ACTION PLAN
SUMMARY FACT SHEET

Background

SEWALL POND (MIDAS No. 9943) is a 45-acre (18 hectare) highly-***colored*** (avg. 74 SPU) waterbody located in the town of Arrowsic in Sagadahoc County, Maine. Sewall Pond has a direct drainage area (***watershed*** - see map at right and on pg. 8) of approximately 0.4 square miles (1.04 sq. km.); a maximum depth of 11 feet (3.4 meters), a mean depth of 9 feet (2.7 meters); and an annual ***flushing rate*** of 1.61.

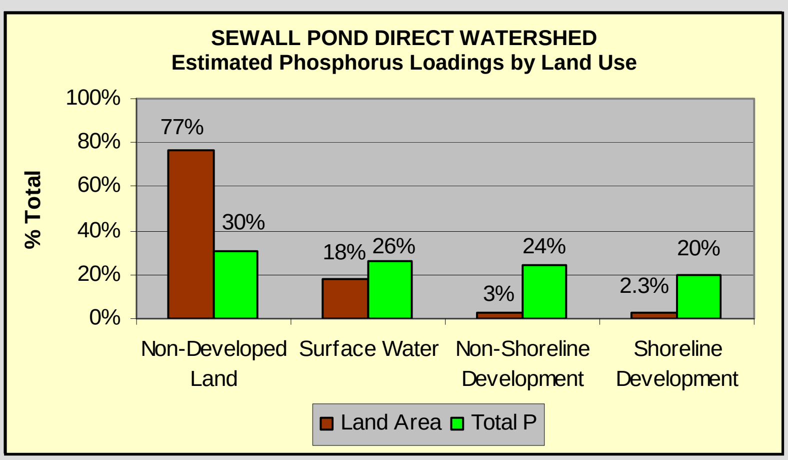


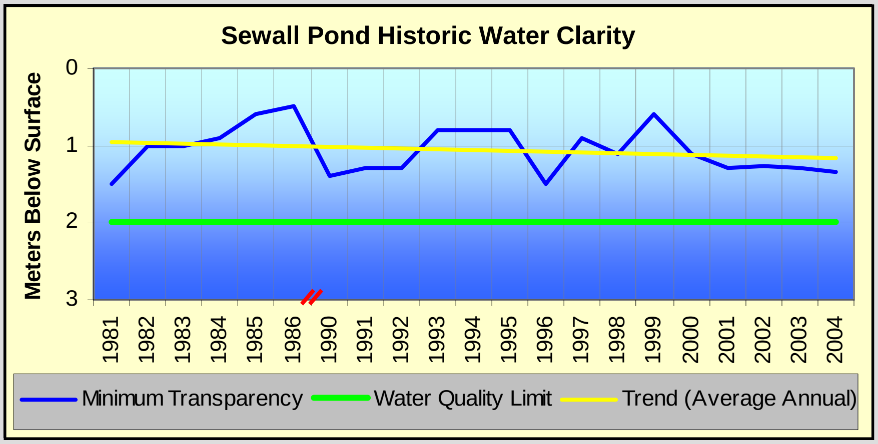
Historical Information

Sewall Pond has a long history of supporting persistent nuisance algal blooms. During the 1970's, heavy logging activities occurred in the northern portion of the watershed and during the 1980's (personal communication, Josephine Ewing) there were concerns about the improper storage and handling of commercial fertilizers next to the pond. Documentation of nutrient contamination in Sewall Pond began in 1981. Since this time, lake baseline chemical information and water transparency data have been collected. Overall, the water quality of Sewall Pond is considered to be poor based on both measures of water transparency (see chart on page 5) and total ***phosphorus***. Phosphorus input is of particular concern since it effectively "fertilizes" the pond to promote algal growth. Consequently, the potential for nuisance summertime algal blooms in Sewall Pond is high.

What We Learned

A land use assessment was conducted for the Sewall Pond watershed to determine potential sources of phosphorus that may run off from land areas during storm events and springtime snow melt. This assessment utilized many resources, including generating and interpreting maps, inspecting aerial photos and conducting field surveys. An estimate of 12 kg of phosphorus is exported annually to Sewall Pond from the ***direct watershed***. The bar chart (below left) illustrates the land area for the representative land uses as compared to the phosphorus export load for each land use. Sewall Pond is located within a 100 year flood zone and may therefore be more susceptible to total phosphorus contamination from storm events since additional runoff could enter from outside the watershed. Water quality data from recent years indicates that the amount of total phosphorus being recycled internally (1.2-1.4 kg/year) from Sewall Pond's accumulated bottom sediments during the summer-





Sewall Pond's minimal water clarity has remained fairly constant over the period of record.

time (2004-05) is well below historical estimates averaging 11.3 kg/year (1982-85). In contrast, Sewall Pond's natural capacity for in-lake total phosphorus assimilation is 2.2 kg/year (assuming a target goal water concentration of <u>16</u> ppb).

Phosphorus Reduction Needed

Sewall Pond's average summertime TP concentration approximates 34 ppb - equal to an additional 2.52 kg (34 ppb summer - 16 ppb target = 18 ppb x 0.14 kg TP per one ppb TP). Including a 0.07 kg allocation for future development, the total <u>annual</u> amount of phosphorus needed to be reduced to support Maine water quality standards (total phosphorus concentrations of 16 ppb or less) in Sewall Pond is <u>2.6</u> kg.

<u>What You Can Do To Help!</u>

The Town of Arrowsic has already implemented strict shoreline zoning to protect Sewall Pond's water quality. As a watershed resident, there are many additional things you can do to help protect the water quality of Sewall Pond. Lakeshore owners can use phosphorus-free fertilizers and maintain natural vegetation adjacent to the lake. Watershed residents can also become involved by volunteering to form a Sewall Pond Association and by participating in events sponsored by State agencies and local organizations. The estimated phosphorus loading to Sewall Pond originates from both shoreline and non-shoreline areas, so all watershed residents and users must take ownership for lake restoration and suitable water quality maintenance.

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

Key Terms

- ***<u>Colored</u>*** *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.*
- ***<u>Watershed</u>*** *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, pond or lake at a lower elevation.*
- ***<u>Flushing rate</u>*** *refers to how often the water in the entire lake is replaced on an annual basis.*
- ***<u>Phosphorus</u>*** *is one of the major nutrients needed for plant growth. It is naturally present in small amounts and limits the plant growth in lakes or ponds. Generally, as phosphorus increases, the amount of algae also increases.*
- ***<u>Direct Watershed</u>*** *refers to the land area that drains to a waterbody without first passing through an associated lake or pond.*
- ***<u>TMDL</u>****, an acronym for 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.*
- ***<u>Best Management Practices</u>*** *are techniques to reduce sources of polluted runoff and their impacts. BMP's are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.*

Project Premise

This lakes PCAP-TMDL project, funded through a Clean Water Act Section 319-grant from the United States Environmental Protection Agency (EPA), was directed and administered by the Maine Department of Environmental Protection (Maine DEP) under contract with the Maine Association of Conservation Districts (MACD), from the summer of 2004 through the fall of 2005.

The objectives of this project were twofold: First, a comprehensive land use inventory was undertaken to assist Maine DEP in developing a Phosphorus Control Action Plan (PCAP) and a Total Maximum Daily Load (TMDL) report for the Sewall 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 the MACD, 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 at david.halliwell@maine.gov*).

Secondly, watershed assessment work, including a shore-line survey was conducted by the Maine DEP-MACD project team to help assess **total phosphorus** reduction techniques that would be beneficial for the Sewall 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 Sewall Pond. **Note:** *To protect the confidentiality of landowners in the Sewall Pond watershed, site-specific information has not generally been provided as part of this PCAP-TMDL report.*

This Phosphorus Control Action Plan (PCAP) report compiles and refines land use data derived from various sources, including the Maine Office of Geographic Information Systems, the Maine office for the Natural Resources Conservation Service and the Maine Forest Service (MFS). 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 Sewall 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.

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

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

Study Methodology

Sewall Pond background information was obtained using several methods, including numerous phone conversations and personal interviews with watershed residents and municipal officials, University of Maine research staff and state agency personnel. Additionally, several field visits were made to the watershed to obtain water quality monitoring data and conduct a reconnaissance of the lake and shoreline area.

> ***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.*

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of topographic maps, (3) analysis of aerial photographs and (4) **ground-truthing**. Much of the non-developed land use area (i.e., forest, wetland, grassland) was determined using a GIS layer which is a combination of Maine Gap Analysis (GAP) landcover and USGS Multi Resolution Landcover Characterization (MRLC) landcover layers. It was created at the request of Maine DEP Bureau of Land and Water Quality (BLWQ) staff. It includes those classes in each layer which are best suited to calculating impermeability of watersheds. Both MRLC and GAP (and so Maine COMBO) are based on 1995 LandSat imagery. The developed land use areas were obtained using the best possible information available through analysis of methods 1 through 4 listed above.

Final adjusted phosphorus loading numbers (see Table 2, page 23) were modeled using overlays of soils, slope, wetlands and proximity to surface water bodies. All of the land use coverage data was re-configured using aerial overlays in conjunction with ground-truthing throughout the watershed.

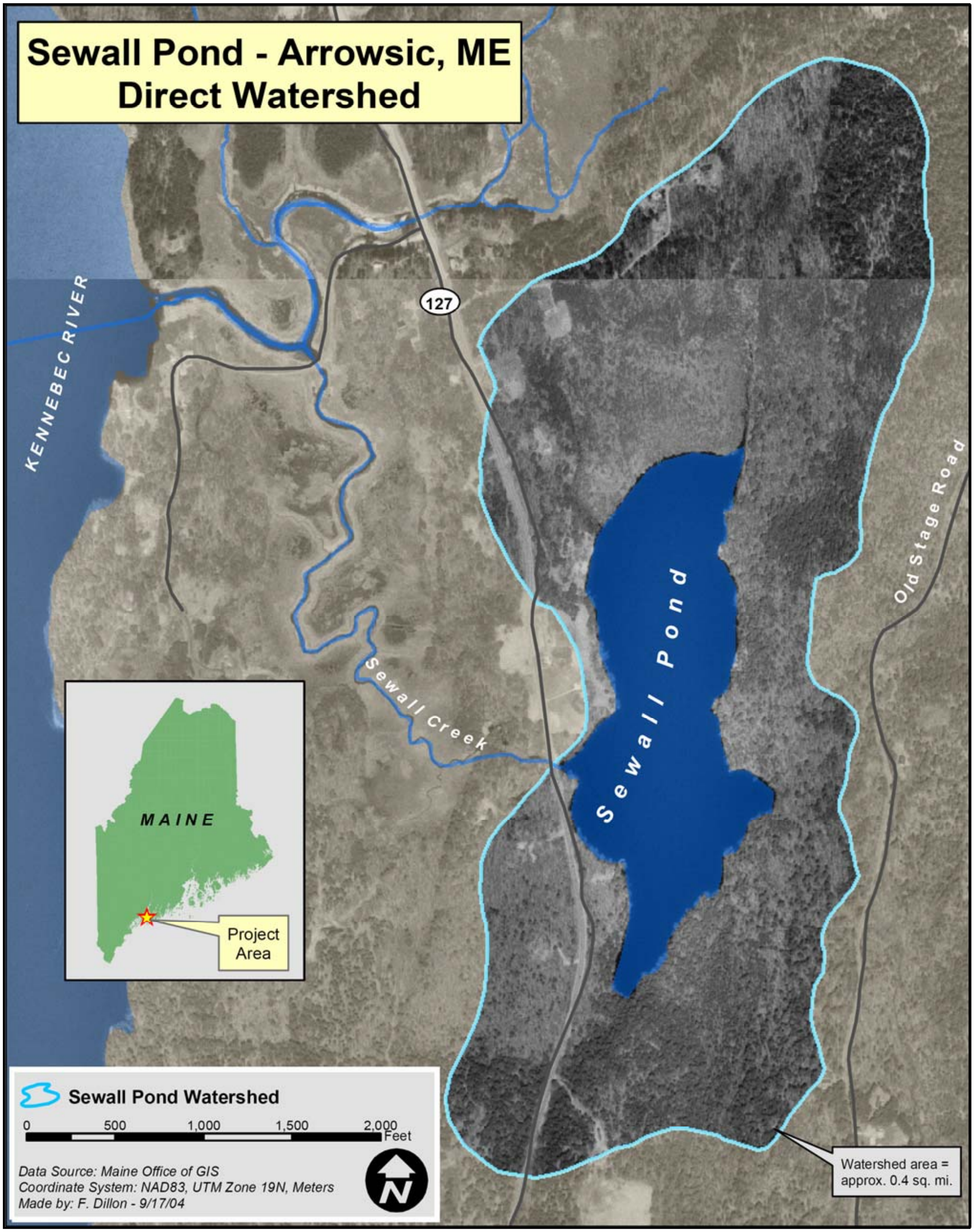
Roadway widths were estimated from previous PCAP-TMDL reports where measurements were made for the various road types and from actual on-screen measurements using GIS. Only a single state-owned road (Route 127) was present in the watershed and was found to be 12 meters wide. GIS was used to calculate total road surface area.

Information regarding forest harvest operations was reviewed by the Maine Forest Service, Department of Conservation.

Study Limitations

Land use data gathered for the Sewall 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 as carefully researched estimations.

Figure 1. Map of Sewall Pond Direct Watershed



SEWALL POND Phosphorus Control Action Plan

DESCRIPTION of WATERBODY (Midas Number 9943) and WATERSHED

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

SEWALL POND is a 45-acre (18 hectare), single-basin, highly-colored waterbody, located in the Town of Arrowsic (DeLorme Atlas, Map 6), in Sagadahoc County, Maine. Sewall Pond has a **direct watershed** area (see Figures 1 and 2) of approximately 258 acres (0.4 square miles) including the lake surface area. Sewall Pond has a maximum depth of 11 ft (3 m), overall mean depth of 9 ft (2.7 m), and an annual flushing rate of 1.61.

Drainage System: Sewall Pond has two inflows. The primary inflow is a large wetland area that enters the pond from the north. The second source of inflow is a smaller wetland area at the southern end of the pond. Sewall Pond's only outflow is through a culvert crossing under Route 127 into Sewall Creek, which then drains into Spinney Creek and the Kennebec River.

Water Quality Information

Sewall Pond is listed on the Maine DEP's section 303(d) list of lakes that do not meet State water quality standards. Therefore, a Phosphorus Control Action Plan (and TMDL) was prepared during the 2004 to 2005 time period.

Based on **Secchi disk transparencies,** and measures of both TP and **chlorophyll-a**, the water quality of Sewall Pond is considered to be poor and the potential for nuisance algae blooms is high (Maine VLMP 2004). Together, these water quality data indicate an impaired **trophic state,** in direct violation of the Maine DEP Class GPA water quality criteria requiring a stable or decreasing trophic state.

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.

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.

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

Principle Uses & Human Development: Forest and wetlands are the dominant land cover types in the Sewall Pond watershed and appear to be relatively undisturbed. The prevalent human uses are low density residential, transportation (Route 127), forest harvesting and recreation, which includes swimming, skating and fishing (Figures 2 and 3). Access to swimming areas occurs across Town-owned property on the east side of the pond and privately-owned property along the west site of the pond adjacent to Route 127. The small amount of forest harvesting that has occurred recently is scattered throughout the watershed and contributes very little additional phosphorus to overall forest land uses. Town officials report that recent bacteria monitoring results have not exceeded swim beach water quality standards. However, NPS pollution is still a potential concern for the watershed and Sewall Pond is on the State's section 303

(d) list of lakes that do not meet State water quality standards primarily due to excessive phosphorus, lake enrichment and the prevalence of nuisance algal blooms.

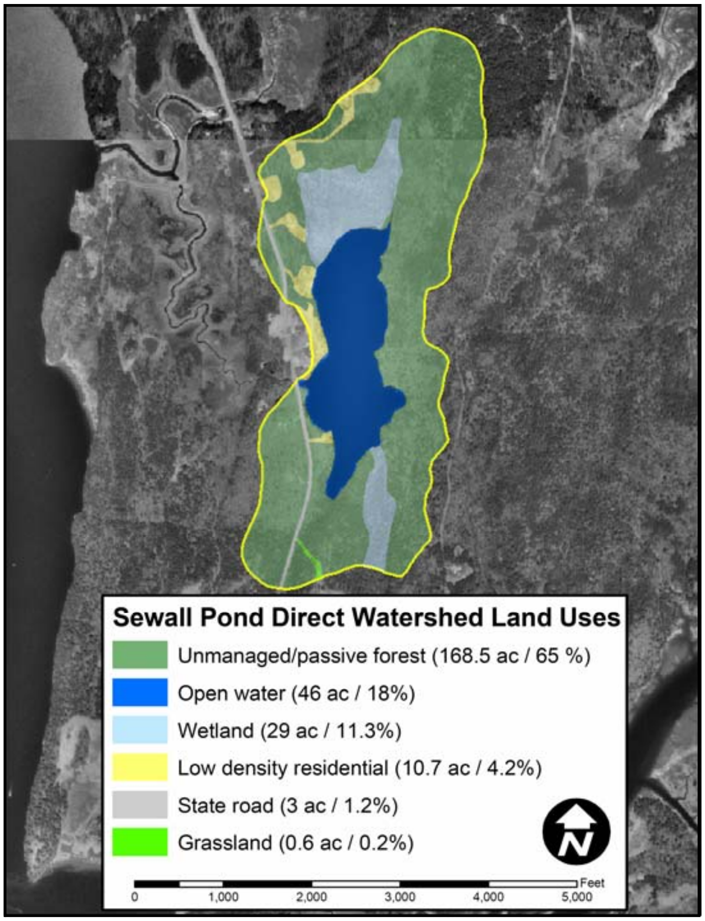


***Figure 2**: land uses in Sewall Pond watershed used to determine extent of phosphorus loading.*

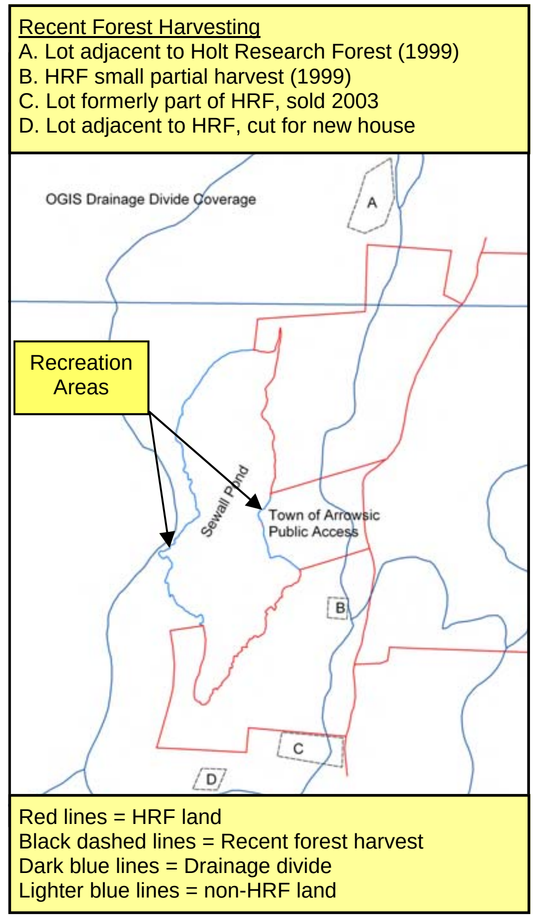


***Figure 3**: land ownership and forest harvesting activities in Sewall Pond watershed (Source: UMO Holt Research Forest)*

Sewall Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and recent conversations with fisheries biologist Bill Woodward (Region B, Sidney DIFW office), 43-acre (maximum depth 11 feet) Sewall Pond (Arrowsic Island, south of Woolwich - Lower Kennebec River drainage) is managed as a warmwater (largemouth bass and chain pickerel) fishery. Sewall Pond was originally surveyed by Maine DIFW in 1955 and resurveyed in 1993 (REMAP), while their lake fisheries report was last revised in 1998. A total of **10** fish species are now found to occur, including: **8** native indigenous fishes (catadromous American eel, anadromous alewife, golden shiner, white sucker, chain pickerel, white perch, pumpkinseed, and yellow perch); and **2** previously introduced fishes (largemouth bass and more recently, illegally introduced black crappie - first reported in 2005). Sewall Pond serves as a spawning site for adult sea-run alewives which enter the pond each spring and provide excellent forage fish for largemouth bass and chain pickerel. Maine DIFW notes that the outlet of Sewall Pond should be maintained free of obstructions to allow the annual spawning of alewives. The Maine Department of Marine Resources also supplements natural reproduction through periodic maintenance stockings of sea-run alewives (personal communication, Nate Gray, Maine DMR). Principal warmwater fisheries include both yellow and white perch.

Yellow perch

White perch

Future improvements in water quality may serve to enhance fisheries conditions in Sewall Pond. A significant reduction in the total phosphorus load in the Sewall Pond watershed may lead to maintaining in-lake nutrient levels within the natural assimilative capacity of this lake to effectively process phosphorus and possibly enhance largemouth bass and chain pickerel fisheries.

Largemouth bass

Chain pickerel

General Soils Description (Source: USDA SCS 1987)

The Sewall Pond watershed is characterized primarily by the Hollis-Sutton-Buxton soil association, which consist of shallow to deep, medium textured and moderately coarse textured, well drained and moderately well drained, nearly level to steep soils, generally on the tops of hills and ridges. To a much lesser extent it is characterized by the Scantic-Leicester-Scarboro soil association, which is deep, medium textured and moderately coarse textured, poorly drained and very poorly drained, level to gently sloping soils.

Both general soil associations fall mainly within the C and D hydrologic soil groups, which have slow infiltration rates and therefore higher runoff potential which could lead to greater amounts of surface runoff. Some of the soils in both of these associations are also underlain by bedrock, which when fractured provides a direct conduit for contaminants to nearby surface waters. This is a potential problem for pre-1974 septic systems, which were constructed and installed before more modern design standards were established.

Land Use Inventory

The results of the Sewall Pond watershed land use inventory are depicted in Table 1 (p.13), and categorized by developed land vs. non-developed land. The developed land area comprises nearly 6% of the watershed while the undeveloped land (including the water surface of Sewall Pond), comprises the remainder. Land areas for each category were used to estimate the respective phosphorus export rates and may be used to assist with future planning and conservation decisions relating to the Sewall Pond watershed. The information in Table 1 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Descriptive Land Use and Phosphorus Export Estimates

Figure 4*: Route 127 passes near the Sewall Pond along its western shoreline*

Shoreline Roads: NPS pollution associated with this land use category can vary widely, depending upon road type, slope and proximity to a surface water resource. Routine maintenance of unimproved roads and associated drainage structures is often inadequate. For Sewall Pond, the average road width of Route 127 approximated 12 meters (based on findings from previous PCAP-TMDL reports and measurements using GIS). Total phosphorus loading was estimated by calculating the surface area for the shoreline section of the road with GIS. Based on these factors, while the shoreline section of Route 127 covers less than 0.5% of the total land area, it is responsible for approximately 10.2% of the total phosphorus load in the Sewall Pond watershed.

Table 1. Sewall Pond Direct Watershed—Land Use Inventory and Phosphorus Loads

LAND USE CLASS	Land Area Acres	Land Area %	TP Export Total %
Shoreline Development			
Shoreline Roads	1.1	0.4%	10.2%
Low Density Residential	4.7	1.8%	9.6%
Sub-Totals	**5.8**	**2.3%**	**19.8%**
Non-Shoreline Development			
Low Density Residential	6.0	2%	13.7%
Roads	1.9	1%	10.3%
Sub-Totals	**7.9**	**3%**	**24.0%**
Total: DEVELOPED LAND	**14**	**5%**	**44%**
Non-Developed Land			
Inactive/Passively Managed Forest	168.5	65%	30.0%
Grassland/Reverting Fields	0.6	0.2%	0.4%
Wetlands	29.1	11%	0.0%
Total: NON-DEVELOPED LAND	**198**	**77%**	**30%**
Total: Surface Water (Atmospheric)	**46**	**18%**	**26%**
TOTAL: DIRECT WATERSHED	**258**	**100%**	**100%**

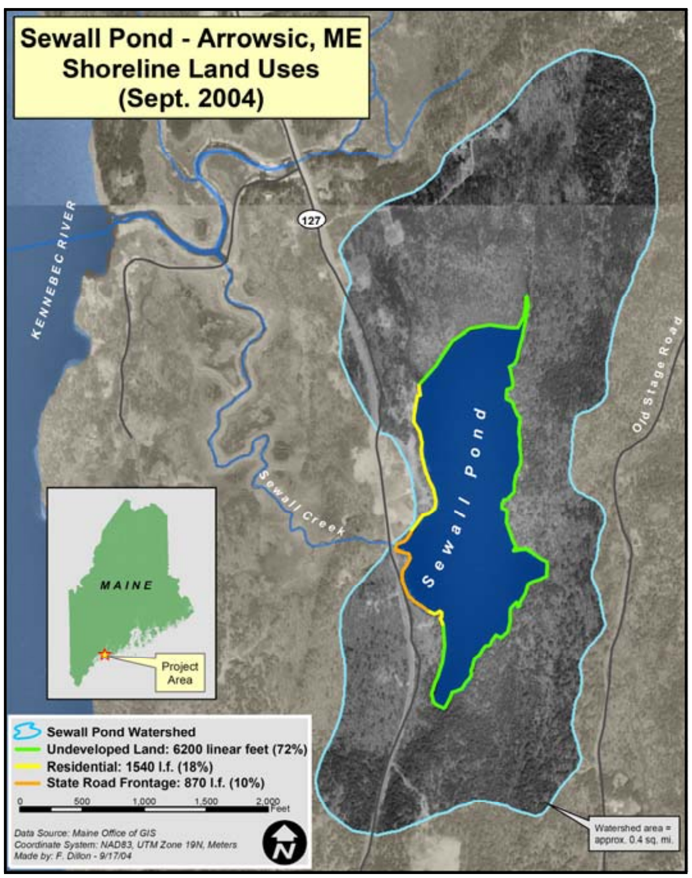


***Figure 5**: Sewall Pond Shoreline Land Uses*

Shoreline Residential (House and Camp Lots): Shoreline lake residences can have a comparatively large total phosphorus loading impact to lakes in comparison to their relatively small percentage of the total land area in the watershed. This is also the case for Sewall Pond, despite the sparse extent of shoreline development. Shoreline residential land use is estimated to consist of only 1.8% of the total watershed land area and contribute approximately 9.6% of the total phosphorus load to Sewall Pond.

MACD project staff determined the lakeside residential phosphorus load estimate by conducting a general shoreline survey in the fall of 2004. This visual survey was carried out while observing the Sewall Pond shoreline from a canoe and using best professional judgment to create a shoreline land-use map (Figure 5, page 13). At this time, shoreline development on Sewall Pond is limited to only 6 residential properties. Consequently, overall shoreline development comprises approximately 2.3% of the total Sewall Pond watershed area, while contributing nearly 20% of the total phosphorus load annually.

Non-Shoreline Development and Land Uses

Non-Shoreline Development consists of all lands outside the immediate shoreline (> 250') of Sewall Pond - including low density residential areas and public roads (in this case only Route 127). The total area occupied by these land-uses was determined using GIS.

Low Density Residential: Low density residential land use consists of approximately 2% of land area and contributes an estimated 13.7% of the total phosphorus loading to the Sewall Pond watershed.

Public Roads: as stated previously, the road width for Route 127 was estimated at 12 meters from previous PCAP reports and from on-screen measurement of digital aerial photos to determine the amount of total phosphorus loading from this land use category. Based on these factors, the non-shoreline section of Route 127 comprises 1% of the total Sewall Pond watershed while contributing an estimated 10.3% of the total phosphorus load.

Phosphorus Loading from Non-Developed Lands and Water

Inactive/Passively Managed Forests: Non-managed deciduous and mixed forest plots occupy nearly 169 acres in the Sewall Pond watershed. This is by far the largest land use category, comprising 65% of the watershed while contributing approximately 30% of the total phosphorus load to Sewall Pond. This large phosphorus contribution is almost entirely due to the high percentage of land area occupied by passive forest land, which, along with sustainably harvested forest lands, are generally some of the most compatible land uses for maintaining water quality.

Other Non-Developed Land Areas: The combination of grasslands/reverting fields and wetlands account for the remaining 11.2% of the land area in the Sewall Pond watershed and less than 1% of the total phosphorus export load.

Atmospheric Deposition (Open Water): The surface of Sewall Pond comprises 18% of the total watershed area and atmospheric deposition accounts for an estimated 26% of the total phosphorus load entering the pond.

PHOSPHORUS LOADS – Watershed, Sediment and In-Lake Capacity

Supporting documentation for the phosphorus loading analysis includes the following: water quality monitoring data from Maine DEP and the Volunteer Lake Monitoring Program, 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 GIS-based model 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 Sewall 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 Method

Watershed Land Uses: Total phosphorus loadings to Sewall Pond originate from a combination of external watershed and internal lake sediment sources. Watershed phosphorus sources, totaling 12 kg annually (corrected GIS) have been identified and accounted for by land use (See Table 2 - page 23), while average annual internal lake sediment P-loadings of 1.3 kg were estimated during the summers of 2004 (1.4 kg) and 2005 (1.2 kg).

2. In-Lake Concentration Method (TMDL)

Lake Capacity: The assimilative capacity for all existing and future non-point pollution sources for Sewall Pond is 2.23 kg of total phosphorus per year, based on a target goal of 16 ppb (see Phosphorus Retention Model - page 25).

Target Goal: A change in 1 ppb in phosphorus concentration in Sewall Pond is equivalent to 0.14 kg. The difference between the target goal of 16 ppb and the measured average summertime total phosphorus epilimnion concentrations (2004-2005 = 34 ppb) is 18 ppb or 2.52 kg (18 x 0.14).

Future Development: The annual total phosphorus contribution to account for future development for Sewall Pond is 0.07 kg (0.50 x 0.14) (see Future Development page 25 for more information).

Reduction Needed: Given the target goal and a 0.07 kg allocation for future development, the total amount of phosphorus needed to be reduced, on an annual basis, to eventually restore water quality standards in Sewall Pond approximates 2.6 kg (2.52 + 0.07).

PHOSPHORUS CONTROL ACTION PLAN

Recent and Current NPS/BMP Efforts

Aside from this current report, no formal studies have been done to determine the extent of nonpoint source (NPS) pollution in the Sewall Pond watershed and there have been no organized BMP efforts to reduce NPS pollution there. However, the Natural Resources Conservation Service and the Androscoggin Valley Soil Water Conservation District (AV-SWCD) have provided past consultation with the Arrowsic Conservation Commission to minimize impacts from the recreational access area located off Old Stage Road along the east side of the pond (Personal Communication, Phoebe Hardesty, AV-SWCD).

Recommendations for Future NPS/BMP Work

Based on current knowledge, Sewall Pond has impaired water quality due mostly to historically high phosphorus inputs from NPS and the resulting internal lake sediment recycling of phosphorus. Consequently, specific recommendations to improve water quality conditions in Sewall Pond by reducing (1) external watershed phosphorus loadings and (2) internal phosphorus loadings from accumulated bottom sediment are as follows:

Watershed Management: Several agencies (i.e., Maine DEP, AV-SWCD, USDA-NRCS) are available to assist in the active restoration of Sewall Pond's water quality. This PCAP-TMDL report will serve as a guide for the various NPS BMP efforts that must be undertaken to adequately address current and future water quality issues in the Sewall Pond watershed.

Action Item # 1: Coordinate existing watershed management efforts		
Activity	**Participants**	**Schedule & Cost**
Initiate efforts to develop a Sewall Pond Advisory Team	AV-SWCD, NRCS, Maine DEP, town of Arrowsic, interested watershed citizens - stakeholders	Annual Roundtable Meetings beginning in Summer 2006 - minimal cost

Shoreline Residential: Even though Sewall Pond's shoreline is sparsely developed with residential dwellings, there is still the potential to negatively impact water quality with this land use. 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 also be undertaken to encourage landowners to establish adequate and effective vegetated buffers along the shoreline. 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 AV-SWCD (753-9400).

Action Item # 2: Develop watershed stakeholder buffer awareness campaign		
Activity	**Participants**	**Schedule & Cost**
Develop a Buffer Awareness Campaign for Watershed Citizens	Maine DEP, AV-SWCD, Town of Arrowsic, interested watershed citizens	Begin immediately - $500/year

Roadways: A common cause of NPS pollution in lake watersheds is often related to roads, which if not properly designed and maintained can be a major source of erosion and sedimentation into ponds, lakes and streams. This PCAP report estimates that public roads (Route 127) contribute slightly more than 20% of the total phosphorus load to Sewall Pond each year. As such, efforts should be undertaken to identify pollution sources from roads so that appropriate BMPs can be designed and installed to remediate problem areas. The Maine Department of Transportation (MDOT) has two programs that may provide funding BMP construction: the Surface Water Quality Protection Program (SWQPP) and Transportation Enhancement (TE) Program.

Action Item # 3: Implement roadway best management practices		
Activity	**Participants**	**Schedule & Cost**
Conduct survey of public roads in watershed to determine NPS pollution sources and establish / implement roadway BMPs	Maine DEP, Maine DOT, AV-SWCD, Town of Arrowsic, interested watershed citizens	2006 - 2007 $1,000-$2,500

Non-Shoreline Development: Combined, these types of land uses are estimated to contribute nearly 24% of the total phosphorus load to Sewall Pond. Therefore, particular attention should be given to properties adjacent to water courses in the Sewall Pond watershed.

Septic Systems: Older, poorly designed and installed septic systems within the shoreland zone may contribute significantly to water quality problems, adding to the cumulative phosphorus load of Sewall Pond. While Sewall Pond septic systems – when properly sited, constructed, maintained, and set back from the water – should not affect water quality, many septic systems may not meet all of these criteria and thus have the potential to contribute phosphorus and other contaminants to lake water. Septic systems around Sewall Pond that are sited in coarse, sandy soils with minimal filtering capacity are especially likely to contribute nutrients to lake waters, as are pre-1974 septic systems underlain by fractured bedrock, which provides a direct conduit for contaminants to nearby surface waters. (In 1974 the Maine Plumbing Code was updated to require septic system design standards that were more protective of public health).

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. In some cases, a revolving loan fund could be established to assist in the replacement of malfunctioning septic systems. Above all, educational efforts should make residents aware of impending problems and possible cost-effective solutions.

Action Item # 4: Develop septic system inspection program		
Activity	**Participants**	**Schedule & Cost**
Conduct septic system inspections to identify any potential malfunctions and promote regular pumping to ensure proper septic system operation	Maine DEP, AV-SWCD, Town of Arrowsic and watershed citizens.	Periodically, beginning in 2006 $500/yr

Individual Action: All watershed residents should be encouraged through continued education and outreach efforts, including: retention or planting of natural vegetation of buffer strips, use of non-phosphate cleaning detergents, elimination of phosphorus-containing fertilizers, adequate maintenance of septic systems.

Action Item # 5: Expand homeowner education & technical assistance pro-		
Activity	**Participants**	**Schedule & Cost**
Increase outreach and education efforts to watershed citizens including technical assistance to landowners.	AV-SWCD, Maine DEP, Sewall Pond Association	Annually, beginning in 2006 $500/yr includes printing of educational materials

Municipal Action: The Town of Arrowsic should ensure public compliance with local and state water quality laws and ordinances (Shoreland Zoning, Erosion and Sedimentation Control Law, plumbing code) through education and enforcement action, when necessary.

WATER QUALITY MONITORING PLAN

Historically, the water quality of Sewall Pond has been monitored via measures of Secchi disk transparencies during the open water months since 1981 (Maine DEP and VLMP). Continued long-term water quality monitoring (water transparencies) for Sewall Pond will be conducted every two weeks, from May to October, through the ongoing efforts of Maine DEP and VLMP. Under this planned, post-TMDL water quality-monitoring plan, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Sewall Pond. A post-TMDL adaptive management status report will be prepared 5 to 10 years following EPA approval.

PCAP CLOSING STATEMENT

The Maine Association of Conservation Districts and Androscoggin Valley Soil and Water Conservation District (AV-SWCD), in cooperation with lake stakeholders, have initiated the process of addressing nonpoint source pollution in the Sewall Pond watershed. Technical assistance by AV-SWCD is available to the Town of Arrowsic to mitigate phosphorus export from existing NPS pollution sources and to prevent excess loading from future sources. The Town of Arrowsic has recognized the inherent value of Sewall Pond and its vital link to the community by establishing strict zoning standards that will provide strong support to ongoing restoration efforts. Its continued cooperation with the AV-SWCD in the pursuit of local and regional pond improvement strategies should result in an eventual and overall improvement in Sewall Pond through NPS-BMP implementation and increased public involvement and awareness.

APPENDICES

SEWALL POND (Arrowsic)

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.' 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.

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

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

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. 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, and Unity ponds and Long Lake (with assistance from Lakes Environmental Association), as well as Togus, Duckpuddle, Lovejoy, and Lilly ponds (pending final EPA review). PCAP-TMDL studies have been initiated for Hermon and Hammond ponds, as well as several of the remaining seven 2004 303(d) listed PCAP-TMDL waterbodies in Aroostook County.

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

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

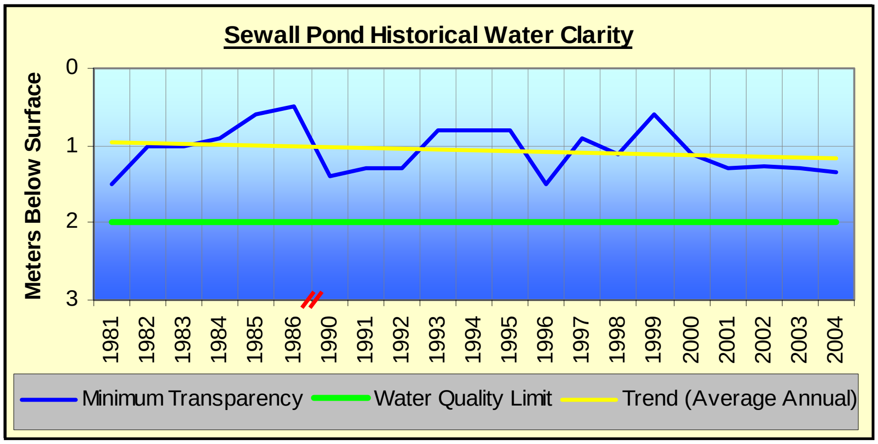
For further information, contact Dave Halliwell, Maine Department of Environmental Protection, Lakes PCAP-TMDL Program Manager, SHS #17, Augusta, ME 04333 (287-7649). E-mail: david.halliwell@maine.gov

Water Quality, Priority Ranking, and Algae Bloom History

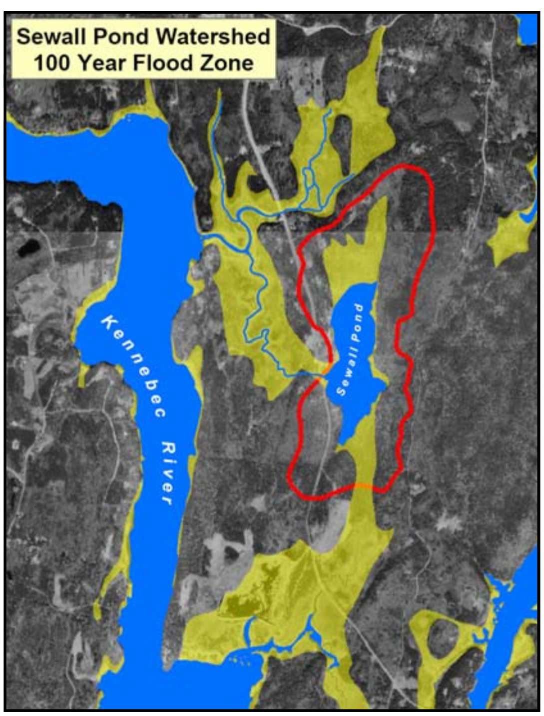
Water Quality Monitoring: (Source: Maine DEP and VLMP 2004) Water quality monitoring data for Sewall Pond (station 1, deep hole) has been collected since 1981 (with exception of 1989). This present water quality assessment is based on 23 years of Secchi disk transparency (SDT) measures, 12 years of chlorophyll-a measures, and 10 years of basic chemical and epilimnion core total phosphorus data.

Water Quality Measures: (Source: Maine DEP and VLMP 2004) Historically, Sewall Pond has had a range of SDT measures from 0.5 to 5.0 m, with an average of 1.6 m; an epilimnion core TP range of 34 to 82 (minus 1981 outlying value of 160) with an average of 54 parts per billion (ppb), and chlorophyll-a measures ranging from 9.4 to 98.2 ppb, with an average of 40.7 ppb. Recent dissolved oxygen (DO) profiles indicate fairly low levels of DO in deeper areas of the pond (which is only 3 m at the "deep hole").

Priority Ranking, Pollutant of Concern and Algae Bloom History: Sewall Pond is listed on the State's 2004 303(d) list of waters in non-attainment of Maine State water quality standards and was moved up in the priority development order due to the need to complete an accelerated approach to lakes TMDL development. This Sewall Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in freshwater lakes in Maine.



Sewall Pond's minimal water clarity has remained fairly constant over the period of record.



As indicated by water clarity, the water quality of Sewall Pond has been very poor during the entire historical monitoring period. Since 1981, minimum transparencies have never met the state's water quality limit of two meters. Consequently, summertime nuisance algal blooms have been a regular occurrence. Associated total phosphorus and chlorophyll-a levels have been fairly high throughout the period of record.

Natural Environmental Background levels for Sewall Pond were not separated from the total nonpoint source load because of the limited and general nature of available information. Without more and detailed site-specific information on non-point source loading, it is very difficult to separate natural background from the total non-point source load (US-EPA 1999). Given that Sewall Pond is located in a 100 year flood zone, further investigation may be warranted to determine whether total phosphorus loadings are being added from outside the watershed as a result of periodic flooding. There are no known point sources of pollutants to Sewall Pond.

WATER QUALITY STANDARDS & TARGET GOALS

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

Maine DEP's functional definition of nuisance algae blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<30 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Sewall Pond is a highly-colored lake (average color 74 SPUs), with low late summer SDT readings (annual average of 1.6 meters), in association with high chlorophyll a levels (40.7 ppb annual average). Currently, Sewall Pond does not meet water quality standards primarily due to non-attainment of water transparency measures over time. This water quality assessment uses historic documented conditions as the primary basis for comparison.

Designated Uses and Antidegradation Policy: Sewall 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 Sewall Pond is set at 16 ppb total phosphorus (2.23 kg/yr). 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 attain the narrative water quality standard. Minimal spring-time (late May - June) total phosphorus levels in Sewall Pond measured 19-23 ppb while maximum summertime-early fall levels averaged 34 ppb.

In summary, the numeric water quality target goal of 16 ppb for total phosphorus in Sewall Pond is based primarily on desirable late spring - early summer pre-water column stratification measures, generally corresponding to non-bloom conditions, as reflected in suitable (water quality attainment) measures of Secchi disk transparency (> 2.0 meters) and chlorophyll-a (< 8.0 ppb).

ESTIMATED PHOSPHORUS EXPORT BY LAND USE CLASS

Table 2 details the numerical data used to determine external phosphorus loading for the Sewall Pond watershed. The key below Table 2 on the next page explains the columns and the narrative that follows (page 24) relative to each of the representative land use classes.

Table 2. Sewall Pond Direct Watershed - Estimated Phosphorus Export by Land Use

LAND USE CLASS	Land Area Acres	Land Area %	TP Coeff. Range kg TP/ha	TP Coeff. Value kg TP/ha	Land Area Hectares	TP Export Load kg TP	GIS Adjusted* kg TP	TP Export Total %
Shoreline Development								
Shoreline Roads	1.1	0.4%	0.60 - 10.0	2	0.5	0.9	1.2	10.2%
Low Density Residential	4.7	1.8%	0.25 - 1.75	0.5	1.9	1.0	1.1	9.6%
Sub-Totals	**5.8**	**2.3%**			**2.4**	**1.9**	**2.3**	**19.8%**
Non-Shoreline Development								
Low Density Residential	6.0	2.3%	0.25 - 1.75	0.5	2.4	1.2	1.6	13.7%
Roads	1.9	0.7%	0.60 - 10.0	1.5	0.8	1.1	1.2	10.3%
Sub-Totals	**7.9**	**3.1%**			**3.2**	**2.4**	**2.8**	**24.0%**
Total: DEVELOPED LAND	**14**	**5%**			**5.6**	**4.2**	**5.1**	**43.8%**
Non-Developed Land								
Inactive/Passively Managed Forest	168.5	65.3%	0.01-0.08	0.04	68.2	2.7	3.5	30.0%
Grassland/Reverting Fields	0.6	0.2%	0.1 - 0.2	0.15	0.3	0.04	0.05	0.4%
Wetlands	29.1	11.3%	0-0.05	0	11.8	0.0	0.0	0.0%
Total: NON-DEVELOPED LAND	**198**	**77%**			**80.2**	**2.8**	**3.6**	**30.4%**
Total: Surface Water (Atmospheric)	**46.1**	**17.9%**	**0.11-0.21**	**0.16**	**18.7**	**3.0**	**3.0**	**25.9%**
TOTAL: DIRECT WATERSHED	**258**	**100%**			**104.4**	**10.0**	**11.7**	**100%**

Key for Columns in Table 2

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, aerial photography, Delorme Topo USA software, and field reconnaissance.

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. The coefficient is often adjusted using best professional judgment based on conditions including soil type, slope, proximity to surface waters and best management practices (BMP's) installed.

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

TP Export Load kg TP: Total hectares x applicable total phosphorus coefficient

GIS Adjusted kg TP: The value resulting from the adjustment to the "TP Coeff. Value" based on soil type, slope, proximity to surface waters and best management practices (BMP's). All of these factors affect phosphorus runoff potential and so the GIS adjustment provides a more accurate estimation of the "TP Export Load."

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 Sewall Pond watershed as presented on the previous page in Table 2 represent the extent of the current direct watershed phosphorus loading to the lake (11.7 kg/yr).

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 Schroeder (1979), Reckhow et al. (1980), Dennis (1986), Dennis et al. (1992), and Bouchard et al. (1995) for residential properties, roadways, agriculture and other types of land uses (e.g., recreational, commercial).

Private and Public Roads: The total phosphorus loading coefficient for public roads (2.0 kg/ha/yr for shoreline roads and 1.50 kg/ha/yr for non-shoreline roads) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997) and phosphorus research by Jeff Dennis (Maine DEP).

Residential Lots (House and Camp): The range of phosphorus loading coefficients used (0.25 – 1.75 kg/ha/yr) was developed from information on residential lot stormwater export of phosphorus as derived from Dennis et al (1992). Phosphorus loading coefficients for low density residential development was estimated to be 0.50 kg/ha/yr.

Total Developed Lands Phosphorus Loading: A total of 43.8% (5.1 kg) of the phosphorus loading to Sewall Pond is estimated to have been derived from the cumulative effect of the cultural land use classes: shoreline development (19.8% - 2.3 kg); and non-shoreline development (24% - 2.8 kg) as depicted in Table 2.

Non-Developed Lands Phosphorus Loading: The phosphorus export coefficient for inactive/ passively managed 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. The phosphorus export coefficient for grassland/reverting fields (0.20 kg/ha/yr) and scrub/shrub (0.15 kg/ha/yr) is based on research by Bouchard (1995) and from an earlier study on Annabessacook Lake (1990), respectively. The export coefficient for wetlands is based on research by Bouchard (1995) and Monagle (1995) (0.0 kg/ha/yr). The phosphorus loading coefficient chosen for surface waters (atmospheric deposition) was 0.16 kg/ha/yr), as originally used in the China Lake TMDL (Kennebec County), and subsequent PCAP-TMDL lake studies in Maine. The lower range total phosphorus loading coefficient chosen (0.11 kg/ha) is similar to that used for nearby central Maine lakes in Kennebec County, while the upper range (0.21 kg/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980)

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 Sewall Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external nonpoint source nutrient pollution approximates 12 kg/yr.

LINKING WATER QUALITY and POLLUTANT SOURCES

Assimilative Loading Capacity: The Sewall Pond TMDL is expressed as an annual load as opposed to a daily load. As specified in 40 C.F.R. 130.2(i), TMDLs may be expressed in terms of either mass per unit time, toxicity, or other appropriate measures. It is thought appropriate and justifiable to express the Sewall Pond TMDL as an annual load because the lake basin has an annual flushing rate of 1.6, quite similar to the 1.5 overall average flushing rate for Maine lakes.

The Sewall Pond basin lake assimilative capacity is capped at 2.23 kg/yr, as derived from the empirical phosphorus retention model based on a target goal of 16 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 16 ppb.

Future Development: The Maine DEP water quality goal of maintaining a stable trophic state includes a reduction of current P-loading which accounts for both recent P-loading as well as potential future development in the watershed. The methods used by Maine DEP to estimate future growth (Dennis et al. 1992) are inherently conservative, as they provide for relatively high-end regional growth estimates and largely non-mitigated P-export from new development. This provides an additional non-quantified margin of safety to ensure the attainment of state water quality goals. Previously unaccounted P-loading from anticipated future development on Sewall Pond watershed approximates 0.07 kg annually (0.5 x 1 ppb change in trophic state or 0.14 kg).

Human growth may continue to occur in the Sewall Pond watershed, contributing new sources of phosphorus to the lake. Hence, existing phosphorus source loads must be reduced by at least 0.07 kg to allow for anticipated new sources of phosphorus to Sewall Pond. Overall, the presence of nuisance algae blooms in Sewall Pond may be reduced, along with halting the trend of increasing trophic state, if the existing annual phosphorus loading is reduced by approximately 2.6 kg (see in-lake P-loading model description from page 15).

Internal Lake Sediment Phosphorus Mass: The relative contribution of internal sources of total phosphorus within Sewall Pond - in terms of sediment TP recycling - were analyzed (using lake volume-weighted mass differences between early and late summer) and estimated on the basis of water column TP data. The only recent years for which adequate lake profile TP concentration was available to derive reliable estimates of internal lake mass was in 2004-05, averaging 1.3 kg (historical average = 11.3 during 1982-85 time period). Given the high levels of total phosphorus in the water column and the presence of nuisance algae blooms, it was expected that internal sediment derived phosphorus mass would be a relatively significant problem in Sewall Pond.

Linking Pollutant Loading to a Numeric Target: The basin loading assimilative capacity for highly-colored Sewall Pond was set at 2.23 kg/yr of total phosphorus to meet the numeric water quality target of 16 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to numeric target.

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

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

L = P (A z p) / (1-R) where, **1 ppb change = 0.14 kg**

2.23 = **L** = external total phosphorus load capacity (kg TP/year)
16 = **P** = total phosphorus concentration (ppb) = **Target Goal = 16 ppb**
.018 = **A** = lake basin surface area (km^2)=18.0 ha or 44.5 acres
2.7 = **z** = mean depth of lake basin (m) **A z p = 0.078**
1.61 = **p** = annual flushing rate (flushes/year)
0.56 = **1- R** = phosphorus retention coefficient, where:
0.44 = **R = 1 / (1+ sq. rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenwieder (Dillon and Rigler 1974) type empirical model for Maine lakes, e.g., Cobbossee, Madawaska, Sebasticook, East, China, Mousam, Highland (Falmouth), Webber, Threemile, Threecornered, Annabessacook, Pleasant, Sabattus, Toothaker, Unity, Upper Narrows, Highland (Bridgton), Little Cobbossee, Long (Bridgton), Togus, Duckpuddle, and Lovejoy PCAP-TMDL reports (Maine DEP 2000-2005) 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 Sewall Pond TMDL was developed using existing lake water quality monitoring data, derived watershed export coefficients (Reckhow et al. 1980, Maine DEP 1981 and 1989, Dennis 1986, Dennis et al. 1992, Bouchard et al. 1995, Soranno et al. 1996, and Mattson and Isaac 1999) and a phosphorus retention model which incorporates both empirically derived and observed retention coefficients (Vollenwieder 1969, Dillon 1974, Dillon and Rigler 1974 a and b, and 1975, Kirchner and Dillon 1975). Use of the Larsen and Mercier (1976) total phosphorus retention term, based on localized data (northeast and north-central U.S.) from 20 lakes in the US-EPA National Eutrophication Survey (US-EPA-New England) provides a more accurate model for northeastern regional lakes.

Strengths:

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

Weaknesses:

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

Critical Conditions occur in Sewall Pond during the summertime, when the potential (both occurrence and frequency) of nuisance algae blooms are greatest. The loading capacity of 16 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide adequate protection throughout the year (see Seasonal Variation).

LOAD ALLOCATIONS (LA's) - The load allocation for Sewall Pond equals 2.23 kg TP on an annual basis and represents, in part, that portion of the lake's assimilative capacity allocated to non-point (overland) sources of phosphorus (from Table 2). Direct external TP sources (totaling 11.7 kg annually) have been identified and accounted for in the land-use breakdown portrayed in Table 2 (corrected GIS). Further reductions in non-point source phosphorus loadings are expected from the continued implementation of NPS best management practices (see summary, pages 16-18). 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 Sewall Pond originate from a combination of direct and internal (lake sediment) sources of total phosphorus.

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

MARGIN OF SAFETY (MOS): An implicit margin of safety was incorporated into the Sewall Pond TMDL through the conservative selection of the numeric water quality target, as well as the selection of relatively conservative phosphorus export loading coefficients for cultural pollution sources (Table 2). Based on both Sewall Pond historical records and a summary of statewide

Maine lakes water quality data for colored (> 30 SPU) lakes - the target of 16 ppb (2.23 kg/yr in Sewall Pond) represents a highly conservative goal to assure attainment of Maine DEP water quality goals of non-sustained and non-repeated blue-green summer-time algae blooms due to NPS pollution or cultural eutrophication and stable or decreasing trophic state. The statewide data base for colored Maine lakes indicate that summer nuisance algae blooms (growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 18 ppb or above.

SEASONAL VARIATION: The Sewall 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 an average flushing rate of 1.6 flushes/year, the average annual phosphorus loading is most critical to the water quality in Sewall 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, nonpoint source best management practices (BMPs) proposed for the Sewall Pond watershed have been designed to address total phosphorus loading during all seasons.

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

1. **November 4, 2005:** MACD staff member Fred Dillon contacted Phoebe Hardesty (Androscoggin Valley Soil and Water Conservation District) to discuss historical information about Sewall Pond.

2. **November 23, 2005:** MACD staff contacted Roy Bouchard (Maine DEP) to discuss historical information about Sewall Pond.

3. **November 23, 2005:** MACD staff contacted VLMP monitor and Arrowsic Conservation Committee member William Blaiklock to discuss historical information about Sewall Pond.

4. **November 23, 2005:** MACD staff contacted Jack Witham, University of Maine Department of Wildlife Ecology, Associate Scientist at the Holt Research Forest, to discuss historical information about Sewall Pond.

5. **December 4, 2005:** MACD staff contacted Josephine Ewing, Arrowsic Town Clerk, for historical information about Sewall Pond. Also discussed Arrowsic Conservation Commission interest in implementing Sewall Pond PCAP-TMDL recommendations.

6. **December 5, 2005:** MACD staff contacted Lee Dogget (Maine DEP) for historical information about Sewall Pond.

7. **December 6, 2005:** MACD staff contacted Phoebe Hardesty (AV-SWCD) to follow up on historical information for Sewall Pond.

8. **January 16, 2006:** MACD staff presented findings from Sewall Pond PCAP-TMDL to the Arrowsic Conservation Commission.

Combined STAKEHOLDER AND PUBLIC REVIEW PROCESS

SEWALL POND - Arrowsic

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 - 0735) for the **SEWALL POND** watershed, located within the Town of Arrowsic. This PCAP-TMDL report identifies and provides best estimates of non-point source phosphorus loads for all representative land use classes in the **SEWALL 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 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 January 27, 2006 to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333 or e-mail: david.halliwell@maine.gov. [As advertised in the Kennebec Journal (Sunday, January 15, 2006) and the Brunswick Times Record (local weekly newspaper)].

PUBLIC REVIEW Comments Received

Comments from Josephine Ewing, Arrowsic Conservation Commission – January 20, 2006

Dear Mr. Halliwell,

The Arrowsic Conservation Commission has been involved with Sewall Pond for many years. We have maintained the Town property that is the official public access on the east side of the pond, and have been the VLMP monitors since the late 1980s. We instigated several of the activities mentioned in the report (stocking alewives, E. coli testing, erosion control at the swim site).

We met with Fred Dillon on Monday night and had an informative presentation on the DEP Phosphorus Control Action Plan. We were very grateful that he was able to present to our committee, and we were happy to have three of the four full time shoreline residents at the meeting, as well as several town officials. We offer these comments, most of which were brought out at the meeting, and which Fred Dillon has probably documented, but so much was being discussed at the time that I don't know how anyone could get it all down.

One of our biggest concerns about the report was the fact that the Town is being charged with the task of fixing a problem whose origin is unknown, and there is no attempt in the report to identify the source of the problem. We are being asked to remediate a high concentration of phosphorus by addressing actually very small likely sources. Even if the town were miraculously able to prevent all phosphorus loading from human sources, the natural phosphorus loading into the lake from rainwater directly into the pond and from run-off from the forested shoreline, according to this report, will keep the phosphorus loading in the 'non-attainment' category. This is very hard for a small town to surmount. While I am sure we will be happy to patch up what erosion sites we can, it seems this is an unlikely source for the historically high phosphorus concentrations. In 1981, the phosphorus concentration was recorded at 160 ppb. The next year, the concentration dropped by half, and it has been, on average, decreasing slowly ever since. Yet the report does not address the possibility that sources other than normal run-off and lakeside dwellings could be the culprit. Do the historical data for phosphorus concentrations look like what one might expect from a one-time overload of phosphorus, or perhaps from years of overloading due to poor land management practices (clearcutting) which were terminated before 1980?

Some possible historical sources of phosphorus include a logging operation on steep land at the north end of the watershed, terminated around the 1950s; improper handling of fertilizers,etc., by a landscaping business formerly located at one of the shoreline residences; former chicken coop at another residence on the shoreline; possible midnight dumping of septic waste; and pollutants from the Kennebec (River) on flood tides.

Maine DEP / MACD Response

Dear Ms. Ewing,

The following is in response to your 20 January 2006 public review comments for the Sewall (please note corrected spelling of lake name, Sewell = Sewall) Pond PCAP-TMDL report.

(1) This report is simply an advisory document which identifies known and probable nutrient-based watershed (external) loads, relative to the capacity of the waterbody to naturally assimilate total phosphorus loads. For your information, the actual P-loads for Sewall Pond are relatively very low, compared to other lakes studied, as reflected in the low-level P-reduction estimate.

(2) We commend the Arrowsic Conservation Commission (ACC) for their considerable past and current efforts in controlling non-point sources of both shoreline and watershed-based nutrient enrichment into Sewall Pond. We also apologize for not initially identifying the ACC as the primary stakeholder group and engaging the ACC during the earlier stages of this study.

(3) Based on your generous input, we have revised this report to incorporate your concerns and added information, as best possible - including the following:
   a) Documentation of skating and ice fishing as popular recreational uses of Sewall Pond.
   b) Corrected location of primary swimming site along the shore of the town-owned property on the east side of the pond (not the Route 127 access point).
   c) VLMP sponsored water clarity measures (SDT's) taken every two weeks, not monthly.
   d) Modified PCAP closing statement to further recognize ongoing efforts of the ACC and Town of Arrowsic in protecting the water quality of Sewall Pond, including adoption of strict shoreland zoning requirements, as part of their 1989 Town comprehensive plan.

Sincerely,

Dave Halliwell
Maine DEP, Lakes PCAP-TMDL Program Manager

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