SEBASTICOOK LAKE

TOTAL MAXIMUM DAILY (ANNUAL) LOAD

Final Report

DEPLW 2000 - 110

Maine Department of Environmental Protection

8 February 2001

Maine Lake TMDLs - What, Why, Where, and When?

You are no doubt wondering what the acronym 'TMDL' represents and what it is all about. TMDL is actually short for 'Total Maximum Daily Load.' This acknowledgment probably does little to clarify TMDLs in most people's minds. However, replace 'daily' with 'annual' and insert 'phosphorus' before 'load' and it may begin to make more sense to more people.

Simply stated, excess nutrients (such as phosphorus) in lakes promote nuisance algae growth/blooms - resulting in the violation of water quality standards. A TMDL is prepared to estimate the total amount of dissolved phosphorus that a lake can accept (annually) 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 Non-Point Sources (NPS) of water 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 phosphorus load in lakes include residential-commercial developments, agriculture, roadways, and commercial forestry. Statewide, there are approximately 35 lakes which do not meet water quality standards due to excessive amounts of total phosphorus.

The first Maine lake TMDL was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with ME-DEP and US-EPA. Recently, a TMDL was approved by EPA for Madawaska Lake (Aroostook County), and a TMDL for Sebasticook Lake (Penobscot County) is currently under review. TMDLs are presently being prepared by ME-DEP for East Pond, China Lake, Mousam Lake, and Unity Pond. Also, this coming summer and fall (2001), TMDLs for Annabessacook Lake and Pleasant Pond (Kennebec and Sagadahoc counties) will be developed by CWD - under contract with ME-DEP and EPA.

TMDL reports are based on available water quality data including seasonal (in-lake) 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; identification of a total phosphorus target goal (acceptable amount); allocation of watershed/land-use phosphorus loadings - while addressing 'margin of safety' (uncertainty) concerns and seasonal variation; as well as a public participation component to allow for public review.

TMDLs are important tools for maintaining and protecting acceptable lake water quality. They are primarily designed to 'get a handle' on the magnitude of the NPS pollution problem and to develop plans for implementing Best Management Practices (BMPs) to address the 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.

Prepared by Dave Halliwell, ME-DEP Lakes TMDL Project Leader (22 January 2001)

TMDL Summary Overview

This summary overview provides **Sebasticook Lake** watershed stake-holders with a brief accounting of facts and figures from the Sebasticook Lake TMDL technical report, as prepared by ME-DEP. Further questions or comments should be addressed to Dr. David Halliwell, Lakes TMDL Project Leader, ME-DEP, State House Station #17, Augusta, ME 04333, 207-287-7649, **david.halliwell@state.me.us)**.

Note - Development of phosphorus-based lake TMDLs are not intended by ME-DEP to be used for regulatory purposes. They are primarily designed to 'get a handle' on the magnitude of the Non-Point Source (NPS) pollution problem and to develop plans to implement Best Management Practices (BMPs) to address the problem. Landowners (agricultural, residential, commercial, municipal) and watershed groups are eligible to receive further technical and financial assistance to reduce lake watershed phosphorus loads (US-EPA and ME-DEP Project 319 funding and support).

Unique Properties - Sebasticook Lake (1,735 hectares) is the largest waterbody in Maine, whose entire lakeshore lies solely within a single township - Newport. The lake watershed is heavily farmed - comprising 67% (3,490 ha) of the culturally impacted land area (5,324 ha). Major tributary drainages include the East Branch (Corinna Stream), Alder, Mulligan, and Stetson streams. The 23-year in-lake phosphorus database (1978-2000) represents one of the longest and continuous nutrient-based water quality records available for Maine lakes.

Historical vs. Current Water Quality - Sebasticook Lake has had very poor water quality for a very long time. Total phosphorus concentrations of several hundred ppb were typical in the 1960s and 1970s, when tributary point source pollution prevailed and nonpoint sources of pollution were relatively insignificant. Following treatment and/or cessation of municipal point source discharges, implementation of BMPs to control agricultural nonpoint sources of pollution, and 18 years of annual fall lake flushing - in-lake phosphorus concentrations have been significantly reduced to levels ranging from 16 to 41 ppb - averaging 19 to 36 ppb seasonally (late spring to late summer).

Water Quality Standards and Lake Target Goals - Notably, the only year on record during which Sebasticook Lake attained water quality standards was in 1997 - when minimum Secchi disk transparencies measured 2.1 meters in late August. Late spring total phosphorus concentrations at this time were 16 ppb. A total phosphorus concentration target goal for Sebasticook Lake of 15 ppb was selected to ensure the future attainment of water quality standards = Secchi disk transparencies 2.0 m or more and the absence of nuisance level, summer-time blue-green algae blooms.

Selection of Total Phosphorus Loading Coefficients - Estimates of phosphorus export loadings (kg TP per hectare per year) were determined using local and regionally published export coefficients for representative land uses. Selection of actual values, ranging from low to high, reflect the relative effects of applied BMPs - as evaluated by Best Professional Judgement (BPJ). In the final analysis, low-level agricultural total phosphorus loadings were chosen to reflect the considerable amount of money and time expended in NPS-BMP implementation over the past 20 years - by farmers, with the cooperation of state and federal agencies. Generally, moderate-level estimates were selected for non-agricultural land uses (e.g., residential development and roadways).

Watershed Land Use and TP Load Allocation - The Sebasticook Lake watershed, excluding the Pleasant Lake and Lake Wassookeag indirect drainages - is dominated (68%) by non-cultural land areas (non-commercial forests, wetlands, and scrub-shrub) - which contributes 10% of the non-point source TP load (545 kg). Atmospheric (lake surface area) sources comprise 8% of the watershed area and 5% of the TP load (278 kg). **Cultural NPS sources** (24% area - 85% TP load - 4,690 kg) include: agriculture (67% area - 52% TP load - 2,477 kg); roadways (7% area - 22% TP load - 1,026 kg); residential development - including septic systems (19% area - 18% TP load - 835 kg); and other development (7% area - 8% TP load - 352 kg), e.g., commercial, institutional, recreational areas. Shoreline septic systems and golf courses contribute similar estimated TP loadings of 2.5% and 2.6% or 137 kg and 145 kg, respectively.

Lake Basin Loading Capacity and External Pollutant Sources - Sebasticook Lake basin loading capacity, based on a phosphorus retention model, equals 4,514 kg of total phosphorus annually - at a target goal of 15 ppb. In contrast, external (watershed) total phosphorus export approximates 5,513 kg per year.

Internal Phosphorus Cycling and Fall Lake Drawdowns - Internal supplies of total phosphorus in Sebasticook Lake have been significantly reduced (4,000 kg to 2,000 kg or 50%) over the past 18 years by the operation of annual fall lake drawdowns and removal of mixed, phosphorus-rich waters. The actual effects of drawdowns vary with the timing and the extent of the flushing period and will continue to result in littoral zone dewatering and associated impacts on mussel populations and the archaic fish wier site.

NPS-BMP Implementation - Historically, agricultural interests in the Sebasticook Lake watershed - for the most part, have actively supported and cooperated with federal (Natural Resource Conservation Service, NRCS) and state (County Soil and Water Conservation District, SWCD) programs to combat non-point sources of water pollution. From the period 1982 to 1992, soil and water conservation practices were applied to 25 active farms in the watershed - which were identified as contributing most of the total phosphorus from non-point sources to the lake at that time. Twenty-one animal manure management systems were also installed. Currently, there are 68 operational farms located in the Sebasticook Lake direct watershed, the great majority of which produce cattle (dairy and beef) and cultivate large amounts of hay and animal feed corn crops. Notably, most of the farms have soil and water conservation plans in place with the Penobscot County NRCS/SWCD. Following a lakeshore watershed survey in 1998, the town of Newport, Sebasticook Lake Association, and the Penobscot Valley Council of Governments - has recently embarked on a project 319 (ME-DEP) BMP implementation program to remedy NPS pollution (soil erosion) from residential and municipal sources.

Water Quality Problem Solving Approach - As a result of much hard work and directed efforts by watershed stakeholders to address both point and nonpoint sources of water pollution, the water quality in Sebasticook Lake has dramatically improved over the past two decades. Further reductions (1-2,000 kg) in total phosphorus loads need to be achieved to meet and maintain targeted water quality standards for Sebasticook Lake. The continued implementation of a combination of BMPs will effectively reduce both the external and internal phosphorus load, including: (1) nonpoint source BMPs to further control soil erosion and NPS pollution from culturally derived sources (agriculture, roadways, residential and commercial development; and (2) operation of strategically planned and aggresively implemented fall lake drawdowns.

SEBASTICOOK Lake TMDL (Penobscot & Somerset Counties) Maine

Final Report: 8 February 2001 ME-DEP Lakes Assessment Section

1. Description of Waterbody, Priority Ranking, Pollutant of Concern, and Pollutant Sources - in Relation to Natural Background Levels

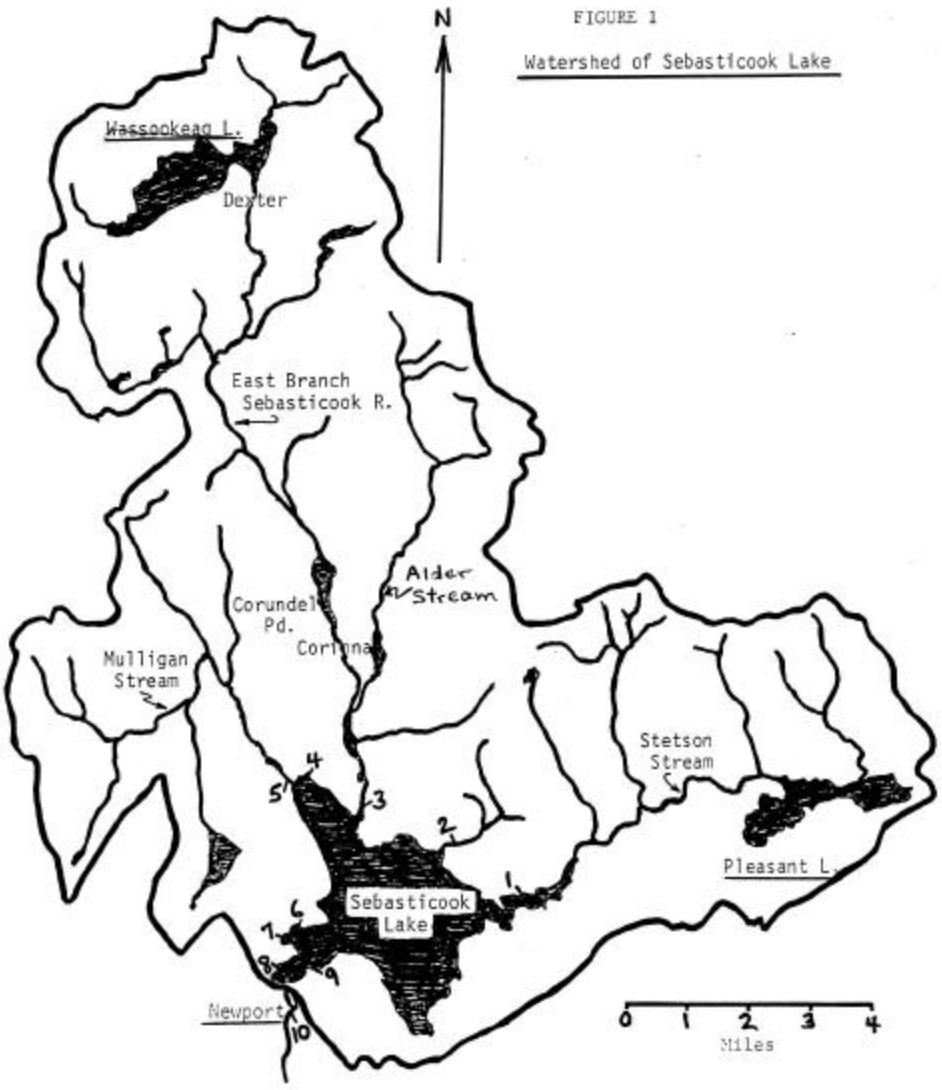
Description of Waterbody

Sebasticook Lake (*MIDAS #2264*) is a relatively large 1,735 hectare (4,287 acre or 17.4 km^2), single basin waterbody located in north-central Maine (DeLorme Atlas, page 22), within Penobscot and Somerset counties. The Sebasticook Lake watershed has a direct drainage area of 21,995 hectares, exclusive of the northwest situated Lake Wassookeag drainage (3,051 ha) and the Pleasant Lake drainage to the southeast (3,801 ha). Sebasticook Lake is the largest waterbody in Maine which lies solely within a single township - Newport. The town center is situated below the lake outlet and most of it drains down-stream of the lake. Over three-quarters of the Sebasticook Lake watershed lies within the towns of Corinna (41%) and Newport (35%), while the towns of Stetson (9%) and Dexter (7%) combine for an additional 16 percent (4 towns = 92%). The remaining eight percent of the Sebasticook Lake watershed lies within the four towns of Exeter, St. Albans, Palmyra, and Ripley.

Sebasticook Lake is moderately shallow, with maximum depths of 15 meters (50 feet) and mean depths of 6.2 meters (20 feet). These lake waters are lightly-colored (average of 35 SPUs), while the annual lake natural flushing rate averages 1.5 flushes per year, or once every 9 months.

Drainage System – (see Figure 1). Major tributaries include the East Branch Sebasticook River, which drains Lake Wassookeag within the town of Dexter to the north and flows south through Corinna (20% watershed area) - receiving Alder Stream to the east prior to draining (37% watershed area and one-half the

Figure 1. Sebasticook Lake Watershed with tributary sampling stations.



total tributary inflow of water) into the north end of Sebasticook Lake in Newport, below County Road. To the west, Mulligan Stream drains 13 percent of the Sebasticook Lake watershed area, while Stetson Stream drains Pleasant Lake to the east and flows directly (17% watershed area) into Sebasticook Lake. The lake outlet/dam is located on the southwestern arm of the lake below Barrows Point in the town of Newport. A four-meter deep canal and gate control dam structure - completed in 1982 - was engineered to allow for annual early fall lake drawdowns. Since this time, water levels in Sebasticook Lake have been drawn down for the express purpose of exporting phosphorus laden waters following fall overturn (see Load Allocation discussion). Rock et al. (1984) importantly note that, "if (the lake) drawdown is to have a major impact, then external inputs (of phosphorus) must (also) be significantly reduced."

A public boat launch is located on the south end of Sebasticook Lake in the town of Newport, just to the east of the outlet dam. The major human use of Sebasticook Lake is recreational, which includes boating, fishing, camping, and beach/residential use. There are two frequently used commercial campgrounds situated on the extreme southern point of Sebasticook Lake. Also, there is a 160-acre parcel (Camp Woody) on the north shore of the lake which is used as a seasonal Girl Scout Camp for two to four weeks during the summer.

Human Development – Sebasticook Lake is highly developed, primarily on the south-east and west shores, with both seasonal camps and year-round residences (32%). Based on recent inventories (MACD 2000), there are 322 shoreline houselots and 288 homes (90% developed), including 216 dues paying members within the Sebasticook Lake Association (MACD communication, Lynn Cianchette). Based on 1998 reports from the Maine State Planning Office, a total population of approximately 5,432 people reside within the Sebasticook Lake watershed.

Priority Ranking, Pollutant of Concern, and Algae Bloom History

Sebasticook Lake is listed as targeted (high priority) on the 1998 303(d) list and the Sebasticook Lake TMDL has been developed for total phosphorus, the major limiting nutrient to algal growth in freshwater lakes in Maine. According to historical records (Courtemanch 1986), water quality in Sebasticook Lake deteriorated due to cultural eutrophication (domestic and industrial wastes) by the latter 1940s through the 1950s - along with the loss of coldwater fish populations -trout, salmon, and smelt (MDIFW 1966).

During the past four decades (1960-2000), water quality in Sebasticook Lake has gradually improved - from a hypertrophic to eutrophic state (Burns 2000) in response to implementation of water pollution control measures, including (Courtemanch 1986): (1) reduction in point-source contributions through effective wastewater treatment within major watershed population centers (Dexter, Corinna, and Newport) and the closure/removal of the Corinna woolen mill; (2) reduction in non-point source contributions through adoption of agricultural best management practices (BMPs) in cooperation with watershed landowners and USDA Soil Conservation Service (since renamed as the Natural Resources Conservation Service - NRCS) programs; and (3) the rebuilding of the outlet dam in 1982, enabling a significant fall (early September to late November) drawdown of phosphorus-laden lake water to be removed on an annual basis (Rock et al. 1984).

Recently, an intense algal bloom occurred in the latter part of July 2000, and continued through September - when water transparency ranged from lows of 1.0 to 1.5 meters and epilimnion total phosphorus measures ranged from 29 to 31 ppb in Sebasticook Lake. In contrast, recent (1995-99) pre-summer bloom epilimnion total phosphorus springtime levels averaged 15 ppb with associated water clarity - transparency measures of 3.2 meters. In-lake core chlorophyll-a levels ranged from 7 to 12 ppb in late May-June to 53 ppb during the latter part of July 2000.

Pollutant Sources

This current water quality assessment is based on 26 years of bi-monthly Secchi disk water transparency measures (1974-2001), combined with 22 years of in-lake monitoring data (1978-2001), including monthly growing season total phosphorus and chlorophyll-a data. The existing phosphorus load was estimated on the basis of Sebasticook Lake watershed land use classes and atmospheric deposition (Table 2). According to both Hannula (1978) and Courtemanch (1986), a combination of internal and external sources of total phosphorus account for the majority of in-lake nutrient loadings. Dennis and Corson (1979) note that during (summer) stratification, internal sources actually contribute approximately as much phosphorus to the water column as the entire annual external loading. Major tributary total phosphorus concentrations and historical loadings are listed in Table 1, while Fig. 1 documents the location of tributaries.

Natural Background - levels were not separated from the total nonpoint source load because of the limited and general nature of available information. Without more and detailed site-specific information on nonpoint source loading, it is very difficult to separate natural background from the total NPS load (US-EPA 1999).

Descriptive Land Use Information

Estimates of total phosphorus export from different land uses found in the Sebasticook Lake watershed are presented in Table 2 and estimate the extent of external phosphorus loading to the lake. These measures are expressed as a range of values to reflect the degree of uncertainty associated with such relative estimates (Walker 2000). The watershed phosphorus loadings were determined using literature-derived export coefficients (Schroeder 1979, Reckhow et al. 1980, ME-DEP 1981 and 1989, Dennis 1986, Dennis et al. 1992, and Bouchard et al. 1995) for: agricultural practices (row crops, hayland, and pasture); low and high-density residential properties; roadways; and others types of developments (commercial, institutional, recreational, cemeteries, golf courses, gravel pits, and tree farms).

Table 1. Annual total phosphorus loading to Sebasticook Lake from major tributaries.

Courtemanch 1986	Loading	TP Loading	Vol-Wgt	**Sub-**	**-Water-**	**-Shed**		**Dennis &**
1980 Thru 1985	6-yr.Avg.	6-yr.Range	6-yr.Avg.	Area	Loading	Area	Loading	**Corson' 79**
Total Phosphorus	kg TP	kg TP	ppb	hectares	kg TP/ha	sq. km	kg/sq.km	kg/sq.km
East Branch SR	4,897	2,901 - 7,478	54	14,450	0.34	144.5	33.9	----------
Alder Stream	----------	----------	----------	----------	----------	----------	----------	16.1

Mulligan Stream	603	316 - 904	17	5,390	0.11	53.9	11.2	15.6
Stetson Stream	553	266 - 764	12	3,470	0.16	34.7	15.9	23.3
Total TP Loading	6,053	3,483 - 9,128	12 - 54	23,310	0.26	233.1	25.9	55.0
Estimated Spring			18 - 38					4,800 kg
Measured Spring			23 - 48					TP-NPS
Dennis&Corson 1979	7,658	----------	----------	23,310	0.33	233.1	32.9	Avg. 18.3
TOWN of NEWPORT	**TP***	**Measures**	**ppb**					
1998 - 2000								
	Average	**Spring Avg.**	**Summer**					
1 Durham Bridge	20	9.3 - 13	15 - 32					
2 Demos Stream	30	12 - 17	19 - 58					
3 County Road	30	12 - 19	25 - 44					
3 County Road DEP	33	19 - 30	37 - 57					
1999 - 2000								
4 Blaisdell Road	35	11 - 22	19 - 74					
5 Mulligan Stream	18	7 - 14	15 - 34					
6 Camp Benson	21	14 - 15	14 - 53					
7 Western Bog	25	6 - 11	13 - 73					
8 Head of the Lake	36	11 - 30	21 - 83					
9 Grove Street	44	10 - 15	36 - 110					

Table 2. Estimated total phosphorus export by land use class for the Sebasticook Lake watershed in north-central Maine.

LAKE	Reckhow	et.al.1980	Sebasticook	Lake	TP	Sebasticook	Lake
hectares	TP Load	Coeffic.	Area	Area	Load	TP	Load
Variable	Coeff.	Range	%	No.	Coeff.	No.	%
	Mean	Low - High		(ha)	1/2Median	(kg)	
Pasture	1.50	0.14 - 4.90	3.2	697	0.40	279	5.1
Hayland	1.08	0.10 - 2.90	5.7	1,257	0.38	478	8.7
Row Crops	4.46	0.26 - 18.6	7.0	1,536	1.12	1,720	31.3
Total AG	**16% area**	**45% Load**	**15.9**	**3,490**		**2,477**	**45.1**
LDResident	0.98	0.25 - 1.75	3.8	843	0.62	523	9.5
HDResident	1.40	0.56 - 2.70	0.8	179	0.98	175	2.9
SL-SepticSys	-------	*EP Model*	*0.1*	*12*	*EP Model*	*137*	*2.5*
Sub-Totals	**5% area**	**15% load**	**4.7**	**1,034**		**835**	**15.1**
Commercial	1.92	0.77 - 4.18	0.3	66	1.44	95	1.7
Institutional	1.92	0.77 - 4.18	0.25	55	1.44	79	1.4
Recreational	0.25	0.25 - 0.25	0.25	54	0.20	11	0.2
Cemetery	0.14	0.04 - 0.25	0.11	25	0.11	3	0.05
Golf Course	3.10	1.55 - 4.50	0.3	62	2.33	145	2.6
Gravel Pits	0.00	0.00 - 0.00	0.3	66	0.00	0	0
Tree Farms**	0.40	0.06 - 0.75	0.3	62	0.30	19	0.3
Sub-Totals	**2% area**	**6% load**	**1.8**	**390**		**352**	**6.4**
State Roads	3.99	0.63 - 10.1	0.7	155	2.5	388	7.1
Town Roads	3.99	0.63 - 10.1	1.1	232	2.5	580	10.5
Camp Roads	3.99	0.63 - 10.1	0.1	23	2.5	58	1.1
Roadways	**2% area**	**19% load**	**1.9**	**410**	**2.50**	**1,026**	**18.7**
Sub-Totals	**4% area**	**25% load**	**3.7**	**800**		**1,378**	**25.1**
Tot-Develop.	**8-9% area**	**40% load**	**8.4**	**1,834**		**2,213**	**40.0**
Tot. Cultural	**24% area**	**85% load**	**24.3**	**5,324**		**4,690**	**85.0**
Forested	0.04	0.02 - 0.09	44.1	9,690	0.04	388	7.1
Wetlands	0.02	0.01 - 0.03	11.1	2,448	0.02	49	0.9
Scrub-Shrub	------	----------	11.4	2,499	0.03	75	1.4
SurfaceH20	0.11	0.11 - 0.21	1.4	300	0.11	33	0.6
Non-Cultural	**68% area**	**10% load**	**68.0**	**14,937**		**545**	**10.0**
TC + NC	**92% area**	**95% load**	**92.1**	**20,261**		**5,235**	**95.0**
Atmospheric	**8% area**	**5% load**	**7.9**	**1,735**	**0.16**	**278**	**5.0**
Watershed	**100% area**	**100% load**	**100**	**21,995**		**5,513**	**100**

** Also includes orchard lands

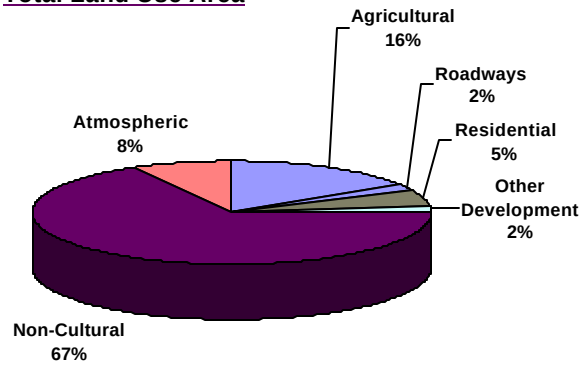
AGRICULTURE – historically, the cultural impact of agricultural practices upon Sebasticook Lake have been relatively large (Courtemanch 1986). Agriculture continues to play an important role in the local economy. Although agriculture - as a land use - comprises less than 20 percent of the watershed area (16% and 3,490 ha), its estimated average phosphorus load of 2,477 kg accounts for 45 percent of the total phosphorus load (Table 2) and 52 percent of the cultural TP load (Figure 2).

Presently, there are 68 operational farms located in the Sebasticook Lake watershed, comprised of 55 dairy/beef, 5 potato, 5 dry bean, and 3 poultry (MACD 2000). Large amounts of hay and animal feed corn crops are also produced. According to Penobscot County SWCD review comments, NRCS records indicate that there are presently only 21 commercial farms within this watershed. Agricultural statistics presented in Table 2 are based on summary data recently updated by Penobscot County NRCS/SWCD (draft TMDL review comments, January 2001).

The Penobscot County NRCS and SWCD has spent considerable time and funds in the Sebasticook Lake watershed to combat non-point sources of pollution. With the help of PL 83-566 funding (1982-1992), soil and water conservation practices were applied to the 25 farms identified as contributing most of the phosphorus to the lake, along with the installation of 21 animal manure management systems (MACD 2000). Today, 69 conservation plans are in place on landholdings within the watershed, however, there still remain a few agricultural problem sites in need of further assistance. In light of these implemented conservation practices - and to account for the high proportion of farm management plans (fields in rotation and properly managed hayfields) - low-range total phosphorus loading coefficients were selected for use (equivalent to one-half of the median values as reported by Reckhow et. al. 1980).

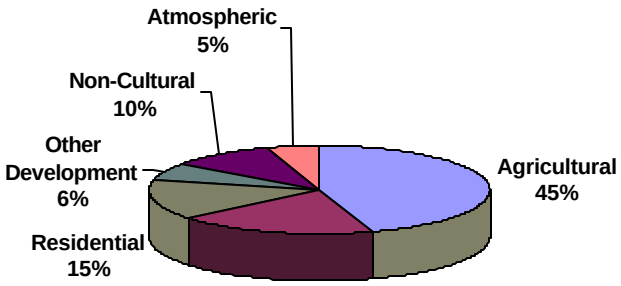
SEBASTICOOK LAKE WATERSHED

Total Land Use Area



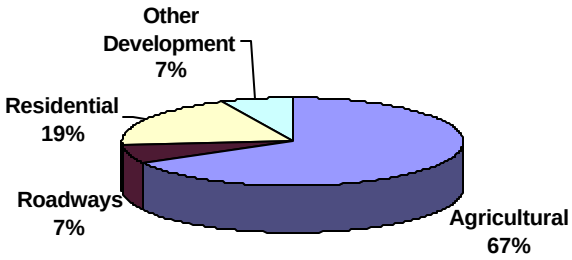
SEBASTICOOK LAKE WATERSHED

Total Phosphorus Load



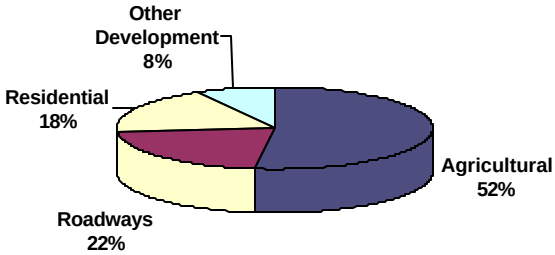
SEBASTICOOK LAKE WATERSHED

Cultural Land Use Area



SEBASTICOOK LAKE WATERSHED

Cultural Phosphorus Load



SHORELINE CAMP and RESIDENTIAL LOTS – may have one of the largest estimated impacts, in terms of total phosphorus loading to lakes, in comparison to its relatively small percentage of the watershed. Seasonal and year-round camp and home lots comprise only 5 percent of the watershed area, however, inclusive of septic systems (see below) - contribute 835 kg of total phosphorus. This amount approximates 15 percent of the estimated total phosphorus load (Table 2) and 18 percent of the cultural TP load (Figure 2).

The residential land use category was divided into low and high-density housing areas. The range of total phosphorus loading coefficients used for low-density houselots (0.25 - 0.98 kg/ha/yr) and high-density houselots (0.56 - 1.40) were adopted from those used for China Lake in Kennebec County, Maine (ME-DEP 1989), Long Lake, Aroostook County, Maine (Bouchard et al. 1995), and the previously accepted Cobbossee Lake TMDL - 0.98 to 1.40 (Monagle 1995, ME-DEP 1999).

SEPTIC SYSTEMS - total phosphorus export loadings from residential septic systems within the 250-foot shoreline zone were assessed for Sebasticook Lake through projections based on the recently completed East Pond (Belgrades) SS-Survey (EP Model, Fall 2000). A total of 288 lakeshore residents (68% seasonal = 196 and 32% year-round = 92) were indirectly assessed based on the average occupancy rates of 3.2 and 2.4, and average annual use of 89 and 325 days. Coefficients for age of system (soil attenuation factor range 0.1 = new, 0.3 = old, and 0.5 identified problem) and distance of septic system to lake (1.0 = >200 ft., 1.1 = 100-200 ft., and 1.2 <100 ft.) were assigned in direct proportion to the EP model. Similar to the EP model, the final modification reflects the estimates for actual total phosphorus loadings to groundwater - which ranged from a low of .0022 to moderate .0038 to high .0068 kg per day. Based on these projections, the estimatede septic system phosphorus loading for the Sebasticook Lake shoreline ranged from 45 to 77 to 137 kg. The highest number approximates phosphorus loadings estimated for golf courses (145 kg) and represents approximately 2.5 percent of the total phosporus loading to Sebasticook Lake.

The Newport Sanitary District services 564 accounts (1994 Newport Comprehensive Plan) - inclusive of residential (431), commercial or small business (116), governmental (12), and industrial (5). There are two public (non-sewered and seasonally operated) commercial campgrounds adjacent to Sebasticook Lake, each of which have 50 RV/tent sites and 6 or more lakeshore cabins. The rest of the town is served by septic/holding tanks and leach fields. According to the town Code Enforcement Officer (MACD communication, Fred Hickey), 6 to 8 septic systems are replaced or installed annually - typically to replace pit toilets or buried 55-gallon drums installed as septic holding tanks.

ROADWAYS – were initially divided into three sub-classes: state public highway, town public highway, and private camp roads. Actual road miles were delineated from USGS 7.5' topographic maps and field measurements of average roadway widths (27 m state, 16 m town, 7 m camp) - as measured from the outer edge of roadside ditches. In the final analysis, road types (both paved and unpaved) were combined as roadways (total of 410 hectares) and assigned a single total phosphorus loading rate of 2.5 kg/ha/yr (Jeff Dennis, personal communication). Similar to camp and home lots, the roadways category of land use accounted for a much greater percentage of the total phosphorus load (19%) versus its area percentage of the watershed (2%) - Table 2 and Figure 2.

OTHER Public Properties - golf courses, cemeteries, recreational ballfields, gravel pits, tree farms, and commercial/institutional sites – comprise only 1.8 percent of the total area (390 ha) and 6 percent of the phosphorus load (352 kg).

TOTAL CULTURAL - A total of 85 percent (4,690 kg) of the total phosphorus loading to Sebasticook Lake (5,513 kg) is estimated to have been derived from the cumulative effects of the preceding four cultural land use classes: agriculture (52% - 2,477 kg), roadways (22% - 1,026 kg), residential, including an estimated septic system component (18% - 835 kg), and other development (8% - 352 kg) - as depicted in Table 2 and Figure 2.

NON-CULTURAL NPS SOURCES

FOREST – Of the total land area within the Sebasticook Lake watershed, 44 percent (9,690 ha) is forested (Table 2), most of which are privately owned deciduous and mixed forest plots (MACD 2000). The total phosphorus loading coefficient chosen (0.04 kg TP/ha) is similar to that used for the Cobbossee Lake TMDL (Monagle 1995) and within the range (0.035 to 0.05) used in previous studies from central Maine (China Lake: ME-DEP 1989). Forest-related total phosphorus export coefficient ranges may be considered to be conservative estimates (ME-DEP 1994), taking into account the gentle to low slopes of the Sebasticook Lake watershed. An average of 7 percent of the total phosphorus load (388 kg TP/yr) is estimated to be derived from these forested watersheds. Combined wetlands and old field scrub shrub comprise 22.5 percent of the Sebasticook Lake direct watershed, which accounts for the remaining 2.2 percent (124 kg) of the total phosphorus export load (Table 2).

ATMOSPHERIC DEPOSITION and DRY FALLOUT – is estimated to account for 278 kg of total phosphorus, representing 5 percent of the total load entering Sebasticook Lake, with lake surface waters (1,735 ha) comprising 8 percent of the total watershed area (21,995 ha). The total phosphorus loading coefficient chosen (0.16 kg TP/ha) is intermediate between that used for the Cobbossee Lake TMDL (0.11 kg: Monagle 1995) and published coefficients (0.21 kg) which generally reflect a watershed which is 50 percent forested - combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980). Direct (wet) precipitation-only total phosphorus loading for Sebasticook Lake watershed was calculated by Dennis and Corson (1979) to be 203 kg.

Taking into account the considerable amount of time and money invested in the reduction of phosphorus loads over the past two decades - it is our best professional opinion that the total phosphorus export coefficients selected are appropriate for the Sebasticook Lake watershed. Results of this land use

analysis indicate that a best estimate of the present total phosphorus loading from all external sources approximates 5,513 kg TP/yr (Table 2).

This 'low-end' external loading to Sebasticook Lake equates to a total phosphorus loading modeled at 19 ppb (5,717 kg) - approximately 1,000 kg in excess of the TMDL target goal of 15 ppb (4,514 kg TP/yr). Accounting for the internal phosphorus component (1-2,000 kg: see discussion below) would bring the total lake/watershed phosphorus load up to 2-3,000 kg TP per year.

2. Description of Applicable MAINE DEP WATER QUALITY STANDARDS And Determination of Appropriate NUMERIC WATER QUALITY TARGET

Maine State Water Quality Standard – standards 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 tropic 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."

ME-DEP's functional definition of nuisance algae blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<26 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Sebasticook Lake is a lightly colored lake (average color 34 SPUs), with characteristically low late summer minimal SDT readings (overall average of 1.8 meters) associated with highly elevated chlorophyll a levels (53 ppb on July 26, 2000).

From a functional perspective, ME-DEP views clearly negative trends in seasonal SDT means or minima as an indication of increasing trophic state condition. This interpretation uses historic documented conditions as the primary basis for comparison. Given the context of "impaired use and enjoyment," along with a realistic interpretation of Maine's goal-oriented Water Quality Standards, we have determined that episodic, non-cyanophyte based algae blooms, limited

to the fall or spring periods only, are not considered as non-attainment for GPA waters.

Designated Uses and Antidegradation Policy

Sebasticook Lake is designated as a GPA (Great Pond Class A) water in the ME-DEP state water quality regulations. Designated uses for GPA waters in general include: water supply (after disinfection); primary/secondary contact recreation (swimming and fishing); hydroelectric power generation; navigation; and fish and wildlife habitat. According to Maine antidegradation statutes, 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 the characteristics and designated uses of downstream GPA waters or cause an increase in their trophic state. Summertime algae blooms are usually considered to interfere with primary contact recreational pursuits (i.e., swimming).

Numeric Water Quality Target

The numeric (in-lake) water quality target for Sebasticook Lake is set at 15 ppb total phosphorus (4,514 kg TP/yr). Since numeric criteria for phosphorus do not exist in Maine's state water quality regulations - and would, in any case, be less accurate targets than those derived from this study - we employed Best Professional Judgement (BPJ) to select a target in-lake total phosphorus concentration that would attain the narrative water quality standard. Springtime total phosphorus levels in Sebasticook Lake averaged 15 - 16 ppb during 1999-2000. In-lake (epilimnion core) total phosphorus summertime (June through August) measures averaged 30 ppb. In summary, the numeric water quality target goal of 15 ppb for total phosphorus in Sebasticook Lake was based on available water quality data (average epilimnion grab/core samples) - which correspond to non-bloom conditions, as reflected in suitable (water quality attainment) measures of both Secchi disk transparency (> 2.0 meters) and chlorophyll-a (< 8.0 ppb).

3. LOADING CAPACITY - Linking Water Quality and Pollutant Sources

Loading Capacity - the Sebasticook Lake basin loading capacity is set at 4,514 kg TP/yr of total phosphorus. As indicated, the Sebasticook Lake 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 Sebasticook Lake TMDL as an annual load because the lake basin has a relatively long hydraulic residence time (flushes once every nine months).

Linking Pollutant Loading to a Numeric Target - the basin loading capacity was set at 4,514 kg/yr of total phosphorus to meet the numeric water quality target of 15 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to the numeric target (see below).

Supporting Documentation for the Sebasticook Lake TMDL Analysis – includes the following: ME-DEP and VLMP water quality monitoring data; watershed/landuse maps using GIS derived data layers; literature derived export coefficients; and specification of phosphorus retention model – including both empirical models and observed retention coefficients.

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

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

4,514 = **L** = external total phosphorus load (kg TP/year)
15.0 = **P** = spring overturn total phosphorus concentration (ppb)
17.8 = **A** = lake basin surface area (km^2)
6.2 = **z** = mean depth of lake basin (m) **A z p** = 165.5
1.5 = **p** = annual flushing rate (flushes/year)
0.55 = **1- R** = phosphorus retention coefficient, where:
0.45 = **R = 1 / (1+ sq.rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenwieder, Dillon and Rigler type empirical model (e.g., Cobbossee Lake TMDL, Monagle 1995 and Madawaska Lake TMDL, ME-DEP 2000) has shown this approach to be effective in linking total watershed total phosphorus loadings to existing in-lake phosphorus concentrations. Additionally, the hydraulic and morphometric features of Sebasticook Lake are within the bounds of the model development data set, following the modifications of Larsen and Mercier (1976).

Strengths and Weaknesses in the Overall TMDL Analytical Process

The Sebasticook Lake TMDL was developed using existing water quality monitoring data, derived watershed export coefficients (Reckhow et al. 1980, ME-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) 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-NES) provides a more accurate model for northeastern regional lakes.

Strengths:

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

Weaknesses:

- Inherent uncertainty of TP load estimates (Reckhow et al.1980, Walker 2000)

Critical Conditions

Critical conditions in Sebasticook Lake occur during the summertime, when the potential (frequency and occurrence) of nuisance algae blooms are greatest. The loading capacity of 15 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide protection throughout the year (see Seasonal Variation section).

4. LOAD ALLOCATIONS (LA's)

The load allocation for all existing and future non-point pollution sources for Sebasticook Lake is 4,514 kg TP/yr, as derived from the empirical total phosphorus retention model for a target goal of 15 ppb (see Loading Capacity discussion). Reductions in nonpoint source phosphorus loadings are expected from the continued implementation of Best Management Practices for agricultural practices, roadways, and residential developments - including lake shoreline stabilization (see BMPs implementation section 9, pg. 24). In addition to the external phosphorus load allocation, in-lake internal phosphorus loadings were also allocated, taking into account past and anticipated phosphorus reductions as a result of annual lake drawdowns (see below). As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in this watershed due to the limited and general nature of the available information.

The following section will review the internal cycling component of the phosphorus load in Sebasticook Lake, including total phosphorus reduction through seasonal drawdown and effects on downstream water quality. In-lake nutrient loadings in Sebasticook Lake originate from a combination of internal and external sources of total phosphorus. External sources have been identified and accounted for in the land-use breakdown and associated estimates of total phosphorus loading based on selected loading coefficients (Table 2).

The relative contribution of internal sources of total phosphorus within Sebasticook Lake, in terms of sediment recycling, have been historically studied by Hannula (1978) and Dennis and Corson (1979) - as summarized and updated

by ME-DEP and Courtemanch (1986). Dennis and Corson (1979) reported that during (summer) stratification, internal lake sources contributed nearly as much total phosphorus to the water column in Sebasticook Lake as the entire annual external loading (7,658 kg TP based on peak summer total phosphorus loading from the three major tributaries: East Branch Sebasticook River, Mulligan and Stetson streams). Courtemanch (1986) calculated this peak summer external load during the 1980-1985 time period to approximate 4,800 kg of TP on an annual basis (Table 1).

A re-analysis of internal (in-lake) total phosphorus based on measures of volume-weighted mass (late summer - early spring) in Sebasticook Lake for the time period 1978 to 2000 is depicted in Figure 3. The results of the empirical modeling for basin 1 and 2 are presented in Table 3. It should be noted that the overall bathymetry and the volume-weighted measures of Sebasticook Lake were recalculated using 1-meter intervals, resulting in a total volume of 91×10^6 m^3, in contrast to past studies which were based on 110×10^6 m^3 - which was the basis for developing the August TP loadings as depicted in Figure 3b.

During the 1978 to 1983 time period - internal sources of phosphorus in Sebasticook Lake contributed approximately 4,000 kg (3,600-4,400) to the summer maximum TP load. Following fall lake drawdown (initiated in 1982), the internal summer phosphorus loads declined to an average of 2,800 kg during the next four years - 1984 through 1987 (32 percent drop). The town of Dexter waste water treatment plant was placed on-line in 1987, and the internal TP load was further reduced to a level of approximately 1800 kg (36 percent reduction). Since 1988, in-lake total phosphorus loads appear to have somewhat stabilized at levels between 1000-2000 kg. However, a closer look at the TP concentrations over this time period shows a substantial drop in the early summer minima - from values of 20 to 27 ppb in the late 1980s to mid 1990s, to 16 to 22 ppb in the latter part of the 1990s.

Figure 3. SEBASTICOOK LAKE Annual Internal Total Phosphorus Load (kg)

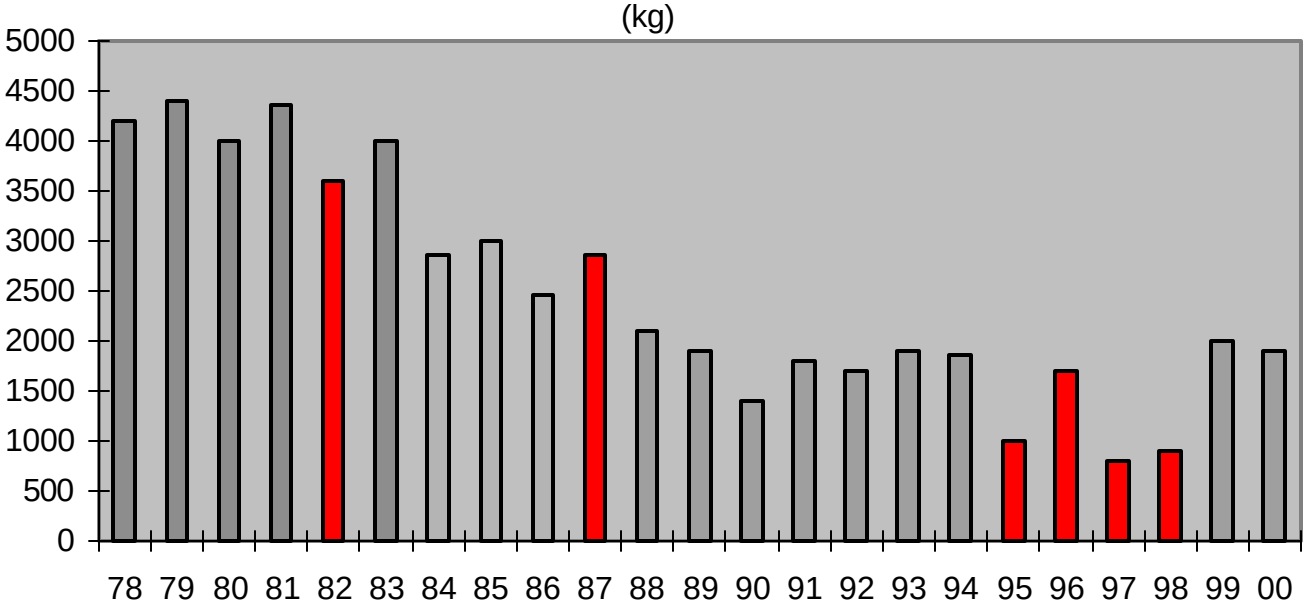


Figure 3b. Late Summer Volume Weighted TP Measures (kg)

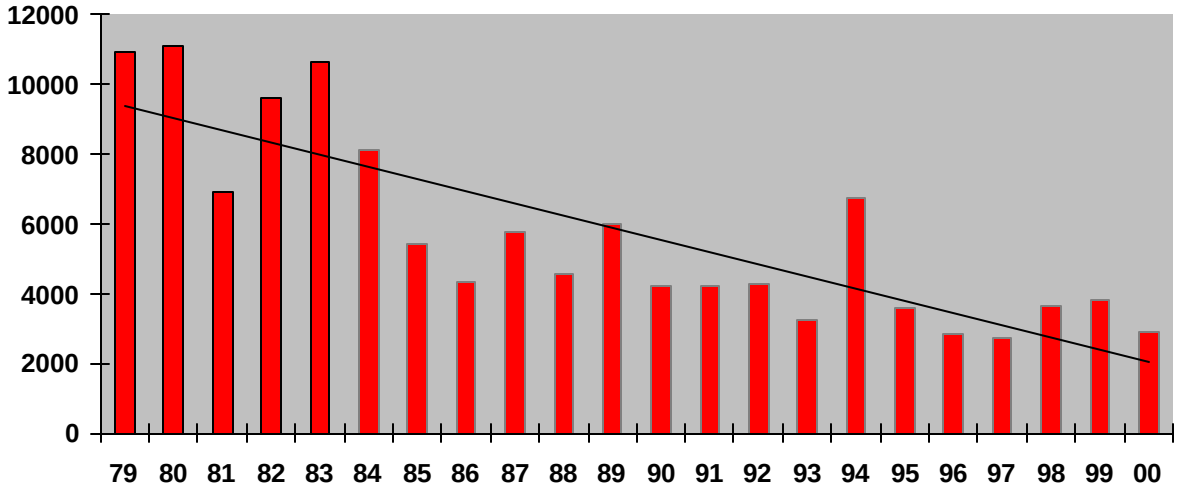


Table 3. Sebasticook Lake Internal Phosphorus Loading (1978 - 2000)

Year	ppb	ppb	kg	kg	kg	ppb	ppb	kg	kg	kg	kg
	DEEP HOLE					SECOND BASIN					Max.
											Avg.
1978	95	49	8613	4415	4198	79	52	7182	4692	2490	4200
1979	87	39	7930	3574	4356	84	40	7664	3668	3996	4400
1980	87	43	7954	3947	4007	85	43	7748	3897	3851	4000
1981	85	37	7712	3358	4354	72	30	6593	2723	3870	4350
1982	85	45	7692	4051	3641	85	56	7747	5098	2649	3600
1983	85	42	7707	3790	3917	83	39	7576	3512	4064	4000
											4100
1984	58	26	5279	2411	2868	63	34	5688	3113	2575	2850
1985	59	27	5407	2415	2992	57	35	5168	3176	1992	3000
1986	54	27	4879	2412	2467	47	23	4291	2078	2213	2450
1987	57	26	5173	2324	2849	47	32	4320	2886	1434	2850
											2800
1988	60	37	5500	3379	2121	51	27	4600	2494	2106	2100
1989	44	23	4007	2084	1923		24		2187		1900
1990	38	21	3448	1875	1573	34	20	3077	1837	1240	1400
1991	39	22	3566	2024	1542	45	22	4056	1998	2058	1800
1992	44	25	3984	2264	1720	39		3563			1700
1993	44	23	3982	2094	1888	42	24	3840	2147	1693	1900
1994	44	25	4011	2260	1751	44	23	4032	2110	1922	1850
											1800
1995	26+	15	2326	1325	1001	27+	17	2495	1516	979	1000
1996	38	19	3427	1698	1729	39	21	3583	1877	1706	1700
1997	25+	16	2262	1482	780	24+	17	2225	1559	651	725
1998	32	22	2920	2022	898	31	20	2806	1864	942	900
1999	41	19	3764	1764	2000						2000
2000	37	16	3364	1483	1881						1900

The Eastland Woolen Mill in Corinna was closed in November of 1996 and its contribution to the sewer treatment plant and East Branch of the Sebasticook River curtailed. Notably, 1997 appears to be the only year on record in which Sebasticook Lake attained water quality standards - with a minimum Secchi disk transparency of 2.1 meters during late August.

Phosphorus Reduction in Sebasticook Lake through Annual Drawdowns

The restoration of Sebasticook Lake, Maine, by seasonal (fall-early winter) flushing was reported on by Rock, Courtemanch, and Hannula (1984). This report provides an excellent historical overview, however, accounts only for the first 2-3 years of lake drawdown - initiated in the fall of 1982. At that time, total phosphorus export was estimated to be about 4,200 kg annually, while earlier studies (Dennis and Corson 1979) estimated the recycling of phosphorus from the lake sediments to contribute 6,900 to 9,900 kg to the water column annually. Courtemanch (1986) reported that the release of water at Sebasticook Lake begins following Labor Day, and is drawn-down to a depth of 3.2 meters over a 10 to 12-week period, while removing about 46% of the lake volume - and typically closed in mid-December each year.

A review of available lake drawdown records (Tom Hannula, personal communication) indicate that, in 1982, the gates were opened in mid-September and closed in early November. Beginning in 1983 and extending through 1992, the drawdown schedule of Labor Day through the end of November was generally adhered to. The presence of the archaic Sebasticook Lake fish weir was discovered in 1991 (Peterson and Robinson 1993), and beginning in the fall of 1993, the drawdown regimen was altered to a 2-month period - from Labor Day to the beginning of November. This regimen lasted until the fall of 1998, when lake drawdown was started in mid-September and the gates closed in mid-November (8-week period). The actual dates during 1999 were September 19 to November 15, while in 2000, the gates opened on September 15 - but were characterized by "less aggressive flushing by the town crews" (Tom Hannula, personal communication).

Tom Hannula has estimated that, on the average, a reliable estimate for TP content in Sebasticook Lake is 1000 kg for each 10 ppb concentration. Thus a fall measurement of 35 ppb would approximate 3500 kg TP in the lake. In the fall of 1999, about 1200 to 1500 kg TP was flushed. The spring refill would be about 600 kg, or about 1/3 of 2000 kg at a concentration of 20 ppb.

The timing and extent of the annual fall drawdown of Sebasticook Lake appears to be critical to the success of removing an adequate amount of total phosphorus to maintain reduced internal loads and to establish suitable water quality conditions. Earlier (prior to or directly after Labor Day) and longer drawdowns (10-12 weeks) should be re-adopted in order to re-establish the minimal TP loadings attained during the 1997-98 time period (Figure 2).

However, such aggressive lake flushings (full lake drawdowns) would tend to compromise the protection (continued watering) of the Sebasticook Lake fish weir site. In order to provide adequate protection to the archaic fish weir site, the existing pre-plan for installing a rock-filled gabion-type dam structure (Arthur Spiess, personal communication) should be finalized and implemented in the immediate future. After 2003, following implementation of the Corinna Treatment Plant land disposal system, the water quality in Sebasticook Lake may improve to a condition where agressive fall lake flushing will not be necessary.

The Contribution of Annual Fall Drawdown in Sebasticook Lake to Downstream Water Quality in the Sebasticook River

As development of the Sebasticook Lake TMDL is partially dependent on annual fall drawdowns to achieve targeted water quality standards, the effects of lake drawdown on downstream uses and water quality must be considered. The existing low dissolved oxygen levels in the downstream 303(d) listed Sebasticook River (Burnham Impoundment), are primarily a problem during the summertime period. Cooler fall water temperatures and the increased level of flushing capacity via extended seasonal drawdown appear to be fully protective of downstream uses and water quality in the Burnham Impoundment. Future DEP

rulemaking and the hydropower water quality certification (401) process will further address downstream water quality non-attainment issues in the Sebasticook River and Burnham Impoundment.

5. WASTE LOAD ALLOCATIONS (WLA's)

The Corinna Sewer Treatment Plant, discharging to the East Branch of the Sebasticook River, currently exists as the single known point source discharge in the Sebasticook Lake watershed. Since this STP discharge is scheduled to implement land treatment by the year 2003, the waste load allocation for all existing and future point sources is set at 0 (zero) kg/yr of total phosphorus.

Prior to the November 1996 closure of the Eastland Woolen Mill in Corinna, 830 kg of total phosphorus was annually discharged into the East Branch of the Sebasticook River from the Corinna STP (Jeff Dennis, personal communication). Since the mill closure, the total phosphorus load from the Corinna STP has been reduced (44 percent) to 364 kg annually (Jeff Dennis, personal communication). By the year 2003, this amount will be reduced to 0, when the land treatment of Corinna STP wastes are implemented. Funding has been secured for this new land treatment system and it is very likely that the discharge removal will occur as scheduled.

6. MARGIN OF SAFETY (MOS)

An implicit margin of safety was incorporated into the Sebasticook Lake TMDL through the conservative selection of the numeric water quality target, as well as the selection of relatively conservative total phosphorus export loading coefficients for both agricultural and forestry land uses (Table 2). Based on both Sebasticook Lake historical records and a summary of statewide Maine lakes water quality data for colored or >26 SPU lakes - the target of 15 ppb (4,514 kg TP/yr in Sebasticook Lake) represents a fairly conservative goal to assure attainment of Maine DEP water quality goals of non-sustained and repeated blue-green summer-time algae blooms due to NPS pollution or cultural

eutrophication. The statewide data base for naturally colored Maine lakes indicate that nuisance algae blooms (plankton growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 17 ppb or above. A range of 14 to16 ppb (4,213 to 4,815 kg TP/yr in Sebasticook Lake) is unlikely to result in nuisance algae blooms, particularly in a colored lake. The difference between the in-lake target of 15 ppb and 16 ppb represents a 6.3% (301 kg TP/yr) implicit margin of safety.

7. SEASONAL VARIATION

The Sebasticook Lake TMDL is protective of all seasons, as the allowable annual load was developed to be protective of the most sensitive time of year – during the summer, when conditions most favor the growth of algae and aquatic macrophytes. With average hydraulic retention times of 9 months, the average annual phosphorus loading is most critical to the water quality in Sebasticook Lake. ME-DEP lake biologists, as a general rule-of-thumb, use more than five to six flushes annually (bi-monthly) as the cutoff for considering seasonal variation as a major factor in the evaluation of lake total phosphorus loadings to lakes in Maine. Also, the Best Management Practices (BMPs) already implemented and proposed for the Sebasticook Lake watershed were, and have been, designed to address total phosphorus loading during all seasons.

8. TMDL WATER QUALITY MONITORING PLAN

Historically, the water quality of Sebasticook Lake has been monitored via measures of Secchi disk transparencies during the open water months since 1974 (Dave Courtemanch, ME-DEP and Tom Hannula, Sebasticook Lake Association). Water chemistry data (pH, total alkalinity, specific conductance, color, dissolved oxygen and temperature/depth profiles, and chlorophyll-a) were collected periodically during the 26 years of record.

Continued long-term water quality monitoring within Sebasticook Lake will be conducted during the open water months (April - October) through the efforts of Tom Hannula and VLMP in cooperation with ME-DEP. Beginning in the late

spring – early summer of 2000, deep hole basin parameters are measured on a monthly basis, including: Secchi disk transparencies, dissolved oxygen and temperature profiles, total phosphorus, and chlorophyll-a. Under this planned water quality-monitoring scenario, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Sebasticook Lake.

9. IMPLEMENTATION PLAN and REASONABLE ASSURANCES

Sebasticook Lake is a waterbody whose water quality is currently impaired mostly by nonpoint sources (see LA's and WLA's), hence, reasonable assurance that total phosphorus load reductions will be achieved are not required for the TMDL to be approved by EPA (U.S. EPA 1999). However, States are strongly encouraged to provide reasonable assurances regarding achievement of load allocations in their implementation planning efforts. An updated listing of high priority non-point source (NPS) problem sites found during the MACD and Town of Newport lake watershed survey is available from Maine DEP and the Penobscot Valley Council of Governments (PVCOG 1999).

Specific recommendations and actions to ensure further reduction of internally generated sources of phosphorus in Sebasticook Lake were previously discussed (Section 4: Load Allocations) and included the re-establishment of an aggressive approach to annual fall drawdowns (see Appendix A: Sebasticook Lake Association Fall 2000 Water Quality Report).

Specific recommendations (Best Management Practices or BMPs) and actions taken for the reduction of external total phosphorus loadings to improve water quality conditions in Sebasticook Lake are as follows (see Appendix B: MACD and Town of Newport Watershed Survey):

1) Agriculture: The Sebasticook Lake watershed survey/inventory work has identified 11 agricultural sites that potentially contribute excess amounts of phosphorus to the watershed. Potential problems related to agriculture include

bare fields, improper manure storage, soil compaction (improper drainage), and lack of buffering on tributaries. Of the 11 sites, 3 have a potentially high impact to Sebasticook Lake and its tributaries while 2 have a medium impact and 6 have a low impact. The cost and technical level need to implement BMPs on agricultural land varies, but generally falls in the "medium" range.

Mitigation of these agricultural problems may be accelerated through the efforts of the Penobscot County Soil and Water Conservation District (PCSWCD) and the USDA Natural Resources Conservation Service (NRCS). If the landowner is an "active" cooperator with the District, then technical assistance from the staff can aid in the installation of BMP sites. If the landowner does not have a relationship with the District office then efforts should be made to direct them to available technical assistance and potential funding for implementation. The extent of agricultural BMP mitigation that has been accomplished through the efforts of the PCSWCD and NRCS in the Sebasticook Lake Watershed has undoubtedly been significant, especially in relation to the installation of manure storage structures. Continued funding with the Environmental Quality Incentive Program (EQIP, $79,000 funding in 1999), Section 319 Nonpoint Source grants ($40,260 two-year funding), and related sources should continue to assure the future protection of Sebasticook Lake.

2) Residential: Thirty residential sites contributing phosphorus runoff have been identified through NPS watershed survey work (PVCOG 1999; Maine Association of Conservation Districts 2000) over the past three years. Of these thirty sites, 8 are considered as having a medium impact, while the remaining 22 are judged to have a low impact. However, the cumulative impact of these sites may require consideration for a high impact rating. Problems that are typical for residential sites include lack of adequate buffers, surface erosion on driveways, and improper erosion control at construction sites.

The Sebasticook Lake Association, in cooperation with Maine DEP and the Penobscot Valley Council of Governments, has initiated the implementation

of a shoreline stabilization buffer strip vegetative cover program for the lake. Efforts include educating lake residents through workshops and providing labor through the Sebasticook Lake Youth Conservation Corps. To date, five of the residential sites have been addressed through the efforts of the Sebasticook Lake Youth Conservation Corps which is funded under a Section 319 grant. Project objectives for 2001 include mitigating 10 to 15 additional residential sites identified in the 1998 watershed survey. Efforts should continue to educate Sebasticook watershed residents and market the availability of conservation crew labor in order to treat the remaining residential sites. Most of the specific residential BMPs are low cost and need minimal technical guidance.

3) Roadways: Of the 96 potential NPS pollution sites identified in watershed survey work, 44 relate to state (8) town (20) or private (16) roads. Problems that are encountered on roadways in the Sebasticook Lake watershed are generally more complex and costly to repair than residential sites. Specific roadway problems include improper ditching, shoulder erosion, buildup of winter sand, improper armoring around culverts, and improper road shaping. Of the eight high impact sites in the watershed that have been surveyed by volunteers and professional staff, five relate directly to roadways. Nineteen sites have been determined to have a medium impact on Sebasticook Lake while the remaining 20 sites potentially have a low impact.

To date, the greatest amount of NPS pollution mitigation work has been done on town roads in Newport. Fifteen town road sites were identified within Newport and BMP work has been implemented on 10 of these problem areas. However, the mitigation work on state (none implemented to date) and private (4 implemented to date) roads has been limited. Because of the high phosphorus export values from roadways in the watershed, continued BMP implementation should occur in towns throughout the watershed. Suggested mitigation work includes armoring and re-sizing culverts, re-shaping several private roads, removing winter sand, and installing properly designed plunge pools and catch basins to settle out sediments before they enter the lake or tributary.

4) Other: This category includes the multiple land uses that have been identified as contributing nonpoint source pollution to the watershed. The remaining 11 identified sites include commercial (5), boat launches (2) railroad beds (2), ATV trail (1), and a logging operation (1). None of these sites have a potentially high impact to Sebasticook Lake and its tributaries but 7 have a medium impact and the remaining 4 are determined to have a low impact. The cost and technical level to install BMPs depends entirely on each individual site, but none of the 11 sites rank in the high cost or high technical level to install ranges.

Mitigation work has commenced on 4 of the 'other' 11 sites in the watershed. The ATV trail, as well as one boat launch, the railroad bed, and one commercial site, have all had conservation measures implemented through the efforts of the Sebasticook Conservation Crew (supervised by field coordinator Sarah Colburn under the direction of Connie Marin - PVCOG project planner). Potential BMPs that are needed include various erosion controls and slope stabilization, establishing buffers on tributaries and lakefront properties, and reconstructing logging access roads to limit polluted runoff.

Relative to external phosphorus loading: Maine DEP is confident that a combination of these NPS/BMPs, taking into account continued implementation of shoreline residential BMPs - and improved agricultural practices - will provide a significant reduction in phosphorus loading to Sebasticook Lake to help achieve water quality standards. This contention is strongly supported by Maine DEP's existing Nonpoint Source Pollution (NPS) Control Program Upgrade and 15 Year Strategy Plan, which was approved by EPA-New England on October 13, 1999. This plan, recognized by the EPA Washington office as "among the best" in the nation, outlines many realistic, yet aggressive, short and long-range goals and actions aimed at the reduction of pollution from major nonpoint source categories, including forestry, transportation, agriculture, and development. This statewide NPS/BMP plan relies on strong partnerships and offers a commitment to provide outreach and technical assistance in priority NPS watersheds.

Sebasticook Lake is on both the 1998 303(d) TMDL list and Maine's NPS priority watersheds list, and has been given priority for funding under the implementation of Maine's 319 portion of the NPS program.

In addition, all eight towns within the Sebasticook Lake watershed prepared and signed a unique and unprecedented agreement in March 1992 which provided for mutual notification of any town developmental projects with a potential for phosphorus contributions, of any magnitude (see Appendix C). The intent of this agreement may not have been ever put into practice (Connie Marin, draft review comments). Also, a 1991 Water Quality workshop on "Phosphorus Control in Lake Watersheds" and "The Importance of Cooperation in Protecting and Managing Shared Resources" was hosted through the efforts of the Penobscot Valley Council of Governments.

10. PUBLIC PARTICIPATION

Adequate ('full and meaningful') public participation in the Sebasticook Lake TMDL development process was ensured through the following avenues.

Final draft TMDL prepared and paper and electronic forms made available, including 'legal' advertising in local newspapers, posting on the ME-DEP Internet Web site, and through normal ME-DEP advertising procedures (information and education). The following ad will be printed in the Waterville Morning Sentinel (Daily/Saturday-Sunday, December 9-10, 2000) and The Bangor News (Weekend/ December 9/10, 2000).

> In accordance with Section 303(d) of the Clean Water Act, and implementing regulations in 40 CFR Part 130 - the Maine Department of Environmental Protection has prepared a Total Maximum Daily-Annual Load (TMDL) nutrient report (DEPLW #110) for phosphorus for Sebasticook Lake/Watershed, located in Newport and neighboring towns within Penobscot and Somerset counties. This report identifies point and non-point source total phosphorus loadings within the Sebasticook Lake watershed and reductions required to

establish and maintain acceptable water quality standards by way of the adoption of Best Management Practices. A draft of the report may be viewed at the ME-DEP Eastern Maine Regional Offices in Bangor (106 Hogan Rd.) or on-line at: http://www.state.me.us/dep/blwq/update.htm. Click on "Public Comment Opportunities." Send any comments, in writing by January 10, 2001, to David Halliwell, Lakes TMDL Project Leader, ME-DEP, State House Station #17, Augusta, ME 04333. 207-287-7649 or e-mail: david.halliwell@state.me.us.

See Appendix E for a public review summary page for the Sebasticook Lake TMDL (2000-2001). Review letters and (DEP) responses are not available electronically, but are available upon request.

ME-DEP Lakes TMDL Project Manager (Dave Halliwell) participated in the annual 1999 Sebasticook Lake summer meeting attended by 75 lakeshore residents and provided a general briefing on the Maine lakes TMDL program. MACD project personnel (Forrest Bell and Jodi Michaud) participated in the annual 2000 Sebasticook Lake summer meeting attended by 120 lakeshore residents and provided answers to questions and distributed ME-DEP/MACD Sebasticook Lake TMDL and Watershed Inventory project information briefs (Appendix C).

ME-DEP (Christine Smith) organized and the Sebasticook Lake Association sponsored a "Plant a Buffer" Family Lake Day at Sebasticook Lake on Saturday, September 18, 1999. Lakes TMDL ME-DEP project manager Dave Halliwell assisted in manning a 'hands-on' lakes algae - phosphorus source informational booth.

During the summer of 2000, MACD project personnel, particularly Sebasticook Lake coordinator Andrea Pearce, paid numerous visits to various town offices in the watershed to compile necessary watershed inventory information. A one-day on-site visit to review the NPS/BMP implementation work of the Sebasticook Conservation Crew, under the supervision of Sarah Colburn,

was also initiated. The ME-DEP and Sebasticook Lake Association and Penobscot Valley Council of Governments sponsored Watershed Survey was conducted for the Town of Newport only, in 1998. The remainder of the Sebasticook Lake watershed survey was completed by MACD staff with US-EPA Section 319 funding during the early summer of 2000 (see Appendix B).

Acknowledgments

In addition to Maine DEP and US-EPA Region I staff (guidance), the following individuals and groups were instrumental in the preparation of this Sebasticook Lake Total Maximum Daily Load report: MACD: Forrest Bell, Jodi Michaud, Andrea Pearce, Jeremy Martin; NRCS and PC-SWCD and PVCOG Bangor offices and personnel; Sebasticook Lake Association, Inc. (Tom Hannula and Lynn Cianchette); Sebasticook Lake Youth Conservation Corp members (Sarah Colburn and crew); watershed town managers, CEOs, and office personnel; and a special thanks to Rob Mohlar (KC-SWCD) for his assistance with GIS applications.

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APPENDIX A

Sebasticook Lake Association

Fall 2000 Water Quality Report

APPENDIX B

MACD and Town of Newport

Sebasticook Lake Watershed Survey

APPENDIX C

Development Notification Agreement

Sebasticook Lake Watershed Towns

APPENDIX D

General Lakes TMDL Information and

Sebasticook Lake Watershed Inventory

APPENDIX E

Sebasticook Lake TMDL - Public Review Summary

APPENDIX A

SEBASTICOOK LAKE

Water Quality Report by Tom Hannula

(As reported in the **Fall 2000** Sebasticook Lake Newsletter, ***FATHOMS***)

I suppose the biggest question in most of our minds is what caused the significant algal bloom at the end of July this summer. The end of winter sampling (3/13/00) by DEP looked good with phosphorus values 16 ppb or less above 11 m (37 ft) and only 19 ppb at 13 m (43.3 ft). These values show that the P content of the lake water at the end of the winter are OK. Sampling just after ice-out on 4/20/00 also had P values of 16 ppb for a 10 m core. The 10 m core is a composite sample of the upper 10 m (33 ft) of water. This shows that we didn't have any increase in P content during the spring runoff. However, this sampling was prior to the heavy rain storm during Easter weekend. There were reports that the East Branch was chocolate brown early Monday 4/24/00. This was the result of massive erosion upstream of the lake. There is some suspicion that this was the result of the demolition of Eastland Woolen Mill in Corinna, but is more likely the result of erosion from partially frozen, bare ground in the upstream farm fields, dirt roads, and drainage ditches. The rain was so heavy that the lake level increase approximately 2 feet and rose more than a foot over the top of the flash boards at the dam. However, the May sampling (5/30/00) had a 10 m core P value of only 16 ppb which indicates any P input from the Easter storm was either flushed from the lake (unlikely) or deposited in the sediment as the mud settled out. Maybe this phosphorus came back and fed the July algal bloom.

Water clarity was good in May and June with Secchi disc readings ranging from 3.5 to 3.9 m (11 to 13 ft). In fact the spring readings and water clarity reading were so good, I told Lynn Cianchette that we were likely to have good water quality and we might consider limiting the fall drawdown. There were signs of a small algal bloom at the end of June. However, the June sampling showed little increase in the lake P content with 17 ppb in a 6 m (20 ft) core and values of 20 ppb between 8 to 10 m (27 to 30 ft).

Water clarity decreased rapidly in July as the bloom developed. Secchi disc readings fell to 1.8 m on July 20 and 0.9 m during a massive bloom on July 26. The P values increased to 29 ppb at 1 m. Since we forgot to take the core tube, we don't have a core value. The 29 ppb is likely higher than the core reading would have been. Under bloom conditions, I have noticed higher P reading near the surface as the algae accumulates near the surface. However this rapid increase in P from the June values are troubling and difficult to explain. We had a relatively dry July, so the increase was unlikely from runoff into the lake. Consequently, the likely source is release from the lake sediment. The question is - did it come from the P that has been historically stored in the sediment and is slowly being flushed from the lake, or was it P that was deposited in the sediment during and after the Easter storm? Another question: Why was it released so rapidly during July? In the past few summers were have had a slower increase in P content.

The July bloom was dominated by these algae: *Anabaena*, *Aphanizomenon*, and *Microcystis*. These are common bluegreen algae which cause blooms. The appearance of *Aphanizomenon* is troubling. It was the dominant algae in the horrific green paint blooms that occurred in the early 70's. *Aphanizomenon* has not been a dominant algae in the lake for a number of years. Its presence appeared to be short lived in the bloom this year as *Anabaena* became the dominant algae during August and September as in the last few years.

In looking over data from the last few years, I noticed that the July 2000 P value was significantly higher than those of July 1997 (16-18 ppb) and July 1999 (15-20 ppb) and somewhat higher than July 1998 (21-29 ppb). The August P concentrations have been slowly increasing since 1997, August 1997 (23-27 ppb), August 1998 (27-30 ppb), and August 1999 (33-37 ppb). We don't have the August 2000 values yet, but water conditions suggest strongly they will be in the mid 30's or higher. **[ME-DEP Update: August 15th - mid to high 20s; August 29th - low to mid 30s; and September 14th - mid to high 30s]**

What has been happening that could cause this trend? Two major changes in the drainage basin are our shortening the fall drawdown with a later start and earlier finish and the closing of Eastland Woolen Mill in Corinna. The shorter drawdown would reduce the amount of algae and phosphorus flushed from the lake. The closing of Eastland has resulted changes in the operation of the Corinna sewage treatment plant that might have increased the amount of P discharged. Funding has been approved for replacement of the Corinna Treatment Plant by a land disposal system. Within the next few years, the completion of the new disposal system should finally remove the Corinna discharge from the East Branch of the Sebasticook River. Once this happens, we should see improvement in lake water quality similar to that which occurred when Dexter installed their land treatment system. In the mean time, we probably should consider going back to aggressively flushing the lake every fall. This means starting the flush after Labor Day and flushing through November. We will lose a couple of weeks of boating, but possibly improve water quality in August.

As the past few summers show, Sebasticook Lake is in a delicate stage of recovery. Little things now might make a difference. Controlling non-point sources of phosphorus to the lake takes on a greater significance. If you are fertilizing your lawn, **STOP**. If you have lawn down to the shore's edge, plant a vegetative buffer. Divert storm runoff into wooded areas. Be careful when disturbing soil in the shoreland zone. Think how you impact the lake by your activities.

APPENDIX B: MACD Watershed Survey

PVCOG, the SLA, and the town of Newport and citizen volunteers conducted an initial watershed survey of the town of Newport during March and April of 1998. Twenty-five volunteers took part in the survey. The watershed was divided into 7 sectors for the purpose of this survey. Approximately 49% of the direct watershed was surveyed. This included the entire town of Newport. The survey identified 74 sites that have potential to impact the water quality of Sebasticook Lake. Residential/Driveways accounted for 38% of the sites while roads (state, town, and private/camp) accounted for 45% of the sites. One state road site and two town road sites were determined to have a high impact level. Copies of this waterswhed survey are available through the Penobscot Valley Council of Governments (1-800-339-6389).

The ME-DEP/MACD project team surveyed the Sebasticook Lake watershed, exclusive of the town of Newport, during the summer of 2000. Twenty-two direct drainage sites were identified in this survey, as well as seven indirect drainage sites. Areas adjacent to major tributary/road crossings were inspected, including four sites identified by the Newport CEO. Observations of agricultural sites were made, as permitted, through drive-by inspections. The following tables (B-1 and B-2) contain information relating to the MACD 2000 watershed survey. The key below explains how the ratings were derived.

Land Use Categories

A = Agriculture LO = Logging C = Commercial T = Town Road
S = State Road P = Private/Camp Road R = Residential

Technical Level to Install BMPs

High: Site requires an engineered design
Medimum: Technical person should visit the site and make recommendations
Low: Property owner can accomplish the BMP w/ minimal support

Impact - factors to consider during evaluation include: area/size, slope, soil type, extent of erosion, proximity to waterbody or buffer, size of vegetated buffer and capacity.

High: Direct flow to tributary or river usually greater than 100 sq. ft. of disturbance
Medium: Sediment transported off site to buffer or wetland or < 100 sq. ft. of impact
Low: Eroding site with **limited transport off site**, even if the disturbed area is large

Cost: High - greater than $2,500; Medium - $2,500 to $500; Low - less than $500

Feasibility - rating of what the feasibility of installing proper BMPs are in relation to landowner participation, agency involvement/performance, cost estimates, etc. This rating is derived using "best professional judgement."

Newport Survey (1998)

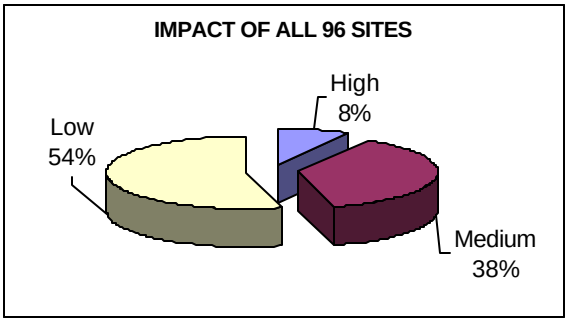
	Impact				Priority			
Land Use	High	Medium	Low	**Total**	High	Medium	Low	**Total**
Residential		6	22	**28**		15	13	**28**
Private Road	1	7	6	**14**	3	8	3	**14**
Town Road	2	5	8	**15**	2	7	6	**15**
State Road		1	3	**4**		1	3	**4**
Agriculture		2	3	**5**	1	2	2	**5**
Commercial		3	1	**4**		4		**4**
Railroad			2	**2**			2	**2**
ATV trail		1		**1**		1		**1**
Boat Launch			1	**1**		1		**1**
Total	**3**	**25**	**46**	**74**	**6**	**39**	**29**	**74**

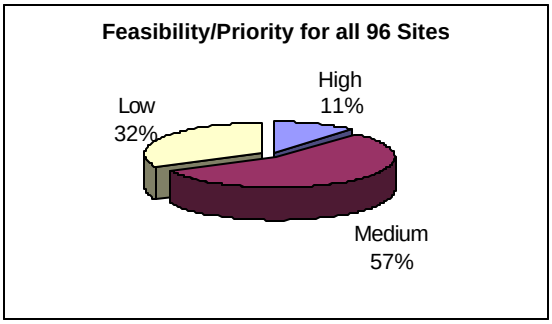
MACD Survey (2000)

	Impact				Feasibility			
Land Use	High	Medium	Low	**Total**	High	Medium	Low	**Total**
Residential		2		**2**	1	1		**2**
Private Road	1	1		**2**		2		**2**
Town Road	1	2	2	**5**		5		**5**
State Road		3	1	**4**		4		**4**
Agriculture	3		3	**6**	3	2	1	**6**
Commercial		1		**1**			1	**1**
Logging		1		**1**		1		**1**
Boat Launch		1		**1**	1			**1**
Total	**5**	**11**	**6**	**22**	**5**	**15**	**2**	**22**
Combined Tot.	**8**	**36**	**52**	**96**	**11**	**54**	**31**	**96**

High	8
Medium	36
Low	52

High	11
Medium	54
Low	31

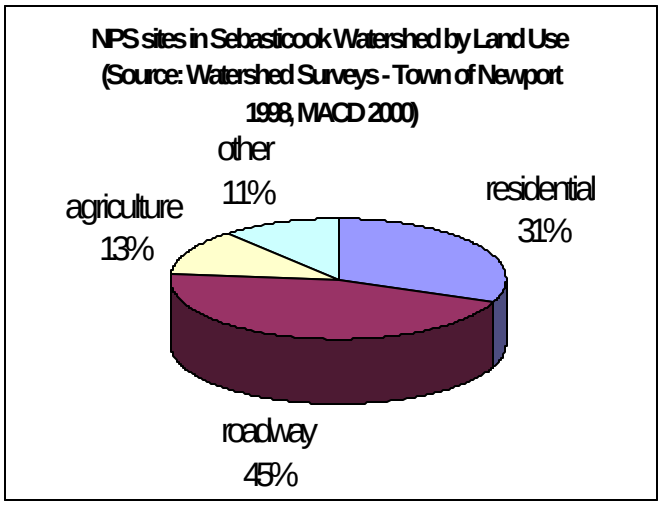




Identified NPS phosphorus sites in Sebasticook Lake Watershed by Land Use

Land Use Category	Direct Lake Wshd	E. Branch Seb. Riv.	Alder Stream	Stetson Stream	Mulligan Stream	Total
Residential	28	2				30 residential
Roadway	35	5	1		2	43 roadway
Agriculture	7	1	2		2	12 agriculture
Other	9	2				11 other
TOTAL	**79**	**10**	**3**	**0**	**4**	**96** total

residential	30
roadway	43
agriculture	12
other	11



APPENDIX C

AGREEMENT

March 1992

We, the eight communities of the Sebasticook Lake Watershed, agree to notify all communities within the same watershed which may be impacted by a development project (*) in a town which is in the direct or indirect watershed of Sebasticook Lake. Notification does not necessarily assume an impact. The notification will describe the development project and state a public hearing date, if a public hearing is to be held. The watershed towns will be invited to the public hearing and allowed comment.

Signed & Dated by Selectman, Councilor, or other authorized municipal representative:

Corinna _____

Exeter _____

Dexter _____

Newport _____

Palmyra _____

Ripley _____

St. Albans _____

Stetson _____

NOTE: Phosphorus loading review of each development may not always occur, depending on the town process. However, notification of all development within a watershed will allow the communities to keep a record of developed acres in that watershed. This record provides information on the cumulative development in the watershed for phosphorus loading information and other purposes.

NOTE: (*) Development Project: (a) All projects which go to town board for review and are in the direct or indirect watershed of Sebasticook Lake;
(b) Optional - projects which may impact water quality, are known by a town, but are not reviewed, such as a school development.

APPENDIX D

SEBASTICOOK LAKE WATERSHED INVENTORY
Watershed Inventory and Best Management Practices Feasibility Study for Reducing NonPoint Source (Phosphorus) Pollution in Selected Maine Lakes

This study is funded through US-EPA and implemented by ME-DEP to supplement current landuse and watershed survey information - to help us characterize the entire watershed and better define what the sediment and phosphorus sources are, where they are located in the watershed, and to evaluate the potential for implementation of BMPs.

This study will be carried out by highly trained natural resource professionals working with the Maine Association of Conservation Districts (MACD) in cooperation with area County Soil and Water Conservation Districts, Town Offices, and Lake Associations.

The lake-watershed related information gathered in this study is needed to complete Total Maximum Daily/Annual Load (TMDL) reports, including total phosphorus export loadings/models and provisions for reasonable assurances in meeting load reductions through implementation of BMPs.

Six lakes will be studied this summer-fall, including Sebasticook Lake, East Pond, China Lake, Androscoggin Lake, Mousam Lake, and Unity Pond. The TMDL for Sebasticook Lake is scheduled to be completed by the end of summer-early fall 2000, so it has top priority.

Initial objectives are to complete partial watershed surveys (beyond the Town of Newport for Sebasticook Lake), including: types and extents of agricultural/forestry practices, density of human habitation (residential use) around the lakeshore, and measures of types of roads (paved and dirt).

All lakes-watershed information gathered will be handled in a confidential manner, similar to previous ME-DEP sponsored watershed survey projects. The object of this project is to promote longterm lake protection efforts.

APPENDIX E

Sebasticook Lake TMDL – Public Review Summary

The final review draft of the Sebasticook Lake TMDL was placed on the ME-DEP web page and advertised in the legal section of the Bangor Daily News and Waterville Morning Sentinel during early December, 2000. The comment period was open for 30-days - until January 10, 2001. The comment period was then extended, at the request of a local farmer, for an additional week (January 17, 2001).

This final public review draft incorporated pre-review comments by the MACD field team and EPA Region I staff. Tom Hannula also reviewed subsections of the pre-draft – dealing specifically with 'development of the internal phosphorus recycling model' and 'the effects of lake drawdown'.

The following individuals/groups responded with comments:

Locally interested and actively invested farmer (e-mail)

Sebasticook Lake Association (Tom Hannula, e-mail)

Penobscot Valley Council of Governments (e-mail)

Central Aroostook Soil and Water Conservation District

Penobscot County Soil and Water Conservation District

Maine Department of Agriculture, Food & Rural Resources

Locally interested and actively invested fisheries biologist

All comments were considered and most either specifically or generally addressed in the final TMDL report. Major changes between draft and final versions of the Sebasticook Lake TMDL report include:

(1) Development and inclusion of a septic system total phosphorus allocation – based on a recently completed East Pond (EP) model.

(2) Incorporation of updated agricultural accounting information (from PC/SWCD-NRCS) within the land-use phosphorus load allocation table.

(3) Selection of low-end range total phosphorus loading coefficients to further reduce contributions assigned to agricultural practices, and to better reflect the considerable amount of time and money expended on agricultural BMP implementation over the past two decades.

(4) Inclusion of a 2-page overview (executive) summary.