Chapter Two

Water Quality and the Health of the Lake

In the last 25 years, water quality has improved largely due to state, federal, provincial, municipal, and private efforts to improve wastewater treatment facilities. Additional cleanup must further address pollutants from urban and agricultural areas, including nutrients, low levels of toxins, and pathogens.

Lake Champlain serves as a catch basin for pollutants entering directly into it and those washed from the land or air into nearby rivers by stormwater or snowmelt. Indicators of the health of the Lake show nutrient enrichment, which leads to overaccumulation of aquatic plant and algae growth; PCB and mercury contamination, which leads to fish consumption advisories; and bacterial contamination, which leads to beach closings.

La qualité de l'eau

Au cours des 25 dernières années, la qualité de l'eau s'est améliorée, principalement grâce aux efforts conjugués de tous (New York, Vermont, Québec, fédéral américain, municipalités, le privé) avec la construction de stations de traitement des eaux usées. Les efforts d'amélioration doivent maintenant être axés sur la réduction de la pollution d'origine urbaine et agricole, incluant les substances nutritives, les faibles taux de toxines et les pathogènes.

Le lac Champlain sert de bassin récepteur aux polluants qui y entrent directement ou, par le biais de ses affluents, lors du lessivage de son bassin versant à la suite de pluies ou de la fonte des neiges. Celui-ci a d'ailleurs tendance à accumuler les polluants, si l'on se fie aux indicateurs d'intégrité du lac: croissance accrue des plantes aquatiques et des algues en raison de l'apport de nutriments; avertissements de non-consommation de poissons dont la chair contient des BPC et du mercure; avis de fermeture de plages résultant d'une contamination bactérienne.

THIS CHAPTER INCLUDES:

Reducing Phosphorus Pollution
Preventing Pollution from Toxic Substances
Protecting Human Health

Reducing Phosphorus Pollution

GOAL

Reduce phosphorus inputs to Lake Champlain to promote a healthy and diverse ecosystem and provide for sustainable human use and enjoyment of the Lake.

Although phosphorus, nitrogen, and other nutrients are needed by the plants that form the base of the food chain in the Lake, nutrients are fertilizers that can promote the rapid growth of algae and plants. Human activities can greatly increase nutrient inputs to the Lake. These nutrient sources accelerate eutrophication, the natural aging process of lakes, and pose the greatest threat to water quality, living organisms, and human use and enjoyment of Lake Champlain. When the amount of nutrients, particularly phosphorus, entering Lake Champlain increases and remains high over time, the Lake becomes over-fertilized and produces excessive amounts of algae and other aquatic plants. Algal blooms turn water green, reduce water transparency, and create odor problems. When the algae die and decompose, the oxygen in the water that sustains fish and other organisms is depleted. Ultimately, these blooms alter fish and wildlife habitat, impair scenic views, reduce recreational appeal, impair water supplies, and lower property values.

Phosphorus levels continue to be at unacceptable levels in many parts of Lake Champlain. In some areas levels are comparable to those found in the most polluted parts of the Great Lakes (Saginaw Bay and the western end of Lake Erie) during the 1970s. Missisquoi Bay, St. Albans Bay, and the South Lake are the segments of Lake Champlain with the highest phosphorus levels (see Figure 2). Nuisance algal conditions exist nearly half of the time in these areas.

Gary Randorf

Algae blooms, a result of excess nutrients in the Lake, impede recreation.

Sources of Phosphorus

Wastewater treatment and industrial discharges are the main point sources of phosphorus, and now contribute about 20% of the total phosphorus entering Lake Champlain. Nonpoint sources, which account for about 80% of the phosphorus loading, include lawn and garden fertilizers, dairy manure and other agricultural wastes, pet wastes, and exposed or disturbed soil, including construction areas and eroding streambanks. At the local scale, nonpoint sources of phosphorus may include malfunctioning septic systems.

The major categories of land use within the Lake Champlain Basin are agricultural land (15% of Basin area), forested land (75% of Basin area), and urban and other developed land (6% of Basin area). Agricultural activities contribute approximately 55% of the annual nonpoint phosphorus load to the Lake. Forests cover a majority of the Basin's surface area but contribute only an estimated 8% of the average annual nonpoint source phosphorus load. Urban land covers only a small portion of the Basin, yet it produces approximately 37% of the average annual nonpoint source phosphorus load to the Lake—much more phosphorus per unit area than either agricultural or forested land (Hegman et al. 1999). Earlier estimates indicate that natural background sources of phosphorus account for only 24% of the present day total load, indicating that human activities in the Basin have increased phosphorus loading to Lake Champlain fourfold over the original predevelopment levels (VTDEC and NYSDEC 1994).

Significant Reductions and Phosphorus Management

While phosphorus loads to Lake Champlain were not well monitored in the 1970s and 1980s, Vermont point source loads have been reduced by an estimated 40% between the 1970s and 1991 as a result of banning phosphate detergents and regulating wastewater treatment plants and industrial discharges (Vermont Department of Water Resources and Environmental Engineering 1981). Additional reductions are presumed to have resulted from New York's phosphate detergent ban, although amounts were not documented. The 1992 Vermont phosphorus reduction statute (requiring improved phosphorus treatment at larger municipal treatment plants), along with decreased phosphorus discharges from several New York communities, resulted in an additional 43% (107 metric tons per year) reduction between 1991 and 1995. USDA Natural Resource Conservation Service models estimate that phosphorus loads from nonpoint sources have been reduced by more than 65 metric tons per year (approximately 10%) since the 1970s through voluntary pollution control efforts on farms supported by USDA cost-share funds. The agricultural community strongly supports these cooperative conservation programs. Many of the recommended actions in this section build on these past successes.

In 1993, New York, Vermont, and Québec signed a Water Quality Agreement committing the three entities to using a consistent approach to phosphorus management. The agreement defined in-lake phosphorus concentration criteria (goals) for thirteen lake segments (see Figure 2). The states of Vermont and New York subsequently completed a study to measure point and nonpoint source phosphorus loads to the Lake, developed a whole-lake phosphorus budget, and developed a load reduction strategy to attain the in-lake criteria (Vermont Department of Environmental Conservation and New York State Department of Environmental Conservation 1997). The results of this study (called the *Lake Champlain Diagnostic-Feasibility Study*) and subsequent analyses indicate that the annual phosphorus load to the Lake must be reduced by another 77 metric tons (relative to the 1995 load) to attain the in-lake criteria. This represents about 15 percent of the estimated 1995 total of 496 metric tons introduced each year. The challenge is to continue to reduce phosphorus loads from both point and nonpoint sources and to allocate load reductions throughout the Basin in a fair, efficient, and cost-effective manner.

In 1995, Holmes and Artuso developed an optimization procedure to determine the cost-effectiveness of various strategies for attaining the in-lake phosphorus criteria (Holmes and Artuso 1995). Designed for use with the *Diagnostic-Feasibility Study*, the optimization procedure takes into account the costs of potential phosphorus reductions achievable from point and nonpoint sources, as well as the manner in which changes to phosphorus levels in each lake segment are expected to affect phosphorus levels in all other lake segments. The procedure enables sorting through the multitude of possible combinations of point and nonpoint source reductions that are predicted to attain the in-lake criteria.

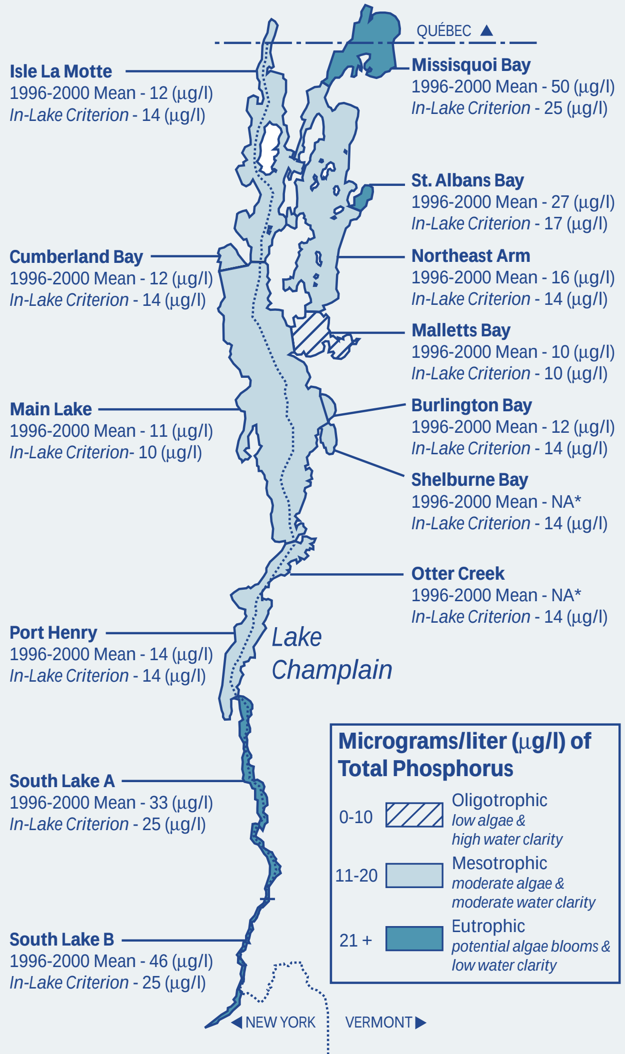

Figure 2. Lake segment boundaries with current phosphorus concentrations and in-lake criteria.

NOTE: The South Lake B in-lake criterion in the 1993 Water Quality Agreement is 25 ug/l, as reflected in this figure. The modeling used to generate phosphorus loading targets for the Lake are based on the Vermont Water Quality Standards, which is 54 ug/l. The in-lake concentration achieved by the phosphorus reduction strategy will fall somewhere between the two values.

Following careful analysis of several reduction scenarios, representatives from the states of Vermont, New York, and the USEPA used the phosphorus criteria, model, and optimization procedure to develop load reduction targets considered both fair and cost-effective. The agreed upon process distributes the responsibility for phosphorus reductions among 12 of the 19 watersheds shown in Figure 2 and was endorsed by the Lake Champlain Management Conference when the original *Opportunities for Action* was completed in 1996.

Table 1 presents the point and nonpoint source phosphorus loading targets for lake segment watersheds. Vermont and New York have committed to reducing the difference between the 1995 loads and the target loads in each lake segment watershed by at least 25% for each five-year period during the next twenty years, pending available federal and/or state funds to support implementation. The states also have committed to identifying specific nonpoint source control actions or specific point source permit modifications that would result in meeting the initial five-year interim goal.

Table 1 also shows the 1995 phosphorus loads, along with phosphorus loading targets, generated by the targeting procedure, as well as the reductions required (relative to 1995 loads) to attain the target loads for each lake segment. While Table 1 shows that most watersheds are targeted for some level of phosphorus reduction, the majority of the reduction is targeted to Missisquoi Bay (52 mt/yr). The State of Vermont and the Province of Québec have developed an agreement dividing responsibility for phosphorus reductions in this segment. Other watersheds targeted for substantial reductions include South Lake B (Vermont portion), Otter Creek (Vermont portion), and the Main Lake (both New York and Vermont portions). The locations of all watersheds targeted for some level of reduction are shown in Figure 3. No change is required for some watersheds, reflecting excess capacity at several wastewater treatment plants. For a more complete explanation of how point source load targets were calculated, refer to Appendix C.

In 2000, the LCBP released a *Preliminary Evaluation of Progress toward Lake Champlain Basin Program Phosphorus Reduction Goals*. The report, which was prepared by a team of scientists and managers working on phosphorus issues in the Lake Champlain Basin, evaluated progress toward the twenty-year phosphorus reduction goal and investigated the feasibility of accelerating phosphorus reduction efforts to achieve that goal sooner. The report predicts that Vermont, New York, and Québec will have reduced the phosphorus inputs to Lake Champlain by about 38.8 mt/yr by 2001, far exceeding the five-year interim reduction goal. For individual lake segment watersheds, Missisquoi Bay is the only lake segment that may fall slightly below a 25% reduction in the first five years.

The report also concluded, however, that not all lake segments can be brought to the loading targets needed to meet the in-lake phosphorus criteria by relying solely on existing reduction programs. By 2002, most of the planned reductions from wastewater treatment plant upgrades have been funded, leaving the remaining phosphorus reductions to come from nonpoint source reductions, especially from agricultural lands. The report estimated

VERMONT

Lake Segment Watershed	1991 Loads (mt/yr)			1995 Loads	Target Loads	Required Changes Relative to 1995
	Point	NPS	Total	Total	Total	
South Lake B	3.2	24.8	28.0	27.6	20.8	-6.8
South Lake A	0.1	2.4	2.4	1.2	0.6	-0.6
Port Henry	0.0	0.4	0.4	0.2	0.1	-0.1
Otter Creek	62.8	58.9	121.7	61.2	56.1	-5.1
Main Lake	27.7	60.3	88.0	80.7	76.6	-4.1
Shelburne Bay	5.3	11.1	16.4	11.8	12.0	none
Burlington Bay	11.2	0.3	11.5	2.5	5.8[1]	none
Malletts Bay	3.1	29.8	32.9	29.7	28.6	-1.1
Northeast Arm	0.0	3.2	3.2	1.4	1.2	-0.2
St. Albans Bay	0.8	7.2	8.0	8.9	9.5	none
Missisquoi Bay	6.9	94.2	101.1	89.5[2]	58.3[2]	-31.2
Isle LaMotte	0.0	0.6	0.6	0.3	0.3	none
TOTAL	121.1	293.2	414.2	315	269.9	-49.2 (net)

QUÉBEC

Lake Segment Watershed	1991 Loads (mt/yr)			1995 Loads	Target Loads	Required Changes Relative to 1995
	Point	NPS	Total	Total	Total	
Missisquoi Bay	8.5	57.7	66.2	59.6[3]	38.9[3]	-20.7

NEW YORK

Lake Segment Watershed	1991 Loads (mt/yr)			1995 Loads	Target Loads	Required Changes Relative to 1995
	Point	NPS	Total	Total	Total	
South Lake B	3.9	24.3	28.2	27.0	26.2	-0.8
South Lake A	9.6	3.5	13.1	10.1	9.4	-0.7
Port Henry	1.8	2.6	4.3	4.5	2.5	-2.0
Otter Creek	0.0	0.1	0.1	0.1	0.0	-0.1
Main Lake	7.1	31.8	38.9	37.5	35.0	-2.5
Cumberland Bay	29.2	8.8	38.0	20.2	25.5	none
Isle LaMotte	7.4	20.9	28.3	22.0	21.5	-0.5
TOTAL	59.0	92.0	150.9	121.4	120.1	-6.6 (net)

[1] Revised from first Opportunities for Action (October 1996) with currently permitted point source loads in the Lake Champlain Phosphorus TMDL Draft (June 2001), VT DEC.
[2] Reflects 60% of the Opportunities for Action 1995 loads and target loads for Missisquoi Bay. Source: Missisquoi Bay Phosphorus Reduction Task Force Report (June 2000).
[3] Reflects 40% of the Opportunities for Action 1995 loads and target loads for Missisquoi Bay. Source: Missisquoi Bay Phosphorus Reduction Task Force Report (June 2000). 1995 loads for comparison only.

Table 1. Phosphorus loading targets in metric tons per year (mt/yr), shown in comparison with the 1991 and 1995 (estimated) phosphorus loads for contributing watersheds.

Source: The 1991 base year loads were measured by the *Lake Champlain Diagnostic-Feasibility Study* (VTDEC and NYSDEC 1997). The 1995 loads were adjusted to reflect expected reductions resulting from point and nonpoint source controls implemented through 1995.

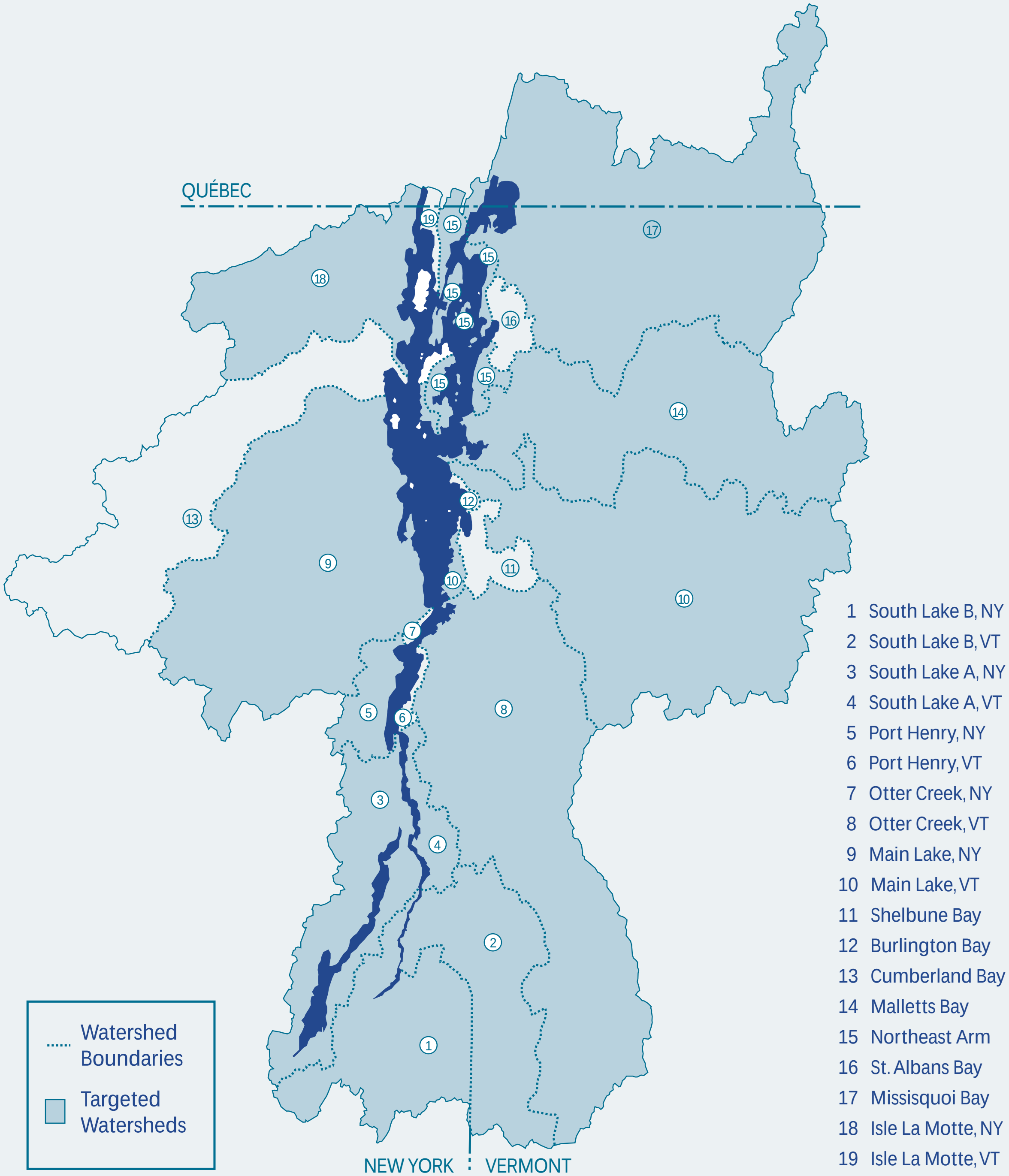

Figure 3. Drainage by lake segment and targeted watersheds for phosphorus reduction.

that after implementation of agricultural Best Management Practices (BMPs) on all of the remaining farms in the Vermont and Québec portions of the Basin needing treatment, the loads would still exceed the twenty year non-point source target for the Vermont and Québec parts of the Basin, not accounting for any other changes within the Basin. Accelerating the timeframe for meeting the reduction targets will require new techniques and higher annual funding commitments than in the past.

Considerations for Implementation

Land Use Change Impacts on Phosphorus Loads

Based on the 2000 LCBP report of the Phosphorus Reduction Team, it appears that phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and nonpoint source reduction efforts. As the population within the Basin increases, more land is becoming developed. Because developed land generates more phosphorus than other land uses, non-point source phosphorus loads may be increasing in parts of the Basin where the land use is changing. Potential options for achieving the additional phosphorus reductions necessary to account for these increases include both additional point and nonpoint source treatments. Emerging technologies may be applied to further reduce point source phosphorus loads and additional nonpoint source reductions may be achieved through

OBJECTIVES

(not listed in priority order)

1) Attain phosphorus loading targets for lake segment watersheds that are consistent with the 1996 New York, Vermont, and USEPA phosphorus reduction agreement.

2) Attain the in-lake phosphorus criteria specified in the 1993 New York, Québec, and Vermont Water Quality Agreement.

QC MENV

The Québec Ministry of Agriculture, Fisheries, and Food is working with farmers in the Québec portion of the Missisquoi Bay watershed on many best management practice (BMP) initiatives to reduce nonpoint source pollution.

actions such as implementing innovative BMPs and site designs, building conservation buffers, and supporting a whole-farm approach to agricultural nutrient planning.

Phosphorus Total Maximum Daily Load (TMDL)

The Federal Clean Water Act requires Vermont and New York to develop Total Maximum Daily Loads (TMDLs) for lakes and rivers that are not meeting water quality goals. A TMDL is an estimate of the amount of pollution that a body of water can receive without impairing vital uses, such as drinking water supply or aquatic life support. Because phosphorus is impairing water quality in many parts of Lake Champlain, Vermont and New York are required to prepare a phosphorus TMDL for the Lake. The bistate TMDL is based on the loading and in-lake concentration targets described in this section. Implementation of the TMDL will be consistent with the actions described in this Plan.

Focusing Phosphorus Reduction Resources on Targeted Watersheds

Twelve lake segment watersheds have been targeted for phosphorus load reductions (see Table 1). While basic statewide phosphorus reduction activities—such as implementation of Vermont's mandatory Accepted Agricultural Practices—should continue, phosphorus reduction actions should be targeted to these watersheds to the extent possible. Many of the recommended actions in this section are directed to targeted watersheds.

Preventing Increases in Phosphorus Loads to the Lake

For watersheds where no additional reduction is targeted, management efforts should focus on preventing increases in phosphorus levels. For targeted watersheds, management efforts should focus on both the reduction from existing sources and the prevention of increases from new sources. One way to minimize loading increases is to ensure that new development complies with appropriate management practices to control phosphorus export. Preventing phosphorus discharges at the initial stage of development is much less expensive than reducing phosphorus runoff after project completion. Both New York and Vermont have programs in place to control erosion, sedimentation, and stormwater runoff from new development. There are opportunities for strengthening these programs and for much more local government involvement in stormwater management.

Improving Nutrient Management on Farms

While it is important to continue with effective structural improvements to farms (such as the construction of manure pits and barnyard runoff systems), all farms can benefit from comprehensive nutrient management planning (CNMP). CNMP is an integrated approach to maximizing the efficient use of plant nutrients. The agricultural community is becoming more aware of the economic benefits of improved nutrient management, and is demanding more nutrient management assistance than can be provided by existing trained consultants.

Highest Priority Action

1) Develop and Assess Options to Achieve the Remaining Targeted Phosphorus Loading Reductions Needed to Achieve the In-Lake Phosphorus Standards

a) Implement the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) for New York and Vermont.

b) Implement the Québec-Vermont Agreement on Phosphorus Reduction in Missisquoi Bay, establishing a division of responsibility for reducing phosphorus loads to Missisquoi Bay during 2002.

c) By October 1, 2002, New York, Vermont and Québec will commit to a specific set of actions that will accomplish at least the second 25% of the total necessary lakewide phosphorus load reductions by October 1, 2006.

d) Determine the additional actions necessary to achieve the load reductions on an expedited schedule—by 2009, the 400th anniversary of Samuel de Champlain's arrival on the Lake, instead of 2016.

- *Identify technical challenges to achieving the phosphorus reductions necessary and outline plans to overcome them.*
- *Estimate the costs of implementing the reductions needed and the options for securing those funds.*
- *Work aggressively to secure the necessary federal, state, provincial, and other funds as appropriate.*

e) By October 1, 2003, New York, Vermont and Québec will identify and commit to the specific actions necessary to achieve the remaining load reductions necessary to achieve the in-lake phosphorus criteria. These commitments will reflect the results of the investigation described in "d" above, and will make clear the most timely schedule of reductions deemed possible.

Potential key LCBP partners: NYSDEC, NYSSWCC, VTDEC, NYDAM, VTDAFM, QC MENV, QC MAPAQ, USEPA
Cost estimate: $100,000, in-kind services
Potential funding sources: LCBP, NYSDEC, VTDEC, USEPA, QC MENV
Timeframe: 2001-2006
Benchmark: Identification of specific actions

High Priority Actions

(not listed in priority order)

2) Provide Funding for Point Source Phosphorus Reductions

Provide sufficient funding to make the improvements to wastewater treatment plants necessary to attain the point source reduction targets agreed upon through the TMDL process and the Québec-Vermont Agreement on Phosphorus Reduction in Missisquoi Bay.

a) In Vermont, continue to provide state funding for implementation of the state phosphorus reduction statute, which currently requires all treatment plants discharging more than 200,000 gallons per day (except aerated lagoon facilities) to lower effluent phosphorus concentrations to 0.8 mg/l or lower.

b) Because additional point source reductions may be an outcome of the TMDL process, investigate the feasibility of additional reductions at selected treatment plants.

c) In New York, continue to provide state funding for wastewater treatment plant upgrades necessary to obtain the load reductions required by the TMDL.

d) The Québec government, in partnership with local municipalities, will continue to support extending wastewater treatment through its CleanUp Wastewater program. Treatment facilities have been constructed in several towns; several others have been connected to the new or existing facilities. Additional facilities are being built or planned for all remaining point source discharges. In the Missisquoi Bay watershed, all current and planned wastewater treatment facilities use an aerated lagoon treatment process with a target effluent concentration of 1.0 mg/l or lower.

e) Investigate the feasibility of updating the Phosphorus Detergent Ban to include products, such as dishwashing detergents, that are now being used in quantities similar to laundry detergents.

Potential key LCBP partners: VTDEC, NYSDEC, QC MENV municipalities
Cost estimate: $30 million or more
Potential funding sources: State, provincial, and federal appropriations
Timeframe: 2002-2015
Benchmark: Point source phosphorus reductions, which in combination with nonpoint source reductions, achieve at least 25% of the total targeted reduction for each watershed (see Table 2) per five-year period for the next twenty years

ACCOMPLISHMENTS

EXCEEDING FIRST REDUCTION TARGET

A June 2000 LCBP analysis estimated that Vermont, New York, and Québec have reduced phosphorus inputs to Lake Champlain by 38.8 metric tons per year, far exceeding the 2001 reduction target of 15.8 metric tons per year.

REDUCING POINT SOURCES

An estimated 22.7 metric tons per year reduction in phosphorus loads from point sources was achieved between 1995 and 2001. Upgrading and constructing wastewater treatment plants in Vermont, New York, and Québec with $25 million in state, federal, and provincial funds accomplished these reductions.

- In Vermont, state and federal funds have provided 100% of the costs of upgrading phosphorus removal processes at wastewater treatment plants in 14 municipalities.
- In New York, funds for wastewater treatment improvements in 12 municipalities were provided through the Clean Air/Clean Water Bond Act.
- In Québec, wastewater treatment plants with phosphorus removal now serve 7 municipalities.

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3) Estimate the Nonpoint Source Phosphorus Load That Is Being Generated by Developed Land Uses (Urban and Suburban Land, Roads, etc.) in the Basin and Work Aggressively to Reduce This Load.

Based on an LCBP analysis in 2000, it appears that increased phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and agricultural nonpoint source reduction efforts. Other studies have shown that developed land typically contributes more phosphorus per unit area of land than other land use types. As the population within the Basin increases, there is the opportunity to encourage growth away from the land-intensive suburban sprawl-type development and to better manage the resulting polluted urban stormwater to minimize increases in phosphorus loads to the Lake.

a) Collect and analyze land use information to estimate the increase in phosphorus load that occurs with new development and to help target improved stormwater management to those areas experiencing the most rapid growth.

b) Develop new options to offset the phosphorus load generated by new development.

c) Increase efforts to reduce phosphorus loadings from new development by assisting local efforts to promote land use planning and innovative subdivision practices that discourage urban and suburban sprawl.

d) Implement retrofitted stormwater management systems and other measures to reduce phosphorus loads from existing urban and suburban areas.

e) Work with the state, provincial, and local stormwater management programs to minimize the phosphorus load generated by new development and reduce the phosphorus load from existing areas undergoing redevelopment, including providing assistance for local compliance with USEPA Phase II stormwater rules.

f) Increase training opportunities for local road supervisors and crews to encourage implementation of BMPs for road construction, repair, and maintenance, according to the standards in state backroads, stormwater management, and erosion and sediment control handbooks.

g) Encourage implementation of erosion and sedimentation control practices for construction activities.

h) Encourage nutrient management on commercial and residential properties.

Potential key LCBP partners: NYSDEC, NYS SWCDs, NYSDOT, VTDEC, municipalities, NY counties, professional organizations
Cost estimate: $100,000 to $500,000 per year
Potential funding sources: USEPA, state appropriations
Time frame: 2001-2006
Benchmark: Revisions to state stormwater control programs that improve their scope and/or effectiveness

4) Expand and Accelerate Implementation of Existing Federal, State, and Provincial Agricultural Nonpoint Source Pollution Programs

Provide sufficient funding to accelerate implementation of federal, state, provincial, and local programs that provide technical and cost-share assistance for best management practices on farms, emphasizing animal waste and nutrient management and pollution prevention. Ensure that allocation of funds is consistent with sub-basin strategies, where applicable. Continue development, coordination, and implementation of state agricultural nonpoint source programs. Specifically:

a) Continue state cost-share funds provided through Vermont's voluntary Agricultural Best Management Practices (BMP) program and New York's Environmental Protection Fund. These funds should be used, where appropriate, to supplement federal cost-share programs to reduce the farmers' share of project costs and increase participation rates.

b) Continue implementation of recommended state management practices. In New York, encourage implementation of appropriate practices through the Agricultural Environmental Management program (AEM). In Vermont, encourage voluntary implementation of the Natural Resource Conservation District's (NRCS) recommended management practices in targeted watersheds. These practices, which are referenced in Vermont's Agricultural BMP rules, go beyond the state's mandatory Acceptable Agricultural Practices. In Québec, continue to provide funds for efficient manure storage required by regulation through the Agroenvironmental Investment Assistance Program and funding and technical support to encourage sustainable agriculture practices, including nutrient and manure management, agroenvironmental advisory services, erosion control, and infrastructure facilities.

c) Seek other sources of funding for agricultural cost-share projects basinwide.

Potential key LCBP partners: NYSSWCC, VTDAFM, NYSDAM, NYSDEC, VTDEC, QC MENV, QC MAPAQ, USDA-NRCS & FSA, USEPA, NYSERDA, USFWS, US Army Corps
Cost estimate: $500,000 to $1,000,000 per year
Potential funding sources: State and provincial appropriations, USDA-NRCS & FSA, USEPA, NY Environmental Protection Fund
Timeframe: 1995-2015
Benchmark: Acceleration of on-farm implementation of phosphorus reduction measures. Improved implementation of recommended management practices and the provision of funds to increase participation in federal cost-share programs within targeted watersheds

5) Expand Programs for Streambank Restoration and the Installation of Vegetated Buffer Areas Along Eroding Streams and Rivers

Studies have shown that vegetated areas along streams and rivers can effectively filter sediment and phosphorus from runoff and reduce streambank erosion while creating habitat for wildlife. Use stream geomorphology to determine where and how to address problems with erosion so that the entire stream system remains more stable over time.

a) Use geomorphic assessment and other techniques to target reaches where significant phosphorus loading may be occurring as a result of erosion.

Accomplishments

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- Several promising new technologies for point source phosphorus removal were tested in the Basin with LCBP funding. The city of Lake Placid constructed a tertiary water treatment process at a golf course. The Town of Willsboro, NY and researchers from Cornell University piloted a new technology that uses wollastonite, a local mineral, in constructed wetlands to remove phosphorus from wastewater.

Reducing Nonpoint Sources

An estimated 16.1 metric ton reduction in annual phosphorus inputs was achieved through implementation of Agricultural Best Management Practices (BMPs) in the Basin 1995 to 2001.

- In New York, the Clean Air/Clean Water Bond Act funds supported 75 agriculture BMP projects from 1995 to 2000, for an estimated phosphorus reduction of over 9 metric tons per year.
- With about $7 million from federal, state, and landowner sources, nearly 600 BMP cost-share projects were implemented in Vermont between 1995 and 2000, for an estimated phosphorus reduction of over 8 metric tons per year.

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Accomplishments

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- Québec has provided over $2.9 million in cost-share funds to farmers for 120 manure storage structures, resulting in an estimated phosphorus reduction of more than one metric ton per year. About 75% of Québec agricultural operations in the Missisquoi Bay Basin now have adequate manure storage facilities.

Developing Alternative Manure Management Techniques

The Winooski Natural Resources Conservation District and the University of Vermont are beginning a cold-climate test of a new manure management technique that uses electrical currents to accelerate composting. This process kills pathogens more quickly and reduces odors. The resulting product is less polluting to surface waters than raw manure and can be more easily transported to areas in need of added nutrients.

Implementing Local Projects

The LCBP has funded a number of local projects that contribute to reducing phosphorus. These projects involve citizen volunteers, willing landowners, and state and federal agency staff. Examples include:

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b) Develop or expand programs that cost-share or offer tax incentives for voluntary restoration or protection of buffer strips on perennial streams, rivers, and lakes in the Basin.

c) Develop a GIS database of streams needing buffer areas for use by programs such as the NY and VT Conservation Reserve Enhancement Programs (CREP) and the USDA Environmental Quality Incentives Program (EQIP).

d) Continue to support Coopérative de Solidarité du bassin versant de la rivière aux Brochets in Québec, a group of volunteers with the Ministry of Agriculture, Fisheries, and Food of Québec (MAPAQ) working to restore streambanks of the Pike River Watershed.

e) Continue to implement Québec's Protection Policy for Lakeshores, Riverbanks, Littoral Zones, and Floodplains, in cooperation with local and regional governments and the Ministry of Natural Resources for lands in the public domain. The Ministry of Environment implements and coordinates the application of this policy.

f) Increase programs aimed at informing professionals working on streams (e.g., municipal officials, landscape architects, etc.) about the value and importance of buffers and stable streams.

g) Identify additional funding sources for streambank restoration.

Potential key LCBP partners: USDA-NRCS & FSA, USFWS, NYSSWCC, VTDAFM, NYSDAM, NYSDEC, VTDEC, QC MENV, QC MAPAQ, Québec municipalities, and professional organizations

Cost estimate: $500,000 per year

Potential funding sources: State, federal, and provincial appropriations, USDA, NY Environmental Protection Fund, the Québec Agroenvironmental Investment Assistance Program, Soil and Water Conservation Program of MAPAQ

Timeframe: 1995-2015

Benchmark: Miles of continuous streambank stabilized and acres of riparian buffer zones established

Priority Actions

(not listed in priority order)

6) Enhance and Refine the Current System for Documenting Non-point Source Phosphorus Control Practices and Estimating the Resulting Load Reductions

Reductions in phosphorus loadings to Lake Champlain resulting from nonpoint source phosphorus control practices have been estimated by tracking the implementation of these practices and then assuming each practice will result in a particular amount of phosphorus load reduction. These reduction “credits” for practices are also used to predict which actions are needed to achieve the in-lake goals.

a) Document and credit nonpoint source phosphorus reduction practices in a comprehensive manner across the Basin, including those implemented by all federal, state, and local programs.

b) Refine the credits currently being applied to agricultural nonpoint source phosphorus control practices to estimate more accurately the true reductions in loadings likely to be achieved.

c) Develop a technically sound and equitable method of crediting the phosphorus reductions achieved by urban stormwater and other non-point source control practices.

Potential key LCBP partners: NYSDEC, VTDEC, NYS-DAM, VTDAFM, QC MENV, QC MAPAQ, USDA-NRCS, USEPA
Cost estimate: $100,000 to $150,000
Potential funding sources: LCBP, NYSDEC, VTDEC, USEPA, QC MENV
Timeframe: 2001-2002
Benchmark: Implementation of a refined tracking system

7) Promote the Implementation of Comprehensive Nutrient Management Planning (CNMP)

Effective ongoing nutrient management on the farm is essential to phosphorus reduction efforts. This action is to provide additional education and technical assistance on comprehensive nutrient management, a complete system of animal waste management practices, and to promote sustained implementation of nutrient management plans that should accomplish the following:

a) Implement nutrient management plans on farms with phosphorus limits by 2004, as required by law in Québec.

b) Promote the use of combined soil testing with manure analysis and risk assessment tools, such as the Phosphorus Index, to minimize the impacts of phosphorus loadings from agricultural areas on water quality.

c) Broaden the support (educational, financial, and technical) for integrated crop management services and promote accurate record-keeping.

d) Provide training to promote implementation and maintenance of buffer strips between croplands and surface water conveyances (see Action 6 above).

e) Encourage farmers to keep livestock out of surface water by providing additional technical and financial assistance for streamside fencing and alternative watering systems.

f) Support demonstration and evaluation of existing and new alternative manure management technologies (e.g., composting and methane generation), including identification of funding, to assist producers in addressing surplus nutrient issues on their farms.

g) Support grassland agriculture and rotational grazing as a means of reducing the demand for more intensively managed row crops and to reduce the reliance on phosphorus imports to the farm.

h) Explore ways to reduce the amount of phosphorus imported to the farm, such as the phosphorus contained in animal feed supplements and other products that ultimately enter the farm waste stream.

i) Promote the development and implementation of CNMPs on all animal feeding operations, including those covered by state regulatory programs.

j) Encourage farmers to reduce soil erosion to tolerable soil loss levels to the extent possible on fields that receive nutrients.

Accomplishments

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- The Missisquoi River Basin Association has ongoing streambank stabilization projects. Activities include planting trees and other streamside vegetation, installing fencing to restrict animals to streams, and stemming erosion at recreational access sites.
- The City of Plattsburgh and the Saranac Lake River Corridor Committee have worked on bank stabilization along the Saranac River.
- The Friends of the Winooski River fenced livestock out of the Huntington River and added streambank revetments and plantings along Mill Brook.
- The Boquet River Association wrote *How to Hold Up Banks*, a guide for nonprofit groups on controlling stream erosion.
- The Lamoille County Regional Planning Commission, the Boquet River Association, and the Lewis Creek Association are cooperating with the VTDEC to conduct stream geomorphological assessments which help prioritize stabilization projects and ensure their success.
- The Vermont Youth Conservation Corps has completed projects along 29 rivers and streams, including planting, mulching, and seeding.

Potential key LCBP partners: Farmers, university extensions, SWCDs, NRCDs, CMAs/private consultants, USFWS, USDA-NRCS and FSA, NYSDAM, VTDAFM, fertilizer dealers, QC MENV, QC MAPAQ, agroenvironmental clubs
Cost estimate: For a) $5 per acre; for b) and d) $100,000 each beyond what is provided for in Action 5; for others, $25,000 per year
Potential funding sources: NYSDAM, VTDAFM, University Extension & Sea Grant Programs, USDA-NRCS and FSA, USEPA, federal appropriations, QC MENV, and QC MAPAQ
Timeframe: Ongoing
Benchmark: Increased implementation of practices described above

8) Research and Demonstrate the Effectiveness of Nonpoint Source Pollution Control Practices

Research on nonpoint source pollution control practices has led to increased understanding of their effectiveness as implemented in the Lake Champlain Basin (Meals 1990; Vermont Rural Clean Water Program Coordinating Committee 1991; Meals 2001). Two ongoing, long-term studies will further document the effectiveness of BMPs, one in an urban watershed and the other in an agricultural watershed. These projects should be continued until completed and additional projects should be considered as the results become available.

Potential key LCBP partners: NYSDEC, VTDEC, NYSDAM, VTDAFM, USDA-NRCS, USEPA, USGS, LCRC, universities
Cost estimate: For the monitoring component, $50,000 per demonstration site per year; costs for implementing the practices will vary depending on the site
Potential funding sources: Federal and state appropriations
Timeframe: 1995-2007
Benchmark: Completion of the research and demonstration projects listed above

Other Actions for Consideration

(not listed in priority order)

9) Develop and Implement an Awards Program for Basin Farmers

Support existing and consider new awards programs to recognize farmers in the Basin who are voluntarily implementing management practices designed to improve water quality.

Potential key LCBP partners: NYSSWCC, VNRC, NYSDAM, VTDAFM, NYSDEC, VTDEC, farmers
Cost estimate: $1,500 per year per state, and limited in-kind participation of agency staff
Potential funding sources: USDA-NRCS & FSA, USEPA, and private sponsors
Timeframe: Ongoing
Benchmark: Development of criteria, application, and evaluation procedures, and initial distribution of awards to at least one farmer in each state

10) Encourage Continued Implementation of State Management Practices for Forestry Activities

In Vermont, continue implementation of Acceptable Management Practices for forest harvesting activities developed by the Commissioner of the Vermont Department of Forests, Parks, and Recreation (VTDFPR). In New York, encourage implementation of the Silviculture Management Practices in the New York *Silvicultural Management Practices Catalogue* (1993).

a) Increase cost-share funding for forest management planning.

b) Seek additional funds from the USDA Forestry Incentives Program (FIP) for practices such as timber stand improvement, tree planting, and site preparation for natural regeneration, all of which enhance the sustainability of forest lands.

Potential key LCBP partners: NYSDEC, VTDFPR, landowners, loggers, VT Forest Products Association
Cost estimate: In-kind participation of agency representatives
Potential funding sources: Same as key partners
Timeframe: 1996 and Ongoing
Benchmark: Improved implementation of management practices

11) Demonstrate the Use of Constructed Wetlands for Treating Domestic Wastewater, Agricultural Wastes, and Urban Runoff

One alternative to treating wastewater is the creation of a "constructed" wetland that simulates the water quality functions of a natural wetland. The technology for constructing wetlands is currently in the experimental stage of development, yet still can be applied to enhance the treatment of domestic wastewater, agricultural wastes, and urban runoff.

Potential key LCBP partners: USEPA, NBS, state and local agencies, NY SWCDs, LCRC, Vermont NRCDs, universities
Cost estimate: $25,000-$50,000 per year
Potential funding sources: Federal appropriations
Timeframe: Ongoing
Benchmark: Completion of one or more demonstration projects