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Lake Champlain Basin Program

Developing and Assessing Policy Options for Reducing Phosphorus Loading in Lake Champlain

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for
Lake Champlain Basin Program

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Final Report to the
Lake Champlain Basin Program

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Executive Summary

This report describes the processes and outcomes of the project titled "Developing and Assessing Policy Options for Reducing Phosphorus Loading in Lake Champlain." While coordinated by Winrock International, this effort drew heavily on the input of nationally recognized scientists, economists, and policy experts with extensive experience on the issue of nonpoint-source phosphorus (P) pollution control. The goal of this project was to facilitate the achievement of the long-term P reduction goals set for Lake Champlain through the development of innovative policy strategies.

The objectives of the project were to:
- Conduct a review and analysis of current policies and programs for controlling P loads in Lake Champlain;
- Provide a review and assessment of innovative strategies for controlling P loads in other watersheds throughout the U.S. and Canada; and
- Create a set of appropriate policy options for reducing P loads to Lake Champlain, with associated cost-benefit analyses.

Section I of this report contains an introduction to the project and report. Section II provides a review and analysis of current policies and programs in place within the Lake Champlain Basin that have a direct impact on P loading to the Lake. Section III provides an overview and analysis of strategies that are being used to control P pollution in other areas of the U.S. and the world. Following the creation of Sections II and III, the project staff and advisory team developed an initial list of policy options thought to be valuable for use in the Basin. This initial list and brief descriptions are presented in Section IV. The initial list of policy options were then presented to the LCBP Technical Advisory Committee and P Reduction Task Force, who provided guidance on policies and areas of greatest interest. The project team then used this guidance, in conjunction with the plethora of information collected, to create a limited number of final policy options. Analyses were conducted on each of the final policy options. The final options and associated analyses are presented in Section V of this report.

The final policy options address nonpoint sources of P only. Focusing on control of nonpoint sources was deemed the wisest use of this project's resources, as they present much more difficult policy issues than does point source control. The policy options in this report are divided between those applicable to agricultural land and to developed land. For both of these nonpoint sources, the policy options are a mix of regulation, technical assistance, and financial incentives. Many of the policy options presented in this report are novel ideas. The project team feels that the set of ideas contained in these policy options provide a greatly increased probability of success for meeting the long-term P reduction goals set for Lake Champlain. Where possible, guidance for specific implementation details for each policy option has been included. For the most part, however, specific decisions concerning resource allocation (i.e. funding sources, staff time, etc.), related rules, and timetables will need to be made by legislators, policy makers, civic leaders, and stakeholders, prior to implementation of any of these policy options. The final set of policy options are listed below.

For agricultural land:

Option AG1a. Require livestock exclusion from all and lakes, ponds, rivers, and streams classified by USGS as first order (blue-line) or greater by April 1, 2006. Exceptions will be made for designated stream crossings.

Option AG1b. Establish and enforce a minimum 50-ft vegetative or forested riparian buffer on all cropland where runoff enters permanent water bodies by April 1, 2005 in Vermont and New York.

Option AG2. Enact nutrient management legislation in Vermont and New York that requires all farms with a stocking rate over 0.5 AUs per acre to develop and implement certified nutrient management plans (NMP). Each farm's plans should be evaluated using the State's official phosphorus (P) index to identify areas (fields) with a high risk for P loss to surface waters. Specific nutrient management guidance for each field will be determined based on the P index score.

Option AG3a: Create a subsidized program that allows livestock farms to ship manure from the farm to centrally located processing facilities in the most livestock-dense watersheds.

Option AG3b: Create a matching service to link farms with surplus manure to farms that could use the manure. This could be done with minimal funds through the Extension services.

Option AG3c: Make additional cost-share funding available for farmers to remove P from manure produced on the farm.

Option AG4: Implement a performance-based policy to reward farmers for documented improvements in moving towards a mass balance of P on the farm.

Option AG5: Create a Basin-wide team to work with individual farmers to assess potential problems, find least-cost solutions, and facilitate the incorporation of environmental quality concerns into long-term farm business planning.

For developed land:

Option DL1: Increase the number of municipalities that are regulated under Phase II of EPA's Stormwater Rule by reducing the population criteria for inclusion.

Option DL2: Increase level of technical assistance available to local municipal authorities to address P and stormwater issues.

Option DL3a: Enact legislation in Vermont and New York to provide direct payments to municipalities that can document the implementation of approved water quality improvement actions. The legislation would create a fund to reward municipalities based on a town's municipal P reduction (or water quality) index score.

Option DL3b: Increase the grant proposal scoring and/or improve the loan repayment terms based on a town's municipal P reduction (or water quality) index score.

Option DL4: Amend the water quality statutes in Vermont and New York to reduce the maximum P content of household cleaning agents, including automatic dishwashing detergents that are sold or distributed, to 0.5 percent by weight.

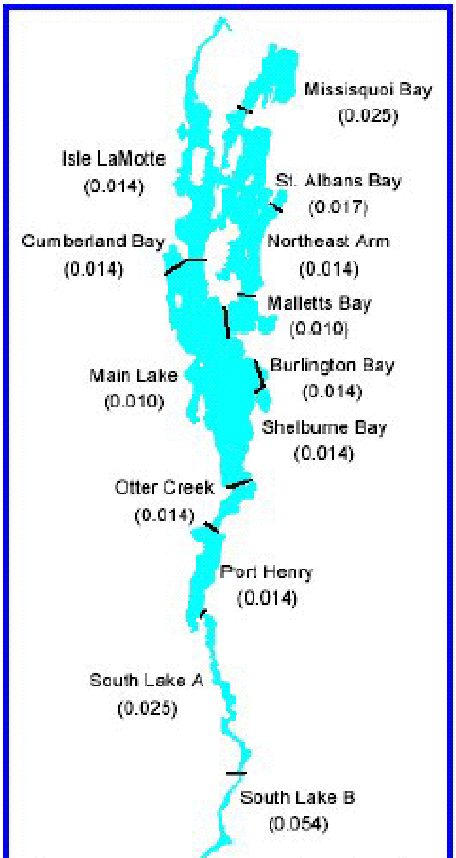
Most of these policy options can be implemented individually. However, some options, such as AG3a, 3b, and 3c, will be of significant value only when implemented in conjunction with others, such as AG2. Additionally, within both the agricultural and developed land sections, the policy options are generally complementary. For example, technical assistance will be valuable, and perhaps necessary, as an accompaniment to increased regulations or new financial incentives.

For some of the policy options described in this report, it was impossible to make reasonably accurate estimates of the technical- and/or cost-effectiveness of the proposed action. This is primarily because these options are based on new ideas; therefore, data on their effectiveness are not available. Additionally, we cannot predict, given the scope of this project, the level of participation that will be achieved in the voluntary, incentive-based policy options for either agricultural or developed land. Where possible, stated assumptions were used to estimate the technical- and cost-effectiveness of such options. Although sufficient data are not available in all cases, it is still very important for policy makers and other stakeholders to begin to consider new and innovative solutions to the P-loading problems in Lake Champlain.

Among the options for which quantitative cost-effectiveness estimates have been developed, livestock exclusion from waterways (Option AG1b) shows the greatest cost-effectiveness at $6.62 per kg P reduced. In general, the agricultural options are estimated to have greater cost-effectiveness than the options for developed land. The most expensive of these is estimated to be the direct payments to municipalities as a reward for documented actions to reduce P loss and improve water quality (Option DL3a), at up to $67 per kg P reduced. These cost estimates are annual amounts and should be considered preliminary and primarily for comparative purposes. They give an overall sense of which options might be most costly, and which might be least costly, but should not be taken as absolute values. They might be considered along with the cost estimates prepared as part of the TMDL process, which consider costs over a longer time period and were developed using a different approach.

I. Introduction

Significant reductions in phosphorus (P) loads to Lake Champlain have already been achieved, surpassing the interim 5-year goals set by the Lake Champlain Management Conference (Vermont DEC and New York DEC 2002). However, these reductions have come primarily from reductions in point sources of P. For several reasons, point source pollution is much easier to address relative to nonpoint source pollution (as discussed in section II.B). Unfortunately, to achieve the remaining targeted reductions in P loads to the Lake, significant reductions will be needed from nonpoint sources. It seems clear that the current policies and programs designed to address nonpoint sources of P will be inadequate to meet the 20-year reduction goals (Donlon and Watzin 2001; Vermont DEC and New York DEC 2002). Innovative policy solutions will be required to achieve these goals while balancing the needs of citizens, farmers, businesses, and local economies.



Phosphorus concentration criteria (mg/l) in Vermont Water Quality Standards for Lake Champlain segments.

The responsibility of reducing P loads to Lake Champlain fall on the states of Vermont and New York and the Province of Québec. The baseline information on the total P loads entering the Lake, as well as for allocating future loads, is from the Lake Champlain Diagnostic-Feasibility Study. In this study, water quality samples were taken from 52 representative sampling stations twice per month from late April to early November in 1990 and 1991. Detailed information on the methods and results can be seen in the study's Final Report (Vermont DEC and New York DEC 1997). These data were used to create an estimate of the total sources of P to the Lake of 647 metric tons per year (mt/yr) for the 1991 base year. Additionally, these data were used, together with other information, to estimate the distribution of P sources from Vermont, New York, and Québec, and among natural, cultural nonpoint, and point sources (Smeltzer and Quinn 1996). This information is presented in Table 1.

Table 1. Estimate of P Sources to Lake Champlain during 1991

	Total Load = 647 mt/yr		
Source:	**Vermont**	**New York**	**Québec**
Natural Nonpoint Sources	-------------24%------------		
Cultural Nonpoint Sources	30%	8%	9%
Point Sources	19%	9%	1%

Source: Smeltzer and Quinn, 1996.

This report contains the outcomes and products from the project "Developing and Assessing Policy Options for Reducing Phosphorus Loading in Lake Champlain." Section II contains a review and analysis of current policies and programs for controlling P loads in the Lake Champlain Basin. Section III contains an assessment of approaches being used in other parts of the U.S. and overseas for reducing P loads.

Section IV contains the initial list of policy options suggested for reducing P loads to Lake Champlain. The project's staff and advisors through input from stakeholders, agency personnel, and scientists from within and outside of the Champlain Basin developed this "long" list. The "long" list includes policy options that range from tinkering at the margins of current policies and programs, to suggestions for radically different new programs to address P control in the Lake Champlain Basin. The long list of policy options was reviewed by the Lake Champlain Basin Program (LCBP) Phosphorus Reduction Task Force (PRTF) and recommendations were made for the development of a final list of policy options. These recommendations, together with preliminary analyses of the technical, economic, socio-political, and administrative factors by the project team, were used to narrow the long list into a set of final policy options; section V of this report contains the final list of policy options.

The final list of policy options includes a combination of regulation, technical assistance, financial incentives, and legislation designed to facilitate P reductions to the Lake. Each of the policy options in the final list is described and analyzed as fully as possible for technical, economic, socio-political, and administrative feasibility. Unfortunately, for some of the more innovative and flexible concepts contained in these policy options, a dearth of research data and wide variability in initial conditions and implementation choices make accurate estimates of the technical- and cost-effectiveness extremely difficult. However, the staff and advisors to this project feel that innovative concepts for P-loading reductions should not be excluded due to our current inability to accurately quantify the results. More research, including computer simulation modeling, could increase our ability to estimate the costs and benefits of the lesser-known approaches described in this report. However, this level of analysis is beyond the scope of this project.

II. Assessment of Current Policies and Programs for Controlling Phosphorus Loading in the Lake Champlain Basin

As a starting point for developing new policy options for meeting the long-term P reduction goals for the Lake, this section provides a review and assessment of current policies and programs that affect P loading, both directly and indirectly. In most cases, quantitative data on the technical or cost-effectiveness of the policies and programs are not available. As such information is nonetheless important for developing improved policies and programs, it is presented in this report wherever possible.

A. Point Sources

The 2002 Lake Champlain Phosphorus TMDL established an annual average load limit, calculated at an effluent P concentration of 0.6 mg/L for all facilities in Vermont that discharge at least 200,000 gallons of wastewater per day. However, aerated lagoon facilities over this size limit are handled slightly differently—they must meet a P effluent concentration of 0.8 mg/L. Currently, there is not a statutory P discharge limit in New York. However, the facilities that are being upgraded with federal funding are designed to meet the 0.8 mg/L standard, and the Lake Champlain TMDL does include annual load limits for each facility. In Québec, discharging facilities are required to achieve a standard of 1 mg/L (Donlon and Watzin 2001).

It is estimated that a reduction of 22.7 metric tons of P per year has been achieved from point sources alone since 1995 (Donlon and Watzin 2001). Most of this reduction has come from upgrading the efficiency of municipal wastewater treatment plants (WWTP) in the Basin. Vermont and New York will have spent in excess of $25 million to achieve these reductions, along with associated improvements in environmental quality.

Because of the relative ease of measuring and monitoring point sources of P, it is possible to use performance-based policy approaches. The 0.8 mg/L concentration standard is a good example. Regulators do not need to dictate specific operating procedures to the WWTP managers; they leave it up to the managers to find the most cost-effective means of achieving the standard. Enforcement of the standard is achieved through monitoring and measurement of effluent.

B. Nonpoint Sources

Unfortunately, the performance-based approaches that have been successful in bringing about reductions in point sources of P are not as easily applied in the case of nonpoint source pollution. This is due primarily to the difficulty of measuring and monitoring the diffuse sources of P, which by definition are nonpoint sources. To place a concentration standard on a nonpoint source is not enforceable because it cannot be monitored. The information burden placed on regulators by such an approach would be prohibitively expensive. Therefore, the approaches that are generally used to control nonpoint source pollution are design-based, focusing on suggested management practices, barriers, and infrastructure.

Some examples of performance-based policy approaches for agricultural nonpoint pollution in Europe are identified in Section III of this report. The Henry A. Wallace Center for Agricultural & Environmental Policy at Winrock International is also leading an effort to develop performance-based environmental policies for agriculture.

1. Agriculture

Agricultural land is estimated to contribute approximately 56 percent of the nonpoint source P loads across the Basin (Hegman et al. 1999). Dairy production, while declining as a percentage of the region's agricultural revenues in recent decades, remains by far the most dominant sector of the Basin's agriculture. The current trend in dairy farming is toward fewer, larger farms, with total animal numbers remaining relatively constant. This trend has implications for the management of P runoff from agriculture. Fewer, larger farms are more easily regulated and monitored than are many smaller farms. However, larger operations may be concentrating more animals (and more manure) on smaller land areas, which can lead to increased P runoff problems. Additionally, larger operations often farm more intensively, which can mean greater nutrient applications and more exposed soils. The recent Concentrated Animal Feeding Operation (CAFO) regulations, which are discussed in this report, are in response to this trend in agriculture.

Managing P runoff from agricultural land in the Basin has been identified as the most important single effort for meeting the 20-year P reduction goals in the Lake (Donlon and Watzin 2001). The implementation of best management practices (BMPs) for agriculture is the primary vehicle currently being used to control agricultural nonpoint P. However, even if BMPs are implemented on all the remaining farms in the Vermont and Québec portions of the Basin, the long-term P reduction goal would likely not be met (Donlon and Watzin 2001). This suggests the need for more effective BMPs with appropriate incentive mechanisms, as well as alternative policy and programmatic approaches to control agriculture's contribution to the P loading problem in the Lake.

a. Basin-wide Issues

Ideally, decisions on public and private expenditures for BMP implementation, in order to address general or specific water quality goals, would be based on the cost-effectiveness of each specific practice on each farm, in this case the reduction of P loads to Lake Champlain. However, this is not currently practical for several reasons. First, information on the technical effectiveness of all BMPs to reduce P loads is incomplete; information that is currently available is discussed below. Second, BMPs will not have the same P reduction effect on all farmland. The use of a P index as a tool for targeting is being used in New York (as discussed in subsequent sections) and a draft version of Vermont's P Index is available (Jokela 2000). Québec's regulations require comprehensive nutrient management plans for farms, with P-based management practiced when indicated. At present, Vermont does not use specific targeting of farms or fields for their likelihood to affect P loads to the Lake.

The effectiveness of agricultural BMPs for improving water quality is an important issue for reducing P loading in the Lake. A review by Jokela et al. (2001) assesses much of the recent research on this subject. Their findings are discussed below. Additionally, from 1992 research in the LaPlatte River watershed, a set of coefficients was developed by Vermont NRCS staff to credit agricultural BMPs for their ability to reduce P loading in the Lake. These estimates have been used and published in the Lake Champlain Diagnostic-Feasibility Study (Vermont DEC and New York DEC 1997) and by Donlon and Watzin (2001). Together with estimates of adoption rates of specific BMPs, these credits are used to calculate an estimate of P load reductions into each segment of Lake Champlain. Unfortunately, there are several sources of potential errors in these calculations, such as divergent sources of information and discrepancies between lake segment watershed boundaries and BMP implementation data (Donlon and Watzin 2001). Another problem in assessing the cost-effectiveness of BMP implementation in the Basin is that the coefficients were developed, in some cases, for categories of BMPs. These categories do not always clearly coincide with the reporting of BMP implementation.

Information on technical effectiveness of BMPs is essential for good policy design. However, as for any pollution reduction effort, the cost-effectiveness of the measure must be considered. Unfortunately, the information that we have on technical and cost-effectiveness of agricultural BMPs is not exact and there are some discrepancies among research studies. Given the available information, estimates have been made on the cost-effectiveness of several classes of BMPs.

In Table 2, the column showing the cost of each BMP is calculated as the present value of the capital and operating costs over 30 years with a 5 percent annual discount factor. The P reduction coefficients were developed by the Vermont NRCS office and represent the expected decrease in edge of field P losses (Vermont DEC and New York DEC 1997). It should be noted that these coefficients were not developed as robust indicators of the effectiveness of specific agricultural BMPs basin-wide. The LCBP has recently convened a group to update these coefficients, to improve their accuracy.

Table 2. Estimated Cost-effectiveness of Agricultural BMPs

Practice	Cost ($/AU)	P Reduction Credit (kg P/AU/year)	P Reduction per $1,000 Spent on BMP (kg P/yr/$1,000)
Milkhouse waste treatment	81	0.91	1.123
Waste utilization	334	0.136	0.407
Barnyard runoff treatment	130	0.227	1.746
Erosion control	341	0.363	1.064
Grazing management	45	0.227	5.044
Nutrient management	108	0.091	0.842

Source: *Lake Champlain Diagnostic-Feasibility Study Final Report* (Vermont DEC and New York 1997)

The BMPs represented by the categories listed in Table 2 are described in Donlon and Watzin (2000). 'Milkhouse waste treatment' is to capture milkhouse effluent in an animal waste containment system, filter strip, or other treatment. 'Waste utilization' refers to the use of a system to manage liquid and solid animal wastes in a manner that minimizes soil and water degradation. 'Barnyard runoff treatment' is done to collect and control runoff from outdoor livestock areas. 'Erosion control' is presumed to be a set of practices (not explicitly listed in the literature) for reducing soil loss from fields. 'Grazing management' represents the exclusion of livestock from water bodies, except at planned watering points. (Note that this practice is not the use of management-intensive or rotational grazing.)

The right hand column of Table 2, calculated for this report, indicates how many kgs of P would be reduced from field flow for every $1,000 dollars spent on the associated practice. This information indicates that grazing management (i.e., livestock exclusion) has the greatest cost-effectiveness of the BMP categories listed, with 5 kg P being reduced for every $1,000 spent on the practice. Research by Meals (2001) estimated that livestock exclusion (with riparian restoration) can reduce total P loss to streams by 49 percent.

As a point of clarity, it must be noted that the specific BMPs for the category of erosion control listed in Table 2 are not available in the literature. Two important BMPs for erosion control are vegetative buffer strips and conservation tillage. Based on the high cost listed in Table 2, it would seem that this category does not contain conservation tillage, which can be a net gain to farm profitability. Erosion control has been assigned a P reduction credit coefficient of 0.363 kg per animal unit (AU) treated per year (Table 2). The cost estimate for erosion control used in the *Lake Champlain Diagnostic-Feasibility Study Final Report* (Vermont DEC and New York DEC 1997) makes it one of the more expensive BMPs to implement. Although it has the highest estimated P reduction coefficient of the BMPs discussed, it ranks behind several other BMPs for cost-effectiveness. If the cost estimate shown here is significantly larger than the actual cost of erosion control, the cost-effectiveness of this BMP is being vastly underestimated. More information on the specific BMPs is required before drawing valid conclusions on cost-effectiveness. Additional information on the technical- and cost-effectiveness of other BMPs is discussed below.

ConservationTillage

Conservation tillage (CT) practices have been shown to reduced the cumulative mass export of runoff and sediment by 80 to 90 percent. In so doing, it also reduces the volume and concentrations of total P, soluble P, and total nitrogen (N) (Jokela et al. 2001). However, these studies were conducted on cornfields that were harvested for grain, which leaves considerable plant residue in the fields. Most of the corn produced in the Basin is harvested as silage, leaving much less residue behind. This will decrease the effectiveness of CT, unless accompanied by a cover crop.

Many studies on the use of CT have shown it to result in increased profitability for the farmer (Harper 1996; Lal et al. 1998). Conservation tillage has also been shown to increase the organic matter content of depleted soils and, in so doing, increasing the rate of carbon sequestration from the atmosphere (Lal et al. 1998). This co-benefit of CT may help to mitigate global climate change. In anticipation of possible future regulations, industries that are heavy emitters of CO_2, such as utilities, are interested in establishing markets through which they can purchase 'carbon credits' from landowners who can demonstrate an increase in carbon sequestration. The establishment of such market mechanisms may provide added incentive to farmers to adopt CT, which is likely to have a positive impact on water quality. However, the increased use of herbicides, which often accompany CT, can result in other water quality problems.

Streambank Fencing/Livestock Exclusion/Grazing Management

Streambank fencing is used to exclude livestock from streams, other than at designated crossing or watering points. Allowing animals to congregate in streams has implications for the direct contamination of waterways with urine and feces. Streambank fencing also has the ability to protect vegetative cover on streambanks to reduce soil erosion. In a paired watershed study in north-central Vermont, where streambank fencing was used to exclude at least 97 percent of pastured livestock in the treatment watershed, mass export of N, P, and total suspended solids (TSS) was shown to decrease by 30 to 50 percent (Meals 2001).

Streambank fencing is the primary component of the grazing management BMP shown in Table 2. The estimated cost-effectiveness of grazing management (reduction of 5 kg P per $1,000 spent) is more than twice the next most cost-effective BMP. If the estimates are correct, efforts to increase the amount of streambank fencing in critical Basin watersheds should be a priority for decreasing P loading to the Lake.

Vegetative Buffer Strips

Preliminary research results from Jokela et al. (2001) suggest that significant reductions in total P export can be achieved with the use of vegetative buffer strips. Their work has shown total P export to decrease by about 25 percent with a 7.5-meter buffer strip and greater than 70 percent with a 15-meter buffer strip. A Connecticut study has shown dramatic reductions in the concentrations of total P and TSS in overland flow from cornfields with the use of a 30-meter buffer strip (with woody vegetation near the streambank) (Clausen et al. 2000).

Although buffer strips of an adequate size are clearly helpful in removing nutrients and sediment in overland flow from cropland, in the long run their ability to counter the effects of continuous nutrient loading and soil erosion on water quality is highly questionable.

Timing and Method of Manure Application

In two paired watershed studies in Vermont, winter manure spreading was shown to reduce TSS reaching surface waters, relative to spring and fall spreading with incorporation of manure into the soil. However, winter manure spreading increased total P export from the farm by 11 to 30 percent (Jokela et al. 2001).

Based on the available research, the bans on winter manure spreading in Vermont and Québec seem to be appropriate policy measures for reducing P transport into surface waters. New York does not ban winter manure spreading. Cost-sharing for the construction of manure storage facilities needed to avoid winter spreading has greatly reduced the burden that this regulation places on farmers. Unfortunately, with the rapid changes in the structure of the dairy industry, particularly in the U.S. portion of the Basin, many farms with relatively new manure storage facilities have exited the industry. This reduces the overall cost-effectiveness of cost-sharing manure storage systems. In some cases, the high proportion of cost-share funds distorts a farmer's decision to construct or upgrade manure storage facilities. In such cases, public monies are not used in a cost-effective manner.

Barnyard and Milkhouse Waste Treatment

At least one study has shown that using a vegetative filter strip for milkhouse wastewater was effective at reducing P, N, and TSS (Schwer and Clausen 1989). However, due to the large amount of water and nutrients flowing off barnyards, filter strips were shown to be relatively ineffective for protecting water quality during heavy rainfall events (Schellinger and Clausen 1992). A more effective practice may be to capture and store these wastes in the farm's manure storage system (as required by the regulation in Québec). However, this will increase the required size and cost of the manure storage system.

Information on how much money has been spent on the implementation of BMPs in the Basin is not readily available. Communication with the Vermont NRCS office indicates that this information is not kept in one central source, and compiling it would require a significant effort (Sylvester 2003). It could be informative to know how much federal, state, and private dollars have gone to support the implementation of agricultural BMPs.

b. Vermont

Vermont's policy approach for addressing agricultural nonpoint source pollution is through the use of Accepted Agricultural Practices (AAPs) and Best Management Practices (BMPs). Both are designed to reduce agricultural nonpoint source pollution. AAPs are statewide restrictions governing farming activities that have pollution potential. AAPs are considered to be basic, but improved, practices that must be adhered to by all farmers. AAPs are focused mostly on practices and techniques that must be technically feasible and cost-effective for farmers, rather than on capital investment and farm infrastructure projects. The latter generally falls under the domain of BMPs. BMPs are subsequent to, and more restrictive than, AAPs. BMPs are site-specific practices designed to correct a specific problem on a farm.

While AAPs set a minimum standard for all farming operations, BMPs are generally voluntary practices that are often heavily subsidized through federal and state cost-share programs. Vermont state law permits the Commissioner of Agriculture to prescribe and mandate BMPs for specific farming operations where the implementation of AAPs have not been adequate to address water quality concerns.

Accepted Agricultural Practices (AAPs)

As of June 1995,Vermont state law charges the Secretary of Agriculture, in conjunction with the Secretary of Natural Resources, to develop, implement, and enforce rules governing agricultural land use practices, in order to “reduce the amount of agricultural pollutants entering waters of the state” (Vermont AAFM 1996). The guidelines set forth in the AAP regulations are to be followed by all Vermont farming operations and are enforceable by state law. It should be noted that enforcement of the AAPs is complaint-driven only. There are no periodic or random inspections performed, as is done in Québec.

Upon the receipt of a complaint, the enforcement procedure starts with a written warning delivered to a farm operator in violation of the AAP guidelines. The warning must describe the violation and the applicable rules, offer recommendations for corrective actions, and provide a summary of relevant federal and state assistance programs. The warning will request a plan for corrective actions with a proposed schedule. The farmer then has 30 days to respond to the warning. If the farm operator fails to respond, the Commissioner may issue cease and desist orders and commence proceedings to enforce the rule. If a cease and desist order is violated, the Commissioner may assess administrative fines of up to $1,000 per day with a $25,000 maximum.

There are numerous components to the AAP guidelines. This section describes the restrictions that most closely address P loading of Vermont waterways and the Lake.

Discharges:

- Without a permit from the Agency of Natural Resources (ANR), no farming operation can have a direct discharge (i.e., from a pipe, ditch, or other conduit) of wastes into surface or ground water.
- Farms are not allowed to create a “concentrated overland flow” of wastes into any waterway. This means a flow of sufficient velocity to detach or carry soil, manure, or other nutrients. Conditions resulting primarily from rainfall or snowmelt are exempt. Field stacking of manure is prohibited where it can result in water contamination.
- Barnyards, holding areas, and manure lagoons must not allow manure or runoff to reach adjoining waterways or to cross property boundaries.

Manure and Nutrient Storage and Application:

- Manure storage may not be sited within a floodway area, unless it conforms to National Flood Insurance Program standards.
- All sources of nutrients shall be accounted for in the field application of manures and fertilizers. Some form of soil and/or manure testing is required to determine nutrient application rates. Professional advice and whole farm nutrient management plans are encouraged. The legislation states: “Nutrient applications shall be based on one or more of the following considerations: leaf analysis, soil testing, manure testing, current recommendations from generally recognized sources such as universities, crop consultants, agricultural professionals, or a nutrient management plan for the

farm approved by the Commissioner." Soil and manure testing are not mandatory; they are only two of the suggested options.
- Manure spread on row cropland that is subject to overland flow must be incorporated into the soil within 48 hours. Exceptions are made for land in no-till cultivation or in cover crops.
- No manure shall be spread between the dates of December 15 and April 1, unless the Commissioner grants an emergency exemption.

Soil Cultivation:
- The cultivation of cropland shall result in no more than two times the soil loss tolerance (or T, as defined by NRCS) for the prevalent soil type, based on the Universal Soil Loss Equation or other accepted estimation method.

Vegetative Buffer Zones:
- A buffer zone of perennial vegetation must be maintained between any row cropland and the top of the bank of any adjoining waters in places where runoff occurs from normal rainfall events. The buffer zone must be at least 25 feet wide where ordinary rainfall events enter surface water by sheetflow runoff. They must be at least 50 feet wide where channelized runoff takes place. No tillage is allowed in the buffer zone except to establish or maintain the buffer. This requirement is beyond that of most other states and is likely to help protect Vermont's waters and Lake Champlain.

AAPs constitute a minimum standard for the protection of Vermont waters from agricultural operations. All farmers who adhere to the AAP guidelines are considered by the State to be in compliance with state water quality standards (Vermont AAFM 1996). According to the Vermont Agency of Agriculture, Food, and Markets (Vermont AAFM) there were 20 official violations of the AAPs in 2000–2001 (Vermont AAFM 2002). The majority (14) of these were regarding nutrient and pesticide application issues, which include the ban on winter manure spreading.

Best Management Practices (BMPs)

In Vermont priority for state cost-share funding for BMP implementation is given to (in descending order):
1. Farms that do not meet AAP guidelines due to the physical characteristics of the farm site.
2. Farms that are in the Lake Champlain Basin, the Lake Memphremagog Basin, the Connecticut River Basin, or the Hudson River Basin.
3. The potential of the farm to contribute to P loading of the waters of the state.

Vermont state BMP grants are tied to and contingent upon federal cost-share assistance for an on-farm improvement project "designed to abate non-point source agricultural waste discharges into the waters of the state of Vermont, consistent with goals of the federal Water Pollution Control Act and with state water quality standards" (Vermont AAFM 1996). The state grants for BMP implementation require the farmer to pay at least 15 percent of the total project cost. The state will pay the difference between the total project cost and the sum of the federal assistance and the farmer contribution, with a maximum of 50 percent of the total project cost.

To be eligible for cost-share funding, BMPs must be:

- Listed in the NRCS *National Handbook of Conservation Practices*. These include, but are not limited to: permanent vegetative cover; animal waste management; stripcropping; terraces; diversions; pasture and hayland management; waterways; cropland protection; conservation tillage; stream protection; permanent vegetative cover on critical areas; sediment retention, erosion or water control structures; tree planting; nutrient management; and conservation cropping; or
- Listed as Farm Service Agency (FSA) Agricultural Conservation Program–eligible practices that are defined in FSA's handbook "1-ACP (Rev. 3) Amend. 3" or as subsequently amended; or
- Infrastructure that is designed and certified by a professional engineer licensed in the State of Vermont to be equivalent to the performance standards of those practices contained in sections (a) or (b); or
- Integrated crop management systems designed to achieve the source reduction of nonpoint source agricultural wastes that are developed by certified crop advisors or other agricultural professionals such as, but not limited to, the University Extension Specialists; and
- Consistent with a "nutrient management plan" prepared by the Vermont field office of the NRCS, or with an animal waste management plan based on standards equivalent to those of the NRCS.

There has been $10.5 million spent on BMP implementation in the Vermont portion of the Lake Champlain Basin for the period 1996–2002. Of these expenditures, 54 percent comes from federal sources, 24 percent from state sources, and 22 percent from farmer/land owner contributions (Vermont AAFM 2002; Cook 2002). This represents the implementation of 888 individual BMPs, for which federal and state cost-share monies have been used. Undoubtedly, additional BMPs have been implemented on farms for which cost-share dollars were not used. Unfortunately, there are no data representing these BMPs. The 888 BMPs are estimated to have reduced P loading by 33,143 lbs per year. These numbers suggest a cost of $317 per pound of P reduction.

However, $317 may be an overestimate of the P reduction cost, because not all BMPs have associated P reduction coefficients. For these BMPs, which represent 25 percent of the total practices implemented in the Basin (219 of 888) and include the use of cover cropping, integrated pest management, and improved animal laneways, there is no estimate of the resulting P reduction.

Regulations on Large Farm Operations

Vermont's Large Farm Operation (LFO) program is designed to achieve the purposes of the State law 6 VSA Chapter 215. The Vermont AAFM intends that the LFO rules will prescribe criteria that will result in the management of LFOs in a manner equivalent to, but not more stringent than, the federal Concentrated Animal Feeding Operations (CAFO) regulations. The U.S. Environmental Protection Agency (EPA) issued the final

CAFO rule (discussed in Section III of this report) on December 16, 2002. The rule can be viewed online at http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm?program_id=7.

Information on the percentage of farms, AUs, or acres in the Vermont portion of the Lake Champlain basin (or in the entire state) that fall under the LFO regulations could not be obtained from Vermont AAFM. Given the size distribution of Vermont dairy herds, it appears that less than 20 percent of farms will be affected by the LFO regulations.

c. New York

There are two primary programs in New York to address agricultural nonpoint P reduction. One is cost-sharing for the assessment, planning, and implementation of BMPs, as well as for watershed-level projects through the Agricultural Environmental Management (AEM) program. The other is the application of special nutrient management regulations that apply to concentrated animal feeding operations (CAFOs) in New York. Both programs are described below.

Agricultural Environmental Management (AEM)

The AEM program is designed to coordinate the federal, state, local, and private sector efforts to reduce agriculture's impact on water quality in the state. It is the primary initiative on agricultural nonpoint source pollution control in New York. The New York State Soil and Water Conservation Committee provides leadership for the AEM program. The funding is coordinated through the New York State Agricultural Nonpoint Source Abatement and Control Program (ANSCAP).

The AEM program has five "tiers" (or steps) in the process of allocating funds for agricultural nonpoint source pollution control (New York State DEC 2000). Tier I collects specific farm information through a questionnaire. Tier II is the evaluation of potential environmental concerns regarding the farm through the completion of a set of worksheets related to the farm and its operations. Tier III is the selection of one or more BMPs to best address the environmental concerns. This is done by the farmer with the county-level AEM team. Tier IV is the implementation of the BMP(s) on the farm. Tier V is the evaluation of the BMP implementation. This is done at four levels: the BMP, the farm, the watershed, and in the context of the AEM program.

ANSCAP is a competitive grant program through the State Department of Agriculture and Markets that awards county Soil and Water Conservation Districts (SWCD) cost-share funding to correct and prevent water pollution from farms in their counties. Funding for this program is provided through the State's Environmental Protection Fund (EPF) and the New York's Clean Water/Clean Air Bond Act. Eligible projects include those that develop water quality assessments; build runoff buffers and waste management systems for watershed protection; and provide technical assistance for farmers.

There are different specifications for the use of funds from the EPF versus funds from the Bond Act. The Bond Act will fund only the implementation of BMPs and is focused on priority watersheds. The funds are awarded through a comprehensive selection and review process. Ideally, such a process would result in the greater cost-effectiveness of the money spent for achieving water quality goals. The EPF money will fund BMP implementation, but is also available for assessment and planning at the farm and/or watershed level. The EPF money, although competitively awarded, is available statewide.

For the fiscal year 2001–2002, $6 million was allocated statewide to the ANSCAP program from the EPF, while $70.7 million was allocated via the Bond Act (of which $1 million was designated for the Lake Champlain watershed) (New York State Soil and Water Conservation Committee 2002).

In New York, unlike Vermont, there is no minimum percentage of cost that the farmer/land owner is required to contribute. The State may fund up to 75 percent of the total eligible costs for assessment and/or planning, or for BMP implementation when there is no farmer/land owner contribution. However, in no event shall the amount of State funding exceed 90 percent of total eligible costs (New York State Soil and Water Conservation Committee 2002).

Regulations on Concentrated Animal Feeding Operations (CAFOs)

Because P is the "primary nutrient" of concern in the Lake Champlain Basin, the Agricultural Waste Management Plan for CAFOs in the New York portion of the Basin must specifically address issues of P loading on a field-by-field basis. This is currently being done through the use of the New York Phosphorus Index (NY PI). The NY PI has been developed by Cornell University faculty and staff, Cornell Cooperative Extension field staff, agencies including NRCS and Soil and Water Conservation Districts, private sector crop consultants, and producers. It includes P transport factors (e.g., soil drainage class, flooding frequency, distance to the stream, and stream type) and P source factors (e.g., soil test P, fertilizer and manure P application rate, timing, and method). The methodological calculations for the NY PI are available from Cornell's website at http://www.css.cornell.edu/nutmgmt/projects/Pindex/P-Indexopening.html.

The calculation of the PI for each field on an animal feeding operation (AFO) or CAFO will result in two scores: one for dissolved P and the other for particulate P. If either value is greater than or equal to 100, the field is considered to be at "very high" risk for P runoff. In this case no manure or P_2O_5 fertilizer can be applied without violating the National Pollution Discharge Elimination System (NPDES) permit. If the PI value is from 75 to 99, the field is considered to be a "high" risk and total P applications must be less than or equal to the amount removed by the crops grown. A PI score from 50 to 74 is considered to be a "medium" risk and the use of nitrogen (N)-based management with BMPs is allowed. N-based management without accompanying BMPs is allowed for fields with a PI score of less than 50.

As of Spring 2004, there were 35 farms in the New York portion of the Basin that are, or are likely to be designated as, CAFOs and require NPDES permits (Table 3). Although CAFOs represent only 16 percent of the farms, they represent 48 percent of the animal units. Therefore, the regulation requiring the use of the PI likely applies to between 30 and 50 percent of the acres used for livestock farming in the New York portion of the Basin.

Table 3. CAFOs in the New York Portion of the Lake Champlain Basin

NY Lake Segment	# of Livestock Farms	Total AUs	Number of Possible CAFOs	Total AUs on CAFOs	Percentage of CAFO Farms	Percentage of CAFO AUs
Isle La Motte	83	16700	16	9360	19.28%	56.05%
Cumberland Bay	18	3896	2	1550	11.11%	39.78%
Main Lake	25	7602	7	4890	28.00%	64.33%
Port Henry	5	697	0	0	0.00%	0.00%
South Lake A	12	1845	2	950	16.67%	51.49%
South Lake B	76	13054	8	4186	10.53%	32.07%
NY Totals	219	43794	35	20936	15.98%	47.81%

Source: Robert D. Brower, Ag Water Quality Specialist with the New York State Soil and Water Conservation Committee, from a database maintained for the New York State Ag BMP Tracking Project of the Lake Champlain Basin Program; 2004.

d. Québec

The Missisquoi Bay and its watershed are shared by Vermont and Québec. The Missisquoi Bay receives the largest P load of any Lake segment and the resulting P concentrations are consistently among the highest in the lake (Missisquoi Bay Phosphorus Reduction Task Force 2000). The Missisquoi Bay Phosphorus Reduction Task Force was created to “propose a fair and practical division of responsibility between Vermont and Québec for achieving target load reductions” in the Bay (Missisquoi Bay Phosphorus Reduction Task Force 2000).

The annual load of P to Missisquoi Bay was estimated to be 167.3 mt/yr for 1991 of which more than 90 percent was from nonpoint sources (151.9 mt/yr) (Vermont DEC and New York DEC 1997). It was estimated by Hegman et al. (1999) that Vermont accounted for 62 percent of the total nonpoint source P load to Missisquoi Bay, and Québec contributed the remaining 38 percent. Of these nonpoint source loads, approximately 80 percent is estimated to come from agricultural land. In August 2002 the State of Vermont and the Province of Québec signed an agreement to reduce the annual P loads to Missisquoi Bay by 70.1 mt from the 1991 loads and in the 20 year timeframe established in *Opportunities for Actions* (Environment Québec 2002). The phosphorus load to Missisquoi Bay during 1991 is apportioned at 60 percent from Vermont and 40 percent from Québec.

As in Vermont and New York, Québec has several on-going programs to address nonpoint source P pollution from agriculture. These include the Agroenvironmental Advisory Clubs, the Soil and Water Conservation Program, and several provincial regulations.

Agroenvironmental Advisory Clubs

The Agroenvironmental Advisory Clubs program was designed to encourage and assist Québec farmers to develop sustainable (environmental) management practices. Farms that are members of a club are entitled to cost-share funding, up to 66 percent of expenses (up to C$1,000 per year), for the services of agroenvironmental consultations. The program was started in April 1998 and is funded under the CDAQ-MAPAQ agreement. The program has been fairly successful and the original funding has been renewed at least once to date (CDAQ-MAPAQ 2002).

Close to 5,000 farms have participated in the services of the 76 agroenvironmental advisory clubs. As of 2001, approximately 12 percent of Québec farms were actively involved. The percentage is higher for livestock farms (10 to 23 percent) than for crop farms (less than 10 percent). Of the livestock farms, the larger farms are more likely to be involved; 12 to 27.5 percent of Québec AUs are covered by the program, with the greatest percentage in the dairy sector (CDAQ-MAPAQ 2002). Approximately 200 farms have participated in the Dura-Club of Bedford in Missisquoi Bay Watershed since 1996. The results show that the clubs have been successful in increasing the implementation of conservation practices on member farms. From April 1, 2000, through March 31, 2001, 1,521 agroenvironmental fertilization plans (nutrient management plans) were created from 70 clubs. From a sample of these farms it is estimated that average application of P_2O_5 is 23 kg per hectare. This is estimated to be 83 percent less than the 42 kg average for all Québec farms (CDAQ-MAPAQ 2002). The clubs also seem effective at increasing the use of minimum tillage practices among their members. By reducing soil erosion, this practice has the potential to reduce P transport to surface water.

Soil and Water Conservation Program

The nonpoint source pollution reduction section of this program is aimed at improving water quality. Through this program the Ministry of Agriculture provides funding to farms, primarily in targeted priority watersheds, as cost-share assistance for conservation practices. The funding will cover 70 percent of the costs of establishing and operating BMPs up to a maximum of $10,000 over the life of the program. However, this limit is doubled to $20,000 for farms that are members of a watershed management group (agroenvironmental advisory clubs included) and have a "farm action plan" (LaPointe 2002).

The farms must have an agroenvironmental fertilization plan required by the regulation of the Ministry of Environment to qualify for the funding. The Ministry of Agriculture can withhold any amount of the funding necessary to ensure compliance with the demands of the program (LaPointe 2002).

Regulations

Québec's environmental legislation is among the most stringent of the Canadian provinces (Sierra Club of Québec 2001). Since 1981, all agricultural operations are required to comply with the *Environmental Quality Act* and all of its standards. There are several prescribed standards that govern farming practices with regard to P pollution in Québec's *Agricultural Operations Regulations*, the new regulation enforced since June

2002 (Québec Ministry of Environment 2001). The most relevant aspects are described here. Generally, there are strict guidelines to prevent livestock wastes from flowing toward waterbodies. In order to give farmers time to adjust to the new regulations, significant grace periods are in place for many of the standards that require capital investments. There are significant non-administrative fines for violations of the Regulation. Penalties for noncompliance of certain provisions can be C$2,000 to 20,000 for a first offence for individuals and C$5,000 to 50,000 for corporations. There have been periodic and random inspections performed since 1981, but more inspections are planned with the implementation of the new regulation and the recent hiring of additional inspectors in 2003.

All manure spreading is banned from October 2 to March 30 to minimize runoff. (Since 1981, spreading manure on frozen or snow-covered ground has been prohibited also.) Consistent with this regulation, livestock operations are required to have enough manure storage capacity for 6 months of production. A small proportion of annual livestock waste may be spread after October 1 if recommended by an agronomist and if manure is incorporated within 2 days after spreading on bare soil and within 5 days on cropland. Although not stated in the regulation, it is assumed that the agronomist must be a certified crop consultant and held responsible in some way for any negative environmental impacts of his/her recommendations.

An agroenvironmental fertilization plan is required for all “large” farms. This is similar to a comprehensive nutrient management plan but with a P limit based on phosphorus soil content (kg P/ha) and percentage of P saturation (P/Al). The plan must be signed by an agronomist and must list the amount of fertilizers used on each field, as well as the dates and methods of the spreading. Soil analyses are required every 5 years and annual manure analyses are required. Field stacking of manure must be at least 150 meters from surface waters, with no possibility of the surface water reaching the stack. The stack must be on ground with vegetative cover and a slope of less than 5 percent. Manure stacking cannot take place on the same spot for 2 consecutive years.

The following infrastructure-related standards go into effect on April 1, 2010, for farms in operation on June 15, 2002; they go into effect on April 1, 2005, for new operations. All farms producing more than 1,600 kgs of P_2O_5 per year (varies from 22 to 40 dairy cows) will be required to have watertight storage facilities with sufficient capacity for all waste produced on the farm during the 6-month spreading ban. The storage facilities must be equipped with an unconnected outer drain that covers the entire exterior perimeter of the structure. The drains outflow must be marked and connected to an observation well from which samples can be taken to ensure that effluent is not flowing from the structure. Additionally, all surface water from barnyards and milkhouse wastes must be intercepted and channeled to the storage structure for farms with liquid manure storage. Farms with existing solid manure storage only are not required to channel milkhouse wastewater to their storage facility unless an increase in herd size requires an increased storage capacity. For new constructions, cost-share funding is available to cover 70 to 90 percent of the cost of the outer drain, as well as barnyard and milkhouse connections to the manure storage system. However, this funding is not available for upgrades to an existing system.

Finally, livestock exclusion will be enforced by April 1, 2005. This will ensure that livestock have no access to any body of water, including rivers, streams, lakes, ponds, and wetlands, except for the purpose of crossing.

Summary of Agricultural Policies and Programs in the Basin

It has been stated in numerous research and Extension publications that the most important aspects of managing agricultural nonpoint P are to move toward a mass balance of P at the farm level to avoid increasing P loading of soils (Sharpley 1998) and to keep soil in place through the use of CT and vegetative cover (Sharpley 1998). For the most part, the current policies and programs to address P loads from agriculture in the Basin appear to be marginal in their effectiveness at minimizing erosion of agricultural soils. Additionally, none of the current policies or programs in Vermont or New York attempt to move toward farm-level P balances.

Although the current set of BMPs attempt to minimize agricultural nonpoint source pollution, they generally do not address the root causes of this pollution, namely stocking rates beyond the nutrient assimilation capacity of the land, and tillage and cropping practices that result in significant soil erosion. As discussed in Section III, a few states are addressing these issues somewhat more aggressively than in the Basin, and several nations in Europe are making significant efforts to address the root causes of agricultural P pollution. Such policies can have very large costs in terms of administration of programs and loss of competitiveness in the farm sector, though this is not always the case.

Another important aspect of controlling agricultural P is the targeting of “critical source areas” within a watershed (Meals 1993; Sharpley and Beegle 1999). The New York PI, applied to CAFOs, and the buffer strip requirement in Vermont both address critical source areas partially, but neither does so in a comprehensive manner. The NY PI identifies fields that have a high risk for P loss and provides management guidance. However, this is currently applied only to a subset of Basin dairy farms, based on herd size. The concept of targeting critical source areas should be conducted on a watershed basis to be more comprehensive. Vermont’s riparian buffer strip requirement is, in a sense, targeting critical source areas. However, proximity to surface water is the only criterion in such targeting.

The primary reasons that the P reduction goals set for the priority lake segments with large agricultural contributions (Missisquoi Bay, Otter Creek, and South Lake B) are not likely to be met with the current policies and programs are because of the lack of P source reduction and lack of widespread critical source area targeting. Public monies may be more wisely spent if such efforts are enacted.

2. Developed Land

Developed, or urban, land constitutes only 5.5 percent of the land area in the Lake Champlain Basin, but is estimated to contribute 37 percent of the P load to the Lake (Hegman et al. 1999). Developed land contributes more P per unit area than either agricultural or forested land (Hegman et al. 1999) and is likely to occupy an increasing percentage of the Basin's land area in the future (Vermont DEC and New York DEC 2002). The concentration of P in urban stormwater runoff varies based on the source of the stormwater. In Madison, WI total P concentration was measured at close to 0.1 mg/L from roofs and parking lots, between 0.22-0.40 from streets, and at 0.79 from lawns (Waschbusch et al. 1999). A stated concern for meeting the P reduction goals in the Lake is that increases in developed land will negate improvements in P reduction from agricultural land (Donlon and Watzin 2001). For these reasons, it is critical that appropriate policies, designed to reduce P runoff from developed land, both existing and new, be implemented.

The policies and programs that address nonpoint source pollution from developed land are similar in approach and content to those used to address agricultural pollution. Larger projects, like larger farms, are subject to a permitting process that requires adherence to certain practices and standards. Permits are generally not required for smaller construction and re-development projects. Best management practices for minimizing nonpoint source pollution from urban areas are known and documented. They are required under the permitting process, but only suggested for smaller projects. Unlike the case of agriculture, cost-share funding for privately-owned urban BMPs is very limited, if available at all. The likely reasons for this are (1) the non-structural, more practice-based nature of urban BMPs and (2) the fact that homeowners and developers, unlike farmers, are not considered to be a threatened population on whom public monies should be spent to ensure their survival. Recently in Vermont, federal funding from State and Tribal Assistance Grants (STAG) have become available to municipalities for urban BMP projects on a cost-share basis.

a. Vermont

A 1997 geographic information system (GIS) analysis of the Vermont portion of the Basin classified developed land into five categories (Millette 1997). Table 4 shows the estimated percentage of the developed land in the Vermont portion of the Basin in each of five categories. Residential and transportation (highways, secondary, and back roads) together account for 92 percent of the developed land use. Stormwater discharge permits, issued by Vermont DEC, are focused primarily on commercial and industrial sites and, to a lesser extent, on highway construction projects and larger residential developments (Vermont DEC and New York DEC 2002). Commercial and industrial uses account for only 6 percent of the developed land in the Vermont portion of the Basin. Smaller residential development (i.e., individual house construction) in urban and rural areas remains an unregulated source of P via stormwater runoff and soil erosion. However, as of March 2003 all construction projects disturbing more than one acre of land require NPDES permits.

Table 4. Classification of Developed Land in the Vermont Portion of the Basin

Developed Land Use Classification	Percentage of Developed Land in LC Basin
Residential	33%
Commercial	4%
Industrial	2%
Transportation	59%
Other	3%

Source: (Millette 1997).

The four areas identified in the Lake Champlain Phosphorus TMDL for concerted efforts to reduce P sources from developed land are:

- Stormwater management
- Erosion control
- Better backroads
- Local municipal actions

Clearly, policies will need to be developed to address the problem of P runoff from developed land that does not currently come under the permitting process. Some combination of financial incentives and regulations will likely be necessary to control the flow of P from rural homes and roads, as well as other sources.

Similar to the case of pollution from agricultural land, stormwater and erosion control on developed land in the Basin is addressed primarily through the use of BMPs, which are required under the permitting process. The following sections briefly describe the salient features of this process.

Stormwater Management and Erosion Control

Stormwater runoff (water that does not infiltrate into the ground) has the potential to cause serious damage to property and public infrastructures, and to transport nutrients (including P) into water bodies. With development comes an increase in impervious land cover. This compounds the problems associated with stormwater management, which can be categorized into two components: (1) the volume and rate of flow of stormwater and its effect on stream channel erosion, and (2) the amount of pollutants that are washed off impervious surfaces and transported to water bodies (Vermont DEC 2001).

Currently, there are changes underway in the regulations that govern stormwater management and erosion control in Vermont. The changes are in response to new state-level recommendations and to comply with the Phase II requirements of the federal Clean Water Act (described below). In order to reduce permit review time as well as the burden on regulatory agencies in Vermont, the use of general permits will replace individual project permits. General permits cover a broad category of projects, such as construction and multi-sector industrial projects. Applicants will need to file a notice of intent, an erosion prevention plan, and a sediment control plan, and follow the stated requirements. In doing so, they will be in compliance of the general permit. However, Vermont will require that applicants submit their erosion control plans for review and comment. Although this will increase the administrative burden, submitting plans for review should help the effectiveness of the program (Greenwood 2002).

In 2000, the Vermont legislature modified its stormwater management legislation to require the development of an enhanced stormwater program. The Vermont DEC contracted the Center for Watershed Protection (CWP) to develop a “state-of-the-art” stormwater control manual, which resulted in the creation *The Vermont Stormwater Management Manual* published by the Vermont Agency of Natural Resources (ANR) in April 2002 (Vermont ANR 2002). The Manual is an innovative and comprehensive approach to stormwater management planning and replaces the “Stormwater Management Procedures” last revised in 1997.

An innovative concept contained in *The Vermont Stormwater Management Manual* is the creation of voluntary stormwater management credits. A developer can apply any of the six identified non-structural practices to increase infiltration and reduce stormwater generation. By applying these practices, the developer will receive stormwater credits that will reduce the size, extent, and cost of structural stormwater treatment practices related to the site (Vermont ANR 2002). Applying the non-structural practices is strictly voluntary.

Unfortunately some other concepts that can be used to reduce pollutant loads from stormwater are not included in the Vermont manual. Innovative ‘smart growth’ concepts such as the redevelopment incentives included in the Maryland Stormwater Manual, which can provide incentives for urban in-fill development, could further reduce stormwater problems in the Basin. Maryland’s redevelopment incentives allow a project to meet its water quality criteria by reducing impervious cover by 20 percent. New development projects have to meet additional water quality criteria (Maryland Dept. of Environment 2000).

The U.S. EPA is required, under the Federal Clean Water Act, to address urban stormwater in a phased approach starting with the largest urban areas (Vermont DEC and New York DEC 2002). Phase II of this approach, which includes the larger communities in the Basin (Burlington, South Burlington, Winooski, Colchester, Essex Junction, Essex, Shelburne, Williston, and Milton (proposed), as well as parts of Queensbury and Glens Falls, New York) became effective on March 10, 2003. By this date, phase II communities were required to file a notice of intent with the Vermont ANR describing how they intend to comply with the new rules (Vermont DEC and New York DEC 2002).

The Phase II stormwater rule states that permits will be required for all projects that disturb more than one acre, regardless of the size of the resulting impervious area. This new regulation greatly increases the number of projects to be covered under the permitting process, which increases the required staff time in the Agency.

A current recommendation calls for the creation of stormwater utilities in urban and urbanizing communities in the Basin. These utilities would be responsible for the stormwater generated within their respective municipalities. They would be responsible for the management and control of stormwater generated within their boundaries. The stormwater utilities would likely operate on a user-pays basis, with costs apportioned by landowners based on the amount of impervious surfaces, taking into account individual stormwater management practices. This approach will certainly provide more attention and oversight to stormwater issues. The city of South Burlington is in the process of creating a stormwater utility.

To date, there are at least 400 stormwater utilities in the U.S., with greatest frequency in the West and Northwest. It has been estimated that there will be more than 2,500 stormwater utilities by 2010 (Kaspersen 2003). User fees are generally in the vicinity of $5 per household per month. Unlike taxes, money that is collected as user fees must be used for stormwater control or treatment. This is part of the effectiveness of the stormwater utility. Problems have arisen in some instances with regard to public acceptance of the costs of operation and management of such a utility, as well as problems of runoff from one municipality to another.

There are 14 small watersheds in the Vermont portion of the Lake Champlain Basin that fail to meet water quality standards, due primarily to stormwater runoff (Vermont DEC and New York DEC 2002). To address this situation, the VTDEC proposed the creation of Watershed Improvement Permits (WIPs) in 2001. However, several environmental groups appealed the WIPs arguing that no new development should occur in these watersheds until stream impairment is addressed. In June 2003, the Vermont Water Resources Board upheld this appeal. Currently no WIPs have been issued and there is likely to be a substantial revision of VTDEC's permitting program in these impaired watersheds in 2004.

In the WIP program, a permit would be created individually for each of the 14 identified watersheds in the Basin (24 statewide). Focus would be placed on the performance of currently permitted discharges, expired and non-permitted discharges that are deemed to have large impact on water quality, and proposed discharges. Certifications on stormwater management would be mandated in many cases. Monitoring would be performed to measure watershed-level improvements. If improvements are not seen in a specified timeframe, additional corrective actions would be taken by the State (Vermont DEC and New York DEC 2002).

As of July 1, 2004, the State of Vermont has enacted new stormwater legislation (Act 140). The act authorizes Vermont ANR to require applicants for stormwater discharge permits to perform an offset or pay a stormwater impact fee. The fees will go into a restoration fund for stormwater-impaired waters. The act also authorizes Vermont ANR to address each of the state's stormwater-impaired waters by September 30th, 2007 issuing a WIP, enacting a TMDL, or establishing a water quality remediation plan.

The standard BMPs for stormwater management and erosion prevention and sediment control at construction sites include the use of diversions dikes to keep runoff from entering disturbed areas, minimizing the area and duration that soil is exposed, the use of temporary seeding and mulching on exposed soil, perimeter controls, timing construction so exposed soil can be reseeded by September 15, 50 feet of buffer strip of undisturbed vegetative cover along streams (100 feet along lakes and rivers) and property boundaries, and the use of snow fencing to keep debris confined to the site. These and several other BMPs are described in the *Vermont Handbook for Soil Erosion and Sediment Control on Construction Sites* (Vermont Geological Survey 1987).

Construction site BMPs are not always implemented and sometimes those that are implemented are inappropriate for the site, which can exacerbate erosion (Greenwood 2002). The expected penalties for noncompliance with the regulations are seen as low, because of the very limited enforcement staff (less than 1 full-time person) in the Vermont DEC (Greenwood 2002).

Better Backroads and Local Municipal Actions

There are 136 municipalities that lie, at least partially, in the Vermont portion of the Lake Champlain Basin (Vermont DEC and New York DEC 2002). These municipalities have jurisdiction over, and make decisions concerning, a significant amount of developed land in the Basin. Local zoning regulations and procedures greatly influence the amount of P that eventually flows into the Lake. Although specific programs designed to help guide municipal actions that affect water quality are limited, there have been efforts at the state level in Vermont toward this end. The Vermont DEC has published *Local Planning and Zoning Options for Water Quality Protection* (Vermont DEC 1998). Financial incentives with regard to state funds may prove to be an effective means for enticing municipalities to consider the water quality implications of their actions and regulations.

Programs such as the Vermont Local Roads Program at Saint Michael’s College are working to improve the planning, education and outreach, training, and funding for enhancing the quality of Vermont’s backroads. These efforts, if successful, will also yield benefits for water quality. Other than municipalities that are subject to Phase II of the Stormwater Rule, efforts made by towns to implement BMPs for water quality improvement are largely voluntary. Incentives may induce more action at the local level. BMPs that are specific to stormwater management and erosion control for driveways and rural roads are well documented by the *Vermont Better Backroads Manual* (Windham Regional Commission 1995).

b. New York

Developed land sources of P are less in the New York portion of the Basin relative to Vermont. Developed land represented approximately 4 percent of land use in the New York portion of the Basin in 1992 (Donlon and Watzin 2001). Regardless of its impact in the Lake Champlain Basin, New York maintains regulations on stormwater and construction site management. The Center for Watershed Protection was also involved in the development of New York’s stormwater management manual. The details of these regulations and programs can be found in the documents *Reducing the Impacts of Runoff from New Development* (New York State DEC 2004a), *New York State Guidelines for Urban Erosion and Sediment Control* (New York State Dept. of Environmental Conservation 2004b), and *The New York State Stormwater Design Manual* (New York State DEC 2004c).

The New York regulations are based upon the same model that was developed in Vermont. However, the voluntary stormwater credits are not part of the New York requirements. Construction site and stormwater BMPs are suggested for areas undergoing development and are required for larger projects. The general approach is similar to that of Vermont, with permits issued to larger projects but with very limited staff for oversight or enforcement. The focus on permitting for smaller construction sites will begin in New York as well on March 10, 2003, with the onset of Phase II regulations of the Clean Water Act.

c. Québec

Developed land was estimated to occupy 4.7 percent of the Québec portion of the Basin, while contributing 19 percent of the P load from Québec to the Missisquoi Bay (Missisquoi Bay Phosphorus Reduction Task Force 2000). This represents a contribution of 10.7 metric tons of P per year. It is assumed in our report that most of this contribution is from point sources (WWTPs). A water quality analyst at the Québec Ministry of Environment believes that impervious cover in the Québec portion of the Basin is too low to present a threat to water quality from urban stormwater into the Lake (Simoneau 2003). To date, our study has not discovered any specific programs or policies for stormwater control in the Québec portion of the Basin.

d. Conclusions

With regard to erosion control from construction sites, both New York and Vermont lack the staffing to enforce construction site BMPs in all cases. By virtue of their recently updated stormwater management manuals, Vermont and New York are positioning themselves well to develop good stormwater control programs. However, even innovative policy concepts may fail to achieve the desired results if they are not supported by sufficient economic incentives or enforceable regulations. Neither the Vermont nor New York stormwater plans have sufficient economic incentives to effect the reductions in volume necessary for meeting P reduction goals from urban areas. The use of incentives and regulations will be explored in the development of policy options for the Basin.

3. Forest Land

The allowable P load into Lake Champlain from forest land, as stated in the TMDL, is held constant at the 1991 level. Forest sources of P are generally associated with nutrient transport from erosion on logging jobs and natural background sources. Forest land is not identified as a major concern for controlling P loads to the Lake.

From Vermont forest land, it is estimated that the P reduction goal will be attainable through compliance with the *Accepted Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont* published by the Vermont Department of Forests, Parks, and Recreation. The AMPs are described as the "proper method for the control and dispersal of water collecting on logging roads, skid trails, and log landings to minimize erosion and reduce sediment and temperature changes in streams" (Vermont

Dept. of Forests 1987). Compliance with the AMPs is mandatory. However, penalties (fines) for non-compliance can be issued only if a discharge has occurred. Complying with the AMPs reduces the liability of loggers in the event that a discharge does occur.

The penalties for debris or sedimentation in streams include the cost of restoring the stream, fines of up to $25,000, and not more than 6 months in jail. While landowners are responsible for the adherence to AMPs on logging jobs, good logging contracts will transfer this responsibility to the logger during harvesting. The landowner is responsible for maintaining AMPs for erosion control after the harvesting is completed.

The New York Implementation Plan for the TMDL lists forest management practices that are consistent with the Vermont AMPs. Additionally, the plan mentions the use of an "ecosystem approach" to manage plant species composition and age-class distribution on forest land, as a means for controlling erosion and nutrient transport to the Lake.

Forest land covers 60 percent of the Québec portion of the Basin, but contributes only 4.1 percent of Québec's P load (Missisquoi Bay Phosphorus Reduction Task Force 2000). Hegman estimates that the per unit contribution of agricultural and forest land in the Missisquoi Bay (Vermont portion included) is greater than in other parts of the Basin (Hegman et al. 1999). While the increased per unit P exports from agricultural land were attributed to higher animal density, there was no reason listed for higher per unit exports from forest land. Our study has not found, to date, any information on regulations governing the management of forest land in the Québec portion of the Basin.

III. Assessment of Innovative Policies and Programs for Controlling Phosphorus Loading in Other Watersheds, States, and Nations

This section describes some of the more notable policy and program efforts related to reducing P pollution in the U.S. and overseas. While the treatment is by no means exhaustive, it highlights policies and programs that may be informative for policy dialogue in the Lake Champlain Basin. To avoid 'reinventing the wheel,' it is important to understand what types of measures have been taken to control P loading in other areas.

The following subsections discuss the federal policy environment regarding water quality, state-level regulations and programs designed to directly or indirectly reduce P from agricultural land, the development and use of P indices for agriculture, an assessment of nutrient trading, state-level efforts to reduce nonpoint sources of P from developed land, and some regulations and programs from European nations concerning agricultural P. Because most of the more innovative P control efforts are fairly new, for many of the programs discussed below there is a dearth of information on their effectiveness and their total costs. When available, this information has been included. The information presented in this section was gathered through extensive literature searches using databases such as Agricola and CAB Abstracts, as well as Internet search engines such as Google.

A. Federal Policy Environment

Although most of the policies that govern nonpoint source pollution are set at the state level, there are a couple of recent changes to relevant federal policy that warrant mentioning. The Federal Water Pollution Control Act of 1972 or Clean Water Act (CWA) strengthened national water quality standards specified in previous legislation and established a regulatory structure to control water pollution. The CWA provided federal funding for the construction and upgrade of WWTPs, which has had a great impact on reducing point source P discharges into waters nationwide. The CWA also authorized U.S. states to set water quality standards for all waters.

The U.S. EPA released the "Final CAFO Rule" on December 16, 2002. The agency has estimated that the new rule will reduce, by more than 56 million pounds per year, the amount of P released into the environment (USEPA 2002b). One of the relevant changes in the CAFO rule is that it will require that permitted operations develop and use P-based nutrient management plans. Some environmental groups have criticized the new rule for being too weak and giving large farms too much flexibility in proposing solutions to potential water quality problems (USGAO 2003). A shortcoming of the regulation seems to be its disregard of the stocking density of an operation.

EPA issued regulations for the Total Maximum Daily Load (TMDL) program in 1985 and 1992 to implement Section 303(d) of the federal Clean Water Act. The TMDL program requires states to identify and prioritize polluted waterways and to calculate the maximum pollutant load that can be received by a water body and remain "unimpaired" for its designated use. To date, close to 10,000 TMDLs have been created and approved by EPA for impaired waters in the U.S; over 50 percent of these TMDLs were approved during 2001 and 2002.

B. State-level Regulations and Programs to Control Agricultural P

Each state has enforceable mechanisms for the control of water pollution. In general, the regulations across states seem to be more similar than they are different. Stricter regulations are emerging in states that are experiencing degradation of highly valued natural resources such as the Everglades and the Chesapeake Bay. The threat of fines is one incentive mechanism to induce farmers to comply with environmental regulations. To be effective, however, the threat must be credible. The probability of violations being detected must be reasonably high and the follow-through for noncompliance with regulations should have a high probability of a financial penalty. These conditions are met in some in some instances but not in others.

Below are several examples of state regulations and programs that directly or indirectly address the control of P. This treatment is not intended to be an exhaustive review, but rather to highlight some of the more notable approaches. In a latter section on control strategies in Europe, further approaches and regulations are discussed.

1. Texas

Texas produces more than twice the amount of livestock waste than any other state and has a sizable dairy industry. The area of the North Bosque River in north-central Texas is the largest dairy area in the state, where large confinement dairy operations are the norm. The Bosque River flows south and empties into Lake Waco, a drinking water supply for the City of Waco. Phosphorus (and fecal coliform) has been a significant water quality concern in the lake, with the majority of the P originating from dairy farms of the North Bosque (Texas State Soil & Water Conservation Board 2003).

Regulations and enforcement related to agricultural water quality issues are handled by the Texas Natural Resources Conservation Commission (TNRCC). Starting in 1996, the TNRCC has implemented the Dairy Outreach Program in the following five counties of the North Bosque: Erath, Comanche, Johnson, Bosque, and Hamilton. This program applies specific regulations to protect water quality. The regulations require livestock farms to implement P-based nutrient management plans. The basis of the dairy water quality regulations is that no farm with more than 200 dairy cows (a CAFO requiring permitting) can have soil containing more than 200 ppm of soil-test P in any of its fields that receive manure (State of Texas 2002). Farmers are required to have representative composite soil samples taken from all fields on which manure is applied. The samples must be taken and analyzed by a certified third party at least once per year. If the results show a soil test P (STP) level of greater than 200 ppm, the operator is required to file a new nutrient utilization plan (NUP) with the Commission that documents a certified P reduction strategy, or to show that the STP level is supported by the current NUP. If the level is above 500 ppm, the operator must file a new NUP. If after 12 months the STP level has not been reduced, the operator is subject to fines at the discretion of the Commissioner.

The effect of this regulation has been that farmers generally do not apply manure to fields that are shown to be in excess of the 200 ppm limit (Jones 2003). While this regulation applies only to CAFOs, in this area of Texas the majority of farms are permitted CAFOs. As of October 2002, there were 52 CAFOs and 27 operations with less than 200 dairy cows in the Bosque river watershed (Jones 2003). The CAFO regulations will not be nearly as far-reaching in the Lake Champlain Basin.

The Dairy Outreach Program office in Stephensville has been very active in inspecting and penalizing dairy operations that violate the terms of their permits. Within the first 2 years, the office had levied more than $114,000 in fines to dairy operations that failed to comply with regulations (Texas Natural Resource Conservation Commission 1998). In 2001, Texas passed legislation that requires all livestock farms in the Bosque watershed to comply with a no-discharge policy. Enforcement actions can be taken if a farm is found to be directly discharging wastes. Two important related programs are discussed below.

Water quality management plan certification program. The state Soil and Water Conservation Board is required to establish a water quality management plan certification program for areas identified as having agricultural nonpoint source water quality problems. Farmers are required to develop individual water quality management plans, including animal feeding operations (AFOs) that are not otherwise permitted under the NPDES program. This is paramount to applying the CAFO regulations to all livestock operations in critical areas. The focus of the regulations is to require nutrient management plans and to ensure that they are implemented. Phosphorus-based nutrient management plans are required in the Bosque River area.

A program of this type could be applied in the Lake Champlain Basin. However, the average herd size and stocking rate in the Bosque River and other applicable Texas watersheds are much higher than in the Basin. Applying this type of program in the Basin would burden some farms that are below the critical stocking rate for manure nutrient assimilation. This could be particularly burdensome for smaller Basin farms. Requiring this type of nutrient management planning for farms above a critical stocking rate may be an appropriate strategy for the Basin.

Dairy Manure Export Support (DMES) Program. The U.S. EPA has provided funding for this program in an attempt to remove excess manure (and associated nutrients) from the watersheds that contain the greatest concentrations of dairy operations in Texas. Participating farms must have a CAFO permit or a Water Quality Management Plan. Manure is composted at central facilities within the watershed and then transported to users in other areas. The Texas Department of Transportation has committed to using this compost for establishing roadside vegetation during road construction or repair projects. The program surpassed its 3-year goal of removing 300,000 tons of manure from the target watersheds within 9 months of project implementation; after 14 months the project had removed 500,000 tons of manure. The estimated cost of the program at that time was $3 per ton of manure (Texas State Soil & Water Conservation Board 2003).

Although this type of program makes the most sense in areas where there is a concentration of larger farms with high stocking rates, such a program could be applied successfully in the Basin as well. Important components for success are having sufficient composting facilities available and willing purchasers or recipients of the processed compost.

2. Maryland

The state of Maryland is doing more than most other states to control nonpoint source pollution. This stems from a strong desire to restore and protect the health of the Chesapeake Bay. Maryland's efforts focus primarily on agricultural and urban nonpoint source pollution. This section will summarize the policies and programs focused on Maryland's agricultural land. A discussion of Maryland's efforts to control urban nonpoint P is presented in the section on developed land.

Water Quality Improvement Act (WQIA)

On the heels of numerous highly publicized and serious *Pfisteria* outbreaks in the Bay, the Maryland General Assembly passed the Water Quality Improvement Act (WQIA) in 1998. This Act is implemented by the Maryland Department of Agriculture (MDA) and may be the most aggressive state legislation in the nation for the control of nutrients from farming and other nonpoint sources. The WQIA applies to all agricultural operations in Maryland with greater than $2,500 in revenue per year or more than 8 AUs. This "all inclusive" approach is a departure from most state regulations on nutrient management, which generally target only CAFOs. Although larger operations can be significant sources of nonpoint pollution, there are two major drawbacks in targeting only CAFOs. Doing so would exclude the majority of farmland in most states from the regulations designed to reduce P losses. Larger operations, in some cases, have greater management capacity (including nutrient management) than do smaller farms. Therefore, some of the most critical land for P control, based on nutrient source and transport factors, would be exempt from the more rigorous regulations.

The focus of the regulation is to require that N- and P-based nutrient management plans be developed and implemented. There are several aspects of this regulation that go beyond the nutrient management plans required in many other states. Several of these requirements are listed below.

- NMPs must incorporate the level of bioavailable N and P in all fertilizer materials (i.e., the proportion of the nutrient that is available for plant uptake). This will help calculate and control the application of nutrients that are more likely to end up in ground or surface waters.
- NMPs must be calculated using "expected" crop yields based on actual yield records. This will help to reduce the overestimation of nutrient needs and subsequent application.

- Any person applying nutrients for hire must be a certified nutrient management consultant (or work for a company that has certified consultants). Farmers who apply nutrients to their own land are required to complete a continuing education course on nutrient application every 3 years.
- Poultry operations must use phytase or a similar enzyme or feed additive to decrease the level of P in manure to the maximum extent possible that is "commercially and biologically feasible."

Erosion control and manure storage and handling are not part of the explicit focus of the WQIA. These aspects continue to be voluntary programs that use technical assistance and cost-sharing as incentives.

There are several programs that have been established to assist in the implementation of the WQIA. Some of these programs are fairly innovative in their ability to help achieve the goals of the Act and are listed below.

Pilot poultry litter transport program. Provides up to $20 per ton of cost-share funding for the handling and transport of poultry litter from farms with excess amounts. The goal of the program is to remove 20 percent of the poultry litter from Maryland's four Lower Eastern Shore counties. The litter must be transported only to land that has the capacity to assimilate additional P. The program is funded jointly by the State and the poultry processors.

Poultry litter matching service. The MDA and the Delmarva poultry industry have developed a service that links poultry producers needing to remove litter from their operations to other farmers who can use the litter as a nutrient source. Helping make such links is an important step in distributing nutrients to where they are needed.

Additional funding. The State has allocated funds for several efforts designed to assist the nutrient control efforts of the WQIA. The animal waste technology fund was established to support research and development of technologies and processes that can improve water quality and enhance economic performance in the state. Another $800,000 per year for 3 years, starting in 1999, was allocated for research and education to expedite the implementation of technologies on farms. Funding was also committed to expand the number of trained field staff in conservation districts around the state from 62 in 1998 to 110 by 2000.

Maryland's approach to agricultural pollution control has been to toughen the regulations, close the loopholes for smaller farms, and provide programs and funding to facilitate compliance. This approach has potential for the Lake Champlain Basin, but the financial impact on the Basin's farms must be considered. The large poultry operations of the Delmarva peninsula, a primary target of these regulations, may be much more able to absorb the costs associated with these regulations than are the dairy farms of the Basin. The political will to impose this level of regulation on the farm sector may not be present in the Basin, which presents another challenge to this approach.

3. Florida

The Everglades National Park in Florida is listed as a World Heritage Site with an endangered ecosystem. An important threat to the Everglades ecosystem is the excess accumulation of P, most of which comes from the vegetable and sugarcane production in the Everglades Agricultural Area (EAA) and from dairy and livestock operations in the Lake Okeechobee area to the north (Schmitz et al. 1995). Lake Okeechobee has also experienced severe algae blooms and degradation from the excess P. A series of state regulations have aimed to stem the flow of P from farms in the EAA and the Lake Okeechobee area.

Dairy Rule Initiative

In 1987, the Dairy Rule (Chapter 62-670, FAC) was adopted by the state of Florida. This rule gave farmers the choice of (1) establishing complete manure and wastewater management systems, implementing BMPs for livestock exclusion from waterways and drainways, and requiring a permit for manure application, or (2) enrolling in a buy-out program where farmers receive a one-time payment for ceasing operation or moving the operation out of the Lake Okeechobee basin.

At the time the Dairy Rule was enacted there were 49 dairy operations in the Lake Okeechobee basin. Eighteen of these farms enrolled in the buy-out program and received a payment of $602 per cow to cease operations. The remainder of their assets was purchased by the South Florida Water Management District (SFWMD). This reduced the number of dairy cows in the basin by 14,000 (Ribaudo 2001). The farms that ceased operations tended to be the smaller farms in the basin (although still much larger than the average dairy farm in the Lake Champlain Basin). Many of the farms in the buy-out program relocated to areas in northern Florida.

The State allocated $8 million to cover 75 percent of the cost of the structural investments needed by the remaining dairy operations to comply with the Dairy Rule. However, the total economic cost of complying with the Rule goes well beyond the remaining 25 percent of the investment cost. It has been estimated that the long-term financial impact for the remaining farms in the Basin will be $1.10 per cwt of milk produced over the life of the systems implemented (Boggess et al. 1991). This figure is net of the cost-share funding provided and incorporates productivity improvements resulting from the new infrastructure. With often very slim dairy profit margins, this cost could mean the difference between farm profit and loss in some years.

Other important P regulations are put forth in the Everglades Forever Act of 1994, F.S. §373.4592. This law mandates a 25 percent reduction in the P discharges from the EAA. This part of the law has several components. First, all farmers in the EAA are required to implement certain BMPs as a condition for obtaining 5-year water quality permits. Second, water quality monitoring must be established by the state in order to accurately determine the benefits of BMP implementation. Third, farmers in the C-139 sub-basin of the EAA will be required to participate in research on the effectiveness of BMP implementation.

Surface Water Improvement and Management (SWIM) Plan for the Everglades

The Interim Lake Okeechobee SWIM Plan (SFWMD 1989a) set forth a recommended approach for meeting the P reduction goals of the 1987 SWIM legislation. According to the plan, all tributary inflows to the Lake were required to meet the 0.18 mg/L (180 ppb) performance limitation for total P, or to maintain their 1989 discharge concentration, whichever was less. Basins that exceeded the 0.18 mg/L limitation were required to reduce their P concentrations and achieve compliance by July 1992. The plan identified priority basins that must meet the 0.18 mg/L limitation. The plan also recommended the WOD Program to achieve target P reduction goals, based on land uses, on permitted parcels within the basins.

Florida, like Maryland and the Lake Champlain Basin, has a vital water resource to protect. Florida has taken some aggressive steps to alleviate the problem. Aspects of the Dairy Rule initiative, such as additional cost-share funding for BMPs, are applicable in the Lake Champlain Basin. However, the farm buy-out program does not seem appropriate for the Basin due to the more numerous and smaller farms.

4. Economic Incentive Mechanisms

Examples of monetary incentives for the control of P are very limited in the U.S. The provision of cost-share funding for the voluntary or mandatory implementation of BMPs is not treated as an economic incentive in this report. Cost-share funding is considered to be a financial necessity for the implementation of BMPs on most farms. The few examples of economic incentives uncovered in the U.S. are described briefly below. Examples of economic incentives with much greater power can be found in Europe and are described in a latter section.

Associated with the Everglades Forever Act is the Agricultural Privilege Tax applied to the EAA of South Florida. This is a per-acre land tax applied to all crop acres in the EAA. The purpose of the tax is to exceed the goal of 25 percent reduction in P discharges from the area. The tax starts at $24.89 per acre. The tax will increase every 4 years to a maximum of $35 per acre, unless the 25 percent basin-wide reduction in P discharges is met. The revenue generated from the tax is designated for the construction of strategically placed wetlands. The constructed wetlands are designed to absorb and store excess P from the EAA before it reaches the Everglades National Park.

Such a basin-wide tax has several advantages and costs. On the positive side, this type of tax has low administrative costs because all producers are taxed at the same per-acre rate regardless of their farm's water quality performance. This tax also has the ability to induce peer pressure among farmers to contribute to the P reduction goals for the basin. On the negative side, this type of tax can penalize farmers who are making 'good faith' efforts to reduce P discharges relative to those who are not. This is the free-rider problem whereby some farmers relying on others to make the extra efforts and incur the additional costs for P reduction.

Maryland has implemented two relatively minor, yet notable, economic incentive mechanisms to aide their nutrient management legislation; both are tax programs related to the WQIA. The first is a tax credit equal to 50 percent of the additional fertilizer costs (particularly N) that may be required for farmers who must reduce or eliminate the use of animal manure on the farm. The amount of the credit is capped at $4,500 per year for up to 3 years (Simpson 1998). The farmer must certify that they have filed a nutrient management plan and that the additional fertilizer is necessary according to the plan. There is also a 100 percent deduction from State income taxes for the purchase of equipment to spread poultry litter that can be calibrated to 1 ton or less per acre. This is to encourage the use of equipment that can avoid over application of manure nutrients.

Economic incentive mechanisms have not been used to a great extent in the U.S. for agricultural pollution control. The land tax used in EAA may be too small and too broad to achieve the type of reductions from the numerous, small farms of the Lake Champlain Basin. Likewise, the input-related tax credits used in Maryland may not induce the level of pollution control that is needed to meet the long-term P reduction goals of the Basin. The policy options presented in Sections IV and V of this report include some economic incentive mechanisms that are farm specific and focused on environmental outcomes. These are likely to be more effective for the Basin.

5. The Development and Use of Phosphorus Indices for Agriculture

As part of the realization that excess P loss from livestock operations is the leading cause of eutrophication in U.S. surface waters, the joint U.S. Department of Agriculture (USDA) and U.S. EPA Unified Strategy for Animal Feeding Operations requires that all AFOs have a comprehensive nutrient management plan (CNMP) in place by 2008 (USEPA 2002c). The NRCS practice standard 590 dealing with nutrient management has been rewritten so that all states require CNMPs to consider P as well as N. Three primary approaches for including P in NMPs are being used. These approaches are agronomic soil test P (STP) recommendations, environmental STP thresholds, and P indices to classify the potential of a specific field to P loss. Each NRCS State Conservationist is responsible for determining which of three P-based approaches will be required in the CNMPs (Sharpley et al. forthcoming). The leading approach among the states is the development of a P index; some form of a P index has been or is being developed in 47 states (Sharpley et al. forthcoming). A P index is designed to identify fields with the greatest risk for P loss to the environment.

The justification for using a P index is that research has shown that many variables play a role in predicting P loss from a field, beyond just STP levels. These factors include, but are not limited to, soil erosion, drainage, flooding, and the amount and type of P added to a field. All of the P indices being developed use some combination of P source and P transport factors. The P source factors generally include the STP level, the application rate of manure and fertilizer P, and the application method. The P transport factors include erosion estimates from the revised universal soil loss equation (RUSLE), runoff potential, the existence and extent of sub-surface drainage, and the distance to surface water.

Not all P indices use the same combination of source and transport factors as described in Sharpley et al. (forthcoming). For example, Vermont and Wyoming include modifiers to the STP level such as the level of extractable aluminum in the soil, which binds P. Several states include a factor for the solubility of P from manure and bio-solids. Vermont and other states have included a factor for flooding frequency, since large amounts of P can be lost to the environment in flooding events. The implementation of BMPs, such as vegetative buffer strips, is also considered in the indices of many states. Lastly, the priority ranking of the receiving water body is incorporated into many of the indices.

There are also differences in the calculation methods among P indices. Twenty of the indices combine the source and transport factors multiplicatively, while 17 used an additive combination (Sharpley et al. forthcoming). Pennsylvania and Vermont calculate their total transport factor to range from 0 to 1. Thus, if there is no potential for P transport, there is no potential for P loss. There is an effort among the Northeastern and Mid-Atlantic states to make the classification of P loss vulnerability consistent, with a score of 100 being the border between the 'high' and 'very high' classes (Sharpley et al. forthcoming). Only 3 of the indices calculate an estimated or expected P loss from each field. The remainder rank the site vulnerability for potential P loss. The weakness of the former approach is that managing for the average amount of P loss may be misguided if a significant percentage of P loss occurs in association with extreme weather events.

The importance of the P index is in determining 'critical source areas' for P loss within a watershed (Gburek et al. 2000). These are areas where transport factors create pathways for P loss from fields and management has lead to elevated sources of P. While P indices seem to estimate with reasonable accuracy the amount of dissolved P in runoff from fields, watershed-scale evaluations have been called for to determine if P-based nutrient management as determined by the indices will reduce P loss to the environment (Sharpley et al. forthcoming).

Phosphorus indices are being used in New York and Vermont, but are more frequently used on larger farms (because of CAFO requirements) and on farms that receive NRCS cost-share funds for nutrient management. Although data is not available, it seems clear that the majority of smaller farms in both states are not using a P index at this time. This tool has great potential to guide nutrient applications according to the risk of P loss to surface water. The policy options presented in sections IV and V suggest the use of the PI on a larger percentage of Basin farms.

C. Nutrient Trading

1. EPA Policy

Water quality trading, whereby one source meets its regulatory obligations by using pollutant reductions made by a source that controls that pollutant more cheaply, is an approach to achieving water quality goals (USGAO 2003). Innovative approaches such as water quality trading are important because, although the National Pollutant Discharge Elimination System (NPDES) permit program has had a significant impact on controlling pollution to water, many of the nation's water bodies are still severely impacted. The U.S. EPA hopes that the introduction of tools such as water quality trading, a market-based approach that provides sources with flexibility to meet their requirements, will lead to greater environmental benefits than those achieved with more traditional regulatory approaches (USGAO 2003). EPA released its final policy on water quality trading in January 2003 (USGAO 2003).

The EPA trading policy encourages states, interstate agencies, and tribes to develop and implement water quality trading programs for nutrients, sediments, and other pollutants when they would result in more cost-effective water quality improvements. The policy is based on lessons learned from pilot trading projects and provides guidance to states already developing trading programs. Developing a trading program does not substitute for federal Clean Water Act (CWA) provisions or requirements.

The policy encourages trading systems to be developed where there is potential to: (1) progress towards meeting water quality standards while TMDLs are developed; (2) provide flexibility and cost savings opportunities for meeting TMDLs; (3) provide an economic incentive for voluntary measures to reduce pollutants within a watershed; (4) offset new or increased discharges affecting water quality; and (5) achieve better or possibly more environmental benefits than those derived from existing regulatory programs.

The policy is appropriate for a watershed or an area for which a TMDL was defined and is appropriate for trading nutrient (e.g., total P and total N) or sediment loads. Trades approved by an NPDES permit, a TMDL, or in the context of a watershed plan or pilot trading project for pollutants other than nutrients and sediments will be reviewed on a case-by-case basis. Only when enough information is available to establish and correlate the impacts on water quality are cross-pollutant trading for oxygen-related pollutants supported. EPA does not support trading pollutants considered by the agency to be persistent bioaccumulative toxics (PBTs), but will consider pilot projects over the next 2 to 3 years to obtain more information regarding trading of PBTs (USEPA 2003b). However, in December 2003 EPA proposed to use trading mechanisms as a way to control mercury emissions. Baselines for generating pollution reduction credits can be derived from waste load allocations or effluent limitations and quantified performance requirements for point sources, or from the pollutant load associated with existing land uses are appropriate for nonpoint sources.

Trading occurs in order to: (1) maintain the water quality in waters where standards have been attained (e.g., compensate for new or increased pollutant discharges); (2) progress towards meeting standards in impaired waters before a TMDL has been established (although a TMDL will be established if trading does not reach the final standard); or (3) meet a TMDL (e.g., trading may be included in NPDES permits and watershed plans), but not delay its implementation. At this point, EPA does not support trading for compliance with existing technology-based effluent limitations although it will consider including it in new or revised technology-based guidelines. Municipality or regional sewerage authorities are encouraged to develop and implement trading programs among industrial users, while intra-plant trading that involves the generation and use of credits between multiple outfalls that discharge to the same receiving water from a single facility that has been issued an NPDES permit is also supported.

Trading can be incorporated into CWA programs by including provisions for trading in water quality management plans, watershed plans, water quality standards, antidegradation policy, and by incorporating provisions for trading into TMDLs and NPDES permits. To comply with CWA regulations, trading programs: (1) take into account required federal permits; (2) provide flexibility by identifying specific trades within NPDES permits; (3) include the required notice and comment opportunities associated with all NPDES permits; (4) continue any methods and procedures (e.g., sampling protocols, monitoring frequencies) specified by federal regulations or in NPDES permits; (5) must not have an impact that would impair water quality or exceed a cap established under a TMDL; (6) follow antibacksliding requirements; and (6) meet antidegradation policies.

To be credible and successful, trading programs should: (1) include clear legal authority to facilitate trading, such as legislation, rule making, incorporating provisions for trading into NPDES permits, and establishing provisions for trading in TMDLs or watershed plans; (2) clearly define the units of trade, expressed in terms of rates or mass per unit time as appropriate; (3) generate credits before or during the period they are used to comply with monthly, seasonal, or annual limitations specified in NPDES permits; and (4) standardize protocols to quantify pollutant loads, taking into account the greater uncertainty in estimates of nonpoint source loads.

Some of the ways that EPA suggests accounting for nonpoint source uncertainty is through monitoring and modeling, using greater than 1:1 trading ratios between nonpoint and point sources, using conservative assumptions for estimating the effect of nonpoint source management practices, using site- or trade-specific discount factors, and retiring a percentage of nonpoint source reductions for each transaction or a predetermined number of credits. States may choose to establish a reserve pool of credits to compensate for shortfalls in credits actually generated. The specific protocols should be developed in consultation with USDA agencies.

Determining and ensuring compliance for trading programs is done through a combination of record keeping, monitoring, reporting, and inspections. Compliance and accountability require frequent audits, as well as appropriate enforcement for either the failure to meet the limits or to generate the quantity of credits traded. If a source generating credits does not achieve the expected amount, the NPDES permittee using those credits is ultimately responsible for meeting the effluent limitations that would apply if the trade had not occurred. Provisions for not generating credits due to extreme weather conditions or other circumstances beyond the control of the source should be included in the program. Eligibility for participating in a trading program should take into account the compliance history of the nonpoint source.

Public participation throughout the development of the program and periodic assessments of its environmental and economic effectiveness need to be built into the trading program. EPA does not anticipate active oversight of the program unless there are questions about the efficacy of a given program and its compliance with CWA regulations.

Simultaneously with the release of its final policy on water quality trading, EPA announced support for 11 trading projects, including $800,000 in fiscal year 2002. Three of the programs are geared towards nitrogen trading (two programs in the Chesapeake Bay watershed, and one in the Neuse River Basin, NC), one towards reducing selenium in the Lower Colorado River, one for reduced mercury discharges to the Sacramento River, one to increase in-stream flow in the Upper Charles River Watershed (MA), one for reducing acid mine drainage in the Cheat River (WV), one for outreach through the National Association of Conservation Districts, one for reducing the impacts of urban and agricultural runoff near Montgomery (AL), and one program for the development of a trading framework for future trading programs in Wisconsin.

2. Case Studies

Although nutrient trading has been discussed as a cost-effective means for controlling nutrient loads since the 1980s, very few nutrient trading transactions have actually been completed. None of the pilot studies to be funded by EPA are P-specific, although P will undoubtedly be one of the nutrients examined in a few of the projects. Below is a description of some of the lessons learned from past and current P-specific nutrient trading programs.

a. North Carolina

One area where nutrient trading has been actively developed is in the Tar-Pamlico River Basin. After being classified as Nutrient Sensitive Water (NSW) by the North Carolina Environmental Management Commission (EMC), stricter N and P effluent standards for the Tar-Pamlico Basin were approved. The goal of the stricter standards was to make sure that N and P loads from point sources did not increase until a more scientific nutrient reduction plan was developed. While N effluent concentrations were held to 4 mg/L in the summer and 8 mg/L during the winter, P concentrations were held to 2 mg/L throughout the year (USEPA 2002a). Due to concerns about the potentially high capital costs of meeting the standards, point source dischargers in the Basin, in cooperation with the Environmental Defense Fund, the Pamlico-Tar River Foundation, and NC Division of Environmental Management (NCDEM), developed a nutrient-trading framework that was approved in 1989 (USEPA 2002a).

Ten of the 21 major dischargers, two smaller municipal dischargers, and one industrial discharger formed the Tar-Pamlico Basin Association to cooperatively meet the nutrient standards (USEPA 2002a). The program requires the Association to purchase pollution offsets by paying a $56 per kilogram per year, if nutrient reduction goals are not met

(USEPA 2002a). This purchase price represents the estimated average cost of removing 1 kg of nutrient loading per year from agricultural nonpoint sources using BMPs. Payments are made to the State's Agriculture Cost-share Program run by the NC Division of Soil and Water Conservation, which pays farmers 75 percent of the average cost of implementing approved BMPs (USEPA 2002a). The dischargers of the Association have met their collective nutrient cap every year since 1990 through operational measures, minor capital improvements, and the addition of nutrient removal processes at two of the larger facilities. The Association has banked credits for future use, but has not yet needed them (Environomics 1999; North Carolina Dept. of Environment and Natural Resources 2001).

Agriculture and forest are the dominant land uses of the Tar-Pamlico Basin (USEPA 2002a). The forest in the upper half of the basin is largely undisturbed, but a large portion in the lower coastal plain is managed for logging. Thirty-seven percent of the basin is devoted to agriculture, predominantly row crop cultivation and intensive livestock operations (USEPA 2002a). Five of the state's 10 leading hog-producing counties and its leading chicken-producing county are in the basin (USEPA 2002a).

The Tar-Pamlico nutrient trading program is unique in that the state takes on the burden of arranging for and vouching for the nonpoint source load reductions, by incorporating the trading program into the responsibilities of the Agriculture Cost-share Program. This reduces private transaction costs and uncertainties for the point source dischargers. In most trading programs, and as recommended by the EPA's new water quality trading policy, the point source purchaser of nutrient credits is ultimately responsible for the reductions from nonpoint sources.

b. Michigan

The Kalamazoo River Water Quality Trading Demonstration Project, focused solely on P, became a fully funded, community-based pilot study by 1997 (Kieser and Batchelor 2001). The 2,000 square-mile Kalamazoo River Watershed receives discharges from over 50 NPDES dischargers, primarily municipal wastewater treatment plants and paper mills (Kieser and Batchelor 2001). The project got underway with the coordination of a non-profit organization (the Forum of Greater Kalamazoo) interested in trading, a state effort to develop a demonstration project that would support the development of trading rules, and a paper company (Crown Vantage) (Kieser and Batchelor 2001). The objectives of the project included developing the framework and design for a state-wide trading program, establishing and conducting nonpoint source monitoring and quantification protocols, facilitating watershed management planning, and identifying policy and program issues related to the development of a watershed trading program (Kieser and Batchelor 2001). While no trades have actually occurred, pending the finalization of the TMDL for Lake Allegan, and because the paper mill that was originally interested in pursuing P trades has decreased its workforce by 28 percent and is addressing other issues, important design features have emerged from the program (Kieser and Batchelor 2001).

One important and unique feature of the project was the focus on equity and accountability (Great Lakes Trading Network 1998). The Kalamazoo River Water Quality Trading Demonstration Project has based its reduction credits criteria on the practices already being employed on the agricultural lands. Farmers whose practices fall short of generally accepted agricultural management practices (GAAMPs) receive one pound of credit for every additional four pounds reduced, while those who already implement GAAMPs or better receive one pound of credit for every additional two pounds reduced (Environomics 1999). This system was put in place so that farmers that had already implemented BMPs could still participate in this program, while farmers with "sub-GAAMP" operations would not receive equal reward (Great Lakes Trading Network 1998). NRCS will provide accountability by conducting follow-up inspections to verify the implementation and maintenance of management practices and to provide technical assistance (Great Lakes Trading Network 1998).

c. Wisconsin

In 1997, the Wisconsin Legislature directed the Department of Natural Resources under s. 283.84 Wis. Stats. "to administer at least one pilot project to evaluate the trading of water pollution credits." A fund of $100,000 was created to support the pilot projects (Environomics 1999; Wisconsin DNR 1998). The pilots were selected based on the following criteria (Wisconsin DNR 1998):

The area is the watershed or a portion of the watershed of an impaired water body. The area includes both agricultural and municipal sources of water pollution. Potential participants in the area must exhibit an interest in participating in the pilot.

Since 1998, three pilot projects have undertaken the work of defining a framework, monitoring and modeling pollutant loads, developing partnerships, and identifying possible situations. State funding will not be provided in the next budget due to budget constraints (Wisconsin DNR 1998). An evaluation of the lessons learned from the pilots will be conducted and the trades currently in place in the Red Cedar River Basin are expected to continue. It is hoped that the lessons learned will help to determine the value of nutrient trading for reducing P loads.

Red Cedar River Basin

In 1994, the Red Cedar River Basin first began addressing water quality issues through the formation of the Red Cedar Steering Committee, which later became a non-profit called the Red Cedar River Basin, Inc. This organization is an important partner in the pilot trading program and actively monitors and plans for implementing P controls (Wisconsin DNR 1998). The land within the northern part of the basin is predominantly forested, while agriculture is the dominant land use throughout the rest of the basin (Wisconsin DNR 1998). Two communities within the Basin became active in the development of nutrient trading. The Village of Colfax has worked with the Dunn County Land Conservation Department (LCD) and a crop consultant who works with landowners. The LCD is currently working with the University of Wisconsin's College of Agriculture and Life Science to develop trading factors for the whole county, and until this is developed, the economic feasibility of trading cannot be determined. While some landowners have been contacted, no incentive costs or BMPs have been implemented. The Village is aiming to trade for 1,570 lbs of phosphorus for less than $23,500 annually (Wisconsin DNR 2002). Based on the experience of a neighboring town, this may be possible, depending on the costs of hiring a crop consultant (Wisconsin DNR 2002). According to the Wisconsin DNR (2002), the City of Cumberland in the Red Cedar River Basin has started their second year of trading, with help from the Barron County LCD. The Barron County LCD is helping the city by contributing the administrative costs for finding the landowners, designing the practices, and inspecting the installations (Wisconsin DNR 2002). Cumberland was able to take advantage of an incentive program for soil conservation developed under the county Land and Water Resource Management Plan to identify landowners interested in changing their practices, and offered to pay the same incentive rate as the county for the implementation of P-controlling BMPs. Although there was some initial concern that Cumberland would face a lack of interest among farmers, those already wary of entering into long-term agreements, 22 landowners who met the criteria for the City's trading dollars have signed cost-share agreements (Environomics 1999; Wisconsin DNR 2002). The criteria included the following items (Wisconsin DNR 2002):

- Land must be within a specified watershed, above a specified impoundment.
- The majority (greater than 50 percent) of treated fields must be within 400 feet of channelized flow.
- The BMPs must be verified by the LCD.
- Soil testing must be provided for erosion-control BMPs.

Payments are made in the same fashion as other conservation programs, such as the Environmental Quality Incentives Program (EQIP); landowners may receive an incentive payment only from one program at a time and the payment is made on an annual basis (the first City of Cumberland payments made in July 2001). The 22 landowners received a total of $14,526 from the City. The City will not pay for the same BMP on a farm for more than 3 years. After 3 years, other BMPs or landowners will be found for the program, with the hope that the original BMPs will continue even without the economic incentive (Wisconsin DNR 2002). If these BMPs are maintained after payments have ceased, the City will have water quality improvements for the watershed above the required 4,400 lbs of phosphorus annually. The most common BMP implemented has been reduced tillage on fields with high STP levels. The first year of trades resulted in a 5,000 lb credit, using a 2:1 trading ratio (Wisconsin DNR 2002).

The BMPs and the payments per acre are:

- Reduced Tillage at $15.00
- No Till at $18.50
- Contour Farming at $3.00
- Contour Strip Cropping at $6.00
- Buffer Strip at $35.00
- Nutrient Management Plan at $3.00

Fox-Wolf River Basin

Requirements to install the necessary processes and equipment to remove P from discharges down to a concentration of 1 mg/l have been in place for many years in the Fox-Wolf Basin, due to an agreement of the International Joint Commission to reduce P discharges to the Great Lakes (Wisconsin DNR 1998). Fox-Wolf River Basin represents the largest drainage basin to Lake Michigan and is the third largest to the Great Lakes (Johnson and Pinkham 1998). Because a significant number of point sources in the Basin are already in compliance with the technology-based P limits, trading will most likely occur only as new point sources enter the area or existing sources expand. Trading may also be encouraged if the Basin moves to a TMDL for the basin or a sub-basin that would force point sources to reduce P loads beyond what is required from technology-based measures (Wisconsin DNR 2002). Until these opportunities arise, trading is not occurring within the Basin, but Fox-Wolf Basin 2000, a non-profit watershed alliance, continues to look for and educate people about nutrient trading.

Rock River Basin

A pilot program in the Rock River Basin also resulted in no actual trades. While 60 participants in the basin showed an initial interest in trading, over the course of the pilot program that number has decreased and now only one Publicly Owned Treatment Works (POTW) facility (a wastewater treatment plant) is still looking into trading. The other participants determined that trading would not be in their best interest after they realized that information about the cost of P removal at POTWs and the cost of implementing nonpoint BMPs for P control were both inaccurate. The costs for removal were overestimated, while the costs of BMP implementation were underestimated. In addition, the administrative cost of installing nonpoint practices was higher than expected (Wisconsin DNR 2002). It is interesting to note that as of 1998, WI DNR staff believed that the Rock River project had progressed the most out of the three. At that time a study was underway to estimate total P loads from all sources in order to best establish water quality objectives for the Basin. Several point sources had formed a partnership and had raised $300,000 to begin modeling and monitoring and the state and provided $80,000 (Johnson and Pinkham 1998).

Thus far, the lessons learned from Wisconsin's pilot program include:

- Economics. The cost of controlling P at a point source and for implementing BMPs must be fully understood and accurate.
- Pollutant load. Accessing enough appropriate acres for trading high P loads can be difficult within a watershed.
- Brokering. Using the county as a broker to contact nonpoint sources and identify potential opportunities for trade helped defray many administrative costs in the City of Cumberland. Without the county to defray these costs, trading may not have been economically or administratively possible. In the Village of Colfax, the county did not take on this administrative role and estimates indicate that the administrative costs of the program may equal the costs of implementing the practices.
- Incentives. Some basins, such as the Fox-Wolf Basin, have already met their technical requirements for reducing P. Unless a TMDL is established or a water

quality-based effluent limit is imposed, there is no incentive to initiate trading programs.

- Agricultural interests. Much of the agricultural community has not expressed an interest in trading, since participation is voluntary and because disincentives may be in place that discourage participation. One example refers to the value assessment law. Converting cropland to prairie, a common practice for conservation programs, can reduce P loss. However, taking land out of use and turning it into prairie makes a farmer ineligible for claiming the lower tax rates allowed for agricultural lands.
- Tools. An improved and agreed-upon set of tools is needed for quantifying P reduction loads from nonpoint sources.

3. Conclusions on Trading

Several states and watersheds have developed water quality trading programs, including many that are specific to P. However, very few actual trades have occurred. This is because of inaccurate cost estimates for controlling P at point sources and reducing it through non-point sources, administrative costs, and because of uncertainties in monitoring and quantifying the reductions and credits. The new EPA water quality trading policy was developed in order to provide guidance for developing trading programs. The agency seems hopeful that many areas will start to incorporate trading into their NPDES permits and other regulations. However, the EPA policy may not encourage as much trading as a stronger policy could. For example:

- While the policy encourages the inclusion of trading within NPDES permits and other CWA provisions, they are not required. In addition, although they are considered an economic incentive, no funding is appropriated to further support the initial phase of developing the programs (except for a modest number of pilot projects, only one of which is directed at developing the state program).
- In general, the policy lacks oversight and enforcement regarding the reductions by the nonpoint sources. Uncertainty is an inherent problem in monitoring nonpoint source pollutant reductions and evaluation of the effectiveness of these management practices is minimal. The practices will be developed with the expertise of agricultural and silvicultural specialists, but after the development of these practices, there is very little evaluation.
- The policy does not include any sort of structure or recommendation regarding who pays for administrative costs and/or serves as a ‘broker’ of pollution reduction credits. At one of the pilot projects in Wisconsin, the Land Conservation Department (LCD) covered administrative costs of the program and served as a broker, working within their own programs to identify farmers who might be interested in nutrient trading. However, at another pilot program in the state, the LCD did not cover administrative costs and the program did not appear to be economically feasible for that community. As the Wisconsin program learned, funds need to be available to provider a brokering service so private transaction costs can be minimized.
- Guidelines for when trading might be appropriate are not sufficiently outlined, if the recommendations from the WI pilot projects are taken into account. Guidelines could help places determine if trading might be appropriate for them even before undertaking more extensive assessments. For example, WI suggests that trading is

more economical in places where the P load to be traded is relatively small. Otherwise, locating enough land within the area to reduce the overall P load becomes overly costly.

- While the policy states that a number of methods and procedures have been developed to determine nutrient and sediment load reductions associated with conservation practices, the WI pilot project states that an agreed-upon set of tools for quantification would be preferred.

This review does not reveal information that recommends the development of nutrient trading strategy for controlling P in Lake Champlain. This is consistent with the recommendations expressed in the Lake Champlain Phosphorus TMDL.

D. Programs to Control Urban Nonpoint P

1. Texas

In an effort to limit stormwater runoff in the watershed, the City of Austin passed the Comprehensive Watershed Ordinance in 1986 that was designed to prevent development from affecting stream water quality in the sensitive Barton Creek, Barton Springs, and Barton Springs aquifer area. This ordinance was enhanced in 1992 and established critical water quality zones, mandatory setbacks, and impervious cover restrictions. It limits the amount of impervious cover in any new development along the watershed of Austin's streams and creeks to 15 percent (McElfish 2000).

A hard cap on impervious cover for all new development can be an effective regulation to address stormwater control. However, such an approach can be very costly in areas with very high land values. This ordinance has been challenged repeatedly and its effectiveness remains questionable. It has been estimated that 90 percent of the new development in the Barton Springs recharge zone has found exemptions to the ordinance (Save Our Springs Alliance 2002). The Comprehensive Watershed Ordinance also calls for the elimination of increased loadings of suspended solids, P, N, and other pollutants. However, it is not clear how this goal will be achieved.

2. Florida

The control and treatment of urban stormwater is a priority in Florida, a state experiencing rapid growth and significant urban sprawl. Stormwater discharges are estimated to contribute more than 50 percent of the pollution load entering Florida's waters (Livingston 2000). Land use planning and growth management are being taken seriously as a means to, among other things, limit problems from urban stormwater. Florida is also using an innovative approach, alum injection, to treat stormwater to reduce bio-available P. Both efforts are discussed briefly below.

Growth Management

The three most important elements of Florida's land use planning policies are consistency, concurrency, and compactness. For consistency, Florida strives to have an integrated policy framework. The Local Government Comprehensive Planning and Land Development Regulation Act of 1985 requires that all local governments prepare comprehensive plans and implement supporting regulations. Vertical consistency is achieved by requiring that local plans be consistent with state and regional plans. Municipalities risk the loss of state funding if their plans are deemed to be inconsistent with state and regional plans. Local plans are also strongly encouraged to promote low-impact development and conservation designs that can minimize the creation and impact of urban stormwater.

The element of concurrency requires that local governments no longer allow deficit financing of services, facilities, and infrastructure based on a ‘pay as you grow’ system. This means that development can only be approved if the services, facilities, and infrastructure needed to support that growth are already in place. Related to the control of P, this applies to stormwater management and wastewater treatment, as well as many other services.

The encouragement of compact urban development is explicit in the State Comprehensive Plan and required as an element in local and regional plans. Some aspects of the compactness policy are the promotion of urban infill development, minimizing urban sprawl, and the separation of rural and urban land uses. Compactness will aid in minimizing impervious cover and allowing for greater control over stormwater.

This type of ‘smart growth’ strategy could be valuable for controlling stormwater and P loss in the more urban and rapidly developing areas of the Lake Champlain Basin. Additional incentives should be created for municipal governments to consider adopting smart growth strategies. This is discussed in Sections IV and V of this report.

Stormwater Treatment

Florida was the first U.S. state to require all new development and redevelopment to treat stormwater before it is discharged (Florida DEP 1999). This policy, the Florida Stormwater Rule, established in 1982, is credited with greatly reducing the impact of stormwater on Florida’s water resources (Livingston 2000). This Rule establishes a performance standard of removing at least 80 percent of the average annual post-development loading of total suspended solids for stormwater discharged to most waters, and 95 percent for specially designated waters (Livingston 2000).

Florida is also a leader in the chemical treatment of stormwater to remove sediments and P. The addition of aluminum sulfate (also called alum), $Al_2(SO_4)_3$, to collected stormwater as a flocculating agent results in the creation of chemical precipitates that remove P and other pollutants from the water column (Harper et al. 1998). While the pH range of the water will influence the effectiveness to some degree, studies have shown that 85 to 95 percent of total P is consistently removed with alum treatment (Harper et al. 1998). There is also a comparable reduction in N, suspended solids, and fecal coliform levels. Heavy metals can be reduced by 50 to 90 percent.

Removal of total P in alum-treated stormwater occurs by direct precipitation of orthophosphorus as aluminum phosphate ($AlPO_4$), as well as enmeshment of particulate P by incorporation into $Al(OH)_3$ floc (Harper et al. 1998). Currently there are 23 alum stormwater treatment systems in Florida. The average capital cost of these alum treatment systems was $245,998, which is largely independent of the watershed size (Harper et al. 1998). The full costs for operation and maintenance of these systems has averaged $17,307 per year or roughly $100 per acre of stormwater generation.

The alum treatment process is expected to result in an accumulation of precipitates on the lake floor. While initial estimates were for 1 to 4 cm of accumulation per year over 50 percent of the lake floor or areas more than 10 feet deep, monitoring in Florida has measured accumulation rates from 0 to 0.33 cm per year (Harper et al. 1998). It is possible to remove sediments (alum floc) after treatment, however this is not widely used. Research from Florida also shows that the P in the lake sediment is more stable after alum treatment than before. No adverse impacts of floc accumulation have been observed in Florida (Livingston 2004).

The Florida experience shows alum treatment to be more effective at removing P than any of the other commonly used treatment systems (Harper et al. 1998). Additionally, the total cost of alum treatment appears to be less than the other systems. While the Florida experience with alum treatment has been very positive, the efficacy of alum treatment in the Lake Champlain Basin is unclear. The City of Burlington has discussed the use of alum treatment in their vortex separator, but concluded that flocculation may not provide enough weight to be effective at P removal during the high-flow storm events (Roy 2003).

3. Maryland

Stormwater management in Maryland is a predecessor to the approaches adopted in Vermont and New York. Maryland has been recognized as one of the leading states in addressing the impacts of stormwater runoff. Its current program, an evolution of one adopted in the early 1980's, embodies a three step approach: avoidance, minimization, and mitigation (Comstock and Wallis 2003). The Maryland Stormwater Design Manual (Maryland Department of the Environment 2000) provides unified sizing criteria and establishes design criteria for structural BMPs. It also includes a series of nonstructural options that can reduce runoff generated by a site to more closely match its predevelopment hydrologic balance. This is achieved through a series of optional site planning techniques or "stormwater credits" which reduce both the amount of impervious cover on a site and destruction of natural areas. This voluntary credit approach to more environmentally sustainable development also appears in the Vermont stormwater management manual, also authored by the Center for Watershed Protection.

Additionally, the Maryland plan seeks to reduce the volume of stormwater by establishing criteria for redevelopment in addition to new development. The redevelopment criteria requires that either (1) impervious cover be reduced by 20 percent, or (2) that 20 percent of the stormwater be treated, or (3) some combination of (1) and (2), or (4) that a locally approved alternative be implemented (Maryland DEP 2001).

Chesapeake Bay Critical Area Program

In 1984, Maryland passed the Critical Area Act (CAA), which established the Critical Area Commission. The CAA was designed to oversee the development and use of land within 1,000 feet of the Mean High Water Line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries. The goals of the CAA are to minimize adverse impacts on water quality; conserve wildlife, fish and plant habitat; and establish land use policies for the Critical Area. This broad law is used to help local municipalities amend development plans, zoning ordinances, and subdivision regulations, with the goal of protecting the Bay (Maryland DNR 2003).

The CAA legislation recognizes the critical nature of protecting riparian areas for maintaining water quality. This strategy is likely to be just as important in the Lake Champlain Basin and should be considered for use. Protecting riparian areas would likely be a criterion of the municipal P reduction strategy described in policy option DL3 in Section V of this report.

4. Use of Green Designs

The reduction in water infiltration into the soil, resulting from increases in impervious surfaces in urban and urbanizing environments, causes changes in water movement across a landscape. This leads to increases in volume and pollution of stormwater, and in many instances, to increased delivery of P to receiving waters. A number of emerging technologies and systems are being developed to increase water infiltration in urban environments. Some of these are discussed below.

Rain Gardens

Rain gardens are a constructed depressional area that allows for water infiltration and storage during rainfall events, particularly when sheet flow occurs. The purpose of a rain garden is to minimize the amount of stormwater entering stormdrains and streams and to use appropriate plants to absorb nutrients and filter pollutants that can degrade receiving waters. The concept is based on the bio-retention function of forest habitat, where the layer of litter on the forest floor soaks up water and allows for slower penetration into the soil (Virginia Dept. of Forestry 2003).

Rain gardens can be designed to attract and filter stormwater from roofs, roads, parking lots, and other impervious services. By keeping the stormwater on-site, rain gardens can prevent excessive contamination of the water by reducing the amount of travel over impervious surfaces. By allowing infiltration, rain gardens have the ability to increase the rate of groundwater recharge, which has been declining in some areas in recent decades (Cozzetto 2001).

The use of rain gardens, while still relatively uncommon, is being considered more often in state and municipal stormwater management. On October 1, 2002, the State of Wisconsin enacted administrative rule NR 151 to address on-site infiltration for all new developments. This rule requires, among other nonpoint pollution controls, minimum levels of on-site water infiltration following development. For residential development, 90 percent of pre-development infiltration is required, and for commercial development, 60 percent is required. These requirements will greatly increase the use of rain gardens and other infiltration practices. The Anacostia Watershed Restoration Committee is considering an effort to retrofit an entire watershed in the Washington, D.C., area with rain gardens, as a way to improve water quality in the Anacostia River.

Greenroofs

Green- (or eco-) roofs, as an alternative to impervious roofs, are designed to cover roof surfaces with permeable vegetative material. This system was pioneered in Germany in the 1960s and is more widely used in Europe, including Scandinavia, than in the U.S. (Greenroofs.com 2003). Currently, several large U.S. cities, including Portland, Seattle, and Atlanta, are considering the use of greenroofs on municipal buildings (Greenroofs.com 2003).

It is estimated that greenroofs can reduce 50 to 90 percent of runoff relative to the same area of impervious surface (Greenroofs.com 2003). There are other ecological and economic benefits of greenroofs. These included carbon sequestration, reducing ambient summer temperatures, filtering pollutants, and reducing heating and air conditioning costs.

There are numerous examples of greenroofs in the U.S. The Maryland Department of the Environment (MDE) has provided a $100,000 grant for a greenroof on the new complex it will share with the Maryland State Lottery. Many states have environmental tax credits that can be used to defray the cost of greenroof installation. However, questions exist about the efficacy of greenroofs in cold climates, due to freezing. Some sources claim that greenroofs are feasible and practical in cold climates (Scholz-Barth 2003). Scholz-Barth claims that due to the increased insulative capacity, snow can build up on a greenroof over the winter and be partially absorbed during melting. Although rain will run off of a frozen greenroof, as from an impervious roof, the average annual performance of the greenroof will be superior.

This study has not discovered any policies or programs that are significantly increasing the adoption of greenroof technology in the U.S. (Author's note: Winrock International is currently building a greenroof on its new headquarters in Arkansas).

Permeable Pavement and Road Design

Permeable pavement consists of structural materials (e.g., concrete or paving blocks) that are interspersed with void areas. The void areas are filled with permeable materials such as gravel, sand, or vegetation. The use of permeable pavement has been shown to greatly reduce the volume of surface water runoff (Booth et al. 2000). The costs of installing permeable pavement are higher than for conventional pavement. However, when the operation and capital costs of reduced stormwater management are factored in, the long-term costs of stormwater management may be less with the use of permeable pavement (USEPA 2000).

An innovative approach for low-impact street design is being pilot-tested in one neighborhood in Seattle, Washington. This design replaces the common curb-and-gutter system with one that maximizes natural drainage. The residential street is narrow and curved with the lawns coming right up to, and flush with, the street pavement. A series of swales are used to absorb, collect, and move stormwater to other areas of natural drainage. In 2 years of testing, the system has reduced stormwater runoff by 98 percent (Taus 2002). This type of design is estimated to cost approximately the same amount as conventional curb-and-gutter systems, with the added benefit of greatly reducing stormwater costs and flooding problems.

Each of these green design strategies, as well as others, could be utilized in the Basin with varying degrees of effectiveness. Incentives for exploring and implementing the most appropriate aspects of green design for P control in the Basin should be created. These incentives can be aimed at municipalities, businesses, and homeowners.

E. Agricultural Phosphorus Control Measures in Other Nations

Several European nations have implemented relatively aggressive policies to control P loading. Many of these countries are using a combination of regulations, financial incentives, and market mechanisms to address N and P loading. A summary of the policies in several of the European countries is presented in this section.

1. Netherlands

The Netherlands has one of the most intensive animal agricultures in the world. Stocking rates have increased as much as 10-fold in some sectors (Hotsma 1997) and are significantly higher than in any other European nation, with a national average of 3.9 AU per hectare (Dutch Ministry of Agriculture 2001). Problems stemming from excess N and P in the environment became obvious as the production of livestock skyrocketed in the late twentieth century. The majority of excess nutrients in the Netherlands come from the swine and poultry industries. Farms in these sectors tend to have very high stocking rates and rely on imported feeds (de Walle and Sevenster 1998). The P loads from the nation threaten the health of the North Sea (de Walle and Sevenster 1998). The Netherlands is a party to the 1985 North Sea Treaty, which stipulates a 50 percent reduction in P loads from 1985 levels. Dutch policy to control agricultural nonpoint source pollution was instigated in the 1980s and has become increasingly aggressive since that time.

The Soil Protection Act of 1986 sought to curb the increasing surplus of P produced in the Netherlands. It did this by setting maximum limits on the amount of P/ha that could be land applied. These limits were initially quite high (125 kg P/ha/yr) to ensure that the amount of P produced in the country could be applied. The effect of this legislation was to improve the distribution of P sources across farmland (Hotsma 1997). Additionally, limits were placed on the timing and methods of manure applications.

In the early 1990s the upper limits for P application were gradually reduced to 56 kg P/ha/yr. Farmers producing more than this level were subject to financial penalties of 20 guilders per kg P/ha. Initially the penalty was only 5 guilders per kg P/ha if the surplus was less than 10 kg/ha. Presumably this was to minimize the penalty on farmers who marginally exceeded the limit. The effect of the reduced limits was to induce farmers to improve nutrient efficiency in their operations.

More recently the Netherlands has instituted the Mineral (Nutrient) Accounting System, known as Minas. The goal of this third phase of Dutch P policy is to achieve a nationwide balance in N and P. Starting in 1998, all farms with more than 2.5 AU/ha were required to calculate and submit a full accounting of all inputs and outputs of N and P. Starting in 2001, this is required of all Dutch farms, including crop and vegetable farms (Dutch Ministry of Agriculture 2001). Minas is a mass balance approach, which compares all inputs to all outputs of N and P without regard to the on-farm nutrient processes and pathways. However, an allocation is made for inevitable losses of N and P to the environment.

If the farm's surplus (inputs less outputs less inevitable losses) is greater than the allowable level, the penalty of 20 guilders per kg/ha is levied against the farmer. As of 2003, the allowable level has been reduced to 20 kg phosphate/ha (Dutch Ministry of Agriculture 2001). There is strict enforcement and oversight of the Minas program. Farms with more than 2.5 AUs per hectare are required to submit their complete nutrient statements to the Levies Office. This office performs an audit on each farm's nutrient statements each year by comparing farm records with that of other farms (one farm's nutrient outputs can be part of another farm's inputs) and of nutrient suppliers (e.g., feed and fertilizer dealers), as well as reconciling the farm's herd records with the nutrient statements. In addition to the audits of the Levies Office for intensive livestock operations, the Ministry of Agriculture's General Inspection Service performs audits on randomly selected farms of all types. These audits are likely to be performed on any given farm once in every 6 years. The Levies Office audits occur each year (Dutch Ministry of Agriculture 2001).

The Minas policy has several advantages and disadvantages, as discussed briefly in the following paragraphs.

Minas focuses on N and P. Since excess of each nutrient is associated with environmental and human health problems, it is important to track the balances of both. Almost all farm inputs and outputs contain both N and P. So while accounting for one, accounting for the other does not require a duplication of efforts by the farmer. Because Minas is focused on the nutrients rather than on the amount of manure, it is more closely linked to the environmental problems of concern, relative to the previous Dutch policies.

Minas has shifted Dutch agri-environmental policy from being design-based (i.e., prescribing practices and infrastructure for farmers) toward a performance-based approach (i.e., linking the incentive mechanisms more closely to the environmental outcomes). Although eutrophication of surface waters and nitrate contamination of ground water are the actual resulting environmental problems, achieving nutrient balance on all Dutch farms is an outcome-based target that has been identified in the Minas policy.

There are a number of advantages of having performance- or outcome-based policies. Such policies allow farmers to achieve the stated goal in the manner that is least costly to the farm operation. The farmer can choose among numerous strategies, such as reducing herd size, changing feeding rations, reducing fertilizer purchases, or exporting manure to farms with nutrient deficits. Because they are more closely linked with the desired environmental outcomes, performance-based policies are also more likely than design-based policies to achieve their stated objectives. The disadvantages of performance-based policies for controlling nonpoint source pollution include the high administrative and informational costs required by farmers and regulators. Clearly, the time and informational burden on farmers is significant and requires organizational and management skills. The administrative costs associated with implementing and monitoring this program must be large, primarily for the additional staff required. The existence of the Minas policy presumes that the Dutch government feels that this cost is justified in an attempt to control the agricultural nonpoint source pollution problems of the Netherlands.

As of January 2002, any Dutch farm that produces more manure than can be applied to its land holdings, at a maximum rate of 170 kgs N per hectare (complying with the EU Nitrate Directive), must export the manure off the farm. The manure can go to a crop or other farm with a nutrient deficit or to a manure composting facility. The surplus farm is required to establish a manure transfer contract with the receiving entity. The purpose of the manure transfer contracts is to link all manure production to the land at an acceptable application rate. This process is designed to create a more uniform distribution of manure nutrients across the country. It is estimated that 15 million mt of manure are shipped from the intensive livestock areas to areas of lower livestock density (Dutch Ministry of Agriculture 2001).

By bringing the supply and demand for manure nutrients into equilibrium and providing mechanisms to ensure the ability to distribute manure across farms, the Dutch government hopes to minimize the amount of cheating on the Minas policy. To reduce the manure supply even further, the government has implemented some policies to reduce the livestock numbers in the country. There are quota systems in place for swine production and for manure production (as discussed in the manure budgeting above). Farmers can increase their production only by purchasing quota from another producer. In 1998, the government imposed a 10 percent reduction in pig production quota across all farms. Each time a quota transaction takes place the government retains up to 25 percent of the quota to further reduce the amount of manure produced in the country. The effect of these stringent policies has not only reduced the amount of excess manure nutrients produced by Dutch agriculture, but chemical fertilizer use has declined by 30 percent since 1986 (Dutch Ministry of Agriculture 2001).

Additional regulations stipulate that no manure can be spread on frozen or snow-covered land. On some soils designated by the government (sandy soils that are susceptible to leaching), no manure can be applied from September 1 to February 1. This restriction is to avoid contamination due to the slower plant growth and nutrient uptake in the autumn and the winter dormancy periods. Livestock farms must have at least 6 months of manure storage capacity.

2. Norway

The problems of excess P in the environment have also been strongly addressed by Norwegian policy. In 1997, Norway established its current regulations on animal manure. The goals of this legislation are to protect ground and surface waters, as well as the health of the fjords, by achieving a reasonable stocking density of farm animals. Animal units are measured by the production of manure that equals 14 kgs of P (Tveitnes 2003). The thrust of the legislation is to ensure a stocking density on farms that allow the maximum percentage of the manure P produced to be taken up in plant growth. The minimum area allowable is 0.4 hectare per AU (roughly equivalent to one dairy cow per acre). Like the Netherlands, Norway has implemented a system of farm nutrient accountability. Unlike the Netherlands, there are no set taxes imposed for surplus production of P. However, non-compliance with the regulation can result in a loss of subsidy payments to the farm, which can be a significant portion of farm revenue (Tveitnes 2003).

Land application of manure can occur only from the start of planting season in spring until September 1. Incorporation of manure must take place within 18 hours of spreading. This has resulted in the widespread use of manure injection systems for application to pastures. Farms are required to have manure storage capacity for at least 8 months. There are not widespread manure transportation programs as in the Netherlands, but farmers can enter into written agreements with other farmers or landowners to take a specified amount of manure and apply it according to the regulations.

3. Denmark

In Denmark, the nutrient of concern is N. Phosphorus in agriculture is not explicitly regulated, but strict controls are placed on manure management. Farmers are limited by the amount of manure they can spread per hectare. Like the Netherlands, Norway, and other European nations, manure management in Denmark considers stocking density of each farm. There is a ban on spreading manure from crop harvest time to February 1. Manure storage capacity is generally required to be equal to 9 months of manure production, and 7 months for cattle that are pasturing during the summer.

Danish farmers are also required to have at least 65 percent of harvested cropland in a winter cover crop. While this is designed to soak up N from the soil, it would also benefits for the reduction of P. The regulations have been quite successful. The use of commercial fertilizers has decreased by 21 percent since 1980, while the crop yields per hectare have increased by more than 60 percent (Birkmose 1999).

4. Conclusions from European Nutrient Policies

Clearly, the political palatability of ‘command and control’ legislation for nonpoint source pollution management in Europe is much greater than in the U.S. This is due to many factors. Europeans, in general, are more willing to be subject to regulations for the protection of the environment and natural resources. The seriousness of the nutrient loading problems experienced in countries like the Netherlands, Norway, and Denmark also make these more extreme policy initiatives justifiable.

While such far-reaching regulations would be politically unviable in the U.S., the efforts of the European nations show considerable success in controlling agricultural sources of P, and, therefore, contain useful information for this country. It is conceivable that policies could be developed in the U.S. that are voluntary and have positive financial incentives for livestock farmers to disclose the required production information and manage their animals and land for zero accumulation of P over time. Such an approach may be particularly valuable when targeted at critical source areas for P within a watershed.

F. Conclusions from Assessment of Current Policies and Programs in Other Regions

Meeting the 20-year P reduction goals for Lake Champlain will require the implementation of strengthened and alternative policies related to agriculture and development in the Basin. Progress in this direction is being made, but appropriate incentive mechanisms to guide producers, developers, and citizens toward decisions that reduce P loads are still lacking. Additionally, strengthened regulations and increased education and outreach and technical assistance are also needed in the Basin to adequately address the P-loading problem in the Lake.

In places where the political will to protect important natural resources has been strongest (e.g., the Chesapeake Bay and the Everglades), we have seen the development of the most stringent, and also the most innovative, policies. However, the use of economic instruments (e.g., incentives and taxes) in policy is still underutilized in these areas. Successful use of economic incentives requires getting the targets, agents, and prices right in the policy design. If the target for the instrument is very broad, as is the case with the land tax in the EAA, free-rider problems will diminish the effectiveness of the program. If the incentive is not placed in front of the agents that make the decisions most closely linked to the pollution issue, desired results will not be achieved. Most importantly, if the incentive (price) is not sufficient, it will not induce the desired action by the agents towards the policy goal. Valuable examples of economic policy instruments are lacking within the Lake Champlain Basin and beyond. This represents an important and innovative policy area for meeting the Lake’s P reduction goals.

The European experience in controlling agricultural P seems to be through the use of regulations and negative economic incentives (e.g., taxes, fines, and loss of subsidy payments). Although regulations and disincentives can be effective at meeting pollution reduction goals, they can be costly to monitor and require political action that is often unacceptable in the U.S., particularly in relation to agricultural production. Increasing and expanding the enforcement of existing regulations may be an appropriate approach for controlling P loading in the Basin.

Protecting Lake Champlain seems to be a priority for residents of the Basin. The remainder of this report discusses policy options for achieving this. This project seeks to develop innovative policy options that balance economic considerations, political feasibility, and the protection of this vital natural resource. Protecting the Lake from excessive P loads is likely to be very costly. It may be possible to re-allocate some of the current funding for Lake protection to provide positive economic incentives for reducing P loads to the Lake. If appropriate incentive mechanisms can be created, the cost of reducing P loading may be minimized. This, and several other policy approaches, are discussed in the following sections.

IV. Initial List of Policy Options

It is expected that existing policies and programs will be insufficient for meeting these goals for all Lake segments. The policy options and ideas discussed in this section represent the initial "long list" of policy options as described in Task 4 of the Project's workplan. This list has been created with input from Project staff, members of the Project advisory team, and scores of other professionals (from within and outside of the Basin) with experience on P reduction efforts and related technical and policy issues. Policy options on the initial "long list" were not required to meet any specific criteria for inclusion. Although not intended to be exhaustive, this list was intended to be inclusive of all ideas for policy options that surfaced in project meetings and related discussions. With consideration of the information presented in the previous two sections, this initial list of policy options represents many potential and varying courses of action for reducing P pollution in the Basin. From a review of this list, numerous discussions, and preliminary analyses, the final list of policy options, presented in Section V, was created.

The policy options discussed below span the range from tinkering at the margins of current policies and programs, to suggestions for radically different new programs to address P control in the Lake Champlain Basin. Some of the options, by their nature, would apply basin-wide, while the applicability of other options would be based on the land use patterns in different Basin watersheds. Although the land use patterns affecting different lake segments vary, discussion of the policy needs for specific lake segments is not included here. Watershed- or lake segment-specific action plans can draw upon the final policy recommendations to help achieve the specific P reduction goals.

Table 5 lists all of the initial policy options that were brainstormed for this project. Each of the initial policy options is described briefly below. These initial options were screened only for their potential to address the P loading problem in the Lake. As such, the following list is not intended to constitute recommendations for policy actions; this list serves as a transitional step in this project toward creating a manageable number of desired policy options. The options that are listed in **boldface** in Table 5 are those that have been developed into one of the final policy options presented in section V. The options that are followed with an asterisk (*) have been incorporated indirectly into one of the final policy options.

Table 5. List of Initial Policy Options.

General Funding
Option 1: Combine federal, state, and provincial appropriations with increased user and polluter fees to create an endowment devoted to the long-term health of Lake Champlain.
Agriculture
Option 2: Supply funding for the identification of critical source areas within each Basin watershed.
Option 3: Develop priority criteria to focus policy efforts on the farms that are most likely to contribute the greatest (per-acre and total) sources P.
Option 4: Develop and pilot test a performance-based P policy for agriculture in one Basin watershed.
Option 5: Require manure management according to P index criteria on all dairy farms that are

over a threshold stocking rate.
Option 6: Create a subsidized program that allows livestock farms to ship manure from the farm to a central composting facility. Processed manure could be used in stable applications (e.g. mixed with soil to support permanent vegetative cover) related to building or road construction projects or at residences within or outside of the Basin.
Option 7: Create a matching service to link farms with surplus manure to farms that could use the manure. This could be done with minimal funds through the Extension services.
Option 8: Require all farms in the Basin to achieve and verify a mass balance of P on the farm.
Option 9: Create an incentive program to induce willing dairy farmers to voluntarily achieve and verify a P balance on the farm.
Option 10: Provide greatly increased education and outreach efforts on the value of, and best ways to use, management-intensive grazing for dairy production throughout the Basin.
Option 11: Provide financial incentives for the use of management-intensive grazing on Basin dairy farms. Because this system often has increased profitability, incentives could be limited to the costs of transition and compensation for perceived risk.
Option 12: Expanded education and outreach efforts to dairy farmers, feed consultants, and veterinarians on the value of reducing dietary P.
Option 13: Require comprehensive P accounting on all farms in the Basin or only those in critical source areas within each watershed.
Option 14*: Create an incentive for comprehensive P accounting, such as a tax break, direct payment, eligibility for other assistance programs, and/or public recognition for stewardship on this issue.
Option 15: Require 50 ft to 100 ft vegetative riparian buffers on all Basin agricultural land along all permanent and intermittent streams. Compensate farmers for lost production.
Option 16: Create a comprehensive set of accepted agricultural practices (AAPs) throughout the Basin. These need to be enforced with adequate staff from the appropriate agencies.
Option 17*: Create incentive mechanisms for farmers to exceed individual practice requirements or a cumulative score based on all practices.
Forest Land
Option 18: Increase monitoring and enforcement of sound logging practices. Impose significant penalties for non-compliance.
Option 19: Enhance education and outreach efforts to loggers on accepted logging practices to minimize erosion control.
Developed Land
Option 20: Increase the funding in the New York, Vermont, and Québec segments of the Basin for education and outreach to municipalities on the importance and best strategies for reducing P loads.
Option 21: Create staff positions at the county, watershed, or regional level that are dedicated to planning and implementing local municipal actions toward the reduction of P loads.
Option 22: Create a low- or no-interest 'P reduction' revolving loan fund from which communities in the Basin may borrow funds to finance activities that have a high probability of reducing P loads.
Option 23: Require all towns in the Basin to create a water quality plan for the town within their facilities plan in order to be eligible for state (or provincial) sewerage funding.
Option 24: Secure federal funds to be used in New York and Vermont to reduce the local share of road projects to 5 percent if the town can show that it has adopted the specified practices that will reduce erosion from roads, ditches and around culverts. A similar program could be instituted in the Québec portion of the Basin.
Option 25*: Create grant and cost-share funds that are available to towns or groups of towns for the creation of (or investigation into) a stormwater utility.

Option 26: Provide cost-share funds for a municipality in the Basin to pilot-test the use of an aluminum sulfate (a.k.a. alum) treatment system.
Option 27: Federal and state (and provincial) monies contribute to the Lake Champlain Basin P Reduction Municipal Action Fund. This fund would create a bonus payment to communities for action to reduce P loads.
Option 28: Pay towns a modest amount to create an active conservation commission. Funds could be drawn from the state budgets or the P Reduction Municipal Action Fund.
Option 29: Reduce the population criteria used to select the Phase II municipalities so as to apply to more towns in the Basin. Apply the six minimum stormwater control measures detailed in the Phase II rule to these towns. Provide funding to offset the costs where needed (as described above).
Option 30*: Require that all towns in the Basin adopt and enforce a minimum set of criteria to be included in local construction permits. These criteria should include most (or all) of the accepted construction site BMPs for erosion control.
Option 31*: Require that all towns in the Basin adopt a driveway ordinance. These criteria would likely include an erosion control plan with specifications on slope and other characteristics.
Option 32: Require that all towns in the Basin adopt a riparian buffer zone ordinance. This should stipulate a minimum 50 ft buffer of undisturbed vegetation along all perennial and intermittent streams.
Option 33*: Encourage or require towns to adopt a 'stormwater index' for residences and businesses. Assess an annual stormwater tax based on the index score.
Point Sources
Option 34: Require that all wastewater treatment plants are subject to meet the necessary effluent P concentration levels to achieve the P reduction goals for the Lake.
Option 35: Designate funding to cover 100 percent cost-share for the necessary upgrades on all wastewater treatment plants in the Basin. Allow the cost-share funds to be used for all cost-effective modifications.
Option 36: Require that all re-permitting and plant modifications be completed in a time frame that will meet the P reduction goals by 2016 or according to the accelerated P reduction schedule.

A. General Policy Options

Option 1: Combine federal, state, and provincial appropriations with increased user and polluter fees to create an endowment devoted to the long-term health of Lake Champlain.

Clearly, reaching the 20-year P reduction goals set for the Lake will require a large amount of additional funding. The Lake Champlain P TMDL has estimated that $139 million will be required for the Vermont implementation plan alone (assuming 0 percent inflation). The policy options discussed below, which include many of those identified in the TMDL, are likely to be even costlier to implement than those discussed in the TMDL. The value of meeting the 20-year P reduction goals is very difficult to quantify accurately, but represents real, long-term economic benefit to the residents of Vermont, New York, and Québec. A very important part of a long-term P reduction policy plan is to find ways to monetize the future stream of public and private economic value that meeting the P reduction goals represents. This monetization will be necessary to implement many of the policy options discussed in this document.

This option will require a great deal of political will, particularly because the time horizon of the payback period will be much longer than electoral politics generally affords. Combining increased appropriations of public dollars with increased user and polluter fees distributes the financial burden across the populace, with greater burdens placed on those most affecting, and affected by, the health of the Lake. The specifics of funding this option will require significant political debate. Possible components could include a general tax increase, a P tax based on estimated contributions by businesses and individuals, and water quality surcharges placed on boat registrations and other Lake-related activities.

B. Options for Agricultural Land

The subsections below start with two broad ideas (i.e., critical source area targeting and performance-based environmental policies for agriculture) that may be important components and/or precursors to effective policy development. The remaining subsections discuss more specific policy options for addressing P loads from agricultural land.

Targeting

Option 2: Supply funding for the identification of critical source areas within each Basin watershed.

The distribution of nutrient loss from agricultural land is not uniform across a watershed, a farm, or even a field. Studies have shown that up to 98 percent of all runoff can be generated from as little as 14 percent of the watershed area (Pionke et al. 1997). Lands that contribute significantly higher nutrient loads can be described as critical source areas. Therefore, if policies to control agricultural sources of P are to be cost-effective, it is important that they target critical source areas. How to use the information that targeting provides is a policy question for which there are a range of answers. It is conceivable that ‘targeted’ areas could simply take priority for current cost-share programs. They could also become areas where additional incentives for BMPs or environmental performance are available and encouraged, or they could be areas where stricter or more comprehensive regulations are established. Targeting could be done in several ways and on several levels. Suggestions for targeting are briefly discussed below, starting with broader targeting strategies and moving to smaller targets.

While estimates of the P loads from each watershed within the Basin have been made, estimates of the areas within each watershed that are likely to contribute greater P loads have not been identified. These areas are referred to as ‘critical source areas’ or CSAs. Identifying CSAs, although not a policy prescription, is an important precursor to developing cost-effective policies to control agricultural P entering the Lake.

The idea behind targeting at the watershed level for control of agricultural P is to find areas within a watershed that are hydrologically active and have surplus P. This analysis can be done in many ways. The easiest way may be to use currently available data sets focused on hydrology, slope and soil characteristics, in conjunction with data on animal stocking density, vegetative cover, and cropping practices. These data can be combined in a GIS framework to spatially identify areas within a watershed that are more likely to contribute greater P loads to the Lake. The resulting maps could be used by local policy makers and agency personnel to achieve greater cost-effectiveness of programs, whether continuation of current programs and/or new and different programs.

Option 3: Develop priority criteria to focus policy efforts on the farms that are most likely to contribute the greatest (per-acre and total) sources P.

There are several other, less-involved means of incorporating targeting into policy development for controlling agricultural P loads. Areas within a watershed could be simply identified and prioritized based on their proximity to Lake tributaries. Farms could be identified based upon their stocking rates. The P index approach of combining P source and transport factors could be used to identify fields that are vulnerable to P loss for all farms in the basin, for farms in targeted areas, or for farms over a threshold stocking rate. Efforts towards targeting for agricultural P control in the Basin should lead to greater efficacy and cost-effectiveness of policies.

Performance-based Environmental Policies for Agriculture

Option 4: Develop and pilot test a performance-based phosphorus policy for agriculture in one Basin watershed.

Performance-based environmental policies have significant potential to reduce agriculture’s impact on the environment and increase the cost-effectiveness of governmental conservation spending across the U.S. Performance-based environmental policy approaches differ from the standard design-based approaches, which focus on production practices and farm infrastructure, by linking incentives more closely to environmental outcomes. Performance-based policy approaches have been successful, in some cases, at controlling point source pollution from non-agricultural industries. However, applying this approach to agricultural nonpoint source pollution presents significant challenges.

The incentives used with design-based approaches have primarily taken the form of cost-share funding for the implementation of best management practices (BMPs) on the farm. With performance-based policies, numerous types of incentive mechanisms can be designed to induce farmers to use their knowledge and information to achieve specific environmental performance targets in the least-costly manner. Additional information related to performance-based environmental policy approaches for agriculture can be found in Casey et al. (1999), Ribaudo et al. (1999), and Shortle et al. (2001).

The Wallace Center is leading an initiative to develop performance-based environmental policy approaches for U.S. agriculture, in collaboration with several university, governmental, and private sector partners. This initiative is currently being implemented in 3 phases. Phase I was a national workshop that took place on March 20–21, 2003, in Washington, D.C. With participation from farmers, practitioners, policy makers, scientists, and other stakeholders, the primary goal of the workshop was to initiate discussion on ways to combine theoretically cost-effective strategies with the knowledge and experience of stakeholders, in order to begin to design performance-based environmental policies for use in watershed management. The workshop had concurrent breakout sessions focusing on five selected watersheds: Suwannee River, Florida; Rathbun Lake, Iowa; Union School Slough, California; Cannonsville Reservoir, New York; and Tillamook Bay National Estuary, Oregon. As a result of this workshop, the Wallace Center will be working with Poultney-Mettowee River Partnership to develop performance-based policy recommendations in that watershed.

Phase II will build on the ideas generated in the workshop by creating a process for more detailed stakeholder and scientific input, in order to fully develop performance-based policy options aimed at agri-environmental issues in each watershed. This work will utilize the Wallace Center's expertise in facilitating grassroots policy development, by convening farmers and other stakeholders, scientists, agency and regulatory personnel, academics, and others to create efficient and cost-effective policies to control agricultural pollution at the watershed level. In Phase III of this project, the performance-based environmental policy approaches developed in Phases I and II will be pilot-tested in appropriate watersheds. This will be a long-term, scientific assessment of the environmental and socio-economic outcomes related to the use of performance-based policies. The lessons learned through pilot-testing will be synthesized and incorporated into the debate on U.S. agricultural support and conservation policy.

Another advantage of using performance-based policy approaches is that the focus on outcomes allows for more accurate estimation P load reduction. If incentive mechanisms are designed that reward farmers for measurable reductions in P loss from agricultural land, much of the uncertainty regarding P reduction coefficients (discussed in Section I) is eliminated. This approach fits very well within the general TMDL framework.

Other Agricultural Policy Options

Option 5: Require manure management according to P index criteria on all dairy farms that are over a threshold stocking rate.

Dairy farming remains the dominant agricultural activity in the Basin, accounting for 70-80 percent of agricultural revenues. Dairy farming probably accounts for an even greater share of the agricultural P sources in the Basin. Reliance on feeds imported into the Basin (primarily grains) to support increasing per-cow milk production levels are contributing to P surpluses on dairy farms and P loads in the Lake. The policy options discussed here to control P from agricultural land will be focused primarily on dairy farming. However, the concepts can generally be applied, as necessary, to other types of agricultural operations. There are several policy options that are able to address the issue of agricultural P sources entering the Basin and farm P surpluses.

In an ideal world, policies would be created that lead dairy farms toward a mass balance of P, without decreasing profitability. This would represent a win-win solution and should be a policy goal, but may prove unattainable. A study in Wisconsin showed that the average dairy farm accumulated 15 lbs P per acre per year and that small farms were just as likely to have high accumulation rates as larger farms (Erb and Fermanich, 2002). Generating P surpluses is more likely to be related to stocking rate than to herd size.

Option 6: Create a subsidized program that allows livestock farms to ship manure from the farm to a central composting facility. Processed manure could be used in stable applications (e.g., mixed with soil to support permanent vegetative cover) related to building or road construction projects or at residences within or outside of the Basin.

Option 7: Create a matching service to link farms with surplus manure to farms that could use the manure. This could be done with minimal funds through the Extension services.

Most dairy farms in the Basin will not be able to achieve a P mass balance without either increasing their land area, decreasing their herd size, and/or shipping manure off the farm. A program in Texas removed more than 500,000 tons of manure from farms in the Bosque River basin in its first 14 months, at an estimated cost of $3 per ton.

Neither of the two options above is likely to be used extensively unless farmers are compelled to reduce their P surpluses and move toward a mass balance. Farmers are unlikely to be compelled in this direction unless policy is used to guide them. The following policy option would require the assistance of the two aforementioned options.

Option 8: Require all farms in the Basin to achieve and verify a mass balance of P on the farm.

Given the widely variable and, on average, quite small profit margins for dairy farming in the Basin, requiring all farms to achieve a P balance would likely have a devastating impact on farm viability and numbers. This approach is currently being used in the Netherlands, but it appears that both farm profitability and regulatory palatability are much greater there to withstand such a Draconian measure.

Option 9: Create an incentive program to induce willing dairy farmers to voluntarily achieve and verify a P balance on the farm.

Incentives would need to be quite large to induce most farmers to voluntarily achieve a P balance on the farm. Because of the anticipated cost, this option may be best if offered only within targeted critical source areas in Basin watersheds. Incentive mechanisms for this program could include direct per-acre payments to farmers, income or property tax credits, or the ability to participate in other designated government assistance programs. A more fiscally prudent way to package this option would be to place taxes or fees on farms that do not achieve a P balance. The incentive in this case becomes the avoidance of the additional costs. This option would jeopardize the viability of many farms in the Basin. In either case, the incentive would need to be larger than the total cost to the farm of achieving a P balance. This cost will vary across farms and those with the least costs will be the most likely to participate. Unfortunately, the farms with the least cost are likely to be those that are already closest to a P balance. To be cost-effective, a policy of this type would need to devise a system of rewarding performance without sending perverse incentives.

The option above is an example of a performance-based policy approach. The issue of monitoring and measuring performance would have associated costs for the implementing agency and the farmer. Farmers would be required to keep close records of all P inputs and outputs and submit annual reports to the agency. The agency would need staff to review the reports, perform audits, and measure soil P levels over time.

Option 10: Provide greatly increased education and outreach efforts on the value of, and best ways to use, management-intensive grazing for dairy production throughout the Basin.

Option 11: Provide financial incentives for the use of management-intensive grazing on Basin dairy farms. Because this system often has increased profitability, incentives could be limited to the costs of transition and compensation for perceived risk.

If a livestock farm can provide a greater percentage of ration nutrients from home-grown feeds, it is more likely to be closer to a P balance. At least one research study has shown that the use of management-intensive grazing (MIG) provides a greater percentage of home-grown nutrients, as well as the ability to achieve a P mass balance at much greater profitability than a conventionally managed dairy farm (Winsten et al. 2000). Additionally, MIG uses permanent vegetative cover (the pasture sward), which minimizes soil erosion. Because manure is not incorporated into the soil, soluble P in surface runoff could be higher that in cropping practices. Further research is warranted on the specific P reductions that could be achieved through increased use of MIG in the Basin. Management-intensive grazing may represent a win-win solution for farming and water quality and should be fully investigated.

Option 12: Expand education and outreach efforts to dairy farmers, feed consultants, and veterinarians on the value of reducing dietary P.

Although there has been extensive research in recent years on the ability of dairy farmers to reduce the dietary P in feed rations to 0.38 percent or less without affecting performance, many farmers continue to feed P according to previous recommendations (at 0.48 percent or higher). The use of precision P feeding could reduce the sources of agricultural P in the Basin and save the farmer some money.

Option 13: Require comprehensive P accounting on all farms in the Basin or only those in critical source areas within each watershed.

Accurate and comprehensive P accounting is an essential precursor for controlling P accumulation on farms. While this is currently required on the largest operations, it is not required of the majority of farms.

Option 14: Create an incentive for comprehensive P accounting, such as a tax break, direct payment, eligibility for other assistance programs, and/or public recognition for stewardship on this issue.

Delaware County, New York (NYC watershed), is implementing a NMP credit program. Farmers can apply for a $10 per-acre payment for demonstrating that they are adhering to their farm's NMP. The payment is designed to offset the cost of numerous NMP practices incurred by the farmer.

Option 15: Require 50-ft to 100-ft vegetative riparian buffers on all Basin agricultural land along all permanent and intermittent streams. Compensate farmers for lost production.

Adequately sized, vegetative riparian buffers have been shown to be very effective at reducing P delivery to surface waters. The opportunity cost (i.e., lost production) to the farmer may be relatively small from the buffer strips relative to the value of the water quality benefits gained. However, because the water quality benefits are a public good and the land along rivers and streams is often the most productive, compensation to the farmer for this mandate should be considered.

Option 16: Increase the comprehensiveness and effectiveness of accepted agricultural practices (AAPs) throughout the Basin. These need to be enforced with adequate staff from the appropriate agencies.

Option 17: Create incentive mechanisms for farmers to exceed individual practice requirements or a cumulative score based on all practices.

AAPs should form a minimum level of environmental performance for all farms. Exceeding this minimal level should be encouraged, with particular emphasis on P control. A 'P control farm score' could be created as a weighted sum of scores for the use of designated practices, infrastructure, and additional efforts. Farmers could voluntarily enter this incentive program, which would provide a bonus payment to the farmer for P control efforts beyond those required in the AAPs. The bonus payment would increase with the level of the P control farm score. The funding for this program could be drawn from the Lake Champlain Endowment option discussed previously.

C. Options for Forest Land

It is estimated that if accepted logging practices are adhered to within the Basin, P transport from forest land will remain within acceptable levels. To ensure this situation, two simple policy options are suggested.

Option 18: Increase monitoring and enforcement of sound logging practices. Impose significant penalties for non-compliance.

Option 19: Enhance education and outreach efforts to loggers on accepted logging practices to minimize erosion control.

D. Options for Developed Land and Municipalities

The primary constraints on towns with regard to P reduction efforts seem to fall into three categories: financial, personnel, and motivation. It costs money to implement practices and structures and it requires staff time to learn, plan, and implement efforts to improve water quality. In many communities, the perception is that P is not a significant problem and, therefore, requires no special actions by the municipality. A combination of programs focused on education, access to qualified staff, cost-sharing, explicit financial incentives, and regulations could be used to increase municipal actions to reduce P loading.

Education

Option 20: Increase the funding in the New York, Vermont, and Québec segments of the Basin for education and outreach to municipalities on the importance and best strategies for reducing P loads.

Most of the policy suggestions discussed below will also have a component that deals with education and outreach. This section merely emphasizes the importance of continuing and expanding education and outreach to communities in the Basin on P reduction issues. Increased outreach to municipalities should convey:

- the importance of reducing P loading;
- the specific actions municipalities can take to reduce P contribution, including immediate and simple actions as well as more involved actions;
- the specific programs available for assistance in developing and funding more involved actions; and
- that spending now to prevent problems later can save towns money in the long-run, and helping to reduce P loads to the Lake would be a valuable first step.

The Vermont Local Roads Program is an example of efforts being made in this direction, though not explicitly focused on P issues. It is important to increase efforts like this and expand them to deal with all aspects of municipal governance that affect P loading.

Access to Qualified Staff

Option 21: Create staff positions at the county, watershed, or regional level that are dedicated to planning and implementing local municipal actions toward the reduction of P loads.

For a great many of the communities in the Basin, staffing is very limited. This is particularly true in the smaller communities, of which there are many. The Lake Champlain Phosphorus TMDL Implementation Plan calls for increased staffing to implement numerous initiatives (mostly in the Vermont Implementation Plan). Many of the increased staffing recommendations seem to be placed within Vermont ANR and in some cases within other statewide programs (e.g., the Vermont Local Roads Program).

Although the TMDL's increased staffing recommendations are important for the programs that it puts forth, the increased access to qualified staff recommendation made here suggests more staffing closer to the local level. This is for two reasons. First, staff persons that are part of one of the state agencies (e.g., Vermont ANR) are likely to be viewed as outsiders to the municipal governments. This may cause some perceptions of loss of local control and limit the effectiveness of the additional staff. Second, the levels of additional staff called for in the TMDL Implementation Plan, while probably adequate for the purposes described therein, will be inadequate to meet the needs of the following option.

These staff positions could be for a limited duration (e.g., 3 years), but should be long enough to work closely with each of the towns in the region to develop a plan with specific recommendations and assist in securing the necessary resources to implement the plan. These staffers should be able to make suggestions and help implement the immediate and minor actions that can be taken by the municipality to reduce P contributions (e.g., level of sand use, placement of sand piles, drainage ditch maintenance, etc.). They should also be able to assist the towns in creating longer-term plans for P control. This will be most effective if they can show the towns that implementing the proper plan can have long-term financial benefits for the town. Additionally and importantly, these staffers need to be able to dedicate the time to create connections between the towns and state and federal grant programs that may be necessary for the implementation of the plan. Staffers should assist in the preparation of proposals for funding related P reduction efforts.

The regional P control staffers could also coordinate the cooperative purchase and sharing of equipment used at the local level that can reduce the delivery of P to waterways and at the same time delivery more effective municipal services. Examples of such equipment are street sweepers, suction trucks for cleaning drop inlets in stormwater drains, and machinery for ditch and culvert maintenance. The appropriation of state, provincial, or federal money could be sought to fund these staff positions.

Cost-sharing / Financial Incentives / Regulations / Green Taxes

There are numerous types and levels of assistance and incentives that can be offered to municipalities for implementing actions to reduce the flow of P into streams, rivers, and the Lake. For communities that have a plan, human resources, and motivation, an acceptable financing mechanism may be adequate to implement the needed actions. For communities that do not perceive the need to take actions to reduce P loads, greater incentives will be required. Generally, providing a greater a level of incentives increases the overall costs of the action, but not in all cases. Additionally, having a program that increases the assistance based on a town's lack of motivation to address the P issue will send a perverse signal to towns to "drag their feet."

Therefore, an option may be to institute some regulations requiring a certain level of municipal action on this issue (as discussed below). Any regulations imposed may need also to provide towns with access to the resources required to comply. The following paragraphs discuss cost-sharing, financial incentives, and regulations. A combination of these mechanisms may prove to be most effective.

Cost-share

Option 22: Create a low- or no-interest ‘P reduction’ revolving loan fund from which communities in the Basin may borrow funds to finance activities that have a high probability of reducing P loads.

For towns that are motivated to take actions to reduce P loads, the availability of adequate cost-sharing and/or favorable financing terms may be an adequate incentive to implement these actions. If the towns in the Basin that are motivated to address this issue are also the same towns contributing the greatest P loads to the Lake, then a non-regulatory, relatively inexpensive subsidized loan program may be sufficient to induce the needed municipal action. Creating a subsidized loan program will likely be an important part of the solution. However, this seems unlikely to be sufficient to induce the needed level of municipal actions.

Whenever possible, coordinated and shared municipal actions should be encouraged to reduce the overall costs of implementing P reduction plans. An incentive for coordinated and shared municipal actions through this mechanism could be to offer increasingly preferential terms on loans that involve increased coordination among municipalities. This multi-town coordination could be initiated and facilitated by the county/regional staff recommended in the “Access to Qualified Staff” section. The types of purchases that could be made under this option include, but are not limited to, street sweepers and suction trucks for cleaning drop inlets in stormwater drains.

Option 23: Require all towns in the Basin to create a water quality plan for the town within their facilities plan in order to be eligible for state (or provincial) sewerage funding.

Option 24: Secure federal funds to be used in New York and Vermont to reduce the local share of road projects to 5 percent if the town can show that it has adopted the specified practices that will reduce erosion from roads, ditches, and around culverts. A similar program could be instituted in the Québec portion of the Basin.

With regard to local road maintenance, the Vermont Agency of Transportation (AOT) has a provision in its town roads grants program that reduces the local share of the total project cost by 10 percent if the town has adopted the set of relevant AOT codes and specifications related to quality road maintenance and conducted a local road infrastructure study. The decreased local share is often extended before the conditions are met and remain unfulfilled.

Option 25: Create grant and cost-share funds that are available to towns or groups of towns for the creation of (or investigation into) a stormwater utility.

The creation of stormwater utilities in towns or groups of towns represents the ability to have attention and funds devoted to the control and/or treatment of stormwater. This approach may not be appropriate for all towns in the Basin, but it certainly holds potential for many. Currently, South Burlington may be the only town in the Basin that is actively creating a stormwater utility.

A stormwater utility would be expected to address cost-effective treatment options. This is something that all towns with stormwater collection systems should be encouraged to consider. Studies have shown that 85 to 95 percent of total P is consistently removed with alum treatment (Harper et al. 1998).

Option 26: Provide cost-share funds for a municipality in the Basin to pilot-test the use of an aluminum sulfate (a.k.a. alum) treatment system.

There are numerous additional actions that a municipality can take with regard to the control of stormwater. These include both structural and nonstructural measures to increase infiltration and treatment of stormwater. In a policy context, these actions can be addressed with cost-sharing, financial incentives, and/or regulations. Many of these will be discussed in a following section as they apply to households and businesses in the Basin.

Financial Incentives

Although cost-share is a form of financial incentive, this section considers a class of options that would pay municipalities for a specified level of implemented practices or for achieving specified P reduction performance targets. This section is based on the assumption that even with education and outreach, access to staff, and cost-sharing programs, many towns will still not implement the practices and structures necessary to minimize P loads into surface waters. Therefore, financial incentives that motivate the municipality to act may be necessary, if a regulatory approach (discussed below) is deemed politically infeasible.

Option 27: Federal and state (and provincial) monies contribute to the Lake Champlain Basin P Reduction Municipal Action Fund. This fund can be used to reduce the tax burden on local residents in communities within the Basin that can document the achievement of stated P reduction actions. This fund would create a bonus payment to communities for action to reduce P loads, in addition to the assistance recommended above.

The criteria for receiving these financial incentives would be designed to inspire towns to conduct comprehensive planning and implementation to minimize P loads from the array of activities under municipal control. An important aspect of this approach is that it is a voluntary program. Towns will find it in their best interests to comply with the stated P reduction criteria by receiving the financial incentive. The incentive payments could be based on a percentage of the town's tax burden to the state or province.

Option 28: Pay towns a modest amount to create an active conservation commission. Funds could be drawn from the state budgets or the P Reduction Municipal Action Fund discussed above.

Towns with conservation commissions tend to have good natural resource sections in their town plans. Conservation commissions have the ability to incubate environmental champions from the citizenry.

The approach of financial incentives, as described in this section, is mostly about 'carrots' and not about 'sticks.' The largest concern with this approach is that it could be prohibitively expensive. An effective, non-regulatory policy approach will require significant funds to induce changes in behavior. In some respects, this represents part of the price of local control and individual freedom. A politically palatable and fiscally practical approach would likely combine both carrots and sticks. The sticks in this case are enforceable regulations.

Regulations

Option 29: Reduce the population criteria used to select the Phase II municipalities so as to apply to more towns in the Basin. Apply the six minimum stormwater control measures detailed in the Phase II rule to these towns. Provide funding to offset the costs where needed (as described above).

Phase II of the EPA stormwater program went into effect in March 2003. This has imposed multiple new regulations on several of the largest communities in the Basin. While it is essentially an unfunded mandate on these towns, it is expected to result in significant improvements in water quality. Applying the appropriate aspects of the Phase II regulations to more towns in the Basin is a policy option. This would likely be politically infeasible without associated funding to offset some or all of the associated costs.

Option 30: Require that all towns in the Basin adopt and enforce a minimum set of criteria to be included in local construction permits. These criteria should include most or all of the accepted construction site BMPs for erosion control.

Option 31: Require that all towns in the Basin adopt a driveway ordinance. This ordinance should require a permit from the town ensuring that the project meets or exceeds a minimum set of criteria. These criteria would likely include an erosion control plan with specifications on slope and other characteristics.

Less comprehensive regulations could also be used to require towns to address the most serious P transport issues. Erosion rates from construction sites are often 10 to 20 times greater than from agricultural land. It is important that proper erosion control measures be selected and implemented on all construction sites in the Basin. The current Phase II stormwater rule requires that this be established on all construction sites that disturb at least one acre of land. However, the vast majority of the construction sites in most towns in the Basin are for residential housing and generally disturb less than one acre. The cumulative effect of erosion on sediment and P loads from these smaller construction sites are likely to be very large. If the zoning in many Basin towns allows these smaller sites to be unregulated or unenforced, P loads from these sources will continue to offset gains made in other areas.

Driveways, like gravel roads, can be a significant source of TSS and P to lakes and streams as surface water is transported along them. The problem is accentuated when improper design and inadequate maintenance cause increased erosion. Sampling in the Basin showed P concentrations of 2.9 and 4.1 mg/L in runoff from back roads (Rutland NRCD 1999). The frequent occurrence of dirt and gravel driveways in rural and semi-rural areas of the Basin, due to increasing residential development, is likely to pose a significant threat to the Lake's water quality. Ensuring that driveways meet specifications and are maintained may have important effects on reducing P loads to the Lake.

Option 32: Require that all towns in the Basin adopt a Riparian buffer zone ordinance. This should stipulate a minimum 50 ft buffer of undisturbed vegetation along all perennial and intermittent streams.

Riparian buffer zones help to protect streambank stability and provide a filter for erosion and stormwater entering streams. This has been a contentious political issue in many Vermont towns recently. Regardless of its political palatability, adequate buffer zones have been shown to be a cost-effective means to protect water quality.

All regulations imposed on municipalities will likely face opposition on grounds of local control. These are difficult issues to address, but are nonetheless legitimate policy issues to consider.

Green Taxes

One approach that is mentioned in the TMDL is the use of "green taxes." Green taxes are a means of changing the relative prices or costs of goods or services (or actions) so as to result in improved environmental quality. Green taxes can result in improved environmental quality in two ways. First, by inducing a change in behavior by individuals and businesses based on the change in relative prices. Second, the revenue generated by green taxes can be used to fund desired environmental improvements through remediation and/or pollution prevention measures.

Relative prices, and hence behaviors, can also be changed through green subsidies, rather than taxes. This can be effective at changing behaviors, but costs money rather than generating revenues. Additionally, the concept of tax shifting, where national tax systems are restructured to reduce taxes on goods and labor and increase taxes on "bads" such as pollution or pollution-causing inputs, is being discussed as a policy tool in some European nations. This concept encourages production and the supply of labor, while reducing the production of pollution.

While substantive tax shifting is very unlikely in the Basin in the near future, the concept of green taxes and/or subsidies should be explored to help achieve the long-term P reduction goals set for the Lake. Encouraging citizens to consider the impact of their decisions and actions on the health of the lake is important for reducing P loads. In the economy, prices act as a guide for making decisions and allocating resources. However, there are no prices associated with the reduction of nonpoint source pollution. An important aspect of policy is to create and impose prices, where markets fail to do so, on items that affect important public goods, such as the health of Lake Champlain.

Option 33: Encourage or require towns to adopt a 'stormwater index' for residences and businesses. Assess an annual stormwater tax based on the index score.

The above option would most likely be used in conjunction with a stormwater utility, but could be used independently. The index would consider factors such as the amount of impervious surface, slope, vegetative cover, detention and infiltration mechanisms, and other factors. This option may require a significant amount of staff time to implement. However, the use of self- or third-party certification could reduce the staff requirements.

Meeting the long-term P reduction goals for the Lake will almost certainly require reductions in stormwater generation from existing properties, to help offset increased stormwater from new development. Imposing a tax on all properties based on the stormwater index would create an incentive for owners of existing properties to retrofit stormwater controls.

Point Sources

Option 34: Require that all wastewater treatment plants are subject to meet the necessary effluent P concentration levels to achieve the P reduction goals for the Lake.

Option 35: Designate funding to cover 100 percent cost-share for the necessary upgrades on all wastewater treatment plants in the Basin. Allow the cost-share funds to be used for all cost-effective modifications.

Option 36: Require that all re-permitting and plant modifications be completed in a time frame that will meet P reduction goals by 2016 or according to the accelerated P reduction schedule.

From a policy perspective, point source pollution is much easier to address than nonpoint source pollution. The New York and Vermont implementation plans in the Lake Champlain Phosphorus TMDL both seem to have an accurate estimate of the load reductions necessary from wastewater treatment plants to attain the TMDL goals. The Vermont implementation plan calls for the continued coverage of 100 percent of capital and construction costs from state grants. The use of anaerobic selector zones is highlighted as means for savings on operating costs. The New York implementation plan calls for all of the wastewater treatment plants in the New York portion of the Basin to contain the appropriate P discharge limits by 2012. This schedule may need to revisited if the accelerated P reduction goals for the Lake are to be achieved.

V. Analysis of Final Policy Options

This section describes the final list of policy options suggested for helping to meet the long-term P reduction goals set for the Lake. The policy options presented below are derived from the initial list of policy options described in the previous section. The final policy options are those that project staff and advisory team felt had the greatest potential for reducing P loads in a cost-effective and socially and administratively feasible fashion. The final list also reflects the recommendations of the Phosphorus Reduction Task Force (PRTF) after members reviewed the initial list of policy options. The scale of this project did not allow for formal analyses to be conducted on all of the policy options on the initial “long list”. Therefore, a consensus approach was used to narrow down the long list into a manageable final list upon which formal analyses could be conducted.

Some of the final policy options are designed as a broad set of incentives with which flexibility can be used to achieve P load reductions. As such, these broader policy options (e.g., Options AG4, DL1, and DL3) incorporate indirectly many of the concepts found in the initial list of policy options. In these cases the discretion is left to the agent (i.e., farmer, home owner, municipality) to choose the most logical course of action to reduce P loading and improve water quality. These types of flexible incentives are more likely to result in lower-cost solutions, because they provide alternatives through which agents can comply with the policy goals.

A. Policy Options for Agricultural Land

Dairy farming remains the dominant agricultural activity in the Basin, accounting for 70–80 percent of agricultural revenues. Dairy farming probably accounts for an even greater share of the agricultural P sources in the Basin. Reliance on feeds and fertilizers imported into the Basin (primarily grains) to support increasing per-cow milk production levels are contributing to P surpluses on dairy farms. The policy options discussed below to control P from agricultural land will be focused primarily on dairy farming. However, the concepts can generally be applied, as necessary, to other types of agricultural operations. Several policy options, discussed below, are designed to address the issue of P loads from agricultural land in the Basin.

Agricultural land is estimated to contribute 56 to 66 percent of the nonpoint source P loads across the Basin (Hegman et al. 1999; Meals and Budd 1998). Dairy production, while declining as a percentage of the region’s agricultural revenues in recent decades, remains by far the most dominant sector of the Basin’s agriculture. The Lake segments of greatest concern regarding P are also some of the most important agricultural watersheds in the Basin. These include Missisquoi Bay, St. Albans Bay, and the South Lake segments.

Recent research predicts that the current trend of decreasing farm numbers will continue over the next two decades, such that the Northeast will lose 80 percent of its dairy farms between the years 2000 and 2020, with about half of the herds having fewer than 100 cows (LaDue 2003). The research also predicts that by 2020 New York farms will have an average herd size of 250 cows. Accompanying these trends, we can expect to see an increase in confinement feeding, a decrease in pasture use, and more intensive cropping systems. These changes in the structure of the dairy industry will affect P loss from agriculture in several ways. Although fewer farms will allow easier coordination and/or regulation for pollution control, larger farms present a greater risk of catastrophic pollution events and more intensive cropping practices may cause greater chronic P loss through soil erosion. Future policies need to reflect the expected changes in the structure of the Basin's dairy industry.

Managing P runoff from agricultural land in the Basin has been identified as the most important single effort for meeting the 20-year P reduction goals in the Lake (Donlon and Watzin 2001). The implementation of best management practices (BMPs) for agriculture is the primary vehicle currently being used to control agricultural nonpoint P. However, even if BMPs were implemented on all the remaining farms in the Vermont and Québec portions of the Basin, the long-term P reduction goal would likely not be met (Donlon and Watzin 2001). This emphasizes the need for alternative policy approaches with appropriate incentive mechanisms to control agriculture's contribution to the P loading problem in the Lake.

Farmers generally make management decisions in a rational manner. They respond to signals from the marketplace and society to prioritize their actions. The low milk prices of recent times in the U.S. have placed additional burdens on the Basin's dairy farmers. Farmgate milk prices have generally not kept pace with inflation in the general economy, including the cost of many farm inputs. This results in diminished profitability and pressure on farmers to either increase cow numbers or to exit the industry.

The impact of these trends on environmental conservation efforts by farmers is significant. The lower real farmgate prices for milk are a signal to farmers that they are required to produce milk for less cost than in the past. For many farms in the Northeast, the milk price is often below the full economic costs of production (Pelsue et al.1994). Dairy farmers have witnessed their share of the retail dollar spent on milk decline over the past two decades. Additionally, farmers have come under increasing scrutiny in recent years in regard to the environmental impacts of their operations. Many farms are financially unable and/or politically unwilling to comply with mandated environmental conservation practices. As businesspersons, farmers are not receiving market signals that good stewardship is valued by society. Although not all of the policy options discussed below suggest the use of financial incentives or market mechanisms, this report strongly recommends that for long-term and sustainable solutions to agri-environmental issues, policy should provide rewards to farmers for the provision of environmental quality. As opposed to mandating practices, clear expectations and financial rewards will result in the integration of environmental quality into farm business planning.

It is also important to note that it may be politically and administratively difficult or infeasible to make the following policy options applicable only to the Lake Champlain Basin without including the other sections of Vermont, New York, and Québec. The alternative, however, to include all of Vermont, New York, and Québec, may be exceedingly costly and overly burdensome in areas where P is not the primary water quality issue.

Option AG1: For near-term reductions in P export from agricultural land in the Basin, implement and enforce regulations on livestock exclusion from water bodies and minimum requirements for vegetative buffers along rivers, streams, and shorelines as soon as possible. Additional education and outreach, as well as enforcement, of the existing Vermont AAPs should also be implemented.

Option AG1a. Require livestock exclusion from all and lakes, ponds, rivers and streams classified by USGS as first order (blue-line) or greater by April 1st, 2006. Exceptions will be made for designated stream crossings.

Description

Throughout Vermont and New York livestock generally have free access to streams and streambanks. In Québec, this will be prohibited as of April 1, 2005. This policy option suggests that Vermont and New York enact regulations to prohibit livestock access to any lake, pond, river or blue-line stream by April 1, 2006. Exceptions will be made for planned crossings as approved by the implementing agency. Compliance should be enforced through the imposition of fines.

Technical effectiveness of livestock exclusion

A 7-year study in the Basin has shown that livestock exclusion and riparian restoration was able to reduce total P export from small agricultural watersheds by 49 percent (Meals, 2001). Reductions in nitrogen export (38 percent) and bacteria levels (35–45 percent) were also demonstrated from the treatments. These water quality improvements were attributed primarily to reduction in direct deposits of animal wastes and other organic matter in the streams and the reduction of streambank erosion; the filtration of overland flow by the restored riparian areas may also have contributed to reductions in pollutant loads.

Coefficients are being used in the Basin to estimate the average P reduction associated with categories of agricultural BMPs. For the category labeled ‘grazing management,’ which primarily refers to livestock exclusion, it is estimated that this practice will result in a reduction of 0.227 kg P per AU per year. An LCBP committee is currently reviewing and updating the set of BMP effectiveness coefficients in an effort to make them more accurate and robust.

A Wisconsin study has shown that streambank fencing in conjunction with conservation tillage and manure management was able to reduce total P loads by 88 percent (USEPA 2003a). However, it is not known how much of this reduction is due to streambank fencing. Line et al. (2000) found that livestock exclusion from streams resulted in a 76 percent reduction in total P load in the stream. The general body of scientific evidence suggests that streambank fencing and riparian restoration are effective ways to reduce P loads and improve water quality.

Cost-effectiveness of livestock exclusion

The "Lake Champlain Diagnostic-Feasibility Study" (Vermont Dept. of Environmental Conservation and New York State Dept. of Environmental Conservation 1997) used an estimate that livestock exclusion costs approximately $45 per animal unit (AU). This represents the present value of the capital and maintenance costs over a 30-year period using a 5 percent discount rate. The P Reduction Task Force felt that this estimate was too low. Therefore, for this analysis the cost estimate for livestock exclusion has been increased by 22 percent to $55 per AU. Using the coefficient for grazing management (0.227 kg P) discussed above, it can be estimated that for every $1,000 dollars spent on livestock exclusion, approximately 4.13 kgs of P per year can be reduced from the load entering the Lake. This results in an estimated P reduction of 124 kgs over the 30-year expected life of the fencing. According to these estimates, the cost-effectiveness of livestock exclusion is $8 per kg of P reduced. The coefficients used in the Diagnostic-Feasibility Study show livestock exclusion to be more than 3 times as cost-effective as any other of the BMP categories.

It is important to realize that the P reduction coefficients are only rough estimates, with some uncertainty in their accuracy transmitted to the estimates of cost-effectiveness. Readers and policy makers need to be aware that in the absence of robust scientific research results, best estimates are used to gauge technical- and cost-effectiveness in this report. This report will attempt to be as clear as possible regarding the accuracy of the estimates used.

It is also important to note that not all livestock farms use pastureland for grazing. Most of the larger operations use confinement-feeding systems. On these farms cows are not on pastures or in streams. Therefore, this policy will have no effect on these farms.

Option AG1b. Establish and enforce a minimum 50-ft vegetative or forested riparian buffer on all cropland where runoff enters permanent water bodies by April 1, 2005, in Vermont and New York.

Description

The Vermont Accepted Agricultural Practice legislation as defined under 10 V.S.A. 1259(f) describes reasonable regulations for vegetative riparian buffers. These regulations call for buffer widths of 25 ft where runoff occurs as sheetflow and 50 ft where runoff occurs as channelized flow. Scientific advisors to this project estimate that sheetflow runoff is fairly uncommon relative to channelized runoff. Therefore, the policy should be amended to require 50-ft buffers wherever runoff occurs into lakes, ponds, rivers, and blue-line streams, and enacted and enforced in New York as well as Vermont. Fines should be assessed for noncompliance. The flatter topography of Québec may result in smaller buffers being sufficient for reducing P runoff in that portion of the Basin.

The USDA Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) are being used to provide incentive to farmers to establish riparian buffers with a particular focus on reducing P loads from agricultural land in the Basin.

Background
Buffer zones can be effective at reducing P run-off in the short-term. The width of the buffer affects its ability to reduce P run-off. Over the long-term, the effectiveness of buffer zones will be limited if on-farm management of P sources is not effectively controlled (Wenger 1999). Therefore, the establishment of buffer zones throughout the Basin can be viewed as a relatively easy and inexpensive, immediate step toward controlling P loading from agricultural land. The establishment of buffer zones throughout the Basin would help keep the P reduction goals on track in the short-run, while longer-term solutions regarding P source control are being implemented.

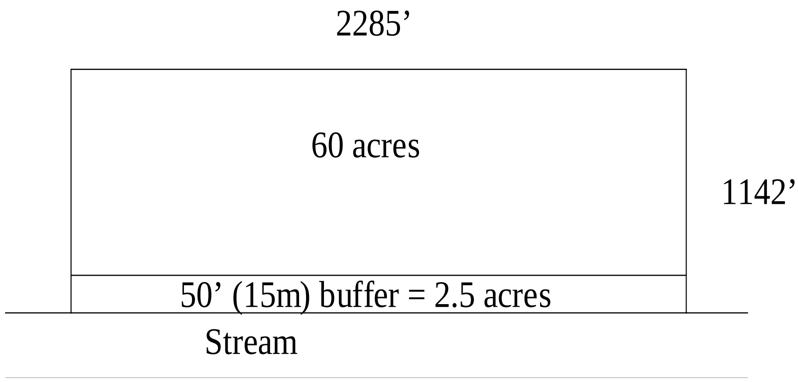
Currently, Vermont and Québec require that a vegetative buffer zone exist between all agricultural cropland and the top of the bank of adjoining waters where runoff occurs. In Vermont the required width of the buffer zone between perennial surface water and row cropland is 25 ft or 50 ft depending on the type of surface flow across the land (sheet flow versus channel flow, respectively). It is perceived by some, that the adoption and adherence to this provision of the Vermont AAPs is not as widespread as it could be (Hopkins 2004). However, actual adherence to this provision has not been formally evaluated. In Québec, the requirements for riparian buffer zones are relatively minimal; 3 m from the highest water line for the previous 2 years and at least one meter of the slope must be covered in vegetation. New York has no regulations on the use of vegetative buffer zones, but CAFOs are subject to application setbacks where they are not allowed to spread manure within 100 ft of a watercourse unless a vegetative buffer of at least 30 ft is present.

Technical effectiveness of riparian buffers
Research results on the effectiveness of vegetative buffers vary widely. Results from the Basin show that a 7.5-m buffer reduced P concentration in run-off by 25 percent, while a 15-m buffer reduced P concentration by more than 70 percent (Jokela et al. 2002). Experimental plot studies in the U.S. have show total P reductions that range from 44 to 93 percent and wider buffers generally provided more than a proportional reduction in P (Muscutt et al. 1993). Results from Sweden show that a grassy buffer of 8 m reduced phosphate concentrations by 66 percent, and a buffer of 16 m by 95 percent (Vought et al. 1994). It must be noted these studies are usually short-term and may overestimate the actual, long-term P reductions.

If we use a hypothetical, rectangular, 60-acre field as an example (as shown in the figure below), it has 0.43 miles of stream frontage. A 15-meter or 50-ft buffer on this field would occupy 2.5 acres of field area along the stream. Using the Basin-wide P export coefficient for agricultural land (as developed by Hegman et al. 1999) of 0.8247 kg P (0.3741 lb P) per acre per year, this field would export 49.49 kgs P each year. Applying a conservative estimate of 50 percent P reduction from a 15-meter buffer, the reduction from this field would be 24.75 kgs per year.

The effectiveness of riparian buffers will differ from tilled cropland to hay fields. The vegetative cover of hay fields will act to reduce the soil erosion and surface flow on the field relative to a field of row crops. Therefore, it can be assumed that the P reduction resulting from riparian buffers will be lower on hay fields than the estimates stated above.

Figure 1. Diagram of a representative 60-acre field with a 50-ft riparian buffer.



Cost-effectiveness of riparian buffers
The primary cost associated with riparian buffers is the opportunity cost of forgoing crop production on the acreage that becomes the buffer zone. While this cost will vary based on the type of land and crops grown, the cost can be approximated based on the average rental rate for cropland. An upward adjustment should be made to the average rental rate of cropland for two reasons. First, the soils along rivers and streams tend to be more productive than average soils. Second, if additional cropland is rented by farmers, it may be further from the farmstead, which increases the transportation costs associated with crop production. For these reasons, we will assume that the per-acre cost of forgoing cropland for riparian buffers is 150 percent of the average rental rate for cropland in that area.

It should be noted that some riparian areas are subject to frequent flooding, which will negatively affect planting and harvests in some years. Therefore, flooding will reduce the effective value of the land and the opportunity costs associated with creating riparian buffers. This cost reduction is not factored into this analysis so as not to underestimate the cost to the farmer of this policy option.

For each mile of riparian frontage, a 50-ft riparian buffer will occupy 6 acres. The average rental rate for cropland in the Northeast is estimated to be $42 per acre for 2003 (USDA, 2003) and between C$25 to C$50 in Québec. Using the hypothetical 60-acre field discussed above, the cost to the farmer of forgoing production (opportunity cost) on the 2.6 acres of buffer in Vermont would be $164 per year. This represents 150 percent of the cropland rental rate. Based on the estimated reduction of 24.75 kgs P, the cost-effectiveness of this strategy would be approximately $6.62 per kg of P reduction.

The amounts of money being spent on riparian buffers through CRP and CREP are much greater than the costs described above. With CRP, farmers with qualifying land receive a one-time sign-up incentive payment (SIP) of $150 per acre, usually 90 percent cost-share for establishing the buffer, and an annual conservation rental payment of $45 per acre.

With CREP, they can receive a SIP of $1,100 per acre for a 10-year contract and $1,700 per acre for a 15-year contract from state CREP money. Additionally, federal money will be used to double the rental payment. Therefore, with CREP, qualifying land will be receiving $200 per acre per year (not including cost-share funds for establishing the buffer). Using the example above, P reductions from voluntary buffers through CREP cost about $218 per kg.

Other costs associated with implementing riparian buffers on cropland in the Basin include repairs and maintenance of the buffer; staff time for education and outreach on the importance of riparian buffers for water quality; and monitoring and enforcement of the regulation. Education and outreach will be required for the first 2 years and monitoring and enforcement will be ongoing. Staff responsible for these duties will also be able to cover several other agricultural conservation efforts.

This analysis estimates that the staff requirements for general education and outreach and monitoring and enforcement on agricultural pollution control are 1 FTE per 200 farms, which will create a very heavy workload for these staff. This staffing level would result in 4 FTEs required for agricultural conservation efforts in the Vermont portion of the Basin, 2 FTEs in the New York portion of the Basin, and 1 FTE in Québec. These staff will not provide individual technical assistance to farms, which will continue to be provided by NRCS and private consultants. It is estimated that for each staff person responsible for compliance with agricultural conservation efforts, 20 percent of his/her time will be dedicated to riparian buffer issues. Therefore, a total of 1.4 FTEs will be required Basin-wide (20 percent of 7 FTEs) to implement the agricultural buffer zone regulation. The total cost of 1 FTE at the state level is estimated to be $75,000 per year ($105,000 for riparian buffers on agricultural land). Unfortunately, estimates of the P reduction from riparian buffers basin-wide do not exist, which are needed to convert this staff cost to per-kg of P reduced. However, when this cost is distributed over all of the cropland adjacent to waterways, it is likely to be very minimal on a per-acre and per-kg of P reduction basis.

Socio-political Viability of Option AG1

Farms and farmers are an essential part of the economic and cultural landscape in the Basin. The economic pressures that most dairy farmers currently face are causing large numbers of producers to exit the industry, thus changing the landscape and rural economies in the Basin. Farmers also tend be independent and sometimes resistant to the imposition of regulations and requirements placed on their operations. Therefore, the socio-political viability of any of the policy options discussed in this section rests on the estimated costs and benefits to the farmer, the amount of change in operating procedure that is required on the farm, and the level of farmer ‘buy-in’ regarding the perceived need for the policy action. The new USDA Conservation Reserve Enhancement Program (CREP) being administered by the Farm Service Agency is a voluntary program that provides funding for the establishment of riparian buffers. This policy should be linked closely with CREP efforts in the Basin.

Livestock exclusion via streambank fencing costs approximately $1.50 per linear foot, with stabilized stream crossings costing about $2,000 to construct (Webb 2003). With state and federal funds available for cost-sharing, this does not have to be prohibitively expensive to the farmer. However, in Vermont required practices as stated in the AAPs are not eligible for federal or state cost-share programs. As such, requiring livestock exclusion may place an excessive burden on the smaller farms that use pasture more widely.

Livestock exclusion requires farmers to make adjustments in their production practices. These include providing water for the cattle to drink while on pasture, which can be a formidable (but not insurmountable) challenge for dairy farmers. Water sources could be at planned access points to the stream, water pumped from the stream, or pumped from another source into the pasture. This issue can and should be addressed at the design stage and, therefore, not require significant changes in daily operating procedures on the farm. Regular repair and maintenance of fencing will be required, which can impose a significant burden on the farmer's time.

The opportunity cost associated with losing pastureland to riparian restoration seems to be quite low. Conventionally managed pasture is not highly valued land to many dairy farmers. Meals (2001) found that participating landowners expressed few concerns about the amount of pastureland being lost to protected riparian zones. However, some farmers refused to participate in the study for a variety of reasons. These include perceptions (1) that livestock exclusion is impractical, (2) that cows in the stream do not contribute greatly to pollution, (3) that pollution is not a serious issue, and (4) that their property rights supercede any pollution issues.

As stated previously, streambank fencing will apply only to farms that are using pastureland for their livestock. The proportion of farms using pasture is higher in Vermont than in the New York portion of the Basin, where larger-scale confinement operations are becoming the norm. A policy that requires streambank fencing may place a much larger burden on the Basin's smaller farms. Smaller farms are considered by many to add value to the Basin's rural economies and working landscape. These farms are already facing great financial pressures. For these reasons, placing additional burdens on smaller farms may be an undesirable effect of this policy option. It should also be noted that this policy may deter some farmers from using grazing systems. The scientific literature suggests that well-managed pasture land can reduce erosion and nutrient loading, and sequester more carbon relative to tilled cropland.

The principal socio-political viability issue regarding streambank fencing and riparian buffers will likely be whether farmers in New York and Vermont perceive the need for this regulation. It is likely that there would be considerable opposition to such a regulation on the grounds that it imposes unnecessary constraints on farming operations. A concerted education and outreach effort focused on the benefits of streambank fencing and riparian buffers will help to increase farmer acceptance of this option. However, mandating a one-size-fits-all approach, such as this, may not be a good long-term solution for reducing P export from agricultural land, because it may undermine the integration of least-cost solutions into the farmer's planning process. This issue is addressed in Option AG5.

Administrative Requirements of Option AG1

The primary administrative requirement related to this policy option is the addition of adequate, qualified staff to conduct education and outreach and enforcement of agricultural water quality regulations. It is estimated that conducting education and outreach and enforcement of a full suite of agricultural water quality regulations in the Basin will require 4 FTEs in Vermont, 2 in New York, and 1 in Québec. Thirty to forty percent of the staff time could be consumed dealing with the livestock exclusion and riparian buffer regulations as described in this option.

Option AG2. Enact nutrient management legislation in Vermont and New York that requires all farms with a stocking rate over 0.5 AUs per acre to develop and implement certified nutrient management plans (NMP). Each farm's plans should be evaluated using the State's official phosphorus (P) index to identify areas (fields) that have a high risk for P loss to surface waters. Specific nutrient management guidance for each field will be determined based on the P index score.

Description

All livestock operations in Vermont and New York with a stocking rate of 0.5 AUs per acre or greater should be required to develop and implement certified nutrient management plans by December 31, 2006. Farms in priority watersheds within the Basin should be placed on an accelerated schedule. This should include farms in watersheds that flow into the Missisquoi Bay, St. Albans Bay, and South Lake A and B lake segments.

The stocking rate of 0.5 AUs per acre, equal to 1 cow per 2 acres, was selected as a rate that is somewhat greater than the rate at which the land could assimilate the P generated by the herd (roughly 0.33 AUs per acre) and as a rate the will require NMPs on a significant portion of the Basin's dairy farms. Clearly, the risk of P loss is not solely a factor of the stocking rate. Manure storage, spreading, and incorporation are also important factors related to P loss. Requiring NMPs for all farms with a stocking rate of 0.5 AUs per acre or greater will ensure that steps are taken to minimize water quality degradation where assimilative capacity is inadequate. Although there are not recent data on the stocking rate of farms in the Basin, the agricultural advisors to this project felt that 0.5 AUs per acre would encompass the majority of farms.

Each farm's NMP must provide the necessary information to assess the risk factors for soluble and particulate P export from each field, based on an accepted P index in each State. The value of utilizing a P index approach is that it provides flexible management options to address agronomic concerns while providing protection from agricultural P impacting water quality.

The implementation of this policy in Vermont and New York should be the joint responsibility of the Department of Agriculture and Department of Environmental Conservation in each state, and the USDA NRCS. NRCS should supply technical guidance and assistance to farmers. The State Departments of Agriculture should take responsibility for receiving and filing all required nutrient management plans and records, as well as provide further technical assistance. The State Departments of Environmental Conservation should provide oversight for compliance, as well as enforcement. The implementation of this policy should build on the efforts of the agencies currently administering NMPs for CAFOs in each state, but other agencies should also be closely involved to distribute the administrative burden and provide additional accountability.

The current approach to NMP in Vermont and New York is according to the NRCS Technical Guidance on this subject. It requires soil testing once every 3 years, the use of risk-assessment tools such as the P index, and appropriate nutrient application recommendations based on test results. NRCS requires NMPs on all farms that receive cost-share funding through the agency and store or apply animal wastes. The State of Vermont requires NMPs as part of the Large Farming Operation (LFO) permitting process (essentially for farms with more than 700 dairy cows). The State of New York requires NMPs on farms with over 200 mature dairy cows. Policy option AG2 will result in NMPs being required on a much larger percentage of farms in the Basin.

This policy option will require information on the stocking rate of all livestock farms in the Basin. Currently, there is no administrative mechanism that provides this information. Farms that qualify as CAFOs or LFOs are required to register with the appropriate agency (VDAFM in Vermont). The VDAFM does some spot checking related to AUs, but does not collect information on the land base. The agencies administering the CAFO or LFO programs should be responsible for collecting stocking rate information for all livestock farms. This task will require an additional administrative program, one to which all livestock farms report their herd size and usable land base on an annual basis. Supporting information should be included in this reporting, such as annual gross sales and land rental agreements.

Background

Currently, farms in Vermont and New York are required to adhere to P-based nutrient management plans if they are designated a CAFO (or LFO in Vermont) and/or they receive federal cost-share money for manure management on the farm. This policy option suggests applying the same standards to all livestock operations with greater than 0.5 AUs per acre. While CAFOs represent an increasing proportion of the total number of livestock farms, AUs, and acres in the Basin, there are many farms, fields, and AUs for which the current policy does not apply. Farms with higher stocking rates are more likely to have nutrient loading and P export problems (all other things being equal) than farms with lower stocking rates. Without including more farms in the current nutrient management efforts, it will be difficult to meet the P reduction goals set for the Lake.

A study in Wisconsin showed that the average dairy farm accumulated 33 kgs P per acre per year and that small farms were just as likely as larger farms to have high accumulation rates (Erb and Fermanich, 2002). Generating P surpluses is more likely to be related to stocking rate than to herd size. Québec currently has regulations requiring P-based nutrient management on all livestock farms. Initially, they have found the required paperwork to be burdensome on the limited staff resources and that the demand for additional land has increased greatly.

Nutrient management planning has been advocated by Extension and other institutions for many years because of its value to production and farm profitability. Requiring NMPs in Vermont and New York may have a net benefit on many farms. Nutrient management legislation exists in Pennsylvania, Maryland, and Delaware. In Pennsylvania, the law applies to all farms with at least 2 AUs per acre, affecting approximately 10 percent of the livestock farms. In Maryland and Delaware, the laws affect essentially all livestock operations. Appendix A contains descriptions of the nutrient management laws in Maryland and Pennsylvania.

Technical Effectiveness

If the nutrient management guidelines associated with the P index are followed, the risk of excessive P loss from any given field should decrease to an acceptable level (if it is not acceptable to start with) over time. It can take many years for soil test P levels to decrease, even without the addition of any additional P sources. However, the P index approach gives farmers several management options for lowering the risk of P loss. These requirements should increase the distribution of manure across the farm. Ideally, the use of the P index should prevent the long-term, excess application of P on fields with low risk due to fear that the fields will become regulated as the soil test P level rises. In reality, highly stocked farms with few other options for manure disposal will likely apply manure to all land where it is allowed. Shipping manure off farms will likely remain an option of last resort.

Because the P index is field specific and will regulate the nutrient management of fields at high risk for P loss, it is virtually impossible to estimate how much P will be reduced by this policy option across the Basin. It can be presumed, however, that adherence to the prescribed nutrient management guidelines will greatly reduce the P loss from high-risk fields relative to the absence of P-based nutrient management. The high-risk fields are most likely those that contribute the majority of P from agricultural land. Overall, it is estimated that the technical effectiveness of this policy option for reducing P loads is ranked as moderate.

The P indices include many factors related to P sources, transport to the field edge, and retention in a riparian buffer. On fields with a high P index score, the farmer will have some flexibility to make management changes that will reduce the score. These include, but are not limited to, conservation practices to decrease erosion, more rapid incorporation of manure into the soil, establishing or increasing the buffer size or vegetation, and/or reducing the sources of P applied. It is important to note that the P indices used in Vermont and New York are slightly different. However, this difference should not affect the technical effectiveness of this policy option. Farmers should choose the least-costly options for reducing the P index score first.

It should be noted that P-based nutrient management in Québec has increased the demand for land on which manure can be spread. Two primary effects of this have been increased conversion of forest land to agriculture and an increase in the value of agricultural land. The conversion of forest land to agriculture has the potential to increase the total P loads to the Lake. Careful analysis of these dynamics must be undertaken to estimate the impact of this policy option on total P loads to the Lake. Such analysis would require data collection on farmers' likely responses to P-based nutrient management with simulation modeling used to determine the impact on total P loads to the Lake.

Cost-effectiveness

Without reasonable estimates regarding the likely P reductions from this policy option, it is impossible to estimate the cost-effectiveness. There are three types of costs that will be incurred with this policy option. These include the costs associated with creating and revising the farm's NMP, costs associated with management changes required for implementing the plan (this set of costs could be positive, negative, or zero), and administrative costs.

All farms with a stocking rate over 0.5 AUs per acre will be required to develop a NMP and conduct soil and manure sample analyses. It is unknown how many farms this regulation would apply to. As mentioned above, there are no recent data on the stocking rate of farms in the Basin, but the agricultural advisors to this project felt that 0.5 AUs per acre would encompass the majority of farms. The analysis of soil samples costs from $8 to $12 and the analysis of manure samples costs from $30 to $45. A nutrient management plan must be created by a certified nutrient management planner. If the farm operator does not have this certification, a consultant will need to be hired, thus further adding to the expense of this regulation. It has been estimated that the annual cost for revising the NMP and the required scouting will be between $5,000 and $10,000 for a typical 200-cow dairy farm (Thomas 2003; Wood 2003).

For farms with a high percentage of fields that score low on the P-index rating, management changes on the farm will be minimal. For these farms, the cost of this regulation will entail only the cost of the soil and manure sampling and the creation of the NMP. For all farms, it is possible that following the NMP will increase the yields and profitability of crop production, thereby reducing the total cost of this policy.

The cost of this policy will be greater for farms that have a higher percentage of fields that score high on the P index rating. In general, high P-index scores are more likely on farms with higher STP levels, greater stocking rates, and more proximity to surface water. Farms that do not have low-risk land on which to apply manure will need to acquire the use of more low-risk land, or to find ways to produce less manure, reduce the P content of the manure, or export manure off of the farm. For these farms, complying with this regulation will require significant changes in the farming operation, which could be costly. The least costly options for farms in this situation may be to rent or purchase additional land that has a low P-index score (the amount needed will depend on the farm and its current P balance), or to pursue precision P feeding. More costly options would be to export manure off the farm or incur the opportunity cost of reducing the herd size so as to produce less manure. Depending on the magnitude of change, these costs could exceed $10,000 per farm per year.

Significant increases in staff resources will be required to implement this policy option. Initially, numerous certified nutrient management planners will be needed to assist farmers in creating NMPs. Many farmers look to the private sector to provide the service for a fee. However, there is not likely to be adequate certified nutrient management planners available from the private sector initially. To address this lack of NMP services available to farmers, 10 FTE staff positions are required basin-wide for the first 3 years of this legislation to assist farmers who require them. These positions are in addition to the private sector and crop management association personnel that currently provide these services. The estimate of 10 FTEs for NMP assistance is based on 80 farms per FTE or 3.25 days per farm of assistance. At $75,000 per FTE (total cost), this would require $750,000 per year for the first 3 years. After 3 years, perhaps only 5 FTEs may be required for technical support and enforcement. The overall cost-effectiveness of this policy options is ranked as moderate.

Socio-political Viability

Most livestock operations in the New York portion of the Basin and in Vermont are currently under great financial stress due to the price of milk relative to average milk production costs. Many farmers are likely to perceive this policy as excessively constraining on their operations. With negative profit margins on many farms in the region from early 2002 through 2003, any additional costs may be excessively constraining and could cause some farms to exit the industry. However, as mentioned previously, NMPs can increase farm profitability in some cases.

The impact of farm profitability on farmer's willingness and ability to incur costs related to conservation practices cannot be overlooked. The case of Québec provides a good example. The Canadian supply management policy guarantees an adequate milk price for all of the milk for which the farmer owns quota to produce. While this system is associated with its own set of constraints, it allows a farm family in Québec to maintain profitability with a herd size as small as 35 cows. Uncertainty about financial returns and pressure to expand are minimized in the Canadian dairy industry, and the ability and willingness to comply with environmental regulations is generally much greater.

Administrative Requirements

Administering this policy will require significant increases in staff in both Vermont and New York. The staff will be required to help farmers create NMPs and to calculate the P index values for each field, provide nutrient management guidelines and technical advice, and monitor compliance. It is estimated that 1 FTE will be required for every 75 farms that are regulated under this policy option and do not already have technical assistance. This staffing rate will allow approximately 3 days of staff time per farm per year.

Option AG3. Subsidize and facilitate the creation of systems that allow livestock farms to reduce P surpluses.

Background

In the long run, managing nutrients in accordance with P-based criteria will require that farms are essentially in a P mass balance. Most dairy farms in the Basin will not be able to achieve a P mass balance without either increasing their land area, decreasing their herd size, reducing P sources in imported feed, and/or shipping manure off the farm.

This policy option describes three options that are intended to facilitate the movement toward P balance on livestock farms in the Basin by shipping manure off the farm and removing P from the manure. This policy option will be most useful in conjunction with other measures that require or inspire farmers to address nutrient imbalances on the farm, such as options AG2 and AG4, respectively. Three specific recommendations follow.

Option AG3a: Create a subsidized program that allows livestock farms to ship manure from the farm to centrally-located processing facilities in the most livestock-dense watersheds.

The manure processing facilities could include composting and/or anaerobic digestion for electricity generation. Both processes create saleable products. Processed manure should be used in stable applications (e.g., mixed with soil to support permanent vegetative cover) related to building or road construction projects or at residences within or outside of the Basin.

The Dairy Manure Export Support (DMES) Program is an innovative effort to the P-loading problems in the North Bosque and Leon River watersheds in Texas. The program has removed more than 678,000 tons of manure from farms over a 3-year period ending in October 2003 (Texas State Soil & Water Conservation Board 2003). The entire DMES program, including hauling costs and program administration, costs less than $4 per ton of manure hauled.

The DMES program uses Section 319 grant funds from EPA to reimburse haulers for transporting manure from dairies to composting operations in the watershed. Eligible farms, haulers, and composting operations must be registered with the program to participate. The Texas State Soil and Water Conservation Board contracts with the Texas Institute for Applied Environmental Research and Imanage LLC to implement the project. The project initially paid haulers the full cost of transporting the manure ($2.25/first mile plus $0.15/additional mile). Eventually these payments were lowered to $1.35 + $0.10, with the farmers expected to pay the difference. A thorough description of the DMES program is included in Appendix B.

The structure and situation of the dairy industry in the North Bosque and Leon River watersheds is very different than that of the Lake Champlain basin. The majority of dairies are CAFOs with an average herd size estimated to be above 700 cows. The P problem in these watersheds is severe and the CAFO permits require strict P-based nutrient management. This, in combination with the very high stocking rates on many of the dairies, makes it necessary for many farms to ship manure off the farm. While the project has removed more manure than expected from farms, the greatest challenge is finding markets for the composted manure.

Option AG3b: Create a matching service to link farms with surplus manure to farms that could use the manure. This could be done with minimal funds through the Extension services.

In addition to centralized manure processing facilities, a Web-based manure-matching service could easily be created. This would allow livestock farmers to find crop farmers who are in need of manure. Any farms receiving manure should be required to comply with nutrient management legislation (Option AG2). A Web-based manure-matching service could be implemented and managed by the Extension services in Vermont and New York.

Option AG3c: Make additional cost-share funding available for farmers to remove P from manure produced on the farm.

There is a common misperception that 50 percent or more of P in manure stays with the solid portion after liquid-solid separation. Although this can vary depending on the method and chemical treatments, the scientific literature shows that the P in the solids portion after mechanical separation is generally less than 30 percent (Ford and Flemming 2002). It is important farmers do not assume that the liquid portion has 50 percent or less of the original P content and then land apply the liquid according to N needs. This will result in excess P applications. Composting of the solids portion on the farm is possible; compost could then be sold, used as a more stable soil amendment, or shipped off the farm. There are at least two new manure treatment processes that are likely to be pilot-tested on farms in Vermont in the near future.

Vermont Organics Reclamation, Inc. is hoping to pilot-test an on-farm dairy wastewater treatment process that, according to company claims, isolates the majority of manure P (83 percent) in the liquid filtrate and then uses an electrocoagulation process that removes 78 percent of the P from the filtrate. The total reduction of P from dairy farm waste would be 65 percent. This process should be examined by Basin scientists and evaluated with by on-farm pilot-testing if warranted. Another on-farm treatment process utilizing solids separation, methane digestion, and bio-filtering will be pilot-tested in Vermont by BioProcess, Inc. of Rhode Island. Both processes claim to result in a nutrient-dense sludge that can be more easily applied, transported, or sold, and a liquid that will meet EPA clean water discharge requirements.

New technologies should be closely examined for their potential to reduce surplus P from farms in the Basin. The two technologies mentioned above, if successfully pilot-tested, offer such potential. If these technologies are to be widely adopted, cost-share funding at the farm level will be necessary. Federal funding from programs such as EQIP and matching State funds could be used to cost-share approved P-removal equipment. The implementation of P-removal technologies should be incorporated into farm NMPs.

Technical Effectiveness
In the case of central processing facilities and the manure matching service, the technical effectiveness is fully dependent on the cost-effectiveness. If shipping manure off farms in the Basin can be financially justified for the farmer (including any subsidies), then potential P reductions from agricultural land are very great. This program will be of greatest benefit to farms for which it would be costly to comply with P-based nutrient management as a result of Option AG2. If shipping manure off farms is made affordable, through a subsidized program or developing market value for manure-based products, it may become the easiest and cheapest option for farms with the most difficulty complying with Option AG2.

It is possible that the use of on-farm manure solids separation could facilitate the reduction of P loss to the environment if it is used as a part of a well-managed plan. Solid–liquid separation could also be a useful tool for nutrient management on many farms. However, it is difficult to estimate the effect that this system may have on reducing P export from agricultural land. If the P-rich solids portion remains on the farm, it must used in applications that are not conducive to surface transport to waterways. The overall technical effectiveness ranking of option AG3 is low to moderate.

Cost-effectiveness
A recent study (not yet published) in the Basin has estimated that the cost of shipping manure to a centrally-located methane digester is not justified by the potential sales of the electricity generated and the processed manure solids (Scruton 2003). However, if the value of P reduction to the Lake and of methane reduction from the atmosphere are factored into this analysis, it is possible that the cost-benefit analysis could become favorable. A study in New York estimated that the total transportation costs associated with shipping manure off the farm equaled approximately $100 per cow per year (Jewell et al. 1997). The same study estimated that a 6,000-gallon manure truck would need to travel a total of 40 miles or less for the co-generation plant (methane digester) to break even. Based on market prices only, a centrally-located methane digester is unlikely to be commercially viable.

The cost-effectiveness of the manure matching service will depend on the distance between farms with excess and deficit manure situations. The greater the distance, the more expensive it will be to haul manure between the farms. Because the Basin's agriculture is predominantly dairy, it is likely that the distances between matching farms may be too great to justify the hauling costs. There has been some success in Québec with surplus manure co-ops that serve a similar function.

The investment in equipment and infrastructure for solids-separation is likely to be between $30,000 and $50,000 on most farms that are well-suited for this (Potter 2003; Bicudo 2003). There are a small number (approximately 10) of solids separators in operation in Vermont. Fifty percent of the P may be retained in the solids, but additional steps need to be taken to reduce P loss from the farm. Therefore solids separators may only be cost-effective on certain farms, if managed well. If the P removal and cost estimates associated with the on-farm manure treatment process are validated, this could be a very cost-effective means for removing P from farms.

Socio-political Viability

A major issue related to this set of policy options will be the increase in truck traffic in rural communities that is necessary for hauling manure off farms. As many of the Basin's farm communities are becoming increasingly populated with non-farm residents, the potential for socio-political conflicts related to manure hauling are to be expected. Hauling manure is a messy process that will leave residue on roadways and create odors.

The site selection for centralized manure processing facilities is also likely to be reasonably controversial in many areas of the Basin. A significant NIMBY ('not in my backyard') response can be anticipated from the neighbors of identified sites. The use of public money to subsidize centralized manure processing facilities may also be a controversial topic.

Implementing systems or technologies that facilitate the removal of manure nutrients from the farm will relieve Basin farms from the nutrient management constraints related to herd size expansion. This can help Basin farms to compete with larger farms in other parts of the country. However, this will also facilitate the trend toward intensification of agricultural production in the Basin. Increasingly large operations on relatively small land bases may present other challenges and problems for the people, rural communities, and/or water quality of the Basin.

Administrative Requirements

If the private sector is motivated to create centralized manure processing facilities, with or without public subsidies, the administrative requirements will be relatively minimal. This will not require a great deal of oversight at the farm level or significant staff time to create and implement plans. Plans have been put forth by the private sector in the St. Albans Bay watershed for a centralized facility.

The creation and maintenance of a manure matching service would be a relatively minor task using a Web-based platform. Similarly, an increase in cost-share funding for solids-separation would be implemented through already existing channels and would not present a significant administrative burden.

None of the three options above is likely to be used extensively unless farmers are compelled to reduce their P surpluses and move toward a mass balance. Farmers are unlikely to be compelled in this direction unless policy is used to guide them. Policy options AG2 and AG4 may necessitate the removal of manure or P from the farm in some cases. If so, then the mechanisms discussed in this policy option (AG3a, AG3b, and AG3c) will likely be feasible, necessary, and cost-effective.

Option AG4. A performance-based policy to reward farmers for documented improvements in moving towards a mass balance of P on the farm.

Description

Performance-based environmental policies for agriculture represent a relatively new approach for pollution control. Performance-based policies can take many forms; the common theme is using financial incentives to link farm management decision-making to environmental outcomes. According to our research efforts, there are not currently any examples of true performance-based policies (those where incentives are linked to environmental outcomes) in effect in the U.S. or overseas. In the Netherlands, Norway, and a few other countries, farms are required to maintain a P balance or incur penalties (as discussed in detail in Section I of this report). However, the regulatory approach used in Europe is quite different from the voluntary, incentive-based program discussed here.

Performance-based policies are more likely to be successful when they are developed for a specific watershed with significant stakeholder input. However, such a process is not feasible within the scope of this project. In order to describe a specific potential performance-based policy concept for application in the Basin, one of many possible performance-based policies for P reduction is detailed below. The performance measure for this example is the reduction of surplus P on farms. For a broader discussion on performance-based environmental policies for agriculture, the Executive Summary of a March 2003 workshop on this subject conducted by the Wallace Center at Winrock International is included in Appendix B. We strongly encourage any pursuit of performance-based policies to start with significant input from farmers, stakeholders, and scientists.

This policy option is designed to elicit P reductions from agricultural lands beyond what can be expected from the requisite management practices suggested in Option AG1 and Option AG2. By placing a financial incentive in front of farmers for on-farm surplus P reductions, this policy option could provide further gains in P reductions while aiding the financial returns of Basin dairy farms. Farmers may find some strategies to be profitable decisions and thus continue the practice beyond the end of the policy subsidies. Reducing excess dietary P is one example of such a strategy, where a subsidy payment may be required to overcome the obstacles to adoption. There are numerous other ways for farmers to reduce P surpluses on the farm.

This voluntary program will reward farmers with direct payments based on documented reductions in their farm's mass balance of P. Reductions in mass balance surpluses of P will be relative to documented levels for a given base year. Mass balance of P will be calculated with an accepted farm modeling software and will be based on farm tax records (Schedule F) and other receipts related to milk, feed, and animal sales, feed, fertilizer, and animal purchases, as well as cropping records. Payments are suggested to be $6.60 per kg ($3 per lb) of reduced P per acre relative to the base year. Payments will be made in each year for performance relative to the base year. This is necessary to maintain the reductions in P surpluses. This level of payment was calculated as an example such that an average size farm of 300 acres that reduces its P surplus by an achievable amount (say 2 kg per acre) would receive a sizable, but not exorbitant, annual payment ($3,960 in this example). The actual level of payment will need to be determined based on funding available and projected participation rates for this voluntary program. Significant research and pilot-testing is necessary to develop this concept into a successful program. The numbers presented here are merely an example.

Funding for this policy should be allocated from USDA conservation funds such as EQIP. Although reward payments are not currently used as part of USDA conservation programs, it is possible that programs such as EQIP could use funds for this purpose (Wood 2004). Other federal and state funding sources, including the Clean & Clear Water Action Plan recently announced in Vermont, should also be examined for their ability to be used for payment for environmental performance. The USDA Conservation Security Program, authorized in the 2002 Farm Bill, may be another source of funding, as P surplus reductions could be incorporated as "watershed-based" criteria for Lake Champlain. To qualify for these performance-based payments, farms should have comprehensive NMPs (Option AG2) and be in compliance with all required accepted agricultural practices for that region.

Paying farmers for reductions in surplus P is only one example of a performance-based environmental policy for agriculture. Farmers and other stakeholders should participate in the process of creating performance-based policies. The Wallace Center at Winrock International is currently working with several U.S. watersheds on this topic and has a proposal pending to work with the Poultney-Mettowee Conservation District.

Technical Effectiveness

The effectiveness of this policy option is dependent on the willingness of farmers to enter the program. Their willingness to enter the program is dependent on the size of the expected payments relative to the expected costs of reducing P surpluses on the farm. If many farms enter the program, the reductions in P surpluses on farms throughout the Basin could be sizable. Paying for reductions of surplus P on farms is a different approach than paying for the achievement of a P balance. The former will encompass reductions of various sizes from farms across the Basin; the size of these reductions is extremely difficult to estimate.

Reducing P surpluses on farms is likely to lead to reductions in P loads to the Lake; the precise relationship, however, cannot be estimated due to the unique and varying situations among farms in the Basin. There are numerous ways that farmers can move toward a P balance on their farms. These include reductions in excess dietary P in rations, acquiring more land, shipping manure off-farm, or reducing herd size. It is essential that manure being shipped off farms moves to a designated use and location that comply with the Basin's P reduction goals. Reducing excess dietary P is only one of many ways to reduce the P surplus on a farm, but it is likely to be where most participating farmers start. For this reason, the paragraphs below discuss precision feeding; other strategies will be pursued also under this proposed policy option.

Although the National Research Council (NRC) introduced new, lower P recommendations for dairy cow feed rations in 2001, many farms continue to feed excess P. A Wisconsin study estimated that 51 percent of dairy cows are being fed excess P in the ration (Powell et al. 2002). Farmers, feed consultants, and veterinarians often feel that excess P in the ration is cheap insurance to guard against reproductive disorders in the herd. However, animal scientists at Michigan State University have shown that there is no benefit in animal performance from increases in dietary P, and excess dietary P can be associated with higher incidence of milk fever. The same researchers estimated that, for a 300-cow operation, every 0.1 percent increase in dietary P in the ration will result in an additional 5,475 lbs of P excreted in the manure each year (Beede 2003).

Phosphorus is one of the most expensive nutrients in the dairy ration. Beede et al. (2003) estimated that overfeeding P costs farmers $10–15 per cow per year, making the reduction of excess dietary P a ‘low-hanging fruit’ strategy, benefiting farmers and the environment. It was estimated that feeding according to the updated NRC requirements for P would reduce the number of Wisconsin farms having a positive P balance by 60 percent (Powell et al. 2002). Although farmers should be eliminating excess dietary P to increase profits, the perceived risk seems to be stopping them from doing so.

This policy option should provide additional incentive for farmers to reduce whole-farm P surpluses. Reducing excess dietary P is just one means to this end. By rewarding farmers based on reductions in P balance, farmers will have the incentive to find the least-costly means of achieving the reductions. Acquiring additional land may be another easy way for farmers to reduce P surpluses. It is important that this policy option be closely tied to nutrient management planning (Option AG2) and the implementation of BMPs, so that additional land receives manure and is managed for environmental quality.

Cost-effectiveness

The cost-effectiveness of this performance-based policy option is determined by the size of the payments used as incentives to farmers in the Basin. The payments of $6.60 per kg P reduced per acre, plus the administrative costs for this program, provide an estimate of the cost-effectiveness. The amount of P loading in the Lake that is prevented by this policy cannot be estimated precisely. However, source reduction of surplus P on farms is expected to lead to reductions in P losses from agricultural land. Without source reduction, other BMPs addressing transport factors are not likely to be effective in the long-term.

If a 300-acre farm reduces its P surplus by 408 kgs relative to the base year (1.36 kgs per acre), the farm would receive an annual payment of $2,700. The Basin has approximately 853,121 acres of agricultural land. If farms enrolled in this program that accounted for 10 percent of the agricultural land and reduced P surpluses an average of 1.36 kgs per acre, P sources would be reduced by 116,091 kgs each year, relative to the base year. At $6.60 per kg per acre, plus the administrative cost of $300,000, the program would cost an estimated $1,067,809 annually Basin-wide. This equals $9.20 per kg P reduced from farms in the Basin.

Unfortunately, the reduction of excess of P on farms cannot be accurately converted into an estimate of reduced P loads to the Lake, although the two have been highly correlated by scientific research (Sharpley 1999). Other forms of performance-based policies could be developed where incentives are tied to P loads to the Lake. Although such an approach would be focused on the ultimate water quality concern, it would be more difficult to link farm management decisions to this outcome via appropriate incentive mechanisms.

Socio-political Viability

Paying farmers to provide environmental benefits, provided the funding is available, is likely to be less contentious than requiring farmers to do so. This policy option will pay farmers for documented performance. It is likely that farmers with the greatest P surpluses will be rewarded for reductions, while farms that have already reduced excess P may not be rewarded. This policy could send a perverse signal to producers that being proactive on environmental concerns is not rewarded. However, if this policy option were to be structured such that it only paid farmers for achieving a P balance, it would attract the participation of farms that have or are near a P balance and probably not attract the participation of farms that have the greatest P surpluses. Farms with the greatest P surpluses are likely to contribute the greatest P loads, and without their participation, the program would not be purchasing much additional P reduction. Therefore, structuring the program to pay for reductions in P surplus, regardless of the initial condition on the farm, will be more cost-effective.

Administrative Requirements

Implementing the policy option as described above will require a significant amount of staff time because it will be time-consuming to monitor the "performance" of farms in reducing on-farm surplus P balances. It is estimated that one FTE staff person will be required for each 75 farms that enroll in the program. These staffers will be required to review all of the paperwork submitted by the participating farms and conduct routine audits to verify P reductions.

With 260 workdays per year, each staffer could spend 2 days per farm on verifying the paperwork and have 110 days for audits and administrative duties. If 300 farms enroll in the program Basin-wide, this would require 4 FTEs. At a cost of $75,000 each, the annual administrative costs for the policy will be $300,000. These costs could be lowered through the use of third party certifications. However, this shifts the burden from the states to the farmer and may diminish farmer participation.

Option AG5: Create a Basin-wide team to work with individual farmers to assess potential problems, find least-cost solutions, and facilitate the incorporation of environmental quality concerns into long-term farm business planning.

Description

Develop a Lake Champlain Basin Agri-environmental Quality Team comprising staff from the Departments of Agriculture in New York and Vermont and MAPAQ, the Departments of Environmental Conservation in New York and Vermont and the Québec

Ministry of the Environment (MENV), Vermont and New York NRCS, UVM Extension, Cornell Cooperative Extension, and IRDA in Québec, as well as input from leading farmers on conservation issues and techniques. Broad participation from the relevant institutions in both States and Québec will foster consistency and cross-border learning toward the common goal of increased environmental quality in the Basin and P reduction in the Lake. The team will use a participatory assistance approach as described by Lanyon (1994), which addresses both the biophysical and management processes of the farm and farmer.

The participatory assistance approach integrates external expertise and environmental expectations with the unique character of a particular farm. This is an alternative to the unidirectional flow of information found in conventional technology transfer approaches. The team, including the farmer, will learn and work with the biophysical and managerial constraints of each farm to help develop an innovative approach to environmental quality that will be compatible and perhaps symbiotic with goals of the farm business. Keys to this approach are providing farmers with a clear set of expectations regarding environmental performance (Option AG4 addresses this) and working with farmers to harness their motivation and ingenuity to solve the problems in a manner that is in concert with the farmer's goals.

Subsets of the team in both States and Québec will work with individual farms to assess the environmental quality issues associated with the operation. Each subset should include a specialist in animal production, crop production, farm management, and water quality. Rather than focusing solely on BMPs, the teams should work with farmers to understand the environmental outcomes, their importance, and their potential relevance in the farm's business plan. The team should strive to work within the business decision-making framework that governs the farmers' actions. The team should also strive to harness the farmers' knowledge and ingenuity to correct environmental quality problems in the least-costly manner.

This approach can be built on the Environmental Management System (EMS) approach that is currently being used in agriculture and other industries in parts of the U.S. EMS is a process of planning, implementing, reviewing and improving the processes and actions that an organization undertakes to meet its business and environmental goals. However, rather than being industry-led, this policy option suggests that public sector entities combine resources to lead this initiative so that there will be greater public accountability for environmental quality.

The Lake Champlain Basin Agri-environmental Quality Team members will work with participating farmers to develop and implement plans for the best means to reduce detrimental impacts from the farm. Although the primary focus of the Team's activities will be on P issues, the plans should address a broad set of environmental impacts and be much more comprehensive than nutrient management plans (Option AG2). Borrowing from the approach of ISO 14001, the teams will work with farmers to:

1. Understand society's environmental expectations for farming operations;

2. Create an environmental policy that is specific to each farm that:
    - is appropriate to the nature and scale of environmental impacts;
    - includes a commitment to continual improvement and to preventing pollution;
    - includes a commitment to comply with relevant environmental regulations;
    - includes a way of setting environmental objectives; and
    - is communicated to all employees and implemented.
3. Develop a plan that reviews legislative and regulatory requirements, significant environmental aspects such as emissions to air, water, and land, and their impact on communities, local environmental issues, the use of natural resources and raw materials, and the waste/resource stream. The plan establishes a system to achieve objectives and targets, and to maintain documentation of progress toward them.
4. Advise the implementation of the environmental plan that:
    - defines and communicates roles, responsibilities, and authorities;
    - provides adequate training and skills for all personnel;
    - maintains information on operating procedures, site emergency plans, etc.;
    - controls all documents needed for effective implementation of the plan, and
    - effects accident prevention and response procedures.
5. Assist in checking and corrective action that:
    - monitors and measures key characteristics of those procedures that can have a significant impact on the environment;
    - documents procedures for handling problems and for initiating corrective and preventative action;
    - establishes and maintains procedures for keeping environmental records; and
    - conducts periodic internal environmental audits.

This program should start as a voluntary, incentive-based effort that helps farmers to find cost-effective solutions and begins to integrate environmental quality concerns into the farm's business plan. The incentive for initial participation could be public recognition or a nominal payment. (A similar approach in Pennsylvania is offering farmers $100 to participate and farmer interest has been high. However, a payment has the potential of attracting insincere participants.) The long-term incentive for farmers should be payments for environmental quality performance (one example of this is described in Option AG4) including P export reduction.

Funding for the establishment of the Lake Champlain Basin Agri-environmental Quality Team should come from Federal (U.S. EPA, USDA, Congressional appropriation), State (legislative appropriations), and Provincial sources. The coordination of this effort in each State/Province should be the responsibility of the respective Extension agencies.

Technical Effectiveness

The overall effectiveness of this option depends on the level of farmer participation and responsiveness to the initiative, as well as the level of associated financial incentives that are created to reward farm-level environmental conservation. In the best case scenarios, it is possible that P export from some farms could be reduced by up to 90 percent. It is more likely that reductions ranging from 30–50 percent would be achieved from participation in this program. If 50 percent of farms participated in the program, it can be very crudely estimated that a 15–25 percent reduction in P export from agricultural land could be seen Basin-wide. Based on Hegman et al.'s (1999) estimates, this could translate to a reduction in P loading of 36,240 to 60,400 kgs per year to the Lake. It is important to note that there are not data from which to develop accurate estimates on the P loss reductions that may result from incorporation of environmental quality concerns into farmers' long-term planning. The numbers presented here are hypothetical.

The New York City Watershed Agricultural Program has been using teams of experts to assist farmers in conducting whole farm planning. The teams include staff from Cornell Cooperative Extension, Soil and Water Conservation Districts, NRCS, and farmers. With funding through the NYC Department of Environmental Protection (DEP), the program covers 100 percent of the cost of planning, implementation, and operation and maintenance of recommended BMPs. A former coordinator of that program feels that the incorporation of environmental quality concerns into farmers' long term planning has been inadequate to date because the goals of the program, set by NYC DEP, are focused on number of plans written and BMPs implemented, rather than on the cost-effectiveness of the approach.

Cost-effectiveness

Successfully harnessing the farmers' knowledge and innovation to meet clearly stated environmental expectations is more likely to result in lower cost solutions relative to mandating practices on all farms.

It is estimated that 20 FTE staff positions will be required Basin-wide to carry out the program suggested in this policy option. Many of these may not have to be new positions requiring additional funds, but all staff time required must be accounted for in these cost estimates. The estimate of 20 FTEs is based on the need to have staff from several farm-related disciplines participate in each team (4 staff plus the farmer). If 300 farms participate in this program across the Basin and the teams consist of four staff each, each team would work with 60 farms. This is a significant workload, but is manageable if each team member acts as the team leader for 15 specific farms and if the farmer is willing to carry some of the workload. At an estimated total average cost of $75,000 per year, this equals $1.5 million in staff costs. If we add to this the cost to the farmer for reducing P export estimated at an average of $10 per kg P, the total cost per kg P reduced ranges from $35 to $51.

If this program is successful (with the aide of the performance-based incentives of Option AG4) in inducing farmers to incorporate environmental quality into business planning, these numbers will greatly overestimate the true cost in the long-term. This is because the Lake Champlain Basin Agri-environmental Quality Team may only be needed in this form for 5 or 10 years. Beyond that, the hope is that farmers have clear signals and incentives to maintain the reductions in P exports that were facilitated by working with the Team.

Socio-political Viability

As a voluntary, incentive-based approach, this policy option is not likely to encounter the explicit political or individual farmer resistance that mandatory BMPs will face. The greatest challenge will be to secure the funding needed for the creation and functioning of the Lake Champlain Basin Agriculture and Environment Quality Team.

Administrative Requirements

As discussed above, this policy option will require an estimated 20 FTEs of staff time in the Basin for 5–10 years. Given the dwindling numbers of staff in Extension and the tight State budgets of late, securing these staff positions will be a significant challenge.

B. Policy Options for Developed Land

The most important actions for reducing P export from developed land are managing stormwater; reducing P applications to lawns, parks, and golf courses; minimizing soil erosion; and controlling streambank erosion. The policy options that are described below are a combination of regulation, technical assistance, financial incentives, and legislation designed to facilitate P reductions to the Lake. These options target primarily municipal actions for P reductions from developed land. Individual and household actions, which are an important part of the solution as well, are primarily to be achieved through education and outreach, incentives, and regulations provided at the municipal level.

Option DL1: Increase the number of municipalities that are regulated under Phase II of EPA's Stormwater Rule by reducing the population criteria for inclusion.

Description

Amend the NPDES General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (Permit No. 3-9014 for Vermont and GP-02-02 for New York) to include additional municipalities that are at least 50 percent in the Lake Champlain Basin and have a population of at least 3,000 according to the Census Bureau figures. A list of these municipalities can be seen in Table 6. The municipalities should be brought under the permit in phases and as geographic clusters to encourage working together and sharing resources. As an example, Vermont municipalities in the Basin could be phased in under the general permit according to the following groupings. This is merely an example of geographic clusters that are prioritized by population and is not intended to be a conclusive list.

First: Barre City, Montpelier, Barre Town, Northfield, Waterbury, Williamstown, Berlin, and Plainfield.
Second: St. Albans City, St. Albans Town, Swanton, Georgia, Highgate, and Enosburg.
Third: Rutland City, Castleton, Rutland Town, Fair Haven, West Rutland, and Wallingford.

Table 6. Municipalities with at least 3,000 people and 50% in the Basin.

STATE	MUNICIPALITY	AREA (SQ KM)	CUMULATIVE	POPULATION	CUMULATIVE
VT	BURLINGTON	28.24	28.24	39,824	39,824
VT	ESSEX	103.34	131.58	18,626	58,450
VT	RUTLAND CITY	19.93	151.51	17,292	75,742
VT	COLCHESTER	94.79	246.30	16,986	92,728
VT	SOUTH BURLINGTON	43.51	289.81	14,879	107,607
VT	MILTON	137.91	427.72	9,479	117,086
VT	BARRE CITY	10.44	438.16	9,291	126,377
VT	MIDDLEBURY	101.82	539.98	8,183	134,560
VT	MONTPELIER	26.55	566.53	8,035	142,595
VT	ST. ALBANS CITY	5.15	571.68	7,650	150,245
VT	WILLISTON	79.40	651.08	7,650	157,895
VT	BARRE TOWN	79.44	730.52	7,602	165,497
VT	SHELBURNE	65.25	795.77	6,944	172,441
VT	WINOOSKI	3.79	799.56	6,561	179,002
VT	SWANTON	127.73	927.29	6,203	185,205
VT	NORTHFIELD	113.08	1,040.37	5,791	190,996
VT	MORRISTOWN	132.26	1,172.63	5,139	196,135
VT	ST. ALBANS TOWN	97.67	1,270.30	5,086	201,221
VT	JERICHO	91.89	1,362.19	5,015	206,236
VT	WATERBURY	129.13	1,491.32	4,915	211,151
VT	GEORGIA	104.22	1,595.54	4,375	215,526
VT	CASTLETON	109.69	1,705.23	4,367	219,893
VT	HINESBURG	104.12	1,809.35	4,340	224,233
VT	STOWE	188.45	1,997.80	4,339	228,572
VT	RICHMOND	83.96	2,081.76	4,090	232,662
VT	RUTLAND TOWN	50.78	2,132.54	4,038	236,700
VT	BRANDON	104.02	2,236.55	3,917	240,617
VT	BRISTOL	107.90	2,344.45	3,788	244,405
VT	FAIRFAX	104.67	2,449.13	3,765	248,170
VT	POULTNEY	116.00	2,565.13	3,633	251,803
VT	CHARLOTTE	106.73	2,671.86	3,569	255,372
VT	HIGHGATE	136.74	2,808.60	3,397	258,769
VT	JOHNSON	119.24	2,927.84	3,274	262,043
VT	WILLIAMSTOWN	104.86	3,032.70	3,225	265,268
VT	CAMBRIDGE	164.58	3,197.28	3,186	268,454
VT	HARDWICK	100.27	3,297.54	3,174	271,628
VT	PITTSFORD	112.92	3,410.47	3,140	274,768
NY	QUEENSBURY	166.96	166.96	25,441	25,441
NY	PLATTSBURGH CITY	13.66	180.62	18,816	44,257
NY	PLATTSBURGH TOWN	120.84	301.46	11,190	55,447
NY	KINGSBURY	103.20	404.66	11,171	66,618
NY	NORTH ELBA	395.36	800.02	8,661	75,279
NY	GRANVILLE TOWN	141.34	941.36	6,456	81,735
NY	FORT ANN TOWN	280.51	1,221.88	6,417	88,152
NY	PERU	206.41	1,428.28	6,370	94,522
NY	CHAMPLAIN TOWN	126.65	1,554.93	5,791	100,313
NY	HARRIETSTOWN	547.24	2,102.16	5,575	105,888
NY	BEEKMANTOWN	156.77	2,258.94	5,326	111,214
NY	TICONDEROGA	218.04	2,476.97	5,167	116,381
NY	DANNEMORA TOWN	171.97	2,648.95	5,149	121,530
NY	SCHUYLER FALLS	97.88	2,746.83	5,128	126,658
NY	SARANAC LAKE	7.82	2,754.65	5,041	131,699
NY	MORIAH	226.81	2,981.46	4,879	136,578
NY	CHAZY	140.87	3,122.33	4,181	140,759
NY	SARANAC	295.65	3,417.98	4,165	144,924
NY	WHITEHALL TOWN	137.48	3,555.46	4,035	148,959
NY	LAKE GEORGE TOWN	82.28	3,637.74	3,578	152,537
NY	MOOERS	130.00	3,767.73	3,404	155,941
NY	ALTONA	262.69	4,030.42	3,160	159,101
NY	AUSABLE	100.53	4,130.95	3,015	162,116

Fourth: Middlebury, Brandon, Bristol, Pittsford, and Vergennes.
Fifth: Morristown, Johnson, Hardwick, and Hyde Park.
Sixth: Warren and Waitsfield.

It is important that on-going technical assistance be made available to the additional municipalities to facilitate compliance with the six minimum control measures required. Option DL2 addresses the need for on-going technical assistance to the municipalities. At least one year of lead-time should be given to the communities to comply with the permit. During this time significant information and education efforts should be made by the respective Departments of Environmental Conservation and the Regional Planning Commissions to assist the municipalities in planning and implementation.

This option does not address the stormwater issues in the Québec portion of the Basin for several reasons. First, the U.S. EPA Stormwater Rule does not exist in Québec. To implement these control measures in the Québec portion of the Basin would require a separate policy. Second, the Québec portion of the Basin does not have many larger municipalities, hence stormwater is not perceived as a major problem. This does not imply that improving stormwater controls in the northernmost part of the Basin is not a worthy undertaking.

Background

Because of the disproportionately large contribution to P loading per unit of developed land, effective control of stormwater from developed land is essential for meeting the long-term P reduction goals set for the Lake. This policy option is a means for extending the 'good housekeeping' practices associated with Phase II to many more municipalities in the Basin.

The Stormwater Phase II Final Rule put forth by EPA applies to *regulated*, small municipal separate storm sewer systems (MS4s). Under Phase II, they must develop, implement, and enforce a stormwater management program, which includes the following six minimum control measures:

- public education and outreach;
- public participation/involvement;
- illicit discharge detection and elimination;
- construction site runoff control;
- post-construction runoff control; and
- pollution prevention/good housekeeping.

Small MS4s are currently designated for regulation under Phase II in one of the three following ways.

1. Automatic nationwide designation.
   All small MS4s located within the boundaries of a Bureau of Census–defined "urbanized area" (UA) are automatically regulated under Phase II. An UA is a place that together with any adjacent, densely settled surrounding area has a population of at least 50,000 and a density of at least 1,000 people per square mile.

The only UA in the Lake Champlain Basin is the greater Burlington area. Therefore, only the greater Burlington area has designated MS4s under the automatic nationwide designation as an UA. This includes 8 municipalities and 3 nontraditional MS4s, covering 81.05 square miles or 51,870 acres, a small fraction of the developed land in the Basin. The municipalities include Burlington, South Burlington, Winooski, Colchester, Essex Junction, Essex, Shelburne, and Williston. Milton has been proposed for designation. The nontraditional MS4s include UVM, VTrans, and the Burlington International Airport. There is also a very small, regulated MS4 at the southern end of the Basin, which includes part of the Town of Queensbury and the City of Glens Falls.

2. Based on a required evaluation by the each state's National Pollutant Discharge Elimination System (NPDES) permitting authority.

   The NPDES permitting authorities for Vermont and New York are the respective Departments of Environmental Conservation. The NPDES permitting authority must, at a minimum, evaluate the designation of all MS4s that are outside of an UA, but have a population of at least 10,000 and a density of at least 1,000 people per square mile. Therefore, all communities of 10,000 or greater must be evaluated for designation. However, communities of any size can be designated for regulation under Phase II. There are numerous designation criteria that U.S. EPA recommends using in this evaluation, including discharges to sensitive waters. Because Lake Champlain is a "sensitive water" with a TMDL for P, this allows for the possible designation of numerous additional small MS4s in the Basin for complying with Phase II stormwater controls.

   Areas such as Plattsburg, Montpelier-Barre, and Rutland are communities that were evaluated by State DECs, but currently are exempted from regulation under the Phase II rule. Many other cities and towns in the Basin could be regulated under this authority. Evaluation of such municipalities should be made based on total population, population density, and connectedness of stormwater to the Lake.

3. Physically interconnected to a regulated MS4.

   If the small MS4 is located outside of an UA, but contributes substantially to the pollutant loading of an adjacent regulated MS4, it must be evaluated for designation by the NPDES permitting authority. This is another reason to evaluate sets of communities in the Basin that are not currently designated.

In New York, the designation of MS4s that are not automatic are based on one of the two following criteria.

Criterion 1: MS4s discharging to waters for which an EPA-approved Total Maximum Daily Load (TMDL) requires reduction of a pollutant associated with stormwater beyond what can be achieved with existing programs (and the area is not already covered under automatic designation).

Criterion 2: MS4s contiguous to automatically designated urbanized areas (town lines) that discharge to sensitive waters classified as AA-Special (fresh surface waters), AA (fresh surface waters) with filtration avoidance determination or SA (saline surface waters).

Not designating Plattsburgh as a regulated MS4 is based on the thinking that New York's P reduction commitment for the Lake Champlain Phosphorus TMDL will be achieved through continued implementation of existing programs. In Vermont, the exemptions for cities, such as Barre-Montpelier and Rutland, were because they are not in a designated UA, as described above. However, Vermont did extend the area subject to the rule to include all stormwater-impaired watersheds in towns automatically designated whether or not the watershed was within the UA (Pease 2003). The NPDES permitting authority does have the ability to revisit the designation of MS4s.

By designating more cities and towns in the Basin, the percentage of developed land on which at least minimum stormwater controls are implemented would increase greatly. This policy option suggests the designation of communities with populations as low as 3,000. If the population criteria were lowered to municipalities that have 3,000 or more people and are at least 50 percent in the Basin, Phase II controls would be required in 60 municipalities in the Vermont and New York portions of the Basin. This would affect 6,900 sq kilometers and 431,000 people in the Basin, representing 36.7 percent of the Basin area in Vermont and New York. Covering this much of a primarily rural basin with Phase II stormwater controls will be viewed as excessive by some. However, others view these controls as commonsense, good housekeeping measures that will ensure some level of stormwater control.

Although the Phase II Rule is an unfunded mandate placed on many communities, it will be important to identify funding sources for stormwater control to cover some or all of the costs incurred by the smaller communities that are targeted in this policy option. For smaller municipalities that could not afford certain capital improvements to infrastructure, efforts should focus on public education and participation, enacting and enforcing construction site and driveway ordinances, and reducing illicit discharges. Just these efforts alone could have a significant effect on reducing P loads from developed land in the Basin. Additionally, if structural stormwater treatment practices, such as retention ponds, were also feasible, this would further reduce the P loads entering the Lake and should be implemented. The DECs in each state should have the authority to grant exemptions from certain control measures based on economic needs.

Technical Effectiveness

It is impossible to accurately estimate the reductions in P loads or concentrations in the Lake that may result from this option. The implementation of the six minimum stormwater control measures will have wide-ranging impact on P reductions in the Lake from different communities, depending on the current level of stormwater control and how the additional control measures are implemented in each community. Regardless of the lack of data from which to estimate reductions, requiring the minimum stormwater control measures will certainly facilitate the reduction in P loading to the Lake.

Each community currently implements various levels of stormwater control, ranging from minimal to extensive. The additional reduction in P loads will depend on the level of current efforts as well as the type and effectiveness of future Phase II stormwater controls. Reductions in P concentrations will also be affected by the proximity and connectedness of the community to the Lake and the land use patterns of the community. However, it is very difficult to estimate the P reductions from a broad set of communities. Although specific P reductions cannot be estimated from each community or for the Basin, recent research establishes a clear link between stormwater and P control. Waschbusch et al. (1999) measured a range of P concentrations in stormwater. Lawns and streets have been shown to contribute the greatest amounts of dissolved P in stormwater (0.79 and 0.40 mg/l, respectively), with roofs and parking lots averaging below 0.15 mg/l (Waschbusch et al. 1999). However, there was large variation in these measurements.

The effectiveness of this approach is assumed to be moderate to high, but will depend on access to qualified staff at the municipal level to design and implement a sound and sustainable stormwater management program. Policy Option DL2 describes the placement of trained technical staff in the regional planning commissions to work with municipalities on stormwater management.

Cost-effectiveness

One recent study has roughly estimated the cost of Phase II implementation to range from $3.50 to $6 per person per year (Reese 2003). This is based on an average population density of 2,000 people per square mile (roughly 3 people per acre). These costs represent the level of effort that might be required to implement a general permit for stormwater quality control. Not all of these costs will be monetary outlays, as some costs represent restructured staff time and some of the control measures are likely to be in place already. For the monetary costs estimated, not all will be new (additional) costs, depending on the level of stormwater control already present in the municipality.

Modeling research in Wisconsin estimated that the cost of reducing total suspended solids (TSS) reaching Lake Wingra (in Madison) by 40 percent or 199 tons per year (from 497 to 298 tons) would cost from $6 to $14 per household per year (Bannerman et al. 2003). The most cost-effective strategy was found to be high-efficiency street sweeping on all streets and Delaware Perimeter sand filters on all parking lots. This strategy was estimated to have an annualized total cost of $573,000, which results in a cost of $2,880 per ton of TSS per year. Approximately two-thirds of P in stormwater is in particulate form. Therefore, decreasing TSS will decrease P loads, but an exact relationship could not be determined.

All relevant information on cost-effective strategies for compliance should be made available through technical assistance to all communities regulated under Phase II. The costs associated with complying with the Phase II regulations will vary greatly across municipalities, but are assumed to be high, resulting a low to moderate cost-effectiveness. In general, there will be five categories of costs. These include developing a plan with a baseline assessment, annual operation and maintenance costs, capital improvements, monitoring, and education and outreach.

As part of their stormwater plan, communities are required to develop a base map of the existing system, including stormwater outfalls, basins, and other features. The base map and plan could have significant costs for a large community. However, for smaller communities, creating the plan and base map will be a fairly small project as they generally have less stormwater infrastructure to inventory. As a general estimate, this task will cost between $10-15,000 for smaller communities.

The plan will have to include recommendations on operations and maintenance for the stormwater infrastructure and will also include how to find and deal with illicit connections to that system. It will include public education requirements to teach the public about illicit connection impacts, as well as issues including disposing of animal waste correctly, hazardous waste, and proper use of pesticides and fertilizers. Depending on what is being done within a community for maintenance and how much of these other items are necessary or desirable, a community could expect to spend a minimum of $10,000 more per year for these tasks. On the high end, a small community could spend upwards of $50-100,000 per year if it has lots of basins to clean and streets to sweep, and it has illicit connection problems.

Capital improvements could be necessary if problems with outfalls are identified, if existing structural BMPs or piping is found to have failed, and for many other reasons. These costs could be inexpensive ($2-5,000) or could be very expensive ($100-300,000 per occurrence), depending on the project. Who pays for these improvements depends on current ownership, current regulatory expectations, and how aggressive a community wants to be. Two contrasting examples from the Basin are Colchester and South Burlington, Vermont. Colchester is taking a regulatory approach; The community will assess problems and intends to use its municipal authority to require land owners to make improvements where necessary. South Burlington has decided to create a stormwater utility and will charge all users of the system for improvements. The city intends to own most of the currently private stormwater infrastructure. For most smaller communities, the Colchester model probably makes more sense since they do not generally have experience managing utilities and have limited, if any, professional staff.

The Phase II regulations will require that the community report to the respective DEC regarding water quality progress. Gathering these data and analyzing them could cost from $10-30,000 per year depending on how many water bodies exist in a community, how much storm water infrastructure impacts the water bodies, and other factors. It may be possible to arrange a less ‘professional’ model for monitoring, by gaining DEC approval of a lay, volunteer monitoring system. For a very small amount of money a consultant could develop a protocol and then summarize data gathered by volunteers. Such an approach would cost the community far less.

Socio-political Viability

Under the Phase II Final Rule, the NPDES permitting authority in each State is mandated, *at a minimum*, to evaluate the designation of all MS4s that are outside of an UA, but have a population of at least 10,000 and a density of at least 1,000 people per square mile. As described above, the NPDES permitting authority has the ability to designate any small communities that discharge to sensitive waters (or meet any of the other numerous selection criteria) as regulated under the Phase II Stormwater Rule.

In order to increase the political palatability of this policy option, funding should be provided to offset a significant portion of the additional costs incurred by the communities. In Vermont, the Governor's proposed Clean & Clear Water Action Plan is designed to help raise the necessary funds to meet water quality goals, most notably for the Lake's P problem. To keep funding needs to a minimum, it is important that the total costs of implementing stormwater programs are minimized. The following suggestions are taken (with the author's permission) from a paper titled "Funding Phase II Storm Water Programs" by Andrew Reese (2003).

Suggestions for minimizing the costs of complying with Phase II Stormwater rules:

1. *Modify local programs.* The first step is to assess the current local program and see what is already being done to contribute to compliance. Based on looking at several stormwater programs across the nation, it was found that, perhaps, 25 percent of a typical Phase II program is already being done to some extent by current staff. With suitable adjustment and refocus, some responsibilities can be covered by current staff as part of, or a redefinition of, their current duties. However, there are very limited staff in many of the smaller municipalities covered by this policy option.

2. *Share costs with neighbors or region/state–wide.* Costs can be minimized by sharing among towns. After determining what can already be done in-house, or offered to others, the next step is to see what can be offered by others. Phase I saw large numbers of group permits issued, which caused regional approaches to spring up. There are various types of relationships that can be formed for sharing. In one set of cities, each agreed to share costs for a minimal program and go independently for a more advanced program. Costs can be shared in a similar fashion for all activities that each community has to accomplish. This is why phasing communities in by geographical clusters has been suggested in this policy option.

3. *Access existing information.* The Internet has hundreds of websites giving examples of BMPs, manuals, ordinances, documents, guidance, pamphlets, etc. Most of the documents that might be necessary for towns are freely available. The new stormwater management manuals developed for Vermont and New York are excellent resources for all communities in the Basin to get specific regulatory requirements and technical guidance on stormwater control. Additionally, the Center for Watershed Protection (http://www.cwp.org/) offers a multitude of helpful documents and links.

The CWP's stormwater center (http://www.stormwatercenter.net/) has hundreds of references and assistance tools. Other useful sites include http://www.mtas.utk.edu/bmptoolkit.htm and http://www.dfwstormwater.com, which has links sorted by each of the six minimum controls. The U.S. EPA's website (best found via a search engine since it changes quite often) offers significant Phase II guidance, as well as information on many related programs.

4. *Partner with non-profits.* There are hundreds of non-profit organizations created to accomplish various environmentally related functions. Often these groups will adopt a watershed, provide workers, perform monitoring, do public education and involvement campaigns, and find sources of money not available to local governments (501(c)(3) grants to non-profits). Some local communities will assist these groups in finding and applying for grants. Organizations are generally less willing to file a lawsuit against a local government when they are partners with it. Areas to investigate beyond the obvious watershed-type grants include Greenspace, parks, quality of life, sustainable development, education, etc. Websites include: http://www.adopt-a-watershed.org/; http://www.cwn.org; http://www.iwla.org; http://ctic.purdue.edu; http://www.nrdc.org/nrdc/; http://www.tnc.org; http://www.waterkeeper.org; http://www.rivernetwork.org/ (provides a complete listing of other organizations as well as a funding source catalog).

5. *Federal, regional and state consulting programs.* Various Federal programs provide consulting either gratis or as cost-share funding. For example, the National Park Service administers a Rivers, Trails and Conservation Assistance Program that provides meeting facilitators and planning assistance for river corridor development (http://www.ncrc.nps.gov/programs/rtca/index.html). Several Phase II communities received significant assistance from the Corps of Engineers in their Phase II permit application and parts of their implementation. The USGS cooperative program will provide monitoring and data analysis (http://water.usgs.gov/coop/). In many cases, a regional flood control authority, planning agency, or state league of counties or municipalities is more than willing to step in and serve as an integrator of programs. Pseudo state/university programs often provide consulting free or at greatly reduced rates, or can use other Federal grant monies to provide consulting or product services. For example, universities in several states used a 319 grant to develop a statewide BMP manual to serve all communities in the state. The Ohio Department of Natural Resources' *Rainwater and Land Development Manual* is an excellent BMP source in Ohio. Sometimes state programs can serve to partially fulfill one, or more, of the minimum controls. For example, in several states an erosion control or channel protection and permitting program operated by the state is being relied on for part of the construction minimum control.

6. *Federal, State and regional grants.* State and federal agencies administer or provide grant monies for local governments to pursue environmental projects. Some examples include programs such as Section 319 (recent congressional action extending the ability to use 319 money for Phase II for one year), 604(b), 104(b)(3), HUD block grants (http://www.hud.gov/progdesc/cdbgent.cfm), Coastal Zone

(http://www.epa.gov/owow/watershed/wacademy/fund/coastzone.html), Well head protection, and FEMA (http://www.fema.gov/regions/iv/2000/r4_06.shtm). Much of this information can be gleaned from Federal web sites including http://www.epa.gov/efinpage/fundings.htm (the environmental finance program), http://www.epa.gov/OWOW/watershed/wacademy/fund.html (Watershed Academy funding site), and U.S. EPA regional sites. While some of these programs are not, per se, to be used for compliance activities, many Phase I cities and regulators have been cagey about how to bend rules and waive requirements in order to secure funding for key projects and programs.

7. *Special fees for service.* Another source of funding is to charge special fees for added services, including inspection fees for BMPs, additional construction program–related fees, plans review fees, etc. These fees can be scaled to cover part of or an entire program area. Some communities have instituted a simple 'environmental' surcharge on a water bill as a special assessment. There are four basic approaches that local governments use to obtain money: taxes, service charges, exactions, and assessments. Each has rules that vary somewhat from state to state.

8. *Private resources.* Corporations often desire to be associated with promoting a clean environment. Therefore, private resources can sometimes be used to fund public environmental projects. This can take the form of corporate grants, corporate involvement in adopt-a-stream programs, and other visible volunteer-based activities. Commercial firms sometimes sponsor stream clean-ups, partner-in-restoration projects, construct greenways, etc. Another innovative approach is to allow businesses to put their logos on such things as storm drain plaques or banners. A firm called adopt-a-storm-drain specializes in this approach (http://www.adoptastormdrain.com/).

9. *Creation of a stormwater utility.* The surest and best way to fund stormwater is through a user fee system based on demand on the stormwater infrastructure. There is ample information available on how to create a stormwater utility. A few good sources on the Web include: http://www.florida-stormwater.org/manual.html; http://www.forester.net/sw_0011_utility.html; http://stormwaterfinance.urbancenter.iupui.edu/. South Burlington is in the process of creating a stormwater utility. This process should provide rich information for use in other Basin communities.

10. *Partner with local organizations/agencies.* Many local/county organizations may be already implementing programs that fall right in line with the Phase II requirements. For example, educational school programs, teacher monitoring workshops, watershed festivals, storm drain labeling and stream walk/community clean-up events, and watershed signage programs are often taken on by county Soil & Water Conservation Districts (SWCDs). Additionally, construction site plan reviews, inspections, and enforcement procedures are carried out by SWCD offices. Other organizations such as Public Works Departments or engineering firms may have the storm sewer systems and detention areas within the county mapped out. The Health Department may have a map of septic system locations, thereby making it easier to determine where illicit discharges may be located.

A guide to financing stormwater programs, prepared by Busco and Lindsey, is available online at http://www.waterweb.org/wis/wis3/presentations/00_Busco_paper.pdf.

Administrative Requirements
Regulation of an additional 60 communities in the Basin for stormwater control will add to the administrative burden within the NPDES permitting authorities. However, if this is done through the existing general permits, as opposed to individual permits, it will add a relatively small amount to the administrative burden. The 37 municipalities in Vermont and 23 municipalities in New York could be handled through the general permit by one FTE in each State. The estimated cost of this increase in staffing is $75,000 per State per year.

The addition of trained staff persons at the County or Regional Planning Commission level will be very important to facilitate Phase II efforts at the local level. This adds to the administrative requirements of this policy option. This is addressed in detail in Option DL2.

Option DL2: Increase level of technical assistance available to local municipal authorities to address phosphorus and stormwater issues.

Description
Using State and Federal funds, create one FTE staff position in each region of the Vermont and New York portions of the Lake Champlain Basin, under the regional planning commissions, to directly assist local municipal authorities to develop action plans for reducing total P export and stormwater volume from within each town. This will include plans for:

- Increasing stormwater infiltration;
- Minimizing streambank erosion;
- Addressing zoning and permitting issues for construction sites and driveways related to erosion control, impervious cover and other stormwater control measures;
- Establishing riparian buffers;
- Maintaining roads, ditches, and culverts; and
- Education and outreach to residents.

These positions will be housed within each Regional Planning Commission (RPC) in the Vermont portion of the Basin and two FTE staff positions will be housed in the Lake Champlain-Lake George (LC-LG) Regional Planning Board to assist municipalities. The RPCs seem to be the most well-suited institution through which to administer this technical assistance. On both sides of the Lake the RPCs were created to, among other tasks, assist local municipalities through education and technical assistance, serve as an information source, and help to secure grants and funding for projects. In New York, the LC-LG RPB manages the section 604(b) Water Quality Management Program to support local water quality improvement projects. The RPCs also tend to be very familiar with municipal plans and zoning regulations.

It is important that these positions are not funded by the municipalities that they are serving. In this way, the staff will have the objectivity to accurately assess the level of effort and effectiveness on P and stormwater control. Therefore, while housed in the RPCs, these positions should not be funded, in whole or in part, by the municipal dues paid to the RPCs. State and federal funding should be used to support these positions. This policy option is related to, but substantively different from, the bill introduced in the Vermont Senate (S.251), which requires the Vermont RPCs in the Basin to have at least one member appointed by the LCBP steering committee.

A 0.5 FTE staff person within LCBP should coordinate, standardize, and adapt information from other regions into a usable set of tools that are specific to the conditions of the Lake Champlain Basin. This information can be used by the P-reduction staff in the RPCs to facilitate their work with the towns. The P-reduction staff should be retained for at least 3 to 5 years so that they can help guide the planning process into the implementation phase in the towns. Once implementation of P and stormwater reduction activities are underway, a smaller staff can help troubleshoot over a wider area when problems arise. If funding is available, it may be beneficial to retain these technical assistance staff permanently in the RPCs.

It may also be valuable to attach some funding for implementation of municipal actions to these staff positions. By doing this, municipalities are likely to be more receptive and eager to work with and accept the technical assistance offered by the P-reduction staff.

Technical Effectiveness

Unfortunately, there are not data to support an estimate of the P reductions that might be obtained among towns by virtue of having adequate access to qualified staff persons. It is hoped that the P-reduction staff could help all towns meet an average 25 percent reduction in total P export through new efforts and good housekeeping. This is merely a ballpark estimate. If this goal is reached for towns in the Vermont and New York portions of the Basin, it is estimated that 38,202 kgs P will be reduced from the total estimated P export from developed land in these areas (25 percent of 152,810 kgs as estimated by Hegman et al. (1999)).

Cost-effectiveness

The cost of this policy option has two components. One is the cost of the additional staff and the expenses associated with carrying out their duties. The other is the cost of implementing the resulting P reduction activities that towns take as a result of working with these staff members. The former is easily estimated, while the latter is not. As discussed under Option DL1, the variability across towns regarding their needs, abilities, and approaches to stormwater and P reduction is too great for valid estimates to be made.

With regard to the cost of staff, the total cost per FTE, including expenses, is estimated to be $75,000 per year. If 6 P-reduction staff are hired in Vermont and 2 in New York and a 0.5 FTE position in LCBP, the total is 8.5 FTEs and the associated cost is $637,500 annually. Over 5 years the cost for the additional staff will be 3.18 million dollars. If we assume that the 25 percent P reduction goal will be achieved (38,202 kgs P reduced annually) and will last for 10 years (although it could last indefinitely), the estimated cost-effectiveness of the additional staff will be $8.34 per kg P reduced. The cost of the municipal actions, while not known, must be added to this estimated cost for technical assistance. It is assumed that municipal actions will cost from $5–20 per kg P reduced, though this can vary even more widely based on several factors. Therefore, a rough estimate of the average total cost for this policy option is $13-28 kg P reduced.

Socio-political feasibility
The only major challenge foreseen for this policy option is the ability to secure the funding required for the additional staff positions. The primary funders of the RPCs in Vermont are the State Agency of Commerce and Community Development and the Department of Transportation, as well as municipal dues. However, new funding will be required for the P-reduction staff housed in the RPCs.

A combination of State funds matched with federal funds should be sought for this purpose. As mentioned in Option DL1, the Vermont Governor's proposed Clean & Clear Water Action Plan, which will primarily support the implementation of the Lake Champlain Phosphorus TMDL, should be viewed as a likely source of funding for the technical assistance described here. The Clean & Clear initiative will make use of citizen environmental bonds, as well as federal grant monies, to facilitate the attainment of the P reduction goals by the accelerated 2009 timeline.

Administrative Requirements
The P-reduction staff should coordinate with the respective DEC stormwater reduction and water quality efforts in Vermont and New York. The staff should report to the LCBP P Reduction Task Force or a subcommittee thereof to increase effectiveness and accountability.

The administration of this policy option is relatively straightforward. Finding office space and facilities within the RPCs for the additional staff to operate may be the greatest administrative challenge, but is clearly surmountable.

Option DL3: Create incentives for towns to demonstrate documented efforts to reduce stormwater volume, erosion, and P export.

Option DL3a: Enact legislation in Vermont and New York to provide direct payments to municipalities that can document the implementation of approved water quality improvement actions. The legislation would create a fund from which to reward municipalities for documented actions to reduce P loads.

Description
In order to entice towns to take actions to improve water quality, financial incentives should be developed. The specific water quality concern of this policy option is P control. However, maintaining a broad focus on overall water quality improvement may be a more sound strategy. More specifically, this policy option is designed to entice

municipalities to ensure appropriate actions are taken for adequate control of stormwater, erosion, pollutants, and other P control efforts. The payments suggested here can serve as rewards for water quality actions taken and to help defray the costs associated with these actions. Technical assistance for implementing the P control efforts is necessary and is described in Option DL2.

A set of criteria should be assembled that can be used to determine if a town is making adequate efforts at the reduction of P export (or general water quality improvement). An expert panel should be formed in each state to assemble this set of criteria and create a 'municipal P reduction' (or 'water quality') index. This index should be created using weighted criterion to calculate a quantitative score that reflects the level of effort by each municipality to reduce P export. The criteria should include consideration of, at least, the following items.

- Road, ditch, and culvert maintenance;
- Frequency and type of street sweeping and drop inlet cleaning;
- Municipal ordinances governing construction sites, driveways, riparian buffers, and P applications in lawn fertilizers;
- Incorporation of 'smart growth' strategies in town plans;
- Presence, maintenance, and enforcement of stormwater infrastructure;
- Incentives for household and business stormwater and P export control, including disconnection from storm drains;
- Water quality planning, education and outreach activities, and other efforts.

This policy option uses financial incentives to motivate municipalities to conduct comprehensive planning and implementation to minimize P loads from the array of activities under municipal control. It also designed so that towns will find ways to inspire its businesses, households, and individuals to do the same. An important aspect of this approach is that it is a voluntary program. By receiving the financial incentive, towns will find it in their best interests to adhere to the stated P reduction criteria. The incentive payments could be based on the town's population, the cost of actions taken, the level of correlation with P loads to the Lake, or a combination of these factors.

Option DL3b: Incorporate a municipal P reduction index into grant proposal scoring and/or improve the loan repayment terms based on a town's municipal P reduction (or water quality) index score.

Description

There are several important funding programs, directly or indirectly related to water quality, that are used by towns. Obtaining funds from such programs should be linked to documented efforts to reduce stormwater volume, erosion, and P export from the town. The P reduction index score, discussed above, should be incorporated into the grant- and loan-making decisions for funding from the relevant programs. These funding programs should include the State Revolving Loan funds, U.S. EPA Section 319 funding, and Department of Transportation funding for local road maintenance. This program should be available to all municipalities in each state.

With regard to local road maintenance, the Vermont Agency of Transportation (AOT) has a provision in its town roads grants program that reduces the local share of the total project cost by 10 percent if the town has adopted the set of relevant AOT codes and specifications related to quality road maintenance and conducted a local road infrastructure study. However, the decreased local share is often extended before the conditions are met and remain unfulfilled. This option suggests that towns that meet the minimum P reduction index score have a reduced local share of transportation and other grants.

Additionally, this policy option suggests that achieving a minimum P reduction index score should increase the points assigned to grant proposals to relevant funds from that town. The P reduction index score could also be used to give towns 3–5 percent more loan funds than they are required to repay; essentially giving a town $1.05 for every $1 that they borrow.

Technical Effectiveness of Option DL3

If towns meet at least the minimum P reduction index score, they may be going above and beyond what is otherwise required of them. There are no data from which to create an estimate of the resulting P reduction. This will depend on the baseline level of P export from a town and its previous level of effort to minimize this. If we assume that an average reduction in P export from developed land in a town would be 25 percent as a result of meeting the minimum P reduction index score, P export from developed land in the Basin would decrease by 38,202 kgs annually for Vermont and New York (and an additional 5,546 kgs in the Québec portion of the Basin). However, not all towns will attempt to meet the criteria or be successful in doing so. If 50 percent of the towns meet the criteria, the reduction in P export will be expected to be 19,100 kgs annually in Vermont and New York (assuming similar P export characteristics between towns meeting and not meeting the criteria).

Lawn fertilizer ordinances should be considered in the municipal P reduction index as suggested in this policy option. Lawns create runoff with the highest concentrations of total P in the urban landscape and in highly residential watersheds contribute significant P loads in stormwater (Waschbush et al. 1999). There have been several proposed ordinances at the local or county level in other states to prohibit unnecessary P applications to lawns. Most notably, the city of Minneapolis has such an ordinance (see http://livepublish.municode.com/13/lpext.dll?f=templates&fn=main-hit-j.htm&2.0 for details). The Vermont Senate Natural Resources and Energy Committee has drafted a related bill that would limit fertilizer and P applications on nonagricultural turf (see S.91 at http://www.leg.state.vt.us for more information). The passage of this bill may negate the need for related municipal ordinances. However, this issue may be more effectively handled at the local level, as lawns constitute a widely varying portion of land area across municipalities in the Basin.

Cost Effectiveness of Option DL3a

If the direct payment to towns is $10 per household and 50 percent of the towns meet the minimum P reduction index score, total incentive payments to the towns would cost approximately $750,000 per year. At this incentive level, a qualifying town with 4,000 people (1,640 households, assuming the Northeast average of 2.44 persons per household) would receive an incentive payment of $16,400. It is presumed that this incentive payment would need to be made annually in order for the towns to maintain their efforts at P reduction. Additionally, a cost of $150,000 annually to cover one FTE staff person in each the Vermont and New York DEC to ensure compliance would be necessary. Therefore, the cost-effectiveness of the incentive program for the Vermont and New York portions of the Basin is estimated to be $47 per kg of P reduced ($900,000/19,100 kgs P). This does not include the costs that the town would incur as a result of their P reduction efforts, assumed to be $5–20 per kg P reduced. The average total cost for this option is $52–67 per kg P reduced.

Cost Effectiveness of Option DL3b

For this option, a 3 to 5 percent bonus payment would be given to towns on loans from the relevant funding sources (as discussed above) for meeting minimum P reduction index score. This will equal $3,000 to $5,000 for each $100,000 in loan funds. Giving bonus points to the score of grant proposals from qualifying towns will put them at a relative advantage to non-qualifying towns, but will not require additional public funds. Additionally, there are the administrative costs associated with ensuring compliance at the local level. This administrative cost is assumed to be $150,000 annually to cover one FTE staff person in each the Vermont and New York DEC.

If we assume that 50 percent of the towns would meet the minimum P reduction index score and $3 million is loaned to these qualifying Basin towns under the relevant programs each year, the cost of an average 4 percent reward to towns would be $120,000 per year. Adding $150,000 per year for oversight staff, the total annual cost (excluding the cost of municipal actions) will be $270,000. Given an estimated reduction in P export of 19,100 kgs annually in Vermont and New York (assuming similar characteristics between towns meeting and not meeting the criteria), reducing P through this policy option is estimated to cost $14 per kg. The costs that the town would incur as a result of their P reduction efforts, as above, are assumed to be $5–20 per kg P reduced. The average total cost for this option is $19–34 per kg P reduced.

If reducing the local share of matching funds for bridge and road grants is used as the incentive mechanism, a 10 percent reduction per $100,000 of grant funds would cost $10,000 in additional state or federal funds. Possibly up to 50 percent of towns would attempt to meet the P reduction index score to save on the local share of funds required. However, this percentage could be much lower. The cost-effectiveness analysis is very similar to that presented for option DL3a above, with a cost of approximately $50 per kg of P reduced.

[Note: A less costly, but perhaps less politically viable option (as discussed below) would be to require all municipalities in the Basin to meet the minimum P reduction index score in order to qualify for associated State and Federal grant and loan programs. In this case, the primary program costs are the 2 FTE staff positions. If the same assumptions are made regarding P reduction and its costs, the cost-effectiveness of such a regulation could be in the range of $9–24 per kg of P reduced.]

Socio-political Viability

Rewarding towns to 'do the right thing' on water quality could be a fairly non-contentious issue, if all of a state's towns are eligible for the reward. A Vermont bill that rated grants for large, capital sewer improvements projects more favorably for towns in the Lake Champlain Basin was opposed by lawmakers from other regions of the State. Therefore, it is important that municipal incentives for improving water quality be available to all municipalities in the respective State. In New York this is a more costly endeavor than in Vermont, but water quality improvements are as valuable outside of the Basin as within.

This policy option is only feasible provided that sufficient funding is made available. Each state has numerous options for sourcing the funds to support this initiative. This approach will reward the 'good actor' towns that have already made efforts to address water quality concerns, thus reinforcing positive policy signals. The burden will fall on the towns that have not made previous water quality efforts. To see net improvements in P loads from developed land, the incentives and technical assistance must be great enough to entice towns to meet the P reduction index criteria.

Requiring towns to meet a minimum P reduction index score in order to qualify for certain state grant money (often combined with federal funds) could be a very contentious issue. For towns that require these grants and loans and require significant investments to meet the minimum P reduction index score, the burden may be very great. For such towns a specially designated fund should be created to help offset the costs of complying with the P reduction efforts.

Administrative Requirements

In order to qualify for incentive payments or for associated state loan programs, the State DECs should maintain a list of towns that meet minimum P reduction criteria. This process could be analogous to Vermont towns being confirmed by their RPC as having an approved municipal plan to be eligible to receive municipal planning grants from the Department of Housing & Community Affairs. In Vermont, verification of the P reduction index score for towns could be facilitated by the staff in DEC conducting the river basin planning processes.

Option DL4: Amend the water quality statutes in Vermont and New York to reduce the maximum P content of household cleaning agents, including automatic dishwashing detergents that are sold or distributed, to 0.5 percent by weight.

Description

In Vermont the applicable statute is Title 10, chapter 47, section 1382, which capped the P content of household detergents, *excluding those for dishwashers*, to a trace amount. In New York, the same standard is created in Environmental Conservation Law, Article 35. Most household laundry detergents contain less than 0.5 percent P by weight. However, most commercially available automatic dishwasher detergents (ADDs) still contain significant amounts of P. This policy option suggests amending the statutes in Vermont and New York to reduce the P content of all household cleansers to less than 0.5 percent elemental P.

Details regarding the ADD issue in the Lake Champlain Basin have been presented in Hanrahan and Winslow (2004). Legislation similar to that suggested in this policy option has been proposed in Minnesota, Michigan, and Massachusetts; though, as yet, none of the bills have been enacted into law. The Vermont Senate Natural Resources and Energy Committee has introduced legislation to remove the exemption for capping the P content in ADDs. As of the current legislative session (2003–2004), the bill has passed the Senate and is being considered by the Vermont House Natural Resources and Energy Committee.

Technical Effectiveness

Seventh Generation, Inc. has commissioned independent laboratories to test the effectiveness of phosphate-free ADDs in soft and hard water. The results show that phosphate-free ADDs, both powder and gel, performed as well as phosphate ADDs. Seventh Generation uses sodium citrate and sodium carbonate (washing soda) in its ADD powder and a polycarboxylate in its gel. The firm claims that these products pose no greater threat to septic systems or municipal wastewater treatment plants (WWTPs) than do phosphates.

The following calculations differ from those presented in Hanrahan and Winslow (2004) in two areas. First, the estimate of the amount of ADD used per wash in Hanrahan and Winslow (2004) is 3 tablespoons. This analysis estimates that there are 5.5 tablespoons of ADD used per wash. Second, based on Wolf (2003), this analysis assumes that the current price differential between P and non-P ADDs will move towards zero as non-P ADDs become the norm rather than the exception, which affects the cost-effectiveness of this policy option.

This analysis estimates that the average household with an automatic dishwasher uses about 15.42 kgs of ADD per year (See Table 7). Based on estimates used in Hanrahan and Winslow (2004), there are approximately 104,845 automatic dishwashers (ADWs) in the U.S. portion of the Basin. This is based on an estimated U.S.-side Basin population of 541,000, an average of 2.58 people per household, and an estimate that 50 percent of homes in the Northeast have ADWs. This analysis estimates that approximately 1 kg P will be emitted per household per year from ADDs alone. Therefore, limiting the P content of ADDs to a trace amount could reduce the P discharge from ADDs alone by an estimated 102 mt per year. However, less than 5 percent of this discharge is likely to find its way to the Lake. It is estimated that P loading reduction from this policy option will be low to moderate.

It is estimated that the average P content of ADDs (weighted by local sales volume) is approximately 6.3 percent (Hanrahan and Winslow 2004). Therefore, for every 10 kgs of ADD used, 0.63 kgs of P leave the household. However, a relatively small portion of this P is discharged into the environment; the exact amount is unknown. Much of the discharged P from household ADDs is ultimately captured in WWTPs or septic systems.

Table 7. Calculations of P Loss from Automatic Dishwashing Detergents

Population in U.S. portion of Basin	541,000		**Households connected to WWTPs**	
Avg population per household	2.58		% of HHs connected to WWTP	43.00%
Number of households	209,690		Avg % P removed at WWTP	90.70%
% of households with ADW	50%		MT P removed/year from ADD	39.90
# of ADWs in U.S. portion of Basin	104,845		Annual cost for P removal from ADDs	$399,008
			MT P escaped/year from ADD	0.50
Avg ADW washes/week	3.5			
Avg TBSP ADD/Wash	5.5		**Households on septic systems**	
Total TBSP ADD/household/year	1,001		% of HH on septic	55%
Total kg ADD/household/year	15.42		% P escaped from functioning septic	0%
Avg P content of ADDs	6.33%		% P escaped from failed septic	20%
Avg kg P/ADW/year	0.98		Avg % of failed septic systems	9%
Total MT P/year from ADD	102		MT P escaped/year from ADD	1.01

Sources: Hanrahan and Winslow, 2004 and Vermont Dept. of Environmental Conservation, 2004.

Approximately 55 percent of the homes in the Basin use private septic systems and 43 percent are connected to sewer systems and WWTPs (Lake Champlain Basin Program 2004). The percentage of homes with on-site septic systems is likely to be higher on the Lake's shores, as public sewer infrastructure is less likely to be present in these locations. Additionally, an increasing number of lakefront homes (and homes in general) are likely to have automatic dishwashers these days relative to previous decades.

The majority of P in the water treated at WWTPs (approximately 90 percent) is removed. However, it is estimated to cost $10,000 per mt to remove P at WWTPs (Vermont DEC 2004). This cost estimate is 10 times higher than that used in Hanrahan and Winslow (2004) because it includes chemical treatment and sludge handling costs. For WWTPs that are subject to a maximum P concentration of their discharge, emissions to the environment would be unaffected by this policy option. Ideally, operators at these plants adjust their treatment process to achieve the required P concentration at the minimum cost.

For WWTPs without P concentration limits, eliminating P from ADDs could reduce the amount of P that is discharged to the environment. However, less than 2 percent of wastewater flows to these plants and it is estimated that banning P from ADDs will reduce P loading to the Lake from Vermont by 0.5 mt per year (Vermont DEC 2004). In general, by reducing the amount of P flowing to WWTPs, P losses to the environment will be reduced, though not greatly, and cost savings will accrue in municipal wastewater treatment.

The efficacy of P removal for septic systems is likely to be highly variable based on the systems age, maintenance, and size and quality of the leach field. It is estimated that 0 percent of P will reach surface water from a properly functioning septic system. However, from a failed septic system it is possible that untreated effluent will reach surface water. Although there are not data available on this, we have roughly estimated that 20 percent of P from failed septic may reach surface water. Additionally, it can be inferred from estimates in Budd and Meals (1994) that an average of 9 percent of Basin septic systems are failed at any given time. This analysis estimates that the amount of P from ADDs reaching surface water from failed septic systems is approximately 1 mt per year Basin-wide.

Cost-effectiveness

Currently, phosphate-free ADDs are approximately 15 percent more expensive to consumers than commercial phosphate ADDs (Hanrahan and Winslow 2004; Wolfe 2003;). Seventh Generation, Inc. attributes this difference to higher margins taken by retailers for their products (29 percent versus 23 percent for larger brands) and not having their own distribution system. They do not see any reason why phosphate-free ADDs would be any more expensive to produce or market if all brands were required to be phosphate-free (Wolfe 2003). Seventh Generation's Director of Product Quality and Technology has said "…there is little doubt that other manufacturers, including mainstream consumer product companies, would produce similar [phosphate-free] products" (Wolf 2003).

Assuming that it is not more expensive to produce phosphate-free ADD products, economic forces should result in no additional cost to consumers from this policy. However, there may be adjustment costs incurred by the manufacturers. As discussed in the previous section, there are some clear cost savings related to P removal at WWTPs. This analysis estimates that a ban on P in ADDs will save approximately $399,000 per year in municipal wastewater treatment costs.

The overall cost effectiveness of this policy depends on the ultimate cost to consumers of banning P in ADDs. If the current price differential is maintained, Hanrahan and Winslow (2004) estimated that it will cost $8.65 per year for each household with an ADW (or $907,000 Basinwide). Even under this scenario, they found a ban on P in ADDs to be much more cost-effective than many other options. If the ultimate price differential were to become zero, as we assume, the cost-effectiveness of this policy option would be very high.

Socio-political Viability

Legislative actions on this issue have been attempted in Massachusetts, Michigan, and Minnesota. None of the bills have yet to pass into law, however Minnesota seems very close to doing so. There has been active opposition to these measures taken by the Soap and Detergent Association in all three states, which could be expected in Vermont and New York also as a result of this policy option. .

Administrative Requirements

This policy option suggests a purely legislative action. Other than developing grassroots and legislative support for this legislation, there are no administrative requirements.

C. Policy Options: Overview, Relationship, and Recommendations

The first two policy options for agricultural land (AG1 and AG2) aim for wider and more comprehensive adoption of current BMPs that can address P transport control. The following three options suggest alternative approaches for reducing P loss from agricultural land. Options AG1a and AG1b examine two BMPs that have been proven to reduce the export of P from agricultural lands in the short-term (livestock exclusion and riparian buffers). Wider implementation of these practices could have near-term benefits for reducing P loading in the Lake; the efficacy of requiring these practices throughout the Basin is examined.

Although not included as a specific policy option, additional education and outreach, as well as enforcement, of the existing Vermont Accepted Agricultural Practices (AAPs) must also be implemented. Developing and enforcing regulations similar to the Vermont AAPs in New York may also be necessary. However, the components of Option AG1 are only partial and short-term solutions. If sustainable solutions for achieving the long-term P reduction goals for the Lake are to be successful, they will need to address the sources, management, and surpluses of agricultural P in the Basin.

Option AG2 recommends enacting nutrient management legislation with the use of a P index assessment for all livestock operations with a stocking rate over 0.5 AUs per acre. This policy is intended to induce more careful P accounting on farms that are likely to have surplus nutrients and result in a more intentional distribution of nutrients away from fields with high risk for P losses. Option AG2 is an intermediate-term solution that will address both P transport and source issues through the use of P indices. Option AG3 presents ideas for facilitating the shipment of manure off farms that have surpluses and the removal of P from manure where feasible. For long-term solutions, farms in the Basin must move toward P balances in their production systems. Option AG4 suggests using P mass balance on the farm as a performance target and rewarding farmers for reductions in P surpluses on the farm. By focusing on the outcome (reducing on-farm P surplus) rather than prescribing the process (e.g., specific and mandated BMPs), farmers have the incentive and flexibility to achieve the outcome at minimum cost. If farmers are compelled to reduce the surplus of manure on the farm due to regulations (AG2) or incentives (AG4), the need for the options presented in AG3 becomes much stronger.

Option AG5 suggests the creation of a Basin-wide network of teams to work with individual farmers to assess potential problems, find least-cost solutions, and facilitate the incorporation of environmental quality concerns into long-term farm business planning. This option is focused on a longer-term solution that recognizes farmers as business people who are adept at finding solutions to problems. Therefore, providing farmers with clear expectations for environmental quality, financial incentives (Option AG4), and help in finding solutions in accord with their business plans and objectives may be the best way to find solutions to agri-environmental problems.

A policy option that is not included in the list, but worth mentioning, is one which creates incentives for the adoption and use of management-intensive grazing (MIG) on Basin dairy farms. This was not recommended by the Phosphorus Reduction Task Force for inclusion in the final list to avoid having one practice as the sole focus of the policy, and because it favors a specific type of farming system (e.g., use of MIG) over other systems. However, the scientific research on the ability of MIG on dairy farms to reduce P loss should be considered. A computer simulation study of farms in Pennsylvania estimated that the use of MIG can reduce the accumulation of surplus P on the farm and increase profitability relative to conventionally-managed dairy farms (Winsten et al. 2000). A 100-cow dairy farm in the Catskills region of New York was estimated to reduce annual P accumulation by 53 percent (2.7 kg/ha) and increase profitability by $93/cow through the use of MIG (Rotz et al. 2002). Other studies have shown that minimizing soil erosion and surface flow through the use of MIG will reduce the loss of P to surface waters (Owens et al. 1983).

The concept of linking consumer dollars for milk and dairy product purchases to environmental protection could also be a valuable one. However, attempts at marketing ‘environmentally-friendly’ milk have proven extremely difficult. The Environmental Quality Initiative, Inc. conducted a test market for Chesapeake Milk™, which was to return $0.05 per half-gallon directly to farmers for “protecting natural resources through environmentally-sensitive farming practices.” They found that sales volume and premiums returned to farmers were less than anticipated, and that consumers were willing to pay about 10 percent more for Chesapeake Milk™, but the costs of the program exceeded that margin (Sandman and Lanyon 2001). Additionally, eco-labeling is generally more of a private sector concept than an option for public policy debate. For these reasons, an eco-labeling effort was not included in the final policy options.

A related policy option that was rejected by this project’s agricultural advisory group is a requirement that milk handlers or processors pay a premium per cwt of milk to Basin farmers who meet a set of stated pollution control criteria. The group considered this to be politically infeasible due to the political power held by the food processing industry. Regardless of these obstacles, harnessing consumer dollars for environmental protection should remain on our collective radar screen as part of the solution to the Lake’s P problems.

The technical- and cost-effectiveness of each of the final policy options could be increased by targeting critical source areas for P delivery within the Basin and its watersheds. Although it is not a policy option unto itself, it is strongly recommended that computer modeling and GIS be used to identify the specific areas within the Basin’s watersheds where targeted efforts could result in the greatest reductions in P loading.

Option DL1 uses States’ authority to expand stormwater regulations under the Clean Water Act to apply to a larger number of municipalities in the Basin. The six minimum control measures that are part of Phase II of the EPA’s Stormwater Rule would help reduce P export if implemented in many more of the Basin’s cities and towns. Because Option DL1 would apply to many towns that do not have adequate staff or resources to comply with the Phase II regulations in an effective manner, Option DL2 suggests that technical assistance on stormwater, P export reduction, and water quality be made available to municipalities. This would be done through the creation of one full-time staff position housed in the regional planning commissions, but funded through state and federal appropriations, not municipal dues. These staff positions would also be a conduit through which municipalities could apply for implementation grants related to water quality improvement efforts.

Option DL3 suggests two separate incentive mechanisms that could be used to motivate municipalities to make water quality improvement efforts. This option could be an alternative to, or a means for augmenting, the expansion of the Phase II regulations (Option DL1). The incentives would be linked to an index score of municipal P reduction (or water quality) efforts. This municipal P reduction index should consider smart growth strategies, road, ditch, and culvert maintenance, municipal ordinances related to construction sites, driveways, riparian buffers, and lawn fertilizers, stormwater infrastructure, incentives for households and businesses, water quality planning, education and outreach, as well as numerous other factors. Option DL4 suggests legislation in Vermont and New York to reduce the maximum P content in automatic dishwasher detergents sold in each state to be 0.5 percent by weight. This follows proposed legislation in Vermont and several other states for the purpose of reducing P loading to surface waters.

Reasonable cost-effectiveness is a necessary, but not sufficient, condition for implementation of any given policy option. Cost-effectiveness is likely to be the primary criterion for selecting policy options for further consideration. Table 8 summarizes the estimates of technical- and cost-effectiveness for each of the final policy options. The other major criteria for policy selection will be socio-political viability and administrative requirements. All of the final policy options presented above have been screened for their socio-political viability and administrative requirements. Although the policy options are not equal in this regard, they are each estimated to be acceptable according to these two criteria; specific discussion is presented in the description of each policy option above.

In general, the policy options focused on agricultural land are estimated to have greater cost-effectiveness (fewer dollars required per kg of P reduced) than do the options aimed at developed land and municipalities. Options AG1a and AG1b, which focus on expanding and enforcing known BMPs, show the greatest cost-effectiveness. These options could be implemented simultaneously and together with option AG2, enacting a nutrient management law applying to farms with a high stocking density. The cost-effectiveness of option AG2 cannot be quantified, but it is estimated to have moderate technical- and cost-effectiveness. It is possible that comprehensive nutrient management planning can increase farm profits in the long-run. Although not particularly innovative, these three options represent a logical, fairly quick, and relatively easy set of policy actions. Together, these options can help to minimize P loss from agriculture in the short-term. However, because these options do not address the longer-term issue of moving toward P balances on farms in the Basin, they represent only a temporary and partial solution.

Table 8. Estimated Technical- and Cost-effectiveness of Policy Options

Policy Option	Brief Description	Estimated Average P Reduction (kgs/yr)	Estimated Total Cost ($/yr)	Estimated Cost-effectiveness ($/kg P)
AG1a	Livestock exclusion	0.227 [1]	55 [2]	8
AG1b	Agricultural riparian buffers	24.75 [3]	164 [3]	6.62
AG2	Nutrient mgmt. law for high stocking rates	Moderate	750,000	Moderate cost-effectiveness
AG3	Manure export from farms	Low to moderate	Moderate	Low to moderate cost-effectiveness
AG4	Payments for reducing on-farm P surplus	116,091	1,067,809	9.20
AG5	Participatory assistance teams	36,240–60,400	1,500,000	35–51 [4]
DL1	Expand Phase II stormwater rule to more towns	Moderate to high	High	Low to moderate cost-effectiveness
DL2	Technical assistance to towns	38,202 [5]	637,500	13–28 [6]
DL3a	Payment to towns for P reduction score	19,100 [7]	900,000	52–67 [6]
DL3b	Improved proposal scoring and loan terms	19,100 [7]	270,000	19–34 [6]
DL4	Ban P in ADDs	Low to moderate	Low cost	Highly cost-effective

1 Kgs per animal unit (AU) per year.
2 Per AU as present value over 30 years with a 5 percent annual discount factor.
3 Based on a estimated reductions from a 60-acre field.
4 Includes $10 per kg implementation cost to farmer; continued P reductions beyond life of project will reduce costs per kg.
5 Based on assumption of 25% P reduction from all developed land.
6 Includes $5–20 per kg implementation cost in addition to staff costs.
7 Based on assumption of 25% P reduction from developed land in qualifying municipalities (50%).

For longer-term solutions, policies need to be created that provide clear signals to farmers of society's expectations regarding pollution from agriculture. Options AG4 and AG5 are policy approaches that attempt to do this. Option AG4 proposes to pay farmers for documented reductions in the mass balance of P on the farm. This policy is estimated to have high cost-effectiveness ($9.20 per kg P reduced). This is an innovative, performance-based policy approach; it will take some time and stakeholder involvement to develop the most appropriate details for implementing this approach. Option AG5, using a participatory assistance approach to help farmers find long-term solutions that fit with their business plans, is a labor-intensive and more expensive ($31–51 per kg P reduced) option. The agri-environmental quality teams suggested that this approach can serve as a conduit to help deliver society's expectations on pollution control to the farmer and incorporate this into the farm's business and operational plan. This option will also take some time to develop and implement effectively, because it requires staff and team training. Options AG4 and AG5 are complementary.

As mentioned previously, the three related ideas that compose option AG3 will be widely utilized and valuable only if policies are enacted that motivate farmers to reduce the amount of manure and P on the farm. As such, this option is complementary to options AG4, AG2, and AG5.

Of the policy options for developed land, the easiest and most cost-effective option to implement will likely be DL4, enacting legislation to ban P from ADDs. Options DL1, DL3a, and DL3b are designed to motivated municipalities to take actions (and motivate their citizenry) to reduce P loads to the Lake and improve water quality in general. Option DL1, expanding the Phase II stormwater rule to more municipalities in the Basin, attempts to do this by regulation. As such, this option may be costly because it does not afford municipalities the level of flexibility that options DL3a and DL3b would. The socio-political feasibility of option DL1 is likely to be more difficult than that of options DL3a and DL3b, as it mandates compliance rather than inducing voluntary compliance through incentives. The most expensive of these options is DL3a, direct payments to towns according to their municipal P reduction score, which is estimated to cost $52–67 per kg P reduced. Although more expensive than DL3b (using the municipal P reduction score in grant proposal scoring and financing loans), DL3a is likely to induce wider participation and result in greater P reductions Basinwide.

Option DL2, providing technical assistance to municipalities, would be most valuable (and necessary) as a complement to options DL1, DL3a, and DL3b. If option DL2 were implemented individually, municipalities may not be motivated to take advantage of the available technical assistance. Therefore, an appropriate strategy may be to implement all of the developed land options simultaneously. There do not seem to be compelling arguments for ignoring a P ban in ADDs (option DL4). Expanding the implementation of the Phase II stormwater rule, as suggested in option DL1, will be applicable only to a small subset of Basin communities. Using the municipal P reduction index scoring will motivate additional communities to increase efforts to improve water quality.

VI. Conclusions

This report describes the processes and outcomes of the project titled "Developing and Assessing Policy Options for Reducing Phosphorus Loading in Lake Champlain." The goals of this project were to develop a set of innovative policy strategies for reducing phosphorus (P) loads in Lake Champlain. While coordinated by Winrock International, this effort drew heavily on the input of locally and nationally recognized scientists, economists, and policy experts with extensive experience on the issue of nonpoint-source P pollution control.

The objectives of the project were to:

- Conduct a review and analysis of current policies and programs for controlling P loads in Lake Champlain;
- Provide a review and assessment of innovative strategies for controlling P loads in other watersheds throughout the U.S. and abroad; and
- Create a set of appropriate policy options for reducing P loads in Lake Champlain, with associated cost-benefit analyses.

The assessment of current policies and programs related to P reduction in the Basin reveals that efforts for reducing P loss from agricultural land are not uniform among the Basin's jurisdictions. Related to P export reduction from agriculture, new regulations being implemented in Québec are more comprehensive than those in Vermont or New York. With regard to developed land, state and federal policies help to reduce P loads to the Lake from larger developments and construction projects and from the urban areas of the Basin. However, control of P loss from the majority of the developed land and construction projects is generally under local municipal control. Clearly, new approaches are needed to motivate more comprehensive municipal actions for P control across the Basin.

The final policy options created by this project primarily address nonpoint sources of P. Focusing on the control of nonpoint sources was deemed the wisest use of this project's resources, as they present much more difficult policy issues than does point source control. The policy options in this report are divided between those applicable to agricultural land and to developed land. For both of these nonpoint sources, the policy options are a mix of regulation, technical assistance, and financial incentives. For the most part, the policy options contained in this report are novel ideas. The project team feels that the set of ideas contained in these policy options provide a greatly increased probability of success for meeting the long-term P reduction goals set for Lake Champlain. Where possible, guidance for specific implementation details for each policy option has been included. However, for the most part specific decisions will need to be made by legislators, policy makers, civic leaders, and stakeholders concerning resource allocation (i.e., funding sources, staff time, etc.), related rules, and timetables before implementing any of these policy options.

For both agricultural and developed land, this report recommends starting with the 'low-hanging fruit,' the easiest and most obvious solutions. Although these may provide only partial or short-term solutions, policy options AG1a, AG1b (agricultural BMPs), AG2 (nutrient management legislation), and DL1 (expanding the Phase II stormwater rule) are natural extensions of existing policies. As such, these options would be relatively simple to implement and will help to reduce the flow of P in the near-term. Options AG1a and AG1b are also likely to be highly cost-effective.

The next step in policy actions should be the simultaneous implementation of incentive mechanisms, technical assistance, and education and outreach. Developing performance-based environmental policies for agriculture, such as AG4 (payments for reducing on-farm P surplus), will provide an incentive for farmers to reduce long-term P loading on agricultural land. Similarly, options DL3a and DL3b (payments and benefits for documented municipal actions) will provide towns with the incentives to voluntarily reduce P loading to the Lake. The success of these policies can be facilitated by implementing options AG3 (subsidized manure exporting), AG5 (participatory assistance teams), and DL2 (technical assistance to towns). These will provide mechanisms, technical assistance, and education that are needed to help farmers and municipal officials and staff to meet the desired P reduction targets.

The policy options described above put forth a combination of regulation, technical assistance, financial incentives, and legislation designed to facilitate P reductions to the Lake.   Some of the options presented contain radically different approaches relative to those currently being used in the Basin or elsewhere. These new ideas present a couple of important challenges for policy makers. First, there are not adequate data to accurately estimate the P load reductions resulting from some of the policy options. Secondly, there will need to be considerable discussion and debate, far beyond that allowed in the scope of this project, to finalize the plethora of details that need to be addressed before implementation can take place. These challenges notwithstanding, the policy options presented in this report represent potential ways to increase the effectiveness and efficiency of long-term P reduction efforts for the Basin.

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Appendix A.

Information on the Maryland and Pennsylvania Nutrient Management Laws

(Files Appendix A – PA.pdf and Appendix B – MD.pdf follow this page)

Appendix B.

Information on the Bosque/Leon Dairy Manure Export Support Project

(File DMES project info and procedures.pdf follow this page)