MARYLAND'S TRIBUTARY STRATEGIES FOR NUTRIENT REDUCTION: A STATEWIDE SUMMARY

March, 1995

Maryland Department of the Environmment
Maryland Department of Natural Resources
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PREFACE

In 1983, the states of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency joined in a partnership to restore the Chesapeake Bay. Leaders of these jurisdictions recognized that the Bay's problems could not be solved by any one of them acting alone. In 1987, they signed the Bay Agreement to remedy the most pervasive pollution problem by working cooperatively toward a 40% reduction in nutrients entering the Bay by the year 2000. In 1992, they acknowledged that the Bay was in decline because of changes in the watershed as a whole, and likewise, that the Bay's restoration is dependent upon a watershed-wide solution. The Bay Agreement was therefore amended to require tributary-specific plans for nutrient reduction in the Bay's major tributaries.

Significant progress has been made toward the nutrient reduction goal, but much remains to be done. This is especially true given that the nutrient reduction goal results in a nutrient load cap which we are not to exceed. Each of the aforementioned jurisdictions is currently developing "Tributary Strategies" that describe the ways in which nutrient pollution loads can be reduced by 40% in the many sub-watersheds that drain into the Bay. This coordinated watershed-by-watershed approach brings the Bay clean-up closer to home for the many citizens and local governments that must participate for the restoration to be successful. The benefits of these Strategies will be realized not only in the Bay itself, but in the local streams, rivers, and groundwater that directly affect our health and quality of life.

This document summarizes and synthesizes the Nutrient Reduction Strategies for Maryland's ten Tributary Strategy watersheds. Each of the ten Strategies provides specific recommendations to achieve the 40% nutrient reduction goal. The Strategies represent a collective effort over the past year among all levels of government with extensive input by various interest groups and citizens. Local governments, in particular, have spent considerable time and effort and provided significant input to the draft Strategies. Each Strategy provides an example of how the goal may be achieved through specific programs and practices, called "nutrient reduction options." In implementing the Strategies over the coming years, new information on methods to reduce nutrient pollution will undoubtedly come to light, available funding will change, more detailed data on watershed conditions and needs will become available, and priorities will shift. The Strategies are meant to be flexible and dynamic so that the goal can be met in the most efficient and practical manner. Locally-based "Tributary Implementation Teams" will be established to facilitate the continued participation of local governments, interest groups, and citizens in deciding how best to refine and implement the Strategies to meet our shared goals.

Public meetings to discuss the draft Strategies were held during the spring of 1994. The Strategies have since been revised in response to public comment. Among the more frequently heard recommendations were a greater focus on education, improvement of existing regulations, and emphasis on cost-effective options and on practices with benefits in addition to nutrient reduction. Other revisions to the Strategies were due to data corrections, practical implementation considerations, and as a result of new or changes in state laws and policies adopted during the drafting of the Strategies.

This summary of the ten Strategies demonstrates that Maryland's overall 40% nutrient reduction goal can be achieved statewide, describes how this can be accomplished, and provides a context in which to review the watershed-specific Strategies.

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The Problem

The Chesapeake Bay is the nation's largest estuary and one of its most valuable and treasured natural resources. It is home to a rich diversity of over 2,700 plant and animal species, and serves as a major commercial and recreational resource for the people of Maryland. Unfortunately, water quality and living resources in this great Bay have declined markedly over the last several decades. Bay waters have become murky from pollution, unable to support the underwater grasses that serve as critical habitat for Bay life. This, combined with other stresses, has dramatically reduced fish, shellfish, waterfowl, and other wildlife populations, degraded our drinking water supplies, and diminished recreational opportunities, thereby reducing our ability to earn a living and to enjoy the Bay. Rapid population growth is at the root of many of these problems. The state's population is projected to increase by 1.3 million people between 1990 and 2020, a 28% increase. How we accommodate this population growth will affect our and our children's quality of life, living resources, water quality, and the opportunities for restoring the Bay and its tributaries.

In the late 1970s, scientists began an extensive study of the Chesapeake Bay to determine the specific reasons for its decline. Three major problems were identified:

- excess **nutrients** from wastewater, agricultural land, and developed land;
- **sediment** runoff from farms, construction sites, and other lands; and
- possibly elevated levels of **toxic** chemicals.

All three problems are being addressed in the Chesapeake Bay restoration. Maryland's Tributary Strategies focus on the largest problem, the reduction of excess nutrients—nitrogen and phosphorus—entering the Bay.

Restoration Commitments

To address the Bay's problems, a watershed-wide restoration effort began in the early 1980s.

- **In 1983**, the Bay jurisdictions (Maryland, Virginia, Pennsylvania, and the District of Columbia), the Chesapeake Bay Commission (representing the legislative bodies of Maryland, Pennsylvania, and Virginia), and the federal government made a joint commitment to restore the Bay's water quality and living resources and established the Chesapeake Bay Program.
- **In 1987,** the Bay Agreement was signed by the parties above (called the Chesapeake Bay Executive Council). A major element of the Agreement was the commitment to reduce nutrients entering the Bay by 40% by the year 2000. Bay scientists have

determined that this step will increase oxygen in the deep waters of the Bay by about 20%, resulting in more "livable" habitat for the Bay's living resources. Equally important, scientific forecasts show that the Bay will get significantly worse if nothing is done.

- **In 1992,** amendments to the Agreement reaffirmed the 40% goal and highlighted the importance of the Bay's tributaries. As a result, the Bay Program is "moving upstream," renewing the focus on the rivers of the Chesapeake. These rivers carry nutrients and sediment to the Bay. If we can reduce the amount of nutrients entering the rivers, we will reduce the pollution flow to the Bay. This will not only help the Bay, but will bring cleaner water and more living resources to the rivers and streams of Maryland.

- **In 1993 and 1994,** the development of the Strategies or plans to reduce the pollution entering the rivers were initiated and are the main focus of this document.

- **In 1997,** the Strategies will be reevaluated for progress to determine if mid-course corrections are necessary.

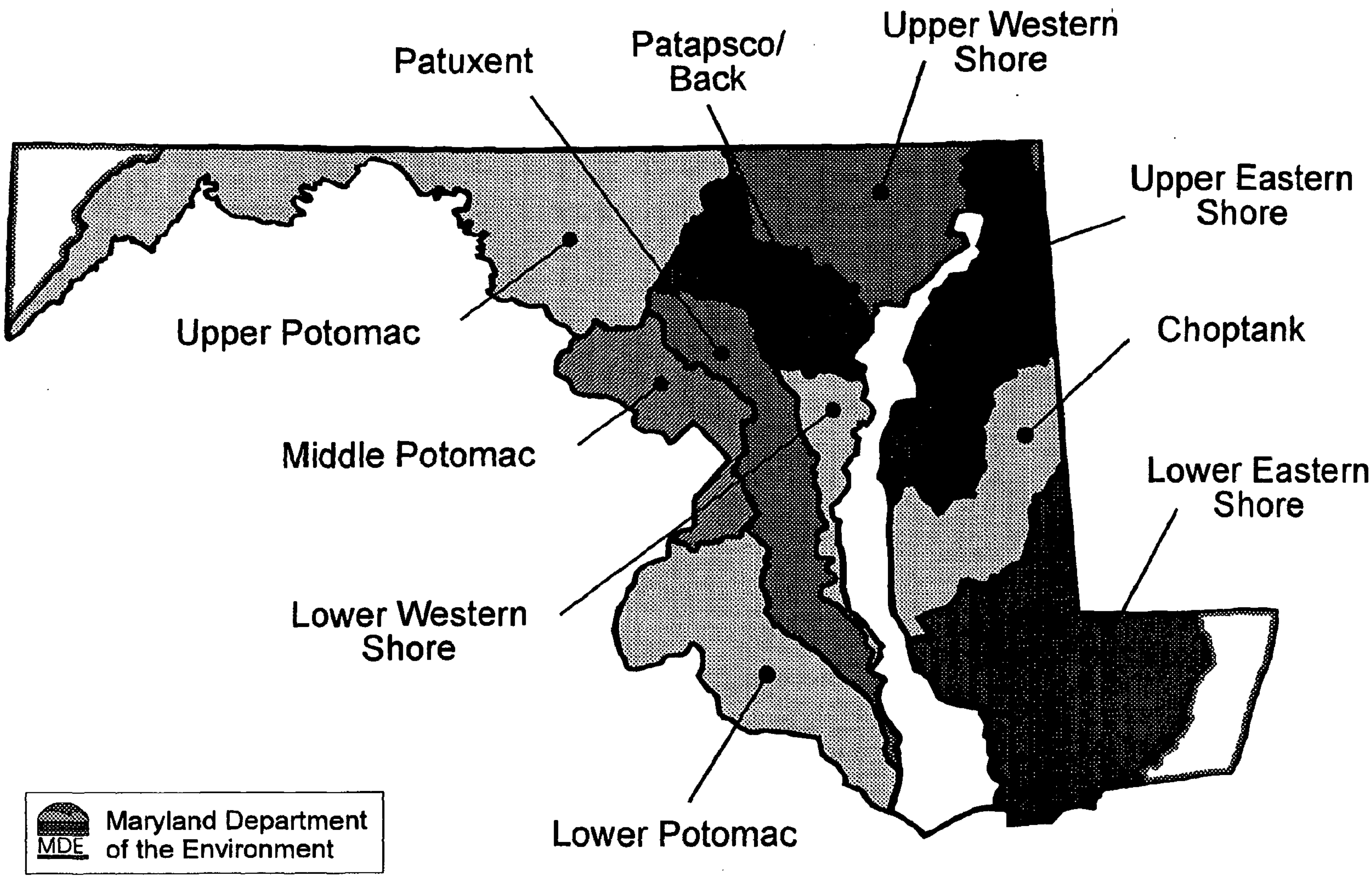
Significant progress has been made as a result of the Bay restoration effort. Since 1985, the baseline year for measuring the reductions, Maryland has reduced nitrogen entering its tidal waters by 17% and phosphorus by 27%. But more remains to be done. To gain the full benefits of our work so far, and to continue our progress toward our goal, we in Maryland must bring the commitment of the Bay Agreement to our own neighborhood rivers and streams.

What are Tributary Strategies?

The Tributary Strategies comprise a comprehensive approach to reducing nutrient pollution in Maryland's tributary watersheds. The Strategies are developed by the state and local governments, and the citizens living and working in their watersheds. To achieve the 40% nutrient reduction for the state, Maryland's Chesapeake Bay watershed has been divided into ten major tributary watersheds including the three subwatersheds for the Maryland portion of the Potomac River (see Figure 1). Each of these tributaries has a specific nutrient reduction goal, which when summed across all the tributaries, will allow Maryland to achieve its overall reduction goal. This regional focus allows the state and local governments to work with the public to build a locally-based framework to protect and restore the rivers and streams of the Chesapeake Bay watershed.

The Tributary Strategies involve a collaborative effort among state and local government staff, workgroups from every watershed, and participants in public meetings. The Strategies

Figure 1. Maryland's Tributary Watersheds



include a number of "options"—practices and programs that reduce nutrient pollution—that together will achieve the 40% nutrient reduction goal.

The Strategies are a combination of existing regulatory programs and comprehensive voluntary programs. They include some options we know will reduce nutrients, but don't know by how much. The Strategies are plans for achieving the 40% nutrient reduction goal in each of the ten watersheds that will undoubtedly be fine-tuned and improved as they are implemented between now and the year 2000. The Strategies will reflect public, local, state, and federal government concerns, availability of resources, and the emergence of new technologies. A critical part of the Tributary Strategies, other than the plans themselves, is the process that is being established for making them work, a process that relies upon the participation of all those who have a role in their success.

The Tributary Strategies present a unique opportunity to change the way we manage resources. The Strategies focus on our watersheds, rather than the traditional jurisdictions of county or state boundaries. This innovative approach is an opportunity for citizens to have critical input into how natural resources are managed in their own watersheds. By providing a framework for a comprehensive approach to watershed management, the Tributary Strategies provide an opportunity to integrate nutrient reduction efforts, habitat restoration, growth management and planning, preservation of agricultural lands, protection of drinking water reservoirs and aquifers, and other initiatives to promote a healthy environment and livable communities.

Living Resources in the Tributary Strategies

The Tributary Strategies are part of a larger effort to restore the Bay's living resources that includes habitat restoration, toxics reduction, removal of blockages to fish spawning areas, and improved fisheries management. The ultimate purpose of the Tributary Strategies is to restore the water quality necessary for the Bay's living resources. The 40% reduction goal was reaffirmed by the Bay scientists after determining that meeting the goal would improve the dissolved oxygen and water clarity needed to support fish communities and Bay grasses in the mainstem of the Bay. The Strategies recognize that improvements in the mainstem of the Bay depend on the nutrient reductions in the tributaries and thereby extend this goal to improve water quality and habitat to the tributaries as well.

Many of the options included in the Strategies have additional purposes other than nutrient reduction. Forested buffers and nonstructural shore erosion controls, for example, create wildlife and aquatic habitat as well as reduce nutrients. Implementing these and other options, such as forest and wetland conservation, will provide additional benefits to living resources through the protection and creation of habitat. Options that create and restore habitat may be particularly cost-effective components of the Strategies when all of their benefits are considered. The Strategies aim to incorporate these considerations in setting implementation priorities.

As we begin to implement and track the progress of the Strategies, living resources will indicate improvements in environmental quality. The Chesapeake Bay Program has already set quantitative targets for the restoration of Bay grasses, a primary indicator of improving water quality. Other indicators are being developed for areas further upstream, such as an "index of biotic integrity" which combines information on different fish species to indicate the overall health of the ecosystem.

The Tributary Strategy Process

A series of public meetings to discuss the Strategies were held in each watershed in 1993 and 1994. During these meetings, interested citizens commented on the process of developing the Strategies, what options should be included in each Strategy, and how these options could be implemented. The public raised strong support for educational programs targeted at homeowners and other voluntary efforts, improved enforcement of existing regulations, options that are cost-effective and site-specific in design and implementation, and practices that have other environmental benefits in addition to nutrient reductions. The public comments on the draft Strategies are helping ensure that the Strategies are workable, fair, cost-effective, and recognize the environmental priorities of the citizens and local governments in each watershed.

Developing and implementing the Strategies is an evolving process. The Strategies, revised in response to the public comments, data fine-tuning, and other technical and practical implementation considerations, comprise Maryland's commitment to meet its 40% nutrient reduction goal. Tributary Implementation Teams will be formed in each of Maryland's ten tributaries to assist with refining and implementing the Strategies (see "Implementation"). A progress review of the Tributary Strategies will be undertaken in 1997.

To maintain the progress that has been made and continue to protect the Bay beyond the year 2000, all of the signatories to the Chesapeake Bay Agreement agreed that once the 40% reduction has been achieved, nutrient pollution to the Bay should not be allowed to increase. This "cap" on nutrient loads means that future growth and development must be managed in a way that does not cause additional nutrient pollution. Meeting this challenge will require ongoing collaboration between state and local governments, and the people who live in each watershed.

Nutrient Loads and Goals

Approximately, 76.4 million pounds of nitrogen and 5.84 million pounds of phosphorus enter the Chesapeake Bay tidal waters each year from all sources in Maryland (see Tables 1a to 1c). To restore important habitats and improve water quality in the rivers and the Bay, state and local governments have pledged to work toward a 40% reduction in the "controllable" part of this load, that is, the pollution part caused by man's activities which include point sources (wastewater treatment plants) and nonpoint sources (polluted runoff and groundwater from agricultural and developed lands). This translates to a reduction goal of 22.8 million pounds of nitrogen and 2.10 million pounds of phosphorus which, when subtracted from the 1985 base load, results in the loading cap. To achieve this loading cap, pollution will have to be reduced from all sources: wastewater treatment plants, agriculture, and developed lands.

Reductions due to air pollution controls are not counted towards the attainment of the 40% reduction goal. Atmospheric loads, however, are included in the nonpoint source (NPS) load estimates. Only deposition directly to water surfaces (a relatively small load) is not considered in these estimates.

How the Tributary Strategies were Assembled

To assemble the individual Strategies, nutrient reduction options were prioritized as described below until the 40% goal was achieved. A "maximum feasible" level of implementation was defined to indicate the upper limit that any Tributary Strategy could achieve in terms of nutrient reduction. This highest feasible level of implementation was determined by the best professional judgment of the Tributary Strategy participants. Achieving equity among categories of options and watersheds was an important consideration throughout this process (see the attached glossary for a complete list and brief description of the options). The first three options below were included in each Tributary Strategy:

- All wastewater treatment plants (WWTPs) with a design flow equal to or greater than 0.5 million gallons per day (MGD) will be expected to implement chemical phosphorus removal and install biological nutrient removal (BNR) or equivalent technology for nitrogen removal. While the technology will be designed to operate seasonally, every effort will be made to operate the BNR process for as much of the year as feasible in order to remove more nitrogen.

- All existing regulatory programs with nonpoint source control benefits (e.g., erosion and sediment control, stormwater management, and implementation of the Forest Conservation Act) will be fully implemented and enforced.

Table 1a. Nitrogen and Phosphorus 1985 Base Loads, Controllable Loads, Reduction Goals and Loading Caps for Maryland's Tributary Watersheds

Loading Source	Nitrogen Load (million lbs/yr) 1985 Base	Nitrogen Load (million lbs/yr) Controllable		Phosphorus Load (million lbs/yr) 1985 Base	Phosphorus Load (million lbs/yr) Controllable	
Point Sources	31.95	31.95		2.52	2.52	
Total Nonpoint Source (NPS)	44.49	25.10		3.31	2.73	
Agriculture NPS	27.94	19.41		2.56	2.18	
Developed NPS	8.47	5.68		0.63	0.55	
Undeveloped NPS	6.71	0.00		0.07	0.00	
Direct Atmospheric	1.37	0.00		0.05	0.00	
Total Load	76.44	67.04		5.84	5.25	
40% Reduction goal	-22.82		(40% of controllable)	-2.10		(40% of controllable)
Loading Cap	53.62			3.74		

Notes:

1) Due to rounding errors, some numbers in the table may not equal the totals shown.
2) 1985 base load is the estimated amount of nutrients entering tidal waters in 1985.
3) Controllable load is the 1985 base load minus the load if the watershed were totally forested and with no point sources. This can be thought of as the "pollution load" due to man's activities in the watershed.
4) 40% Reduction Goal = 40% of Controllable Load. The 40% reduction goal applies to the total controllable loads. Load reductions from each source will depend on the final strategy that is selected and implemented.
5) Loading Cap = 1985 Base - 40% Reduction Goal.
6) Point source load is the load delivered to tidal waters from municipal point sources > 1000 gal/day plus major industrial and military discharges.
7) Undeveloped land nonpoint source (NPS) load is from forest and wetland areas and is not considered a controllable or "pollution load".
8) Direct atmospheric is the load from the atmosphere to water surface only; atmospheric load to land is included in the three land use categories.

Table 1b. Nitrogen Loadings in Maryland's Tributary Watersheds (in million lbs/year)

Watershed	1985 Base Load	Background Load	Controllable NPS Load	Point Source Load	Controllable Load	40% Reduction Goal	Loading Cap
Choptank	3.7	1.4	2.1	0.2	2.3	0.9	2.8
Lower Eastern	9.2	3.9	4.9	0.4	5.3	2.1	7.1
Lower Potomac	3.7	1.2	1.9	0.6	2.5	1.0	2.7
Lower Western	1.7	0.4	0.6	0.7	1.2	0.5	1.2
Middle Potomac	9.1	1.1	1.3	6.7	8.0	3.2	5.9
Patapsco/Back	21.9	1.0	1.9	19.1	21.0	8.4	13.5
Patuxent	4.9	1.4	1.8	1.7	3.5	1.4	3.5
Upper Eastern	5.6	2.0	3.3	0.2	3.6	1.4	4.2
Upper Potomac	10.7	5.2	4.0	1.5	5.5	2.2	8.5
Upper Western	5.8	1.7	3.3	0.8	4.1	1.6	4.2
Maryland Total	76.4	19.4	25.1	31.9	57.0	22.8	53.6

Notes:

1) Due to rounding errors, some numbers in the table may not equal the totals shown.
2) 1985 base load is the estimated amount of nutrients entering tidal waters in 1985. The 1985 base load is equal to the sum of the background, controllable nonpoint source (NPS), and point source loads.
3) Background load is the uncontrollable NPS load or the load that would exist if the watershed were totally forest and with no point sources.
4) Point source load is the load delivered to tidal waters from municipal point sources > 1000 gal/day plus major industrial and military discharges.
5) Controllable load is the 1985 base load minus the background load. This can be thought of as the "pollution load" due to man's activities in the watershed. Conversely, controllable load is equal to the controllable NPS plus the point source load.
6) 40% Reduction Goal = 40% of Controllable Load. The 40% reduction goal applies only to the total controllable load. Load reductions from each source will depend on the final strategy that is selected and implemented.
7) Loading Cap = 1985 Base Load - 40% Reduction Goal.

Table 1c. Phosphorus Loadings in Maryland's Tributary Watersheds (in million lbs/year)

Watershed	1985 Base Load	Background Load	Controllable NPS Load	Point Source Load	Controllable Load	40% Reduction Goal	Loading Cap
Choptank	0.31	0.04	0.17	0.09	0.26	0.10	0.20
Lower Eastern	0.70	0.12	0.43	0.15	0.58	0.23	0.47
Lower Potomac	0.30	0.03	0.17	0.10	0.27	0.11	0.19
Lower Western	0.26	0.01	0.06	0.18	0.24	0.10	0.16
Middle Potomac	0.31	0.04	0.17	0.10	0.27	0.11	0.21
Patapsco/Back	1.24	0.02	0.19	1.02	1.22	0.49	0.75
Patuxent	0.53	0.03	0.21	0.29	0.50	0.20	0.33
Upper Eastern	0.44	0.07	0.31	0.06	0.36	0.15	0.29
Upper Potomac	1.26	0.18	0.64	0.44	1.08	0.43	0.83
Upper Western	0.50	0.04	0.37	0.09	0.46	0.18	0.31
Maryland Total	5.84	0.59	2.73	2.52	5.25	2.10	3.74

Notes:

1) Due to rounding errors, some numbers in the table may not equal the totals shown.
2) 1985 base load is the estimated amount of nutrients entering tidal waters in 1985. The 1985 base load is equal to the sum of the background, controllable nonpoint source (NPS), and point source loads.
3) Background load is the uncontrollable NPS load or the load that would exist if the watershed were totally forest and with no point sources.
4) Point source load is the load delivered to tidal waters from municipal point sources > 1000 gal/day plus major industrial and military discharges.
5) Controllable load is the 1985 base load minus the background load. This can be thought of as the "pollution load" due to man's activities in the watershed. Conversely, controllable load is equal to the controllable NPS plus the point source load.
6) 40% Reduction Goal = 40% of Controllable Load. The 40% reduction goal applies only to the total controllable load. Load reductions from each source will depend on the final strategy that is selected and implemented.
7) Loading Cap = 1985 Base Load - 40% Reduction Goal.

- All other options currently being implemented will continue to be implemented at least at current funding levels.

If the combination of the above options did not reach the 40% goal, then the following options were included, as needed, above and beyond the first three options to achieve the 40% goal:

- A target of at least 10% of the maximum feasible level was set for educational programs promoting septic system pumping, urban/suburban nutrient management, and domestic animal waste control.

- Increased implementation of the remaining options at "realistic" levels based on cost-effectiveness and past implementation levels. (Cost-effectiveness is the lowest cost per pound for the nutrient not yet reduced by 40%.)

If the combination of the options listed above still fell short of the 40% goal, then:

- Remaining options were included at the maximum feasible level, in order of cost-effectiveness.

Statewide Summary of the Tributary Strategies

Over the past year, state and local government staff and concerned citizens have worked together to develop a menu of "nutrient reduction options." These include both regulatory and voluntary (e.g., incentive and educational) programs encompassing existing programs, new directions for state and local governments, and nongovernmental activities. Many of these options have important benefits, such as habitat creation or runoff control, in addition to nutrient reduction. The following sections describe what is necessary to achieve an overall 40% nutrient reduction statewide in the four major categories of options: wastewater treatment plants, developed land, agricultural land, and resource protection and watershed planning. The potential for further expanding the selected options, or adding new ones, is also discussed. Several options could contribute more significantly to nutrient reduction if existing obstacles to implementation (such as need for public education, lack of eligibility for funding, etc.) are addressed.

Wastewater Treatment Plants

The Strategies call for the implementation of biological nutrient removal (BNR) of nitrogen and chemical phosphorus removal (CPR) at all wastewater treatment plants that currently have a design flow equal to or greater than 0.5 MGD. If smaller WWTPs are expanded to above 0.5 MGD in the future, the expectation is that BNR and/or CPR will be implemented at the time of expansion.

The implementation of BNR at each of these WWTPs has been and will continue to be achieved through the adoption of a BNR Agreement between the Maryland Department of the Environment (MDE) and the jurisdiction controlling the plant. The Agreement calls for the controlling jurisdiction to design and construct facilities so as to achieve a seasonal (April-October) total nitrogen concentration of 8 mg/l and operate the BNR process for as much of the year as possible in order to maximize nitrogen removal. After a trial period of operation, permit language will be drafted based upon the plant's performance during this period. The duration of the trial period as well as the conditions that will be included in the plant's discharge permit have not yet been determined. For most major WWTPs in the state, phosphorus removal is a permit requirement.

Based on our limited experience with the performance of BNR at existing WWTPs, MDE believes that a plant designed to meet a <u>seasonal</u> total nitrogen (TN) limit of 8 mg/l will actually yield an <u>annual</u> average TN concentration of 8 mg/l if the BNR process is operated year-round. In the warmer months of the year (April-October), TN concentrations should range from 4 mg/l to 8 mg/l, while in the colder months of the year (November-March), TN concentrations should range from 9 mg/l to 13 mg/l. If the BNR process is only in effect during the design period of April-October, the average annual TN concentration will be about 10 mg/l.

Annual BNR with CPR was selected as the point source nutrient reduction option because it was determined to be the most cost-effective method of removing nitrogen and phosphorus from wastewater. If future evaluations of nutrient reduction progress show that the goals in a watershed will not be met with the existing Tributary Strategy, options that may be considered as part of the revised Strategy are upgrading of major WWTPs with advanced nutrient removal (limit of technology) and/or the implementation of BNR and CPR at some of the minor WWTPs (less than 0.5 MGD).

There are currently seventeen major WWTPs in Maryland that are actively removing nitrogen. Eight of these seventeen WWTPs are located within the Patuxent watershed where much of the effort toward point source nutrient load reduction has been directed. Because of the Upper Bay Phosphorus Removal Policy, all major WWTPs above Baltimore Harbor are required to remove phosphorus to a level of 2 mg/l. In addition, all major WWTPs in the Patuxent watershed have a 1 mg/l phosphorus limit. There are also several other plants which have a phosphorus limit because of local water quality conditions (i.e., La Plata, Salisbury) or because of the Potomac River Embayment Standards (i.e., Blue Plains, Piscataway, Mattawoman).

The point source component of Maryland's Tributary Strategies currently calls for an additional 47 major WWTPs to be upgraded for nitrogen and phosphorus removal. Twenty-four of these plants have entered into an agreement with MDE to implement nitrogen removal. The jurisdictions controlling the remaining WWTPs not yet scheduled for upgrading will be encouraged to commit to the implementation of nitrogen and/or phosphorus removal through the execution of such an agreement in the next few years.

The Metropolitan Washington Council of Governments (MWCOG) has recently proposed an innovative Regional Pilot Program to help meet the restoration goals of the Chesapeake Bay Program. This program would help meet the nutrient reduction goals in the Potomac River basin through a regional, cooperative effort to implement nitrogen removal at major WWTPs in the basin, including those in Washington, D.C. and Virginia. This program would allow for flexible measures such as nutrient trading between WWTPs, between jurisdictions, and between nonpoint sources and point sources. Emphasis would be placed on identifying the most cost-effective overall strategy for achieving the nutrient reduction goals. In addition, this pilot program would require that funding sources, such as MDE's Biological Nutrient Removal Cost-Share Program, be identified before the local governments are required to implement nitrogen removal. The State of Maryland will continue working with the MWCOG to try to integrate the pilot program's objectives with the Tributary Strategies.

One result of the wastewater treatment process is a by-product known as sludge. The sludge that remains after organic material is broken down contains valuable plant nutrients. Some sludge is incinerated or landfilled, but the best way to dispose of sludge is to "recycle" it as plant fertilizer. Many farmers therefore allow sludge application on their crop or pasture land to save on chemical fertilizer costs. MDE requires nutrient management plans to be in place before sludge application, facilitating development of nutrient management plans and assuring that only necessary amounts of nitrogen are added to the land.

Developed Land

For all newly developed land, the Strategies call for the full implementation of existing state and local regulatory programs for erosion and sediment control and stormwater management. Granting of waivers should be minimized. In addition, state requirements for both programs are being revised and strengthened. Erosion and sediment control standards and specifications were revised and implemented in the summer of 1994. State stormwater management program requirements are currently being revised to improve stormwater quality control by introducing alternatives for development site design and promoting the use of marshes, wet ponds, and extended detention or retention facilities.

Nonregulatory programs for urban lands that contribute to nutrient reductions include retrofitting previously developed land with stormwater control measures and converting existing dry ponds to more effective stormwater management practices. Stormwater retrofits apply to land that was developed without stormwater controls. This option is expensive because land available for stormwater facilities is often scarce, but controls are necessary to achieve water quality and stream protection benefits in urban areas. Several such projects are planned in each of the ten watersheds. Additional projects will be identified as part of more detailed watershed water quality management planning by local governments.

Educational efforts will also be enhanced in a number of areas affecting pollution control on developed land. Nutrient management efforts for private homes, businesses, roadways, and public land need to be increased. Outreach and education efforts will be strengthened and improved; educational materials will be developed and published to provide landowners with specific guidance for types of vegetation, landscaping methods, and organic waste and fertilizer management to minimize environmental impacts. Operation and maintenance of septic systems can also be improved through the use of low-flow plumbing fixtures, reduction in the use of garbage disposals, and regular pumping to remove accumulated solids. Not only will these measures improve the nutrient removal capabilities of septic systems, but they will also prolong the life of these systems and save on expensive repair and replacement costs.

Agricultural Land

Agriculture is the most widespread land use in Maryland, and the implementation of agricultural best management practices (BMPs) will make a significant contribution to nutrient reductions in the state. Local Agricultural Tributary Teams identified a list of applicable BMPs for each tributary. In addition, the local agricultural tributary teams pointed out that there are BMPs that many farmers implement on their own. The level of implementation of these practices outside of federal, state, and local programs has not been quantified, but needs to be determined. The Strategies call for varying levels of implementation of BMPs to meet the 40% reduction based on the needs in each tributary.

Expanded and accelerated levels of implementation of Soil Conservation and Water Quality Plans (SCWQPs), nutrient management plans, cover crops, conservation tillage, and treatment of lands with high erosion potential will contribute significantly to nutrient reduction in Maryland. SCWQPs are currently on 41% of the agricultural land in the state and this percentage is expected to increase to 64%. Nutrient management plans will need to be increased from the current level of less than 20% to 56% of cropland. Much of this will be achieved through the assistance of certified private consultants. In addition, cover crops will need to be planted on 29% of the cropland acres available for timely planting of cover crops. Conservation tillage in Maryland will need to be accelerated from the current level of 40% to 57% of cropland. Existing education programs can be used to achieve this goal. Treatment of lands with high erosion potential will be increased from the current level of 50% to 84%.

While most of the nutrient reductions from agricultural lands will be achieved through the five practices described above, others will also be important. Animal waste management systems are an integral part of the nutrient management planning on farms with animals and will contribute to reducing pollution from those farms. Stream protection BMPs, including stream crossings, remote watering facilities, fencing, and buffers will also play a role in meeting the nutrient reduction goals in Maryland. The ten agricultural tributary teams identified additional best management practices that addressed specific resource issues in their basins. These include the use of water management systems for reducing nutrient loss from farm drainage systems, the application of presidedress soil nitrate tests, and outreach to recreational horse owners for implementation of horse pasture management. While nutrient reductions associated with these options have not been quantified, they add to our ability to meet our water quality goals.

Resource Protection and Watershed Planning

Resource protection options include a range of practices designed to protect forests, wetlands, and other natural areas. These ecosystems generate fewer nutrients than any other land use, and some, such as forests and wetlands, actually function as nutrient filters. Many of these options—such as forested buffers and nonstructural shore erosion control—help restore habitat for fish and wildlife, and the food webs they depend on. The implementation targets for each practice included in the Strategies are the minimum needed to achieve the 40% nutrient reduction goal. Additional implementation above these targets would help to restore the biological diversity and abundance of our streams, rivers, and the Bay.

Among the resource protection options, a priority will be planting streamside forested buffers and protecting existing buffers on agricultural and developed lands. The Departments of Natural Resources and Agriculture, together with other interested groups, have begun working to identify and address existing obstacles to planting forested and grassed buffers, and other stream protection measures. Recommendations include promoting flexible, site-specific solutions; providing incentives to private landowners to protect riparian areas; and providing additional resources for technical assistance. By 2000, the Strategies aim to protect at least 850 miles of streams through the establishment of forested and grassed buffers, and many additional miles through local stream protection ordinances.

The Strategies recognize the benefits of the Forest Conservation Act, which is estimated to reduce forest loss by at least 20% between now and the year 2000. Under the Strategies, tree planting will be increased and a broader coverage of forest harvesting best management practices will be achieved statewide through logger training, enforcement, standardized permit procedures, and monitoring. These steps will promote full implementation of existing regulatory requirements, such as erosion and sediment control, and greater coverage of additional voluntary measures that may be appropriate at a given site. The Strategies also recommend an increase in structural and nonstructural (vegetative) shore erosion controls, which prevent sediment and associated nutrients from entering the Bay.

In Spring 1994, Maryland passed legislation requiring the installation of marine sewage pumpouts at all marinas with 50 or more slips and all new or expanding marinas over ten slips. Federal funding under the Clean Vessel Act will allow the state to expand its grant program to marinas to cover the full cost of installing these new pumpouts. State and federal law prohibit the discharge of raw sewage into the Bay, and legislation passed in 1994 will allow state enforcement of this provision. The Strategy calls for pumpout use by all boats with holding tanks. The state will focus its efforts on educational programs for boaters to encourage pumpout use.

Many resource protection and watershed planning options help reduce nutrient pollution, but have benefits that are difficult to quantify. The Critical Area Law, for example, has been estimated to reduce nutrients from the critical areas by 20-30%. Other programs that prevent nutrient pollution include the 1992 Economic Growth, Resource Protection and Planning Act, which requires the state and local governments to protect sensitive areas and concentrate growth, and local planning and zoning ordinances to protect streams, shorelines, and wetlands. Because we lack nutrient reduction estimates for these programs, they are considered to be "unquantified options" that contribute to maintaining the cap on nutrient loads.

Statewide Summary of the Tributary Strategy Load Reductions

The figure and tables that follow provide a summary of the estimated nutrient load reductions to the Bay that will be achieved with the implementation of the Tributary Strategy recommendations.

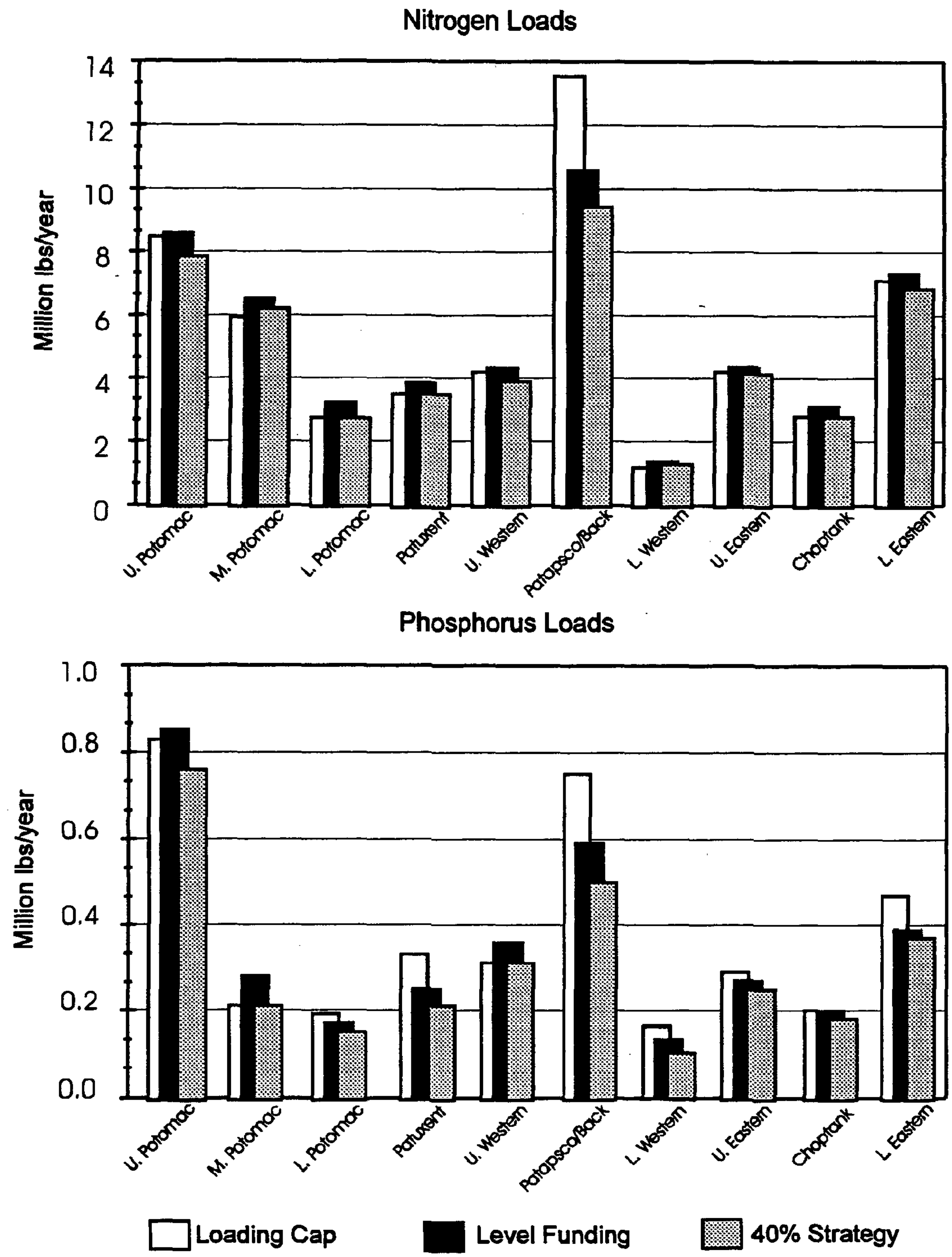
Figure 2 presents the projected nutrient loadings under two loading scenarios in each of the ten watersheds by the year 2000. For each watershed, three nitrogen and phosphorus loading levels are presented, as follows:

- The white bar, labeled "Loading Cap," indicates the load remaining after the "controllable" or pollution load of the estimated amount of nutrients entering the Bay's tidal waters in 1985 (shown in Tables 1a to 1c) is reduced by 40%. This cap represents the commitment made in the Chesapeake Bay Agreement.

- The black bar, labeled "Level Funding," shows the estimated load in 2000 if reductions achieved by current programs are continued at the same rates through 2000. This scenario includes projected growth and illustrates what will be achieved if we continue current program implementation with financial and staff resources comparable to the present.

- The gray bar, labeled "40% Strategy," shows the estimated loads in 2000 after growth is accounted for and the Tributary Strategies' recommendations are implemented.

Figure 2. Level Funding and 40% Strategy Projected Nutrient Loadings



Notes: This figure compares nutrient loads under two possible management scenarios ("Level Funding" and "40% Strategy") with the "loading cap," the goal of the Chesapeake Bay Agreement. The loading cap (white bar) was calculated by reducing the controllable 1985 loads by 40%. The first management scenario, "Level Funding" (black bar), shows the loads that would result if current programs were continued without increase until the year 2000. The second management scenario, "40% Strategy" (gray bar), shows the loads that would result from increasing implementation of nutrient control practices in order to reach the 40% goal for nitrogen and phosphorus. The figure illustrates that level funding is not adequate to achieve the loading cap in nine of the ten tributaries.

Figure 2 shows that with level funding, all but one tributary does not meet its Strategy goal for nitrogen, phosphorus or both. With plans in place to upgrade large WWTPs and because of the large point source component to its loads, only the Patapsco/Back River watershed can meet its goal for nitrogen and phosphorus with level funding. This watershed will however require additional effort to reach its nonpoint source targets. Additional resources will be needed to reach the goal in the remaining tributaries. (More specific information on what additional implementation efforts will be needed can be found in the Strategy documents for each individual tributary.) Two of these tributaries—the Middle Potomac and the Lower Western Shore—will come close to but not quite attain their loading cap for nitrogen even at maximum feasible levels of implementation of the nutrient reduction options. In the Potomac River as a whole (Upper, Middle, and Lower Potomac) and in the Western Shore as a whole (Upper Western Shore, Patapsco/Back River, and Lower Western Shore) the Tributary Strategy goals can be met with additional resources required to implement the Tributary Strategies. Similarly, the nutrient reduction goal can be met statewide with the implementation of the Tributary Strategies.

Table 2 summarizes the practices, levels of implementation, and the nutrient reductions they are expected to achieve. There are also many unquantified options (listed in Table 3) which will further reduce the loads. In the face of continued population growth and development, maintaining a load below the capped load beyond the year 2000 will eventually require additional options not presented in the current Tributary Strategies.

The list of quantified options in Table 2 are recommendations for the level of implementation aimed to achieve the 40% reduction goal in each of the ten watersheds. Achieving the goal in the ten watersheds will not only improve water quality in the Bay's mainstem, but will also help restore rivers and streams throughout the state. The local benefits are critical for protecting and restoring living resources, protecting drinking water supplies, and all of the other ecological, recreational, and economic benefits associated with clean water in each of the watersheds. For example, while sewage treatment plant upgrades on the Patapsco and Back Rivers will significantly reduce nutrients entering the Bay, they will do little to protect prime striped bass spawning areas in the Choptank, nontidal stream habitat in the Middle Potomac, or drinking water reservoirs in the upper Patuxent.

The first column of Table 2 names the options, which are described in more detail in the attached glossary. The second column indicates the units used to describe the physical measures or units of implementation such as "plants" for wastewater treatment, "systems" for septic systems, or "acres" for cover crops. The third and fourth columns set the boundaries for nutrient reductions that would attain nutrient loads which correspond to "Level Funding" and "Maximum Feasible." The latter represents the maximum nutrient load reduction that can be accomplished between 1994 and 2000 with projected growth and with highest feasible level of implementation of nutrient reduction options as determined by the best professional judgment of the Tributary Strategy participants. The fifth column is a set of recommendations which will result in 40% nutrient reduction at the state level.

Table 2. Statewide 40% Nutrient Reduction Strategy

Option	Unit	Coverage by 2000 w/ Level Funding	Coverage by 2000 w/ Maximum Feasible Resources	Coverage with 40% Strategy	N Load Reduction w/ 40% Strategy (lbs/yr)	P Load Reduction w/ 40% Strategy (lbs/yr)
Wastewater Treatment Plants						
Biological & Chemical Nutrient Removal**	# of plants	24	47	47	11,409,306	252,700
Developed Land						
Erosion and Sediment Control	acres	18,693	19,272	19,272	37,041	21,909
Enhanced Stormwater Management	acres	130,854	134,901	134,901	333,226	35,284
Stormwater Management Retrofits	acres	5,766	14,416	7,554	18,614	2,028
Stormwater Management Conversion	acres	2,384	4,768	3,426	8,403	935
Septic pumping	systems	?	13,801	3,269	3,962	0
Septic Denitrification	systems	?	662	101	1,215	0
Septic Connections	systems	5,752	15,093	5,946	75,357	0
Urban Nutrient Management	acres	?	160,797	49,818	34,973	0
Domestic Animal Waste	households	?	0	0	0	0
Clustering of New Development	acres	?	10,118	1,920	5,760	768
Agricultural Land						
Soil Cons./Water Quality Plan Implementation	acres	251,639	856,058	468,377	658,556	86,620
Conservation Tillage	acres	327,789	494,802	339,805	1,385,902	133,881
Treatment of Highly Erodible Land	acres	65,546	219,264	186,511	333,876	85,168
Retirement of Highly Erodible Land	acres	5,872	9,901	5,941	58,587	7,895
Animal Waste Management System--Livestock	systems	324	1,797	637	338,550	66,537
Animal Waste Management System--Poultry	systems	252	548	392	82,352	16,434
Runoff Control	acres	562	1,676	566	38,026	7,770
Stream Protection with Fencing	acres	2,584	6,212	2,668	7,847	335
Stream Protection without Fencing	acres	6,008	20,278	6,656	8,780	605
Nutrient Management - Fertilizer	acres	517,398	1,121,282	766,849	1,987,773	166,450
Nutrient Management - Organic	acres	91,495	170,974	100,052	535,782	34,602
Cover Crops w/ Nutrient Management	acres	62,655	238,490	150,698	1,218,976	32,611
Cover Crops w/o Nutrient Management	acres	7,345	24,750	16,500	196,350	3,300
Horse Pasture Management	acres	23	231	23	*	*
Presidedress Soil Nitrate Test	acres	1,679	3,917	1,679	*	*
Water Control Structures	acres	4	240			
Wetlands/Sediment Basins	acres	2	120			
Poultry Waste Distribution	acres	0	1			
Resource Protection & Watershed Planning						
Buffers						
Forested (overall)	acres	2,737	7,362	3,204	61,910	8,432
Forested (on agricultural land)	acres	?	?			
Forested (on developed land)	acres	?	?			
Grassed (on agricultural land)	acres	3,688	11,748	4,173	73,745	9,866
Structural Shore Erosion Control	linear feet	35,742	295,284	37,782	38,312	25,186
Nonstructural Shore Erosion Control	linear feet	53,060	389,476	76,810	59,327	39,240
Forest Conservation	acres	16,499	18,333	18,333	196,002	23,175
Tree Planting	acres	8,775	19,470	10,290	21,154	3,919
Forest Harvesting Practices	acres	12,205	19,530	19,530	54,587	35,859
Marine Pumpouts (installation)	marinas	164	295	164	99,490	22,072
Pumpout Education	boaters	30,535	30,535	30,535	*	*
				Total Reductions (million lbs/yr) >	19.39	1.06

Nitrogen (million lbs/yr)	Phosphorus (million lbs/yr)	
76.44	5.84	< 1985 Base Load (from Table 1)
53.62	3.74	< Loading Cap (from Table 1)
67.98	4.11	< Projected Total Load in 2000 with no additional implementation effort
-19.39	-1.06	< Less: Total Reductions (from above)
48.59	3.05	< Projected Total Load in 2000 with Strategy implemented
9%	18%	< % Below Loading Cap

Legend:

** Assumes plant designed for seasonal BNR will be operated year-round; point source strategy includes chemical phosphorus removal.

? This information is not currently available.

* Loads are not computed for these options because loading reduction rates have not been quantified.

Notes:

1) "Level Funding" coverage is the coverage that can be expected by 2000 if current programs and practices were continued through 2000 with financial and staff resources comparable to the present.
2) "Maximum Feasible" coverage is the coverage that can be expected by 2000 with the highest feasible level of implementation as determined by best professional judgment.
3) "40% Strategy" is the coverage estimated by the year 2000 if the Strategy is fully implemented.
4) "Loading Cap" is the loading expected if 1985 point and controllable nonpoint source loads are reduced by 40%.
5) Coverages and reductions shown in this table are for 1994-2000. Projected total load in 2000 with no additional implementation effort includes nutrient reductions achieved over the period, 1985-1993.
6) Most options have benefits in addition to nutrient reduction, for example, forested buffers provide wildlife habitat, stormwater management prevents erosion, etc.
7) The Draft Strategy illustrates how the 40% reduction goal can be met through specific programs and practices. The Strategy is intended to be flexible to reflect public input and practical considerations such as available funding and new technologies.

Table 3. Nutrient Reduction Options Currently Not Quantified*

Point Sources/Developed Land

Infrastructure Improvement (e.g., leaking sewer pipes)
Stormwater Facility Maintenance
New Small WWTPs
Elimination of Combined Sewer Overflows
Water Conservation
Improved Site Design and Planning

Agricultural Land

Public Education/Outreach
Horse Pasture Management
Presidedress Soil Nitrate Test
Water Management Systems

Resource Protection

Stream Stabilization/Restoration
Land Easements and Acquisition
Wetlands Protection
Critical Area Law Implementation
Mine Reclamation
Restoring Aquatic Ecosystems (e.g., oyster restoration)

Watershed Planning

1992 Planning Act Implementation
Concentrating Growth
Agricultural Land Preservation
Stream Corridor Protection
Reservoir Protection
Roadside Drainage System Management

*Many of these options are defined in the attached glossary.

The last two columns (shaded) translate the Statewide 40% Strategy recommendations from implementation units to actual pounds reduced for each option. Note that although these reduction benefits may appear to be fairly precise, these numbers are only a function of the calculations. The rounded values at the base of the column, which represent the sum of the reductions, are more reflective of the actual precision appropriate for these estimates.

Finally, in the shaded box at the bottom of Table 2, a summary calculation shows the difference between the projected loads and projected reductions resulting from the implementation of the Tributary Strategies to the year 2000. This difference is then compared to the loading cap. If the difference is equal to or less than the cap, the 40% reduction goal is attained.

In summary, Table 2 indicates that Maryland's Chesapeake Bay nutrient reduction goals can be achieved provided that:

- Recommended wastewater treatment plant upgrades are implemented;
- State and local erosion and sediment control regulations and stormwater management programs are fully implemented on all new development;
- The Forest Conservation Act reduces forest loss by at least 20% between 1993 and 2000; and
- Implementation of other existing state and local nonpoint source pollution control efforts continue at current or expanded levels.

The 40% reduction goal specified by the Chesapeake Bay Executive Council was framed in quantitative terms, that is, 40% of the 1985 loads. Table 2 responds to those specific quantitative terms, and provides for accountability and measurement of progress. However, there are many practices for which nutrient reductions cannot be quantified at this time. These practices are a critical part of the Tributary Strategies even though they are not included in Table 2. Despite the current inability to estimate the nutrient reductions associated with these practices, their continued implementation will contribute substantially to nutrient reduction efforts between now and the year 2000, and toward maintaining the cap on nutrient loads thereafter. These options provide valuable environmental and living resources benefits that go directly to the ultimate goal of the Bay restoration: improved habitat for the Bay's living resources. For example, land acquisition for recreation or wildlife habitat also helps to keep areas in forest, which has a naturally low nutrient pollution load. Wetland protection laws protect tidal and nontidal wetlands that act as natural filters. Watershed planning, which helps local governments to concentrate growth and protect sensitive areas, reduces nutrient pollution resulting from sprawling development and loss of forests, wetlands, and other open space.

As mentioned previously, Strategy recommendations for the ten watersheds summarized in Table 2 will change as new and more refined information and estimates become available. The Tributary Strategies will evolve to reflect the ideas and concerns of the public and the local, state, and federal governments. The Strategies will embody the most efficient, effective, and practical methods of achieving the nutrient reduction goal.

Implementation

The implementation of the Tributary Strategies initiates a new phase of the Bay clean-up efforts that began over a decade ago. The Tributary Strategies are meant to be the start of a comprehensive watershed- and locally-based approach that will reduce nutrient pollution from most controllable sources. The next challenge will be implementation. Existing programs may need to be refined or expanded, as needed, by state and local agencies, industries or individuals currently responsible for them. New programs may also have to be developed to meet needs identified in the Strategies, such as public education regarding septic maintenance or landscaping and lawn care. These programs will be developed and implemented through a collaborative process with state and local government agencies and citizens.

Implementation of the Strategies will involve:

- identifying the agencies and groups who will implement needed programs;
- refining implementation mechanisms and identifying the types and amount of additional resources required;
- identifying and addressing any obstacles to implementation; and
- setting schedules for implementing any needed programs.

Tributary Implementation Teams

To assist with developing implementation plans, Tributary Implementation Teams will be formed at the local level to represent the needs and concerns of each watershed. These teams will consist of local and state government representatives, concerned citizens, and representatives of affected economic interests such as the agriculture and land development industries. It will promote watershed integration of activities by:

- developing and revising implementation plans to meet nutrient reduction goals;
- tracking Strategy implementation to help it proceed on schedule in a fair and flexible way with consideration given to sensitive areas such as reservoir watersheds and stream headwaters;

- coordinating cooperation among citizens, state and local government agencies, and other interested parties;
- identifying and communicating potential problems, needs, and concerns, as well as possible solutions to responsible state and local agencies; and
- promoting the Strategies through public education activities.

Additional Funding for the Strategies

Additional funding and staff for state and local agencies will be necessary to implement the Strategies. Of course, the amount and types of funding needed will depend upon the programs ultimately selected as part of the Strategies. For example, funds from MDE's Water Quality Revolving Loan Fund can be used for wastewater treatment plant upgrades and nonpoint source water quality improvement. Many agricultural options are implemented by providing technical assistance and cost-share funds available from federal, state, and county funding programs.

A "Blue Ribbon Panel" of financial experts from the investment community, local, state and federal government, academia, and other private sector concerns was convened by Governor Schaefer in June, 1994. The Panel's final report, completed in January, 1995, identified funding options to assist state and local agencies in financing portions of the Strategies and recommended ways to provide private sector support.

Tracking Progress

The Strategies set targets for the implementation of certain practices between 1994 and the year 2000. To evaluate the Strategies' effectiveness, monitoring and tracking programs are needed. Tracking and monitoring programs may be grouped into three categories:

- **Tracking implementation.** For some practices, tracking mechanisms are already in place because of program requirements, permit or other regulatory requirements, or funding mechanisms. For example, there is a system, which is currently being improved, for tracking the implementation of agricultural BMPs. For many voluntary options, such as incentive or cost-share programs for agriculture or resource protection, tracking programs are in place, but may need to be revised to provide watershed-based information.
- **Monitoring nutrient load reductions.** The nutrient load reductions that have been estimated for most of the options are listed in Table 2. These will continue to be refined using new research and field data and local data sources to improve the estimates of the impact of various practices. Monitoring programs are in place to

track point and nonpoint source nutrient loads, but these programs are being re-examined to ensure that adequate information is being collected. In addition, the watershed and water quality computer models, primary scientific tools for developing the nutrient reduction strategies, are being refined to improve estimates of nutrient loads and reductions in the watershed.

- **Monitoring status and trends in water quality, habitat, and living resources in response to the Strategies.** Many comments were received concerning the need to adequately monitor water and habitat quality in each of the ten tributary watersheds. Several existing programs will help us to evaluate the impact of the Strategies on water quality and living resources in Maryland's portion of Bay watershed.

  - MDE's Chesapeake Bay Water Quality Monitoring Program tracks changes in water and habitat quality in the mainstem of the Bay and the tidal portions of the tributaries.

  - Stream habitat and living resources monitoring data are currently being collected by DNR, MDE, and local jurisdictions. Biomonitoring can show changes in pollution-sensitive organisms. Stream walks for habitat assessment help to identify land use conditions that are harming aquatic resources. This information can also be used to evaluate existing management practices or to target future implementation of BMPs.

  - The Chesapeake Bay Program tracks the extent of Bay grass beds which have shown rapid increase in some areas with improved water quality.

  - Volunteers conduct water quality monitoring and provide valuable information on status and trends in many tributaries. The use of volunteers can be expanded to assist government efforts.

These monitoring efforts are also being reexamined to ensure adequate tracking of the Tributary Strategies. There is also a need to integrate these statewide programs with any monitoring being conducted by local government agencies. One of the functions of the Tributary Implementation Teams will be to ensure that the necessary integration of state and local monitoring occurs.

All of these efforts will contribute to a reevaluation of the Tributary Strategies in 1997, which will allow us to assess how much progress has been made toward the 40% goal and what mid-course corrections may be needed.

Legacy

The Tributary Strategies present an opportunity for all of us who are concerned about the Bay and the creeks and streams in our own backyards to work together to protect these irreplaceable resources for ourselves and our children. The plight of the Bay illustrates that every individual and every part of the economy have an impact on the Bay. The progress in the Bay—clearer water, more striped bass, returning Bay grasses—illustrates the positive results that can be achieved when governments, farmers, business, and active citizens work together toward a common goal.

We are now faced with a difficult and critical challenge: building management strategies to provide a legacy of healthy rivers with abundant living resources that sustain the very water and food that each of us require to exist. The Tributary Strategy process aims to heighten the awareness of the citizens of Maryland that their lives and livelihoods are enriched by the Bay and its tributaries. This awareness will foster the actions needed today to ensure healthy waters for tomorrow.

Glossary of Option Terms

1992 Planning Act implementation — Requires local governments to update comprehensive plans and development regulations to incorporate the seven environmental principles or "visions" in the Act, protect sensitive areas, streamline development approval procedures in growth areas, and ensure that all development regulations are consistent with comprehensive plans.

Animal waste management system — Systems for the proper handling, storage and use of waste generated by confined animal facilities. These include ponds, lagoons, and tanks for liquid waste, and sheds or pits for solid waste.

Animal waste runoff control — Measures to prevent runoff from animal confinement areas, including upslope diversions and directed downspouts to minimize offsite water entering the facility.

Biological nutrient removal (BNR) for nitrogen — A temperature dependent process in which the ammonia nitrogen present in raw wastewater is converted by bacteria first to nitrate nitrogen and then to nitrogen gas. Annual BNR refers to the operation of this process for as much of the year as possible in order to maximize nitrogen removal.

Chemical phosphorus removal (CPR) — The addition of chemicals to wastewater in order to precipitate phosphorus which is ultimately settled out and removed with sewage sludge.

Clustering of new development — Voluntary or required measures to group new residential or other development on a smaller portion of the available land in order to preserve open space.

Concentrating growth — Reduces nutrient pollution by preserving open space and reducing transportation needs.

Conservation tillage — A process that uses tillage equipment to seed the crop directly into the vegetative cover or crop residue on the surface, with minimal soil disturbance.

Cover crops	Small grains (rye, barley or wheat) planted in September or early October on land otherwise fallow with no fertilizer applied. This practice reduces nitrate leaching losses during the winter, and also reduces erosion.
Critical Area Law implementation	Requires a special planning process for all lands within 1,000 feet of tidal waters including the designation of three land use categories (i.e., intensely developed areas, limited development areas, and resource conservation areas) and the establishment of a 100-foot vegetative buffer around the Bay.
Domestic animal waste	A public education program targeted at pet owners to properly dispose of pet waste.
Enhanced stormwater management	The regulatory requirement for the control of stormwater on all new development, including maintenance on new and existing facilities. Enhancements include improved standards and guidance emphasizing water quality controls in addition to water quantity controls.
Erosion and sediment control	The regulatory requirement for erosion and sediment control on all new development over 5,000 square feet. Assumes that the enhanced standards now being developed by MDE will be fully implemented and enforced.
Forested buffer	A linear strip of forest along rivers and streams that filters nutrients and sediment and enhances stream habitat.
Forest conservation	Implementation of the Forest Conservation Act, which requires the retention of a portion of forested lands on any newly developed site.
Forest harvesting practices	Application of regulatory and voluntary best management practices applied to timber harvests, including erosion and sediment control, streamside management zones, etc.
Grassed buffer	A linear strip of grass along rivers and streams that filters nutrients and sediment.
Highly erodible land (HEL) retirement	The removal of lands with a high potential for soil loss from crop or hay production for at least ten years.

Highly erodible land (HEL) treatment	An accelerated application of practices used in SCWQPs on lands with a high potential for soil loss. (See definition of SCWQP.)
Horse pasture management	The use of a range of practices to address erosion and animal waste problems on horse pasture operations in suburban to rural areas.
Land easements/ acquisition	Easements are voluntary, long-term restrictions on the permitted uses on a parcel of land that remains in private ownership, and are usually donated or purchased. Acquisition is the purchase of land by a public or nonprofit agency for conservation purposes.
Marine pumpout	A facility sited at marinas for pumping sewage from boat holding tanks to a dockside storage facility.
Mine reclamation	The restoration of lands disturbed by mining operations. May include seeding of areas to grass, reforestation, or creation of nontidal wetlands.
Nonstructural shore erosion control	A practice for stabilizing eroding shorelines by establishing marsh grasses; suitable for sites with lower wave energy. Also creates wetland habitat.
Nutrient management plan	A comprehensive plan to manage the amount, placement, timing and application of animal waste, fertilizer, sludge, or other plant nutrients.
Point source control	See definition for BNR and CPR.
Pumpout education	Boater education programs to encourage pumpout use and responsible environmental behavior.
Presidedress soil nitrate test	A test to determine if additional nitrogen is needed during the growing season for corn.
Restoring aquatic ecosystems	The restoration of tidal and nontidal ecosystems to a healthy state which maximizes nutrient recycling and biological diversity (e.g., oyster restoration, which is expected to improve water quality in the Bay for many other living resources).

Roadside drainage system management	The use of buffers, stormwater controls, and maintenance requirements to achieve nutrient reductions from roadside drainage systems.
Septic connections	The connection of failing septic systems to sewer lines.
Septic denitrification	The installation of new systems or retrofitting of existing systems with technology to remove nitrogen from individual systems.
Septic pumping	Pumping of individual septic systems once every three years, the average for routine maintenance of these systems.
Soil conservation and water quality plan (SCWQP) implementation	A comprehensive plan addressing natural resource management on farmlands directed toward the control of erosion and sediment loss and management of animal waste or agricultural chemicals to minimize their movement from agricultural land to surface waters.
Stormwater management conversion	Conversion of dry ponds for stormwater management to extended detention or retention facilities which are more effective at nutrient removal.
Stormwater management retrofits	Construction of stormwater management facilities on lands previously developed without such facilities.
Stream corridor protection	The use of a variety of tools (local ordinances, land acquisition and easements, buffers, etc.) to protect streams and their buffers for living resources, recreation, and other values.
Stream protection with fencing	Fencing along streams to completely exclude livestock from the stream. Also improves streambank stability and reduces sedimentation.
Stream protection without fencing	Providing troughs or other watering devices in remote locations away from the stream to discourage animals from entering the stream, and the provision of some fencing adjacent to stream crossings to limit access points.

Stream stabilization/ restoration	May include a variety of practices, depending on the needs of the site, including streambank erosion controls, re-establishment of riparian vegetation (see buffers), channel erosion control, in-stream habitat creation/enhancement, and mitigation of upstream pollution sources.
Structural shore erosion control	A practice for stabilizing eroding shorelines using stone riprap or timber bulkheads. Suitable for sites with high wave energy.
Tree planting	Reforestation or afforestation on any site except along rivers and streams (see Forested buffer).
Urban nutrient management	A public education program to reduce excess lawn fertilizer use, targeted at suburban residents and businesses.
Water management systems	The use of water control structures, sediment basins, and/or small constructed wetlands to reduce phosphorus and nitrogen levels in water flowing through farm drainage systems.
Wetland protection	Protection of tidal and nontidal wetlands through federal and state laws and planning processes.

For additional information and copies of other Maryland Tributary Strategies documents, please contact:

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