Current Status of the Nutrient Reduction Strategies for the Potomac Watershed

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by

Carlton Haywood

Interstate Commission on the Potomac River Basin
6110 Executive Boulevard, Suite 300
Rockville, MD 20852

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I. INTRODUCTION

In 1983, the District of Columbia, the states of Maryland, Pennsylvania, and Virginia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency agreed to work together to restore the Chesapeake Bay. In 1987, the executives of these jurisdictions signed the Chesapeake Bay Agreement in which they agreed to a reduction in nutrient (nitrogen and phosphorus) loads to the Bay by the year 2000.

In 1992, the jurisdictions added to the Bay Agreement specific numerical targets for reducing nutrient pollution in each jurisdiction and agreed to write strategies that would describe specifically what actions will be taken to achieve those targets. The jurisdictions also agreed to numerical targets for ten tributary watersheds that together form the Chesapeake Bay watershed. Nine of those tributaries lie entirely, or almost entirely, within a single jurisdiction so the strategies for achieving their tributary nutrient targets are part of a state strategy. One tributary, the Potomac River, is shared by all the jurisdictions in the Bay Program. Thus, a nutrient strategy for the Potomac watershed requires that each jurisdiction take actions in their part of the watershed that will together achieve the nutrient targets for the Potomac.

To coordinate the nutrient strategies of the jurisdictions for the Potomac, the Chesapeake Bay Program established in 1993 a Potomac Strategy Workgroup, coordinated by the Interstate Commission on the Potomac River Basin (ICPRB), with representation from each jurisdiction. This workgroup met in 1993 and 1994 to exchange information about how the state strategies were being developed, to resolve technical problems related to characterization of nutrient sources and loads, and to explore ways to incorporate cost and equity considerations into strategies. One decision of the workgroup was that there should not be a Potomac watershed strategy independent of the state strategies, because the Potomac strategy must be consistent with the decisions that each state makes for its own jurisdiction. As a result, it was decided that the Potomac strategy would be composed of the Potomac parts of the state strategies.

The states' strategies are not "final". Each jurisdiction is engaged in a process that incorporates new information about point and nonpoint source treatment and funding options, and includes input from citizens, business, and local governments. This report is being produced by ICPRB to document the current status (as of September 1995) of the jurisdictions' nutrient strategies, and to provide an overview of how the states propose to reduce nutrient pollution and to answer the question: will the state strategies, when fully implemented, achieve the nutrient goals? For more detailed information about specific state strategies, the reader is encouraged to contact their state environmental and natural resources agencies, or the U.S. EPA Chesapeake Bay Program. Document references, and agency addresses and phone numbers are listed at the end of this report.

II. THE POTOMAC WATERSHED

The Potomac River's drainage area includes 14,670 square miles in four states: Maryland (3,818 sq.mi.), Pennsylvania (1,570 sq. mi.), Virginia (5,723 sq. mi.), and West Virginia (3,490 sq.mi.), plus all of the District of Columbia (69 sq. mi.). The Potomac is the second largest tributary to the Chesapeake Bay, accounting for approximately 23% of the Chesapeake's drainage area. Just over half the watershed is covered by forest, about one third is in agriculture or pasture, and about 11% is developed urban or suburban land. Most of the developed land is located in the Washington metropolitan area, where 80% of the Potomac's approximately 4.6 million population (1990 census) live. This region also is the center of population growth and land development for the basin.

The amount and sources of nutrient pollution are determined by population density and land uses, which vary across the basin. Figures 1 and 2 show graphically these relative distributions of land use and population among the jurisdictions. The District of Columbia has a very small land area (60 sq.mi.), with a high population (600,000). The Maryland and Virginia suburbs surrounding Washington also are characterized by high population density and urban development. Almost all of the growth in the basin's population between 1980 and 1990, an increase of 690,000, occurred in Maryland and Virginia as the Washington suburbs expanded. In this region, the dominant nutrient sources are wastewater treatment plants and urban stormwater runoff. The middle third of the basin is predominantly agriculture with smaller urban centers. This area includes the Shenandoah River and the Piedmont areas of Virginia and West Virginia, and the Monocacy River, and the Antietam and Conococheague Creek watersheds in Maryland and Pennsylvania. Nonpoint source runoff from cropland, pasture, and animal feedlot operations is the dominant source of nutrients in this region. The western third of the Potomac, including most of West Virginia's part of the basin, is predominantly forest with some agriculture. Population densities in the West Virginia and Pennsylvania parts of the basin are relatively low. The dominant land uses in Pennsylvania's portion of the Potomac are forest and agriculture. The area south of Washington draining to the tidal Potomac is a mixture of forest, farmland, and urban/suburban development. Industrial discharges of nutrients are relatively few in number and, while they may have impacts on local streams, they are a much smaller source of nutrients for the basin as a whole relative to municipal waste water treatment plants and nonpoint source runoff.

III. NUTRIENT REDUCTION TARGETS FOR THE POTOMAC

Nutrient loads from point and nonpoint sources were developed by the states in conjunction with the Chesapeake Bay Program. Information about point source flows, nutrient concentrations, and land uses were incorporated into a mathematical model of the Chesapeake Bay Watershed. The model simulates physical and chemical processes that affect nutrients, and calculates the transport of

Figure 1: Land Uses in the Potomac

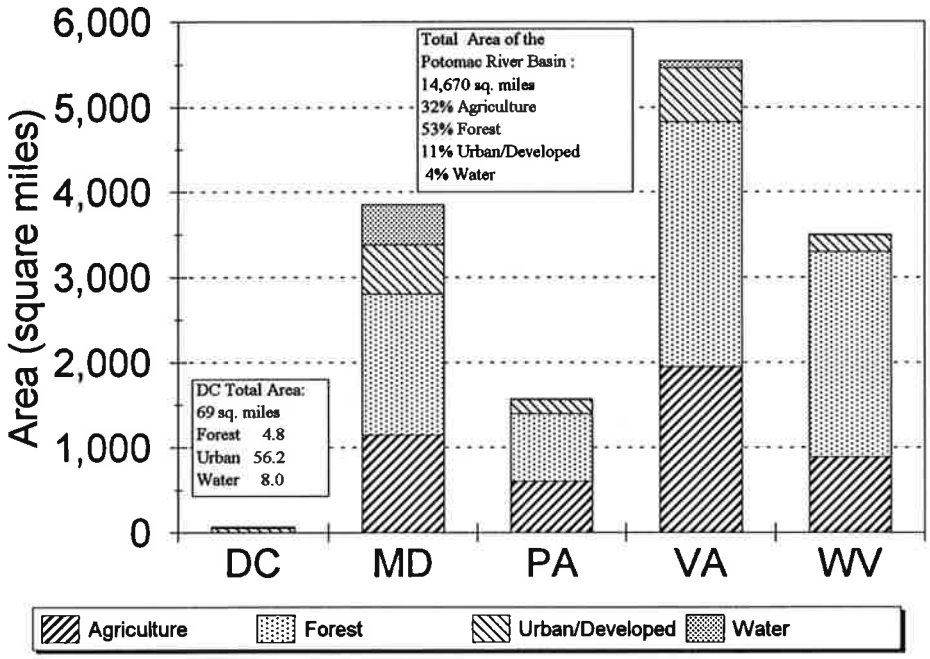
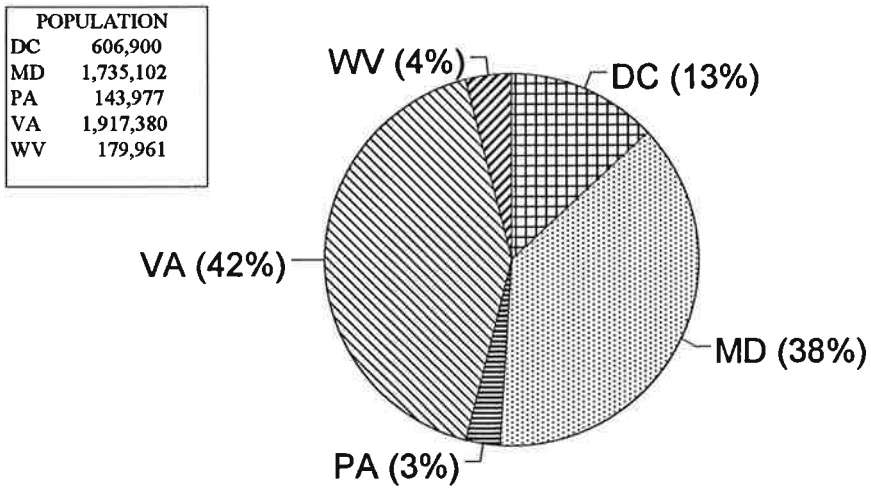


Figure 2: Population in the Potomac
1990 Census



nutrients across the landscape to the Chesapeake Bay. Nutrient loads from the Watershed Model are input into the Chesapeake Bay Water Quality Model. The Water Quality Model simulates processes in the Bay itself to determine what factors are limiting Bay water quality, and how changes in nutrient inputs to the Bay can improve water quality.

Results from these models formed the basis for the states to agree that a 40% reduction in nutrient loads to the Bay compared to the 1985 baseline level is necessary to achieve an acceptable improvement in Bay water quality. The nutrient load equivalent to a level 40% below the 1985 baseline load is called the nutrient cap. The nutrient cap takes into account which loads are controllable or not controllable, and which loads are actually delivered to the Bay. The states have agreed that once loads are reduced to the nutrient cap level, they should be held below that level indefinitely to preserve the water quality of the Bay.

Because natural processes will generate some nutrients, some of the nutrients entering the Bay are considered not controllable. The Watershed Model was used to estimate the fraction of nonpoint source nutrients that is not controllable. The 40% reduction agreement applies only to the controllable fraction of nutrients. All point source nutrients are considered controllable.

Natural processes in streams act to prevent or slow down the transport of a fraction of the nutrient load. As a result, less than 100% of the nutrients that enter streams may reach the Bay. The Watershed Model calculates this reduction, as a function of distance and other factors, to determine how much of a nutrient load generated in one part of the watershed is actually delivered to the Bay. The nutrient reduction targets and nutrient cap refer to delivered loads. All of the load numbers used in this report are delivered loads.

Almost 25% of the Potomac watershed lies in West Virginia, which is not a signatory to the Chesapeake Bay Agreement. Because of its relatively low population, high fraction of area in forest, and long transport distance to tidal waters, its contribution of nutrients to the Bay is relatively low. About 13% of nitrogen and phosphorus delivered to the Bay by the Potomac comes from West Virginia.

Table 1 shows nutrient loads and reduction commitments for each Bay Program jurisdiction in the Potomac Watershed. The 1985 Base is the baseline annual load. This is divided into Background (not controllable) loads, Controllable nonpoint source loads, and point source loads. The total controllable load is the sum of controllable nonpoint source and point source loads. The 40% reduction load shows the amount of the total controllable load the jurisdictions have agreed to reduce. The Load Cap is the target upper limit for controllable plus background loads after the strategies are implemented. West Virginia is not included in this table because it is not a party to the Bay Agreement. The West Virginia 1985 baseline loads (point plus nonpoint source) are 10.55 million pounds nitrogen and 0.86 million pounds phosphorus.

In this report, the strategies are sometimes described in terms of reductions, and sometimes in terms of the delivered load after reductions. The reduction attributable to each nutrient control program

TABLE 1. Nutrient Loads[1] and Reduction Commitments in the Potomac Watershed

Part A: Nitrogen
(Annual loads in millions of pounds)

Jurisdiction / Watershed	1985 Baseline Loads: Total	Back-ground	Control-lable NPS	Point Sources	Total Controllable	40% Reduction	Load Cap
District of Columbia[2]	8.03	0.10	0.16	7.78	7.94	3.17	4.86
Maryland	23.51	7.60	7.20	8.80	16.00	6.40	17.11
Pennsylvania	7.01	4.05	2.68	0.28	2.96	1.18	5.83
Virginia	30.84	10.13	10.64	10.06	20.70	8.28	22.56
Potomac[3]	69.39	21.87	20.68	26.92	47.60	19.03	50.36

Part B: Phosphorus
(Annual loads in millions of pounds)

Jurisdiction / Watershed	1985 Baseline Loads: Total	Back-ground	Control-lable NPS	Point Sources	Total Controllable	40% Reduction	Load Cap
District of Columbia[2]	0.12	0.001	0.02	0.10	0.12	0.02	0.10
Maryland	1.87	0.25	0.98	0.64	1.62	0.65	1.22
Pennsylvania	0.71	0.18	0.41	0.11	0.53	0.21	0.50
Virginia	2.65	0.59	1.48	0.57	2.05	0.82	1.83
Potomac[3]	5.35	1.02	2.89	1.42	4.31	1.70	3.65

Sources: The states' nutrient reduction strategy reports. See References.

Notes:
1. Loads are delivered to tidal waters.
2. District of Columbia point sources include nutrients from combined sewer overflows: 148,000 pounds nitrogen and 37,000 pounds phosphorus per year. 40% reduction does not apply to District of Columbia's share of phosphorus (64,000 pounds) from the Blue Plains WWTP.
3. Potomac total loads do not include West Virginia loads (10.55 million lbs nitrogen, 0.86 million lbs phosphorus).

is a measure of the effort expended to control nutrients. The load remaining after reductions, when compared to the cap, is a measure of success in attaining the nutrient goals.

IV. THE DISTRICT OF COLUMBIA STRATEGY

The District of Columbia held two public meetings in 1993, and published a draft strategy for public comment in January 1994 and a final strategy in October 1994 (District of Columbia Environmental Regulation Administration, 1994). The nutrient reduction problem faced by the District government is unique among the Bay Program jurisdictions. The District is a small land area that is 92% developed, with a high population density (600,000 people in 60 sq. miles). Its sources of nutrient pollution are dominated by a single point source, the Blue Plains Regional wastewater treatment plant (WWTP), which generates 95% of the nitrogen and 53% of the phosphorus load from the District. Almost half of the District is served by a sewer system which combines sanitary flows and stormwater runoff. Periodically, significant rain events cause more runoff to enter the combined sewers than the WWTP can process, resulting in overflows which are diverted to the Anacostia and Potomac rivers. These combined sewer overflows (CSO) contribute 2% of the nitrogen and 31% of the phosphorus. Nonpoint source runoff accounts for only 3% of the nitrogen and 16% of the phosphorus.

Blue Plains is an important point source for Maryland and Virginia, as well as for the District of Columbia. Operated by the District government, it is a regional facility that serves the Maryland and Virginia suburbs of Washington as well as the District. For the purposes of the nutrient reduction strategies, the nutrient load from Blue Plains is apportioned among Maryland, Virginia, and the District of Columbia in proportion to the wastewater flows contributed by each jurisdiction. It is projected that by the year 2000 the flow to Blue Plains will include 162 MGD from Maryland, 41 MGD from Virginia, and 160 MGD from the District of Columbia. With such a large total flow, Blue Plains is by far the largest point source for nitrogen in the entire Chesapeake watershed. Within the Potomac watershed, Blue Plains is the source of 52% of the nitrogen from all point sources, and 30% of the nitrogen from all controllable point and nonpoint sources. Since the early 1980s, Blue Plains has employed advanced treatment processes to remove nearly all phosphorus. Its effluent phosphorus concentration of 0.13 mg/l is considered to be at the limit of technology. Because the District's only point source (for nutrients) was already at the limit of technology for phosphorus removal, the 1987 Chesapeake Bay Agreement exempted the District from having to make additional reductions in phosphorus from Blue Plains.

The District proposes to upgrade the Blue Plains WWTP with a biological nutrient removal (BNR) process that will reduce total nitrogen effluent concentration from 15.5 mg/l to 7.5 mg/l on an annual average basis. The first step in this upgrade will be a two year test of the proposed process, with one half of the plant's flow receiving nitrogen removal treatment. If results of the test are positive, in the sense that all effluent permit conditions are met with this design or with modifications of this design, then a full upgrade at Blue Plains will proceed and should be completed within a few additional years.

If the test is not successful, then the District government will reevaluate alternative technologies for nitrogen removal.

The District government has had a Combined Sewer Overflow Abatement Program since the early 1980s. In Phase I of that program, facilities were constructed to separate some combined sewer flows, increase temporary storage of combined flows, and provide minimal treatment of overflows before discharge to streams. Phase I has been completed and additional facilities have been planned in a second phase though at present the District is evaluating the performance results of Phase I before proceeding with the next phase. Although the mix of measures yet to be implemented for additional control of CSOs has not been decided upon, the District of Columbia Environmental Regulation Administration has set a goal of reducing CSO nutrient loads by 15% for nitrogen and 30% for phosphorus. This is roughly the reduction that would be achieved if all CSO flows received primary treatment. The District's calculations of nutrient loads after full implementation of its nutrient strategy assume this level of reduction in nutrients from CSOs.

Control of nonpoint source pollution is important to the District of Columbia to help reduce trash, sediment, toxics, and organic waste, as well as nutrient pollution, to the Anacostia and Potomac Rivers. The District is addressing nonpoint source pollution with a variety of programs. The DC Nutrient Management Plan includes:

- Amendments to stormwater management and soil erosion regulations to make for more effective program management and enforcement of regulations.
- Construction of stormwater control BMPs, especially in the Anacostia watershed, as part of the Anacostia Watershed Restoration program.
- A pollution prevention program that includes education for the public and businesses.

Working with Federal agencies to reduce nonpoint source nutrient runoff from Federally owned land is a significant part of the District's nonpoint source control plan because the Federal government is the largest landowner in the District. A special tributary strategy for Federal lands in the District is being developed now by the federal agency landowners.

The District of Columbia nutrient strategy, when implemented, will reduce nitrogen loads delivered to the tidal Potomac (and to the Chesapeake Bay) to an annual level of 4.02 million lbs per year and reduce phosphorus loads to 0.11 million lbs per year (Table 3). At this level, the District's annual nitrogen load will be 0.85 million pounds **under** the nutrient cap, thereby achieving that goal. The Blue Plains WWTP upgrade will account for 99% of the reduction in nitrogen load. The phosphorus load, however, still will be 10,000 pounds per year **over** the cap. Control of combined sewer overflows is projected to reduce phosphorus loads by 11,000 lbs per year, while nonpoint source controls are expected to reduce phosphorus in runoff by 1,000 pounds per year.

Construction of a large scale test of the BNR process began in June 1995. Operation is planned to begin in April of 1996 and continue for two years. In the test phase, one half the flow through the plant will receive BNR treatment, reducing the effluent nitrogen concentration of that half of the plant's discharge from 15 mg/l to 7.5 mg/l (annual average). Construction of the test facilities will

cost $2.5 million, and operation and maintenance costs will add $8.7 million/year. The District's share of these costs is 43%. The District has secured funding for its share of construction and operation of the test phase and is negotiating with its Maryland and Virginia partners for their participation in the upgrade.

The DC Department of Public Works is gathering additional monitoring information to refine estimates of annual nutrient loads from CSOs and the impact CSO controls are having on nutrient loads, but that information is not available yet. Funding for additional CSO control facilities in Phase II of the CSO Abatement has not yet been secured, and is likely to prove the major impediment to progress on control of this source of nutrients.

Since 1987, stormwater control facilities have been installed in the District at the rate of about 100 acres of drainage area served per year. Assuming funding levels remain constant, this rate of installation is expected to continue.

V. THE MARYLAND STRATEGY

Maryland's approach to developing a nutrient reduction strategy was to divide the state into ten watersheds and to develop strategies specific to each of these watersheds. The intent was to develop strategies more closely tailored to the specific characteristics and issues in each region of the state. Although the state's commitment to the Bay program was for a 40% reduction in nitrogen and phosphorus across the state, Maryland elected to try to achieve approximately 40% reductions in each of its ten watersheds. Setting a goal of similar reductions in all parts of the state was one way of sharing the burden of effort.

Maryland's portion of the Potomac was divided into three watersheds: the Upper Potomac (the Monocacy River and Potomac tributaries to the west), the Middle Potomac (the Potomac and its tributaries in the Washington area), and the Lower Potomac (the Potomac and its tributaries from Mattowoman Creek to the mouth of the Potomac). In each watershed, three public meetings were held in 1993 and 1994, and additional briefings were held for local government officials. These meetings provided an opportunity for citizens and local government officials to meet with state staff to discuss the objectives of the nutrient reduction commitment, the sources of nutrient pollution, options for reducing nutrient pollution, and problems facing nutrient strategy implementation.

Draft strategies and discussion papers were distributed for public comment in 1993 and 1994. During this period the strategies were refined to incorporate comments from citizens and local government officials, and to include the best available information on nutrient loads and the effectiveness and practicality of nutrient control options. Documentation for the revised strategies were distributed in the summer of 1995 (Maryland Dept. of the Environment, et al, 1995 A-D). The actions described in the strategies combine elements to be implemented through existing regulatory programs and voluntary programs for participation by landowners and local governments. It is noted also in the

strategies that it is Maryland's intent that the strategies will be fine-tuned and improved as they are implemented and as experience is gained about which actions are the most practical and cost effective.

Maryland's strategy is based on nutrient control programs that fall into four areas: wastewater treatment plants, developed land, agricultural land, and resource protection and watershed planning. The strategy proposes implementation of BNR and CPR at all wastewater treatment plants (WWTPs) that currently have a design flow of 0.5 million gallons per day (MGD) or greater. When smaller WWTPs are expanded to greater than 0.5 MGD capacity then BNR and/or CPR should be added at the time of expansion. While there are 25 plants larger than 0.5 MGD flow, one plant, the Blue Plains Regional WWTP, dominates. Maryland's share of the total flow to Blue Plains, expected to increase to 162 MGD by the year 2000, is greater than the flow of all other Maryland plants combined. Implementation of BNR at Blue Plains will account for 48% of the nitrogen reductions proposed for all point and nonpoint sources in Maryland's portion of the Potomac watershed.

For control of nutrients in runoff from newly developed land, Maryland proposes full implementation of existing state and local regulatory programs for erosion and sediment control and stormwater management. State requirements for erosion and sediment control and for stormwater management are being revised and strengthened to improve effectiveness. In some areas, stormwater management facilities will be added (retrofitted) to already developed watersheds that lack stormwater controls. Educational programs directed toward informing landowners about appropriate nutrient management methods will be enhanced. Educational programs will also be directed toward informing homeowners how septic systems operation and maintenance can be improved to increase nutrient removal capability, as well as to reduce repair costs and extend the useful life of these systems.

The level of proposed implementation of agricultural BMPs varies among the three areas into which Maryland divided its part of the Potomac, reflecting the different levels of significance of agriculture as well as the difficulty in achieving a 40% nutrient reduction in the local watershed. In each area, an agricultural workgroup was established, made up of members of the local agricultural community, which worked with state officials to develop the strategy for agricultural lands. To varying degrees the strategies call for increased usage of nutrient management plans, cover crops, conservation tillage, Soil Conservation and Water Quality Plans, and treatment of lands with high erosion potential. Table 2, below, shows the proposed level of implementation of these major nutrient management systems in each of the Maryland subwatersheds.

Maryland's strategy includes a resource protection and watershed planning component which includes practices designed to protect forests, wetlands, and other natural areas. These practices include planting forested and grassed buffers along streams, improved forest management practices as required by the Forest Conservation Act, and planning and zoning ordinances that manage growth to protect streams, shorelines, and wetlands. The Maryland strategy notes that the implementation targets for resource protection practices are the minimum needed to achieve the 40% nutrient reduction goals. The strategy notes further that these practices also help restore wildlife habitat and thus have ecological benefits in the local watershed, in addition to helping achieve the nutrient reduction goal for the Chesapeake Bay.

Table 2: Percent of eligible agriculture acres in Maryland to be treated with BMPs

Best Management Practice	Upper Potomac	Middle Potomac	Lower Potomac
Nutrient Management	29%	86%	59%
Cover Crops	42%	21%	29%
Animal Waste Management	31%	100%	*
Conservation Tillage	75%	*	43%
Soil Conservation & Water Quality Plans	65%	*	63%
Treatment of highly erodible lands	77%	*	*

* percentage not available. See relevant Maryland strategy document for acreage.

Maryland's three Potomac watershed strategies, when implemented, will reduce nitrogen loads delivered to the tidal Potomac (and to the Chesapeake Bay) by 7.63 million lbs per year and reduce phosphorus loads by 0.48 million lbs per year (see Table 3). Wastewater treatment plant upgrades will account for 68.3% of the reduction in nitrogen load and 41.8% of the reduction in phosphorus load. Nonpoint source controls on developed land will account for 2.5% of the nitrogen and 6.0% of the phosphorus load reduction. Implementation of best management practices on agricultural land will account for 26.9% of the nitrogen and 41.4% of the phosphorus load reduction. Resource protection practices will account for 2.3% of the nitrogen and 10.8% of the phosphorus load reduction.

Achieving this strategy will require some increase in funding for both point and nonpoint source control programs. Maryland has a program for assisting local governments upgrade their wastewater treatment plants with BNR by sharing capital investment costs. If this program and the various nonpoint source control programs continue at current funding levels, then the state projects that it will achieve most, but not all, of the reductions necessary to meet the reduction target. Maryland will still be approximately 1.22 million pounds of nitrogen and 0.08 million pounds of phosphorus over the nutrient cap. Closing that gap will require expansion of state and local government programs and efforts by landowners and businesses. In 1994, the Governor of Maryland appointed a "Blue Ribbon Panel on Financing Alternatives for Maryland's Tributary Strategies" to identify new cost effective financing mechanisms for funding the necessary increase in effort. That Panel has produced a report that will be used by the state to consider funding options (Governor's Blue Ribbon Panel, 1995). The state also has appointed Tributary Implementation Teams in each of its regional watersheds. These teams are made up of members of different segments of the local communities (business, agriculture, environmental groups, local government, and academia) to provide state/local coordination and to help find nutrient reduction solutions that are both feasible and realistic.

As part of its efforts to explore innovative solutions, the state is cooperating with the Metropolitan Washington Council of Governments, which has proposed a Regional Pilot Project under which communities in the metropolitan Washington area (including Virginia, the District of Columbia, and Maryland) will work together to reach a regional nutrient reduction goal in the most cost effective manner. Options under consideration include nutrient trading between WWTPs, between communities, and between WWTPs and nonpoint sources.

VI. THE VIRGINIA STRATEGY

Prior to publication of its draft nutrient reduction strategy in September 1995, Virginia published two options papers in 1993 and 1994, and held several series of meetings with citizens, local government officials, and interest groups to explain the strategy goals, the options, and to receive comments. The draft strategy describes nutrient pollution reductions as a result of activities in the period 1985 - 1994, and reductions projected for the year 2000 as a result of current and projected activities (by state and local governments and by individuals). It also presents options for how Virginia can accomplish the additional reductions required to achieve the year 2000 nutrient cap. These actions include continuing and additional state programs, and suggestions and options for local governments to adopt in a voluntary, cooperative effort to reduce nutrient pollution. The central theme of the Virginia strategy is that the state will work with citizens and local governments in a cooperative partnership to implement solutions for reducing nutrient pollution.

Virginia estimates that the implementation of agricultural and urban BMPs from 1985 through 1994 has reduced annual loads of nutrients from nonpoint sources by 1.789 million pounds nitrogen and 0.313 million pounds phosphorus. Phosphorus from point sources decreased during this period by 0.213 million pounds, a decrease principally attributed to the phosphate detergent ban and to improved treatment at certain WWTPs. Nitrogen from point sources increased by 0.442 million pounds, with improved treatment at several plants more than offset by increased wastewater flows resulting from increasing population. Total point and nonpoint source reductions by 1994 of annual nutrient loads of 1.35 million pounds nitrogen and 0.526 million pounds phosphorus are equivalent to 6.5% and 25.6% respectively of the nitrogen and phosphorus 1985 baseline controllable loads.

From 1995 to the year 2000, Virginia's point source nutrient strategy incorporates nitrogen reductions due to implementation of BNR at two wastewater treatment plants, the federal facility at Quantico and the Blue Plains WWTP (see page 10). In addition, the strategy assumes that the WWTPs in the Northern Virginia region subject to Virginia's Potomac Embayment Standards will be required to install nitrification to meet water quality standards for ammonia. The addition of this process is expected to reduce total nitrogen concentrations by 20%. Other WWTPs in Virginia's Potomac watershed are expected to maintain their nutrient effluent concentrations. Offsetting these reductions from improved treatment are increased wastewater flows due to population growth. Flows to all municipal WWTPs increased from 185 million gallons per day (MGD) in 1985 to 220 MGD in 1994, and are projected to reach 288 MGD by the year 2000. Even with BNR installed at Blue Plains,

flows from Fairfax County are increasing so much (from 17 MGD in 1985 to 41 MGD in the year 2000) that the nitrogen load from Virginia's share of Blue Plains will be greater in 2000 than in 1985. The net effect of upgraded treatment at the plants noted above, balanced by increased flows at nearly all plants, is that the annual load of nitrogen and phosphorus from point sources is projected to increase rather than decrease in the next five years.

Continued implementation of BMPs as part of existing nonpoint source control programs is expected to reduce annual nonpoint source nutrient loads by an additional 1.55 million pounds nitrogen and 0.25 million pounds phosphorus below what had been achieved by 1994. Principal sources of additional nutrient reductions from 1994 to the year 2000 are

- increasing acreage under nutrient management plans from 100,000 to 375,000 acres (57% of applicable acres),
- increasing application of BMPs to 100% of land affected by forest harvesting operations,
- additional animal waste control facilities (increasing from 467 to 666 facilities),
- improved compliance with the state Erosion and Sediment Control Law,
- increased application of urban nutrient management practices to 10% of applicable acreage.

Calculations of nutrient reductions on agricultural land are based on BMPs installed through cost share programs, but do not include BMP practices that are implemented by farmers on a voluntary basis. Virginia is in the process of evaluating the results of a survey of farmers to estimate the level of voluntary BMP implementation. Eventually, the state may add nutrient reductions from voluntary BMP implementation to the reductions from cost share programs.

The cumulative impact of point and nonpoint source nutrient reduction programs already implemented and those currently planned, combined with the effects of population growth, are estimated to result in a net reduction in annual nutrient loads by the year 2000 of 1.49 million pounds nitrogen and 0.66 million pounds phosphorus (see Table 3). This represents a reduction from 1985 baseline levels of 7.2% for nitrogen and 32.3% for phosphorus, not enough to achieve the 40% reduction goal. The difference between expected loads in 2000 and the nutrient cap targets is referred to as the "nutrient gap".

Virginia's draft strategy proposes a process for how further reductions to close the nutrient gap will be "fostered and achieved". In the strategy, Virginia's portion of the Potomac is divided into four regions. In a manner similar to Maryland's approach with its part of the Potomac, point and nonpoint source nutrient loads and nitrogen and phosphorus targets were calculated for each region. Sources of nutrients and levels of BMP implementation in each region were determined, and from that information the potential for additional BMP implementation was identified. The process calls for local governments to form Tributary Teams, consisting of representatives of business, agriculture, environmental groups, and state and local officials, to facilitate development of local and regional nutrient reduction strategies. Adoption and implementation of local strategies will be by local initiative. The strategy endorses regional cooperation as a means to find cost effective and equitable nutrient strategies. The Washington Council of Governments' regional point source initiative, the Virginia Poultry Federation Commitment to Nutrient Management Planning, and nutrient trading

systems like the Tar-Pamlico River Basin Association are presented as examples of regional cooperation that should be explored further.

The strategy document itself includes lists of programs and BMP options that local governments may undertake to reduce nutrient loads and/or offset the nutrient increasing effects of population growth and land development. The options listed show that it is technically feasible to achieve the nutrient reduction goal. In Virginia's assessment of options, it appears that the nutrient goals cannot be achieved without nitrogen removal at most, if not all, wastewater treatment plants because, by the year 2000, point sources will account for 60% of the controllable nitrogen load (see Table 3).

VII. THE PENNSYLVANIA STRATEGY

Pennsylvania's approach to developing a nutrient reduction strategy was similar to the other jurisdictions in that multiple public meetings were held to explain to the nutrient reduction goals and options and to solicit comment from citizens and local government. Two draft strategies were published for public comment, the last being issued in March 1994 (Pennsylvania Department of Environmental Resources, 1994). As of September 1995, a final strategy incorporating comments received on the draft, plus more recent information on point sources and nonpoint source control programs, is nearing completion. The text of the final strategy was not available for review in this report, but the nutrient load reductions attributable to various nonpoint source control programs were provided (Pattison, 9/12/95, pers. comm.). Those numbers were used to complete Table 3. This summary of the Pennsylvania strategy is based on those numbers and on the description provided in the 1994 draft strategy.

In Pennsylvania's portion of the Potomac watershed 90% of the controllable nitrogen and 77% of the phosphorus comes from nonpoint sources (Table 1). Thus nutrient pollution is primarily a nonpoint source problem, and the state's nutrient strategy addresses primarily nonpoint sources. There are several programs in place for promoting implementation of best management practices on agricultural operations through a combination of regulations and cost sharing. Among these are:

- the Nutrient Management Act, which addresses nutrient pollution in runoff from concentrated animal operations,
- state and federal conservation practices programs which provide assistance to address nutrient runoff problems,
- programs to address erosion and sediment control, runoff from barnyards and feedlots, implementation of erosion and sediment control plans,
- a program to install streambank fencing to keep livestock out of streams.

The 1994 draft strategy proposed that approximately 10% of farms will be required by the Nutrient Management Act to implement nutrient management plans, and another 10% will participate voluntarily. With this level of implementation, the nutrient management act is expected to yield 539,000 pounds per year in nitrogen reductions and 101,000 pounds per year in phosphorus

reductions. This is 54% and 58% of the total reductions expected from nonpoint sources for nitrogen and phosphorus, respectively. Implementation of BMPs through the conservation practices cost share programs is expected to affect approximately 100,000 acres of farmland and will include the construction of 135 animal waste storage facilities between 1985 and the year 2000. These programs are expected to yield 372,000 pounds per year in nitrogen reductions and 62,000 pounds per year phosphorus in reductions, or 37% and 36% of the total reductions expected from nonpoint sources. Another 91,000 pounds nitrogen and 26,000 pounds phosphorus reductions are expected from the combined effects of the Conservation Reserve program, erosion and sediment control plans, barnyard runoff control program, and streambank fencing.

In its 1994 draft nutrient strategy, Pennsylvania proposed to reevaluate its point source nutrient control strategy. The state wanted to obtain better data on nutrient concentrations from point sources, and to consider further the feasibility and costs of options (including BNR) for upgrading wastewater treatment plants for more effective nutrient removal. The special study to analyze nutrient concentrations and flows from WWTPs has been completed (but not yet published) and the state has refined its calculations of point source nutrient loads. The state also is participating, with Maryland, Virginia, and the Chesapeake Bay Program, in a study to evaluate the feasibility and costs of BNR at selected plants in each state. That study, now underway, will be used by Pennsylvania to help determine the costs of point source nutrient removal options and their feasibility for implementation. In the interim, the point source component of Pennsylvania's nutrient strategy reflects the impact of current WWTP management policies, which include regulations for limiting ammonia effluent and, in certain cases, limiting phosphorus concentrations where phosphorus is determined to be a limiting factor in local water quality. Pennsylvania does not have regulations limiting total nitrogen. The net impact of increases in plant flow to accommodate population growth, combined with upgrades at certain plants for phosphorus control, is expected to result in an **increase** in nitrogen of 236,000 pounds nitrogen and a **decrease** of 15,000 pounds phosphorus per year from 1985 to the year 2000.

VIII. SUMMARY

Each of the Chesapeake Bay Program signatory jurisdictions is in the process of developing and implementing tributary specific nutrient reduction strategies. As mandated in the 1992 amendments to the Chesapeake Bay Agreement, each of the jurisdictions has engaged in a public participation process to explain the nutrient reduction goals and to obtain the participation of citizens and local government officials in strategy development. In each jurisdiction the process included multiple meetings with citizens and local officials, and circulation of draft documents for comments. Maryland and Virginia are continuing that process by establishing local tributary teams to work with state agencies during implementation of their strategies. Each jurisdiction has published at least a draft nutrient strategy.

The principal component of the District of Columbia strategy is to upgrade the Blue Plains regional

wastewater treatment plant to include nitrogen removal. Construction of a test phase treating one half the plant's flow has begun and is expected to be operational in April 1996. The upgrade of Blue Plains, when complete, will accomplish the single largest point source nitrogen reduction in the entire Chesapeake. The District strategy states that it is the intent of the District to reduce nutrients from combined sewer overflows (CSO) by 15% for nitrogen and 30% for phosphorus. However, specific actions to accomplish this have not been identified. Because opportunities for controlling phosphorus are limited in the completely urbanized District, their strategy for nonpoint sources will not achieve the nutrient target for phosphorus. The District's plan will reduce controllable nutrients by 50.6% for nitrogen and 20.8% for phosphorus (nonpoint source and CSO only) below the 1985 baseline levels.

Maryland has published a strategy that, when implemented, will reduce its share of the Potomac nutrient loads to below the caps for both nitrogen and phosphorus. The strategy is based on upgrading all major WWTPs with BNR, and implementing sufficient agricultural and developed land nonpoint source BMPs to meet the nutrient targets. Implementation of this strategy will require an expansion of, and additional funding for, current nutrient control programs at the state and local level. The Maryland strategy will reduce controllable nutrients by 42.8% for nitrogen and 45.7% for phosphorus below the 1985 baseline levels.

Pennsylvania is about to release its final strategy. Earlier drafts and preliminary information about the final version indicate that the Pennsylvania strategy will be based on programs to control agricultural nonpoint sources of nutrients. The state is continuing to study options for a point source control program. The strategy will reduce controllable nutrients by 26.0% for nitrogen and 35.8% for phosphorus below the 1985 baseline levels.

The Virginia strategy identifies actions that have been and will be taken with current programs. Those current programs will reduce controllable nutrients by 7.2% for nitrogen and 32.3% for phosphorus below the 1985 baseline levels. The strategy also lists additional nutrient reduction measures as options that may be implemented to achieve the nutrient targets. The Virginia approach is to encourage local communities to voluntarily make the decisions on implementing appropriate measures to reduce nutrients.

Based on these strategies (see Table 3), plans are not yet in place that will reduce nitrogen and phosphorus to below the nutrient cap levels agreed to by the Chesapeake Bay Program in 1992. Added together, the strategies when implemented will achieve a reduction in controllable nutrients of 27.6% for nitrogen and 36.9% for phosphorus below 1985 baseline levels.

TABLE 3: Nutrient loads expected after state strategies are fully implemented[1].

Part A: Nitrogen
(millions of pounds annual delivered load)

	Back-ground	Control-lable NPS[2]	Point Source	Total	Load Cap	amount over (under) Cap
District of Columbia[3]	0.10	0.15	3.77	4.02	4.86	(0.85)
Maryland	7.60	3.55	5.60	16.75	17.11	(0.36)
Pennsylvania	4.05	1.68	0.51	6.24	5.83	0.42
Virginia[4]	10.13	7.30	11.91	29.34	22.56	6.78
Potomac[5]	21.87	12.68	21.79	56.35	50.36	5.99

Part B: Phosphorus
(millions of pounds annual delivered load)

	Back-ground	Control-lable NPS[2]	point source	Total	Load Cap	amount over (under) Cap
District of Columbia[3]	0.001	0.02	0.09	0.11	0.10	0.01
Maryland	0.25	0.60	0.28	1.13	1.22	(0.10)
Pennsylvania	0.18	0.24	0.10	0.52	0.50	0.02
Virginia[4]	0.59	0.92	0.47	1.98	1.83	0.15
Potomac[5]	1.02	1.77	0.94	3.73	3.65	0.08

Notes:

1. Based on information contained in the respective state strategy documents (Pennsylvania information provided by K. Pattison (pers. comm.).
2. Controllable nonpoint source load.
3. District of Columbia point source loads include nutrients from CSO (126,000 lbs nitrogen, 25,800 lbs phosphorus).
4. Virginia loads are based on current programs and projects and do not include additional actions that may be taken by local governments.
5. Potomac total does not include nutrients from West Virginia.

REFERENCES

District of Columbia Environmental Regulation Administration, (1994), *The District of Columbia Tributary Nutrient Reduction Strategy for the Restoration of the Chesapeake Bay*, District of Columbia Environmental Regulation Administration.

Governor's Blue Ribbon Panel (1995), *Financing Alternatives for Maryland's Tributary Strategies, Office of the Governor*, State of Maryland.

Maryland Department of the Environment, et al, (May 1995A), *Maryland's Tributary Strategies for Nutrient Reduction: A Statewide Summary,* Maryland Department of the Environment.

Maryland Department of the Environment, et al, (May 1995B), *Tributary Strategy for Nutrient Reduction in Maryland's Lower Potomac Watershed*, Maryland Department of the Environment.

Maryland Department of the Environment, et al, (May 1995C), *Tributary Strategy for Nutrient Reduction in Maryland's Middle Potomac Watershed*, Maryland Department of the Environment.

Maryland Department of the Environment, et al, (May 1995D), *Tributary Strategy for Nutrient Reduction in Maryland's Upper Potomac Watershed*, Maryland Department of the Environment.

Pennsylvania Department of Environmental Resources (March 1994), *Pennsylvania's Draft Nutrient Reduction Strategy*, Pennsylvania Department of Environmental Resources, Bureaus of Land & Water Conservation and Water Quality Management.

Virginia Department of Environmental Quality, et al, (August 1995), *Virginia's Potomac Basin Tributary Nutrient Reduction Strategy, Draft for Public Review and Comment*, Department of Environmental Quality

For more information about the nutrient reduction strategies

The District of Columbia,
Water Resources Management Administration
Environmental Regulation Administration
Department of Consumer & Regulatory Affairs
2100 Martin Luther King Avenue, S.E., Suite 203
Washington, DC 20020
ph. (202) 645-6601

Maryland,
Ms. Carol Bruner
Chesapeake Bay and Watershed Management Division
Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
ph. (410) 631-3681

Pennsylvania,
Bureau of Land & Water Conservation
Pennsylvania Department of Environmental Protection
P.O. Box 8555
400 Market Street, 11th floor
Harrisburg, PA 17105-8555
ph (717) 787-5259

Virginia,
Tributary Strategies
Department of Environmental Quality
P.O. Box 10009
Richmond, VA 23240-4000
ph. (804) 762-4318

For more information about the Chesapeake Bay Program

The Alliance for the Chesapeake Bay
6600 York Road Suite 100
Baltimore, MD 21212

U.S. EPA Chesapeake Bay Program
US EPA Chesapeake Bay Program Office
410 Severn Avenue
Annapolis, MD 21403
ph. (800) 968-7229