JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION
OF THE VIRGINIA GENERAL ASSEMBLY

Virginia's Progress Toward Chesapeake Bay Nutrient Reduction Goals

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Preface

Through Chesapeake Bay agreements, Virginia has committed to achieve by the year 2000 a 40 percent reduction of two nutrients (nitrogen and phosphorus) that enter the Chesapeake Bay, and to maintain at least this level of reduction thereafter. The focus of Virginia's efforts to achieve this reduction has been on the Potomac River Basin.

Item 14C of the 1996 Appropriation Act required a Joint Legislative Audit and Review Commission (JLARC) review of Virginia's progress toward meeting its nutrient reduction commitments. This report focuses on the Commonwealth's strategy to reduce nutrients from Virginia's portion of the Potomac River Basin, although nutrient reductions in Virginia's other tributary rivers to the Bay are also discussed.

There is reason to expect that Virginia will make some short-term progress in the Potomac Basin towards its nutrient reduction commitments. The Commonwealth's strategy document recommends an increase in activity to achieve reductions, compared to the existing level of effort. Also, the Governor has proposed an initial $11 million to be dedicated to Potomac nutrient reductions.

However, it is unlikely that Virginia will produce a 40 percent nutrient reduction in its portion of the Potomac by the year 2000. In part, this is because aside from a phosphate detergent ban, Virginia has taken limited action since the time the commitment was made. In addition, whether Virginia could maintain a 40 percent reduction in the years after 2000 is in great doubt. In the face of rising nutrient levels due to population growth, the commitment to maintain such a reduction once it is achieved is a very challenging goal.

Also, the Commonwealth's Potomac strategy document has two major shortcomings. First, the strategy utilizes some questionable assumptions that lead to the calculation of greater nutrient reductions than are likely to be achieved. The more time that passes before realistic assumptions are made, the more action may be deferred on suitable alternatives.

Second, the strategy does not address what actions need to be planned now in order to at least maintain the level of reduction that is achieved. Decisions made now on long-term capital investments (such as sewage treatment plant upgrades) will have an impact on how much progress is made, and how much is eroded, for many years into the future. Therefore, it would be a mistake to view the issue of maintaining the reduction as a discrete step that can be considered later.

On behalf of JLARC staff, I would like to express our appreciation to the State natural resource agencies and the local government and sewage treatment plant staff who assisted us in this review.

Philip A. Leone
Director

February 5, 1997

JLARC Report Summary

Virginia's Progress Toward Chesapeake Bay Nutrient Reduction Goals

February 1997

Joint Legislative Audit and Review Commission

As part of the Chesapeake Bay Agreement of 1987, Virginia committed to achieve a 40 percent reduction of two nutrients, nitrogen and phosphorus, entering the main stem of the Bay by the year 2000. The commitment was reaffirmed in 1992 amendments to the Agreement, which also included a commitment to "maintain at least this level of reduction thereafter" and a commitment to develop specific strategies by tributary river to achieve the nutrient reductions.

Nutrients such as nitrogen and phosphorus are essential as raw materials for organism growth and development, and are present in nature. However, in excess, they have been held to negatively impact water quality in the Bay and its tributaries. Excess nutrients relative to human activity stem from point sources (discharges from specific conveyances, such as sewage treatment plant discharges) and nonpoint sources (pollutants such as fertilizers which are set in motion by rainfall or snowmelt moving over and through the ground).

The focus of Virginia's efforts to achieve a 40 percent reduction in nutrients to the Bay has been on the Potomac River Basin. Virginia's lower tributary rivers (the James, Rappahannock, and York Rivers) and its coastal shores are also targets for nutrient reductions, but strategies for those waters have been a lesser priority and specific reduction goals have not been finalized. Nutrients in these waters are held to be of concern for the health of the river basins themselves, but not so much for the health of the Bay.

The Joint Legislative Audit and Review Commission was directed by Item 14C of the 1996 Appropriation Act to examine the Commonwealth's progress towards meeting the nutrient reduction commitments set forth in the 1992 revisions to the 1987 Chesapeake Bay Agreement. Because the Potomac strategy currently under development is critical to meeting Bay goals and has been the focus of State strategy efforts to date, the JLARC review focused on this strategy. Pursuant to the mandate, the review focused on "progress" issues — it is not a reassessment of the need for the goal, nor is it a cost study. The study examines: what progress is reported and expected under current levels of effort, what Virginia's Potomac strategy achieves as it is given, problems with accepting the strategy as given, and key issues that will probably impact Virginia's future progress.

The overall conclusion of the report is that Virginia is unlikely to produce a 40 percent reduction in nutrients in its portion of the Potomac by the year 2000, and whether it will produce a 40 percent reduction in the years after 2000 is also in great doubt. There appear to be some unresolved questions at the State and local levels as to the priority or worth that is attached to addressing the Bay's problems. This is reflected in the slow State and local response to the commitment, contrasted to a long-standing knowledge of the types of actions that would be needed to achieve the goal.

More specific findings of the report can be summarized as follows:

- The State's Potomac strategy calls for actions and nutrient reductions beyond existing levels of effort.

- However, estimated nutrient reductions contained in the strategy, accepted at face value, are not projected to result in the 40 percent goal being met by the year 2000, and may be inadequate for meeting the goal even once fully implemented.

- There are also problems with accepting the specific reductions of the strategy at face value, because some assumptions appear questionable.

- The strategy does not address the goal of maintaining a 40 percent reduction after the year 2000, and therefore does not seek to prevent the probable erosion of progress shortly after 2000.

- There are key areas of uncertainty that will need to be considered in the policymaking process for Potomac nutrient reduction.

- The timeframe specified in the *Code of Virginia* for the lower tributary strategies is at risk of not being met.

Potomac Strategy Provides Basis for Expecting Progress Beyond Current Efforts

The Commonwealth Potomac strategy estimates that annual nitrogen loads decreased by only nine percent from 1985 to 1994, while phosphorus was reduced by about 27 percent. The strategy indicates that expected current efforts through the year 2000 will roughly maintain nitrogen and phosphorus at these 1994 levels. Further, without additional actions beyond expected current efforts, nitrogen loads from Virginia's portion of the Potomac could be substantially greater by the year 2015 than they were in the 1985 baseline year. If the goal of improving the health of the Bay through nutrient reductions is made a priority, there will be a need to take substantial policy actions beyond current levels of effort.

The Commonwealth's strategy does call for actions and reductions that go beyond current levels of effort. The strategy calls for point source actions at many sewage treatment plants that will reduce nitrogen concentration levels. The strategy also calls for heightened implementation of a variety of nonpoint source best management practices (BMPs) to reduce nutrients (for example, better management of fertilizer applications on farms). The estimated costs of these controls, according to the strategy, is between $129 and $167 million, the vast portion of which are point source costs. The strategy thus provides a basis for expecting progress beyond current levels of effort.

Potomac Strategy Does Not Meet Goal by 2000 and May Be Inadequate to Meet the Goal Once Fully Implemented

The Commonwealth's Potomac strategy is not expected, however, to meet the State's commitment to reduce nutrients by 40 percent by the year 2000. Virginia's slow progress in tributary strategy development and in addressing funding issues has contributed to this situation. The Virginia Water Control Board estimated in 1991 that a 7.0 milligrams per liter nitrogen concentration would be needed to meet Bay goals. However, since 1991, Virginia has made minimal technologically-based progress in this direction. It is now unlikely that Virginia will achieve the goal, in large measure due to construction schedules for major wastewater treatment plant projects. While the inability of the strategy to achieve the year 2000 goal is not explicitly addressed in the strategy document, the Secretary of Natural Resources has drawn this conclusion in a sentence of a November 1996 report, stating that "it is not realistic to expect that the 40% nutrient reduction goal in the Potomac strategy can be achieved by the year 2000."

Moreover, a JLARC staff analysis of the strategy described in Chapter II of this report indicates that the strategy may be inadequate to produce a 40 percent reduction once fully implemented. The analysis indicates that accepting the strategy as given and fully implemented by the year 2003, nitrogen reductions may peak at 37 percent, and phosphorus reductions may peak at 38 percent, unless sewage treatment plant flow growth diminishes from the rates that have been projected.

Point Source Success Will Be Difficult, and Nonpoint Source Reductions Are Based on Some Questionable Assumptions

There are also concerns with accepting the strategy as given. On the point source side, success may be more difficult to achieve than is indicated in the strategy. Nitrogen concentration issues at several key facilities will need to be resolved in order to be more certain of Virginia's progress. If reductions averaging seven to eight milligrams per liter or less cannot be achieved at the large sewage treatment plants, then the progress suggested by the strategy will be at serious risk. The proposal of a key association for municipal sewage treatment plant agencies may not provide this level of reduction. Further, the reductions calculated in the strategy for one of the major treatment plants will need particular scrutiny. A retrofit to reduce nutrients is not planned for this plant. Nonetheless, strategy projections show nitrogen loads from this plant as less than in the baseline year, despite an approximate tripling of the plant's wastewater flow that is projected from the baseline year.

On the nonpoint source side, there is a concern with the existing calculation framework for nonpoint source reductions. The framework assumes consistently better nutrient management practices by land users. The exclusive focus of the framework on reductions through BMPs means that the potential for land user behaviors that work at counter-purposes is not recognized. For example, some farmers may have reasons to increase rather than decrease fertilizer usage over baseline levels, and this is not captured in the framework, as is indicated in Chapter III of this report. Further, the framework allows for the calculation in some cases of a level of nutrient reduction that exceeds the amount of controllable nutrients.

The individual best management practice percent reductions that are being used in the calculations in Virginia and in other Bay states, as well as the cumulative results of those calculations, need to be systematically and skeptically reviewed. Over time, best management practices have been added, and assumed reduction percentages have changed to some extent, and State actors invested in achieving the reduction goal have had a major role in these changes. As of early December 1996, another revision to these efficiencies had been underway and was to be released soon. However, it was not yet publicly known if the revision would introduce more caution in reduction assumptions.

Potomac Strategy Does Not Address the Goal of Maintaining Reductions Once Achieved

The Commonwealth's strategy does not address the issue of maintaining a 40 percent reduction (which is referred to as maintaining a nutrient cap). A November 1996 report of the Secretary states that at this point, "the resolution of issues associated with reaching the 40% goal itself is so critical that the next major step beyond must wait its turn for a detailed examination."

However, maintaining achieved reductions is likely to be an even more difficult goal than initially obtaining a 40 percent reduction. An analysis of the strategy (again accepted at face value and assumed to be fully implemented) indicates that a peak nitrogen reduction of about 37 percent could erode to 21 percent by the year 2015, and a peak phosphorus reduction of 38 percent could erode to 32 percent by the year 2015. These findings are based on extending sewage treatment plant flow projections. The findings indicate that not long after the year 2000, Virginia may be faced with projections indicating more growth in plant flows, and it may have just completed a systematic, major, and fairly expensive upgrade across plants that is not sufficient to address the emerging problem. The State and local will to take further action on the heels of a major undertaking is questionable.

Thus, it appears that it would be a mistake for policymakers who wish to see Virginia reach and maintain a 40 percent reduction to view looking beyond the year 2000 as a discrete step to be considered later. Decisions made now about long-term capital investments (such as point source upgrades) will have an impact on how much progress is made, and how much progress may be eroded, for some time to come. If there is a strong desire to reach and maintain the goal, then it may be necessary to give some consideration now to "limit of technology" approaches at some key point source plants.

Key Areas of Uncertainty Need to Be Considered in the Policymaking Process

In addition to the concerns with the nonpoint source calculation framework already discussed, there are a number of other areas of uncertainty that will need to be considered as part of the policymaking process. These areas of uncertainty include: the State's priorities, funding and leadership, including State agency attitudes and commitments to the goals; whether all localities in the Basin will support the strategy; what plants will be upgraded and to what concentration levels; point source flow projections; and the extent of land user commitments to achieve the nonpoint source reductions of the strategy.

The Timeframe for the Lower Tributary Strategies Is At Risk

In 1993, the Commonwealth committed to "implement an interim 40 percent reduction strategy" for the lower tributaries by 1997. The *Code of Virginia* requires strategies by January 1, 1998 for Virginia's tributary rivers other than the Potomac.

During the period since 1993, the executive branch decided on a phased approach to tributary strategy development in Virginia, with attention directed first to the Potomac. Hence, there have been four Potomac nutrient reduction papers since the beginning of 1993, but an initial 1993 paper on the lower tributaries has not been updated. Reasons given for the delay on the lower tributaries have included a lack of staffing, the benefits of the opportunity to learn from a prototype effort, and the desire for monitoring to determine the specific goal before commencing the effort. However, as a consequence, Virginia is in a poor position at this time to complete these strategies. A November 1996 report of the Secretary of Natural Resources now indicates that: "we have concluded that the strategies for those tributaries [the Rappahannock, York and James] cannot be completed in any acceptable fashion by that [statutory January 1, 1998] deadline...."

State leadership will be critical on nutrient reduction issues for the lower tributaries as well. As with the question of maintaining Potomac progress, natural resource leadership in the executive branch appears to have assigned a low priority to this point on the lower tributary effort, rather than to heighten resources or activity levels in order to make greater or more timely progress toward the State's commitments.

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I. Introduction

Under various Chesapeake Bay agreements, the District of Columbia, Maryland, Pennsylvania, and Virginia are committed to a number of goals related to improving the water quality of the Bay. One of these goals is to reduce the level of nutrients (nitrogen and phosphorus) entering the Bay by 40 percent by the year 2000 and to maintain at least that level of reduction thereafter. An initial component of the multi-state effort to meet this goal is the development by each state of "tributary strategies." These strategies are plans for achieving nutrient reductions for each of the tributaries, or major rivers, that feed into the Bay. A key purpose of these strategies is to indicate each state's approach to reducing the entry of nutrients into the Bay.

Exhibit 1 provides an overview of the evolution of the Bay nutrient reduction goals and Virginia's nutrient reduction effort. The extent of Virginia's progress toward the nutrient reduction goal and in developing tributary strategies was a subject of concern during the 1996 General Assembly session. Pursuant to this concern, the General Assembly required in the 1996 Appropriation Act that JLARC staff review Virginia's progress toward achieving its nutrient goals (see Appendix A).

Since the 1996 Session, several of Virginia's natural resource agencies — the Department of Environmental Quality (DEQ), the Department of Conservation and Recreation (DCR), and the Chesapeake Bay Local Assistance Department — have been working in conjunction with localities to develop a tributary strategy for the Potomac River Basin. This work has proceeded within four regions: the Southern Shenandoah, the Northern Shenandoah, Northern Virginia, and the Lower Potomac (Northern Neck). Initial regional assessments were produced in late August and September of 1996. A final comment draft, entitled *Commonwealth of Virginia: Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy*, was released on October 31, 1996, and a final strategy document dated December 1996 is now available.

The objective for the strategy effort was to produce a plan that would enable the State to meet the 40 percent reduction goal by the year 2000. However, as a practical matter, it is becoming increasingly clear that even if the provisions of this strategy are accepted as given, there is probably not sufficient time to achieve the reductions by the year 2000. Also, an analysis of the strategy, with the specific reductions again accepted as given, indicates that unless the rate of growth in sewage treatment plant flows or discharges is less than what has been projected, the strategy will not provide for a 40 percent reduction in the years shortly after 2000. Further, in the long-term, progress toward the 40 percent reduction goal will be eroded. The issue of maintaining the progress that is made is one that receives little attention in the strategy, but has the potential to be more costly and difficult than making the initial progress toward the goal. Additionally, this assessment of the strategy indicates that the level of reductions projected or claimed should not be accepted as given. Some of the reductions contained in the strategy appear to be based on some questionable or overly optimistic assumptions.

Exhibit 1

Timeline of Bay Goals and Virginia's Nutrient Reduction Effort

1983	Chesapeake Bay Agreement signed to address sources of pollutants to the Bay. Virginia program established to assist Division of Soil and Water Conservation in addressing nonpoint source pollution in the Chesapeake Bay Drainage Basin.
1987	Virginia General Assembly adopts phosphate detergent ban. 1987 Bay Agreement includes 40 percent nutrient reduction goal.
1988	Phosphate detergent ban effective (January 1).
1992	Amendments to Bay Agreement reaffirm reduction goal and call for tributary strategies.
1993	Virginia agencies produce nutrient reduction discussion papers for the Potomac and lower tributaries. Chesapeake Executive Council directive indicates Virginia's lower tributaries may have little impact on the Bay's nutrient problem, but sets interim goal for improving local conditions.
1994	Second Virginia Potomac nutrient reduction document (October).
1995	Third Virginia Potomac nutrient reduction document (August).
1996	Regional assessments conducted to develop nutrient reduction strategies (Southern Shenandoah, Northern Shenandoah, Northern Virginia, and the Lower Potomac). Sewage treatment plant association (VAMWA) makes nutrient reduction proposal. Final comment draft released on Virginia's strategy for nutrient reductions (October 31), followed by a final strategy document dated December 1996.
1997	Potomac strategy required by the *Code of Virginia* (by January 1).
1998	Strategies required for other tributary rivers (by January 1).
1999	Strategy required for coastal basins (January 1).
2000	The year that parties to the Agreement are committed to achieve a 40 percent reduction in controllable nitrogen and phosphorus.

Source: JLARC staff summary of key events.

This chapter discusses the nutrient reduction goals of the Chesapeake Bay Agreement, and then provides a background discussion of some of the important events that led up to the development of the 1996 Potomac strategy document. Finally, JLARC's review and the organization of the report are discussed.

NUTRIENT REDUCTION GOALS UNDER THE CHESAPEAKE BAY AGREEMENT

In 1983, Virginia, Maryland, Pennsylvania, the District of Columbia, the Environmental Protection Agency (EPA), and the Chesapeake Bay Commission formally agreed to undertake a cooperative effort to restore and protect the Chesapeake Bay. One of the cornerstones of this effort began with the Bay Agreement of 1987, which provided that the parties would "begin implementation of a basin-wide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the main stem of the Chesapeake Bay." In the 1992 amendments to the Bay Agreement, the commitment of the parties to the 40 percent reduction goal was affirmed, and a commitment was added to "maintain at least this level of reduction thereafter."

Nutrients are elements or compounds that are essential as raw materials for organism growth and development. Nitrogen and phosphorus are two major nutrients that are naturally present to some extent in soils and in bodies of water. However, in excessive amounts they can lead to algal blooms and low levels of dissolved oxygen which have a negative impact on the ecology of the Bay and its tributaries. Human activity contributes added nutrients from both point sources and nonpoint sources. (Point pollutants are discharges from specific conveyances, such as pipes, while nonpoint pollutants include fertilizers and other substances that are set in motion by rainfall or snowmelt moving over and through the ground). Amendments to the Bay Agreement in 1992 required the participants "to develop and begin implementation of tributary-specific strategies by August 1993," which in part were to be designed to "meet the mainstem nutrient reduction goals."

An important point to emphasize is that progress toward a 40 percent reduction is measured against baseline year nutrient loads from 1985 as calculated by Bay models. A portion of the total nutrient load to the tributary rivers and the Bay is considered controllable, and a portion is considered uncontrollable. Uncontrollable loads are basically the natural background loads that would occur even if the land use in the region was 100 percent undisturbed forest land. Controllable loads are the loads that stem from human activity. The 40 percent reduction goal applies against the loads that are controllable. Thus, the achievement of the 40 percent reduction goal does not mean that total nutrient loads received by the Bay have been reduced by 40 percent, but rather that the portion due to human activity has been reduced by that percentage. A 40 percent reduction in controllable nutrients produces about a 20 percent reduction in the overall nitrogen load, and about a 33 percent reduction in the overall phosphorus load.

From the time of the 1992 Bay Agreement amendments, Virginia's primary focus with regard to reducing the entry of nutrients to the Bay and achieving a 40 percent reduction goal has been on the Potomac River. DEQ's 1993 discussion paper on the Potomac River Basin stated:

> For the Potomac, these excess nutrients have already been shown to have a damaging effect on the Bay as a whole. Consequently, the states that share the Potomac are developing strategies to reduce nutrients by forty percent, an amount that scientific modeling had shown will improve Bay water conditions.

Virginia has several other tributaries to the Bay, and these tributaries have not been ignored in Bay agreements. For example, a directive of the Chesapeake Executive Council, signed in late 1993, stated that by 1997 "Virginia will implement an interim 40 percent reduction strategy" in its lower tributaries. However, studies indicate that these tributaries do not contribute a great deal to the problems of the Bay that are nutrient-related. This finding, coupled with the fact that an appropriate reduction goal for these tributaries has not been determined, has meant that the nutrient reduction issue for the lower tributaries has received less focus from the State to this point.

TRIBUTARY NUTRIENT REDUCTION STRATEGIES

The 1992 amendments to the Chesapeake Bay Agreement required the signatories to develop strategies for the tributary rivers of the Bay. The agreement indicated that the water quality goal needed to be amended to "reflect the critical importance of the tributaries in the ultimate restoration of the Chesapeake Bay." The parties to the agreement were to "develop and begin implementation of tributary-specific strategies by August 1993." A major function of the strategies was to provide a plan for meeting the mainstem nutrient reduction goals.

In the spring and summer of 1993, the newly-formed DEQ in Virginia released two discussion papers on reducing nutrients, one for the Potomac and one for the lower tributaries. The first page of the introduction to both of these papers stated:

> As part of the multi-state Bay cleanup, we are developing strategies for each of the tributary rivers that flow into the Chesapeake Bay to reduce the pollution caused by excess nutrients. Public involvement is an essential ingredient in that process. We want all interested citizens to be aware of these efforts. And, we invite you to share your ideas and concerns by participating.

Six public meetings were held in May and June of 1993 on the tributary strategy effort. In addition, pertaining to the Potomac paper, three more public meetings were held in late August and early September of 1993. The Potomac paper was distributed to more than 850 people. DEQ has noted that in addition to the three public meetings on the Potomac paper, "tributary issues and characterizations were also presented at meetings of professional and civic organizations and various interest groups."

DEQ's April 1994 305(b) report to the EPA and Congress, *Virginia Water Quality Assessment for 1994*, summarized the tributary strategy process to that point and gave the following timeframe for completion of a final Potomac strategy:

> A series of public meetings were held around the state to get input and comments on the developing strategies, with plans to have a final strategy for Virginia's portion of the Potomac by mid-1994....

However, this timetable was not realized. With a change in administrations in Virginia, concerns were raised that the nutrient reduction goals had been set, and the effort had proceeded, without sufficient local knowledge, involvement, initiative, and input. The 1996 biennial report of the Secretary of Natural Resources to the General Assembly stated this perspective as follows:

> Prior to 1994, commitments were made by Virginia state government officials to achieve certain goals regarding the Bay and its tributaries, but the very citizens most directly affected by these commitments — and who pay the bills for implementing strategies to achieve these commitments — were left out of the decision-making process. Consequently, locally elected officials were often times surprised and shocked to learn in 1994 and 1995 about the tributary strategies mandated by the Chesapeake Bay Executive Council and Virginia state government and the state's commitment to reduce nutrients by 40 percent by the year 2000.... Localities now must be included in all future goal setting and implementation strategies related to the resources of the Chesapeake Bay. Such increased involvement by the citizens of the Commonwealth may affect the timetable for development of specific strategies, but increases the likelihood that these locally developed strategies will be implemented successfully.

Thus, a second discussion paper was produced in October 1994, and six more public meetings were held that month in the Potomac River basin to inform citizens about the effort and obtain input. Further, DEQ, DCR, and CBLAD staff and the Secretary of Natural Resources held meetings with local officials and representatives of interest groups throughout the Potomac River basin during March and April of 1995. A third Potomac paper was produced in August 1995 to provide "a menu of best management practices and local program options for use by local governments in the development of their own strategies."

As the Secretary of Natural Resources indicated, the decision to expand local involvement did have an impact on Virginia's timeframe. By January 1996, Virginia was alone among the parties to the Bay agreement in not having a strategy paper containing specific choices about how to pursue the goal. In the absence of specific choices about how to expand existing efforts, progress was made by continuing with existing nutrient reduction programs during the development process.

In the other Bay jurisdictions, Maryland had ten watershed plans for its four tributaries indicating that the 40 percent goal could be achieved, and the State had begun to pay half the costs for sewage treatment upgrades. Pennsylvania had a tributary strategy with which it anticipated achieving 91 percent of its nitrogen reduction goal and 94 percent of its phosphorus reduction goal, and the strategy outlined several options to potentially address the nutrient reduction shortfall. The District of Columbia had a strategy which anticipated achieving more than a 40 percent reduction in its controllable nitrogen load. However, for phosphorus, where its baseline loads under the model were already minimal, the District anticipated falling below its goal.

As a consequence of Virginia's slow progress in tributary strategy development, a bill was introduced in the 1996 General Assembly Session to require the State to meet a prescribed schedule for tributary strategy planning. This bill was House Bill 1411.

HOUSE BILL 1411 FROM THE 1996 SESSION AND ENSUING PROGRESS

During the 1996 General Assembly Session, there was discussion that the State had missed three deadlines for the production of a Potomac plan, and that Virginia was alone among Bay participants in not producing a final plan. The General Assembly passed House Bill 1411 in 1996 to require that tributary planning meet a specified schedule: January 1, 1997 for the Potomac, January 1, 1998 for the other tributary rivers, and January 1, 1999 for the coastal basins.

As of the beginning of 1997, the tributary strategy processes other than the Potomac (those which are due at later dates under House Bill 1411) are in fairly early stages of development. However, the natural resources agencies involved in the tributary strategy process made a significant effort in 1996 to produce a Potomac strategy paper that would be ready for the 1997 Session. In Virginia's 1995 strategy paper, the four previously-mentioned regions of the Potomac were identified. Team leaders from State natural resource agencies were designated in 1996 for each of these four regions, and organizing meetings were held in the spring. The State team leaders worked with local staffs to assess the mix of nonpoint source best management practices (BMPs) and point source actions that might be applied to achieve 40 percent reductions.

Draft strategies were produced and released in late August and September of 1996. Local governments were asked for their support of the proposed strategy for their locality. During October, State staff worked to produce a compiled Potomac tributary strategy document. A final comment draft and a set of appendices was released to the public on October 31, 1996, and a final strategy document dated December 1996 was then produced.

JLARC REVIEW OF NUTRIENT REDUCTION PROGRESS

The mandate for this review requires an assessment of the Commonwealth's progress toward meeting its nutrient reduction commitments under Chesapeake Bay agreements. JLARC staff identified several issues and conducted a number of research activities in order to meet the study mandate.

Study Scope

This study focuses on issues pertaining to the Commonwealth's progress in meeting its nutrient reduction commitments. The report focuses on where the State stands relative to the commitments that were made and what it may need to do in order to meet its commitments. The mandate did not require an examination of the appropriateness of the commitments that were made, which is fundamentally a policy question. Therefore, the nutrient reduction commitment to achieve and maintain a 40 percent reduction was taken as a given and as the baseline against which progress should be measured. Also, an examination of the costs of various nutrient reduction strategies was generally beyond the scope of the review.

To meet the mandate, the following issues were identified:

(1) In order to enable Virginia to meet its nutrient reduction commitment and then at least maintain that level of nutrient reduction, what are the key issues that a Virginia Potomac nutrient reduction strategy must address?

(2) Is the Commonwealth's Potomac strategy, in its current form, likely to achieve a 40 percent reduction by the year 2000 and maintain the reduction thereafter?

(3) Is the Potomac nutrient reduction strategy realistic, and does it provide realistic projected reductions that meet the goal?

(4) What is known about nutrient reduction progress in Virginia's lower tributaries to the Bay (the James, the Rappahannock, the York, the Eastern Shore, and the Western Shore)?

Research Activities

Several research activities were conducted in JLARC's review of Virginia's progress in achieving nutrient reductions pursuant to Chesapeake Bay goals. These activities included: document and data reviews; interviews; permit file reviews; and meetings with Potomac Basin county administrators or city managers and their designees about local nutrient reduction efforts.

Document and Data Reviews. JLARC staff reviewed a number of key documents produced by DEQ and DCR, including the 1993 Potomac and Lower Tributary nutrient reduction papers, the 1994 and 1995 Potomac papers, written public participation comments upon DEQ's 1995 Potomac paper, the draft strategy assessment papers of 1996, and the October 1996 final comment draft and appendixes for the Potomac strategy. Several of the spreadsheets used by DCR to calculate nonpoint source reductions were reviewed, as well as spreadsheets created to examine the impact of alternative point source technologies or approaches. Key changes in the reductions shown in the strategy between the October final comment draft and the December 1996 strategy document were also noted.

Virginia Department of Agriculture reports on fertilizer usage were also reviewed for the period from FY 1985 to FY 1995. Some material on shoreline erosion protection issues was requested from the Virginia Institute of Marine Science (VIMS) and was reviewed.

A number of additional technical reports and studies about nutrient reduction issues were reviewed, as well as tributary strategy documents that have been produced by the other Bay Agreement participants. JLARC staff also reviewed the *Virginia Register of Regulations* for the appearance of proposed or final regulations that may impact the State's nutrient reduction effort.

Interviews. JLARC staff conducted several interviews at DEQ and DCR with individuals who are working on nutrient reduction issues relative to Virginia's Chesapeake Bay commitments. An interview was also conducted with the director of CBLAD, who at that time was also serving as the new director of DCR.

In addition, interviews were conducted of staff within the EPA Chesapeake Bay Program, including scientific and modeling experts. JLARC staff also interviewed the Secretary of Natural Resources about the progress that is expected through the direction the State is pursuing, and what the outlook is with regard to the State's role in funding.

Permit File Reviews. Certain information that was needed for this review was obtained by JLARC staff working on the concurrent study of DEQ. Specifically, for the DEQ study, JLARC staff reviewed DEQ permit files in the regional offices. As part of this fieldwork, JLARC staff collected information on how recently permits have been reissued for the Potomac point sources captured in the Bay nutrient model, and noted whether there was any correspondence or discussion about nutrient reduction issues in the files.

Attendance at Meetings With Local Representatives in the Potomac Basin. JLARC staff attended the four meetings that were held to consider the regional assessment drafts in the Lower Potomac, the Northern Shenandoah, the Southern Shenandoah, and Northern Virginia. In addition, JLARC staff met with and discussed specific questions about nutrient reduction activities with designated locality and/or sewage treatment plant staff in four Northern Virginia localities (Arlington, Alexandria, Fairfax, and Prince William).

REPORT ORGANIZATION

This report examines Virginia's estimated and projected progress in achieving nutrient reductions, especially focusing on the State's Potomac strategy. Chapter I has provided an introduction to Virginia's nutrient reduction goals under the Chesapeake Bay Agreement, and described the nutrient loads of the watershed and of the jurisdictions that are parties to the Bay agreement, Virginia's Tributary Strategy process and papers, and legislation requiring a specific schedule for completing the tributary strategy process in Virginia. In addition, the chapter discussed the JLARC study mandate, scope, and research activities.

Because the focus of Virginia's effort to protect the Bay from excess nutrients is on the Potomac, and because little current information on progress in the lower tributaries is available at this time, Chapters II and III of this report focus on the Potomac Basin and the State's strategy. Chapter II provides an assessment of the performance of the Commonwealth's strategy for the Potomac relative to the 40 percent reduction goal. This assessment accepts the reductions of the plan as given and assumes full implementation of the plan. Chapter III then addresses the particular provisions of the strategy for point and nonpoint source nutrients respectively, and considers whether the provisions are realistic. The last chapter draws some summary conclusions about Virginia's progress in the Potomac, and what may be required to meet and maintain the 40 percent nutrient reduction goal. It also briefly summarizes the current status of nutrient reduction strategy development for the lower tributaries.

II. Projected Performance of the State's Potomac Strategy Assuming Full Implementation

In October 1996, a final comment draft was released on the State's tributary nutrient reduction strategy for the Shenandoah and Potomac River Basins. This draft was prepared by the Virginia Secretary of Natural Resources, the Virginia Chesapeake Bay Local Assistance Department, the Virginia Department of Conservation and Recreation, and the Virginia Department of Environmental Quality. The analysis contained in this chapter was performed during the fall of 1996, and this analysis and discussion is based on the October 1996 draft strategy. With the exception of the calculations for one sewage treatment plant, the numbers contained in the December 1996 strategy document did not change greatly from the October comment draft.

The draft strategy was the culmination of a process that moved forward throughout 1996 in response to House Bill 1411. The effort was organized into four discrete regional efforts, involving local actors in the development of individual strategies for the Southern Shenandoah, the Northern Shenandoah, Northern Virginia, and the Lower Potomac (Northern Neck).

The draft strategy contained a regional assessment and a recommended basin strategy:

- The "Regional Assessment" — This was a compilation of the recommendations from the four assessment processes that were conducted in the regions. The final comment draft states that this recommendation would achieve a 36 percent reduction in nitrogen and phosphorus by the year 2000.

- A Recommended Basin Strategy — The document indicated that this is the State's strategy recommendation. It included some additional options to close the gap from the regional assessments, including the upgrade of several sewage treatment plants (STPs) in the basin, above and beyond those plants identified for upgrade in the regional assessments. According to the document, the recommendation achieves a 40 percent reduction in nitrogen and phosphorus.

This chapter provides an independent assessment of the projected performance of the draft strategy, focusing on the recommended basin strategy that purportedly accomplishes a 40 percent reduction. Projected performance is assessed in terms of whether the 40 percent reduction goal is achieved and maintained if the strategy's reductions are accepted as given and if full implementation is assumed. Chapter III of the report then examines issues regarding the feasibility or appropriateness of the strategy's current content, for both point and nonpoint sources.

The major finding of this performance assessment is that full implementation of the strategy, even if possible, is unlikely to achieve a 40 percent reduction in the year

2000. Further, unless the rate of growth in sewage treatment plant flows after the year 2000 decreases substantially from the rate that has been reflected in DEQ's figures for the period from 1985 to the year 2000, then the progress that would be made through the strategy is likely to erode over time, as has been the case with some previous progress Virginia made on point source phosphorus through the phosphate detergent ban.

ASSUMPTIONS USED IN PROJECTING PROGRESS

To assess the performance of the strategy, there is a need to identify the goals against which the strategy should be compared, determine the assumptions to be applied in making projections, determine whether any additional scenarios would be useful for comparative purposes, and calculate the results for the strategy and other scenarios based on the selected assumptions. This section discusses the assumptions made about the goals and the factors to be considered in making the projections.

The Bay goals are to reach a 40 percent reduction and maintain it thereafter. The State's commitment is described as follows in the draft strategy:

> The difference between the 40% goal and the actual reductions...yields an annual "nutrient loading gap," that will need to be closed.... Closing this gap is the task of Virginia's Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy. Once the 40% nutrient reduction goal is achieved, it will be important to maintain the annual "nutrient cap" while still accommodating growth and development in the Potomac Basin.... Thus, as growth occurs, programs must be in place that ensure that nutrient loads do not increase beyond the cap level.

JLARC staff conducted an analysis to assess what full implementation of the strategy might accomplish relative to these Bay commitments.

In projecting the performance of the strategy, assumptions must be made about the time frame for the implementation of the strategy. For nonpoint sources, the timeframe assumption used in the analysis was that the reductions called for in the strategy would be achieved by the year 2000. For point sources, the timeframe assumption was taken from the strategy document. The document states:

> Due to construction schedules for major wastewater treatment plant projects, the time needed to put into place all of the Strategy's recommended nutrient controls is anticipated to range from five to nine years.

Therefore, in the analysis, the midpoint (seven years) was assumed as the timeframe for full implementation, or the year 2003. In the years 2000, 2001, and 2002, the following percentages were used to estimate the proportion of flow of sewage treatment plants that would have come under the strategy: 57.1 percent, 71.4 percent, and 85.7 percent, respectively. These percentages were obtained based on dividing the number of years that would have passed (four, five, and six years) into the seven-year total timeframe.

In making the projections, an assumption must also be made about the extent of growth and development that needs to be accommodated. The primary impact of this growth is in terms of nutrient loads from sewage treatment plants. Therefore, an average annual rate of growth factor for sewage treatment plants was needed. The average annual growth rate assumed in making the projections for these plants after the year 2000 was the average rate of growth in plant discharge flow levels for the period from 1985 to 2000, or 3.5 percent. DEQ staff believe that the year 2000 flow projection may be high. If that proves to be the case, there may be more of a "cushion" in the timeframes than results from the most recent projections that were available at the time of the analysis and that were used at that time by DEQ. For this analysis, flows from industrial plants were assumed to remain at the levels in the most recently available information, as has been done by DEQ staff.

SCENARIOS INCLUDED IN THE PROGRESS PROJECTIONS

In the analysis, projected loads for the Commonwealth's recommended basin strategy were compared against the 1985 baseline loads and the 40 percent reduction goal for both nitrogen and phosphorus. An assessment was made of the loads that are projected (under the stated assumptions) from 2000 to 2015.

In addition, to provide some context for the data on the projected performance of the strategy, projections for two other scenarios were made and displayed. Specifically, the first of these scenarios is the amount of the nutrient load that would be expected without the implementation of a new strategy ("expected current efforts"). It is essentially DEQ and DCR's projection of what current and already planned State programs can accomplish by the first year shown, the year 2000. The potential impact of sewage treatment plant flow growth past the year 2000 is calculated for this scenario. Because additional reductions beyond the year 2000 have not been estimated by DEQ and DCR, a maintenance of year 2000 effort, rather than further reduction activities beyond the year 2000, is assumed in the calculation for the scenario at this time.

The second of these scenarios is the projected load amount that might be achieved by applying the limits of technology (LOT) to point sources, coupled with the State strategy's nonpoint source reductions to the year 2000. LOT is used here to refer to point source control technologies that have extremely high reduction capabilities.

The "expected current effort" and LOT provide a general range within which strategy results are likely to fall. The results or performance of the strategy should be better than that obtained from projecting "expected current effort", because the latter category refers to what is achieved from "business as usual." Unless it relied on LOT, however, the strategy would not be expected to perform as well as LOT because LOT provides for especially high levels of nutrient removal.

PEAK NITROGEN REDUCTIONS OF 37 PERCENT COULD ERODE TO 21 PERCENT BY 2015

An assessment of the performance of the strategy was conducted for both nitrogen and phosphorus. This section addresses the findings for nitrogen.

The last year for which the 1996 strategy document provides an estimate (rather than a projection) of nutrient reductions from the 1985 baseline is 1994. For 1994 nitrogen, the data in the strategy estimates that total annual loads were 18,555,000 pounds, or a reduction from the 1985 baseline of about 9 percent. The data used in the strategy indicate that point source nitrogen was actually up over 1985 levels, but due to claimed reductions from nonpoint sources, in aggregate nitrogen reductions were being achieved. Water quality data for the period from 1978 to 1993 indicate that nitrogen concentrations at the Potomac fall line increased and then leveled off since the mid-1980s. DCR and DEQ have noted that "reductions of nitrate due to nonpoint sources can take several years to become apparent because of the slow transportation rate of groundwater to streams."

From 1994 to the year 2000, DCR and DEQ project that expected current efforts will roughly maintain the overall nitrogen progress that they estimate has been made. The strategy projection is that under expected current efforts, the year 2000 nitrogen load will be about 18,584,000 pounds per year.

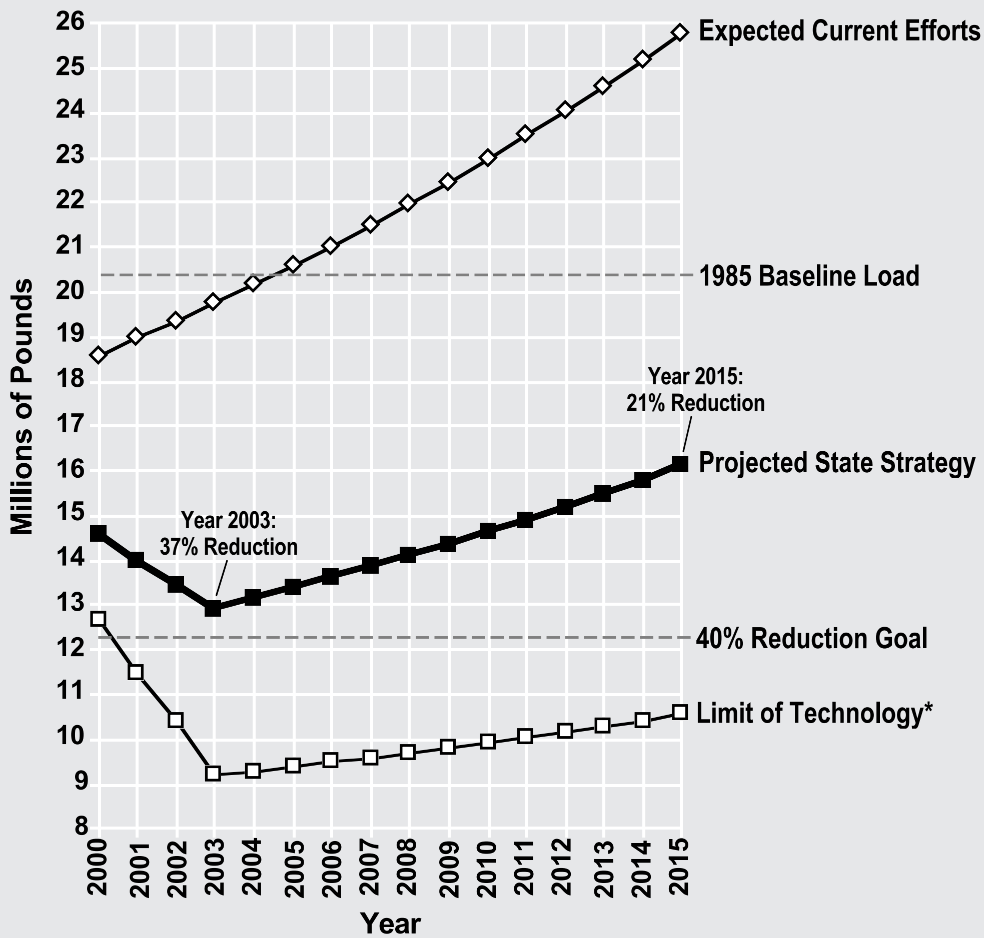
Figure 1 examines nitrogen loads based on the previously-discussed scenarios. The graphic starts at the year 2000. Therefore, the uppermost trend line, or the loads based on expected current efforts, begins at the 18,584,000 pounds per year that DCR and DEQ project for the year 2000 (about nine percent below the 1985 baseline load).

The figure illustrates the importance of growth in sewage treatment plant flows with regard to model outcomes. The trend line reflecting expected current efforts shows the impact if no new strategy or strategies are pursued, and "progress" consists only of what DEQ and DCR project will be achieved through current or already-planned programs to the year 2000. If no further progress is made, then based on sewage treatment plant growth, by about the year 2005, Virginia's nitrogen load would be at about the 1985 baseline load level, or zero progress. From there, sewage treatment plant growth would increase nitrogen loads substantially above 1985 levels.

The lowermost trend line shows what is projected if LOT point source controls were put in place, coupled with the projected State strategy for nonpoint sources. As indicated, if LOT were installed by the end of the year 2000 on plants that generate four-

Figure 1

Nitrogen Comparison: Reduction Goals, Expected Current Efforts, Projected State Strategy, and Limits of Technology



*Reductions from point source Limit of Technology plus the strategy's recommended nonpoint source reductions.

Source: JLARC staff analysis based on Potomac tributary strategy data provided by DCR.

sevenths of the sewage flow, then this would generate approximately a 40 percent reduction. When full implementation is assumed, in 2003, LOT lowers the amount even more substantially. Growth calculated upon this lower base is fairly slow, and LOT is therefore projected to continue to be below (that is, surpass) the level of a 40 percent reduction through the year 2015, as is shown in the figure.

The trend line shown in the figure that is between expected current efforts and LOT is the projection for the Commonwealth's recommended basin strategy. The Commonwealth's final comment draft displays a 40 percent reduction result for the strategy, but does not attach a year to that result. However, if the assumption from the body of the report is applied (that full implementation is not likely to occur by the year 2000), and if the previously-discussed assumptions about sewage treatment plant flows are applied, then a different result is obtained. The best single year for the strategy under these assumptions is projected as the year 2003, when a 37 percent reduction is projected.

In contrast to this analysis, the strategy document does not seek to address the impact of growth after the year 2000 upon strategy reductions, nor does the strategy contain a program or response to address that growth. The strategy therefore does not address an important part of the Bay nutrient reduction goal. The strategy indicates that "as growth occurs, programs must be in place that ensure that nutrient loads do not increase beyond the cap level", but the strategy does not provide such programs.

This limitation is particularly important for nitrogen, because point source nitrogen loads exceed nonpoint source loads, and point sources are where most of the growth is. There is a large component of the total nitrogen load that is driven by increases in sewage treatment plant growth. Based on the projection of nitrogen using a 3.5 percent growth factor after the year 2000, nitrogen reductions under the strategy could fall from a high of 37 percent to 21 percent, even if the strategy is fully implemented.

PEAK PHOSPHORUS REDUCTIONS OF 38 PERCENT COULD ERODE TO 32 PERCENT BY 2015

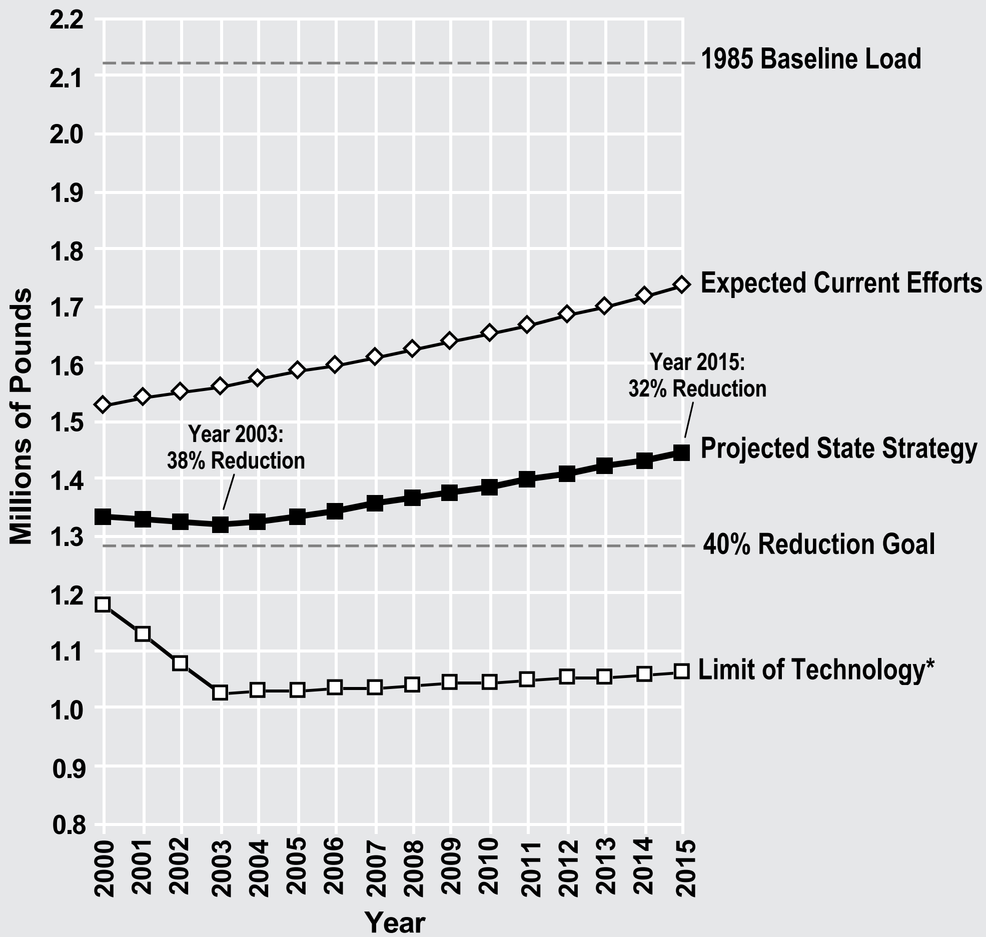
This section addresses the findings of the assessment for phosphorus. As with nitrogen, the last year for which the 1996 strategy provides an estimate (rather than a projection) of phosphorus reductions is 1994. For 1994 phosphorus, the data in the strategy indicate that total annual loads were 1,562,000 pounds, or a reduction of about 27 percent from the baseline load. Much of this estimated progress is from point sources, which are estimated to have been reduced by about 41 percent since 1985, in large measure due to the phosphate detergent ban adopted by the 1987 General Assembly. Water quality data for the period from 1978 to 1993 also indicate that phosphorus concentrations initially increased, then leveled off in 1984 and declined after the phosphate detergent ban.

From 1994 to the year 2000, DCR and DEQ projected that expected current efforts will roughly maintain the overall phosphorus progress they estimate has been made to 1994. Thus, the strategy projection is that under current efforts, the year 2000 phosphorus load will be about 1,528,000 pounds per year.

Figure 2 shows the results for phosphorus from the same type of projection that was shown earlier for nitrogen. The graphic also starts at the year 2000. Therefore, the uppermost trend line, or the loads based on expected current efforts, begins at the 1,528,000 pounds per year that DCR and DEQ project for the year 2000 (about a 28 percent reduction).

Figure 2

Phosphorus Comparison: Reduction Goals, Expected Current Efforts, Projected State Strategy, and Limits of Technology



*Reductions from point source Limit of Technology plus the strategy's recommended nonpoint source reductions.

Source: JLARC staff analysis based on Potomac tributary strategy data provided by DCR.

Again, given growth in sewage treatment plant flows and a lack of concrete proposals in the State's strategy for implementation after the year 2000, there is a concern that the progress under the strategy will be eroded, although not as much as for nitrogen. Specifically, under the assumptions applied, the peak level of phosphorus reduction occurs in 2003, at about 38 percent. The level of reduction could fall to 32 percent by the year 2015.

Compared to nitrogen, the percentage reduction for phosphorus does not fall as much over time in the projections, for two reasons. First, a higher proportion of the phosphorus loads of the Potomac are from nonpoint rather than point sources. Second, within the point source category, a substantial proportion of the load (almost one-quarter) is from industrial dischargers for which no flow increase is assumed. Therefore, phosphorus load amounts in Virginia's portion of the Potomac are less affected than nitrogen load amounts by increases in sewage treatment plant flows.

CONCLUSION

The assessment contained in this chapter indicates that it is unlikely that the 40 percent reduction goal can be achieved by the year 2000. In addition, the strategy does not substantially address the issue of what needs to happen after the year 2000 to meet the 40 percent reduction goal in light of likely increases due to growth, such as increases in sewage treatment plant flows.

The Secretary of Natural Resources has indicated in the *First Annual Report on the Development and Implementation of Nutrient Reduction Strategies For Virginia's Tributaries to the Chesapeake Bay* (November, 1996) that:

> ... it is not realistic to expect that the 40% nutrient reduction goal in the Potomac strategy can be achieved by the year 2000.... The draft Shenandoah-Potomac nutrient reduction strategy does not in any direct way address the task of maintaining a cap. At this point in the process the resolution of issues associated with reaching the 40% goal itself is so critical that the next major step beyond must wait its turn for a detailed examination.

However, it appears that it would be a mistake for policymakers wishing to see Virginia reach the 40 percent goal to view looking beyond the year 2000 as a discrete step that needs to be considered later. Decisions made now that relate to long-term capital investments (such as point source upgrades) will have an impact on how much progress is made, and how much progress may be eroded, for some time to come. If these decisions are made independently of what may be required after the year 2000, and if policymakers still desire to reach the goal, then too little investment may be made. The findings in this chapter suggest that if there is a strong desire to reach the goal, it may be necessary to give some consideration to limit of technology approaches at some key point source facilities.

Recommendation (1). **For the 1997 Session, the Secretary of Natural Resources and Virginia natural resource agencies should outline the costs and reductions for a limit of technology point source option in a supplemental memorandum to the strategy for the House Appropriations and Senate Finance Committees, in order to facilitate a discussion of that option as part of the policymaking process.**

Recommendation (2). **The General Assembly may wish to request that the Secretary of Natural Resources and Virginia natural resource agency staff**

provide a report to the 1998 Session assessing the operational feasibility of a limit of technology approach for some key plants.

Recommendation (3). **The General Assembly may wish to consider a resolution to request that the Chesapeake Executive Council include issues associated with maintaining reduction progress after the year 2000 in its 1997 Reevaluation of the Tributary Strategies Program.**

III. Appropriateness of the Strategy's Point and Nonpoint Source Reductions

As indicated in Chapter II, the Commonwealth's Potomac strategy is projected to yield some nutrient reduction progress. However, it is not likely to be adequate to meet and especially to maintain a 40 percent reduction. In addition, another question that must be examined is whether the strategy is fully appropriate, such that full implementation can be reasonably expected.

The concerns identified in this chapter first stemmed from an analysis of the October 1996 final comment draft strategy, but also apply to the December 1996 strategy document. Several issues are raised pertaining to the appropriateness and practicality of some of the reductions projected by the strategy, and these issues were not successfully addressed by the natural resource agencies within the timeframe of the strategy document dated December 1996. In fact, for two of the issues raised (the Upper Occoquan Sewage Authority reductions and shoreline erosion protection reductions in the Lower Potomac), changes were made from the draft strategy to the final strategy that heighten the level of concern as to whether the magnitude of the reductions projected are credible.

For sewage treatment plants, or the bulk of the point source component, the strategy reduction numbers are mostly based on an assumption of a nitrogen concentration level of about 7 milligrams per liter. A pivotal issue is whether future upgrades to reduce nutrients from the plants will be designed to achieve this concentration level or less. There is a proposal of municipal wastewater treatment agencies in Virginia that is supported by many of the local governments with key sewage treatment plants. This proposal endorses the use of a nutrient reduction system that DEQ has historically estimated to achieve a much higher nitrogen concentration level than 7 milligrams per liter (at 12 milligrams per liter) — that is, a much lesser level of reduction. However, the strategy document does not engage this discrepancy in assumption, but rather blurs it, stating that the intention behind the alternative proposal is to produce a nitrogen concentration level of eight milligrams per liter and that this level should become the target level for the strategy. If the upgrades at the plants are not designed or do not prove to be as effective as the nitrogen removal assumed in the strategy, then the State could fall very short of its goal for reducing nitrogen loads from Virginia's portion of the Potomac.

For the nonpoint source component, there are a number of instances in which questionable or overly optimistic assumptions are built into the reductions calculated by the strategy. Some of these problems may stem from assumptions made by DCR in conjunction with other Bay Agreement participants. Still, the nonpoint source strategy is a compilation of reductions that results from a focused effort by State and local staffs to identify reduction possibilities. This compilation, however, is applied within a framework that does not appear to be adequately calibrated to produce credible results when these numerous reduction possibilities are applied.

The resulting strategy document appears to understate the obstacles that will exist in reaching the stated degree of success. The more time that passes before the point source situation is clarified, and before a more realistic screening of some of the nonpoint source reduction amounts is performed, the less time that is available to determine if there are any suitable alternatives to replace potentially impractical or questionable elements of the strategy.

POINT SOURCE SUCCESS APPEARS MORE DIFFICULT THAN INDICATED IN THE STRATEGY

There are two projections of point source reductions by the year 2000 contained in the Potomac strategy. The first projection is for the reductions that were developed through the regional assessment process. This process involved local "actors" working with State team leaders. The December strategy document indicates that the overall reductions (for point and nonpoint source loads) from the regional process are 37 percent for nitrogen and 36 percent for phosphorus. The reductions expected from the point source component are about the same for nitrogen but somewhat less for phosphorus than the overall reductions expected (see Table 1). However, when what the strategy document designates as "additional potential strategy reductions" are considered, the greater use of point source upgrades suggests that reductions at or just over 40 percent overall (point and nonpoint) can be achieved. Under this scenario, somewhat greater reductions than 40 percent are achieved from the point source component.

Three issues regarding the point source component of the strategy are addressed in this portion of the chapter. First, the strategy is ambiguous about the impact

Table 1

Point Source Reductions Expected Under Strategy Scenarios

Strategy Scenario	Point Source Nitrogen Reduction Expected	Point Source Phosphorus Reduction Expected
Regional Assessment (36 to 37 Percent Reduction Overall)	37%	30%
With Additional Potential Strategy Reductions (40 to 41 Percent Overall Reduction)	44%	42%

Source: *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy*, December 1996.

of a seasonal biological nutrient removal (BNR) approach to achieve sewage treatment reductions. Second, the strategy does not adequately explain the basis for its assumption that despite an approximate tripling of the wastewater flow expected, the nitrogen levels at the Upper Occoquan Sewage Authority (UOSA) plant will be less than in the 1985 baseline year. Third, and somewhat related in principle to the UOSA issue, the strategy documents have not made consistent assumptions as needed between the baseline year and future projections. Thus, any set of such figures produced by DEQ needs to be scrutinized on this issue.

The Appropriateness of Funding Seasonal Biological Nutrient Removal to Pursue a 40 Percent Reduction Is Left Unclear by the Strategy

The critical factors in point source nutrient reduction estimates and projections are point source "concentration" levels and "flow" levels. The first factor addresses nutrient levels in the discharge, while the second factor addresses the quantity of the discharge. There is a standard formula that DEQ applies, to multiply the concentration times the flow times a conversion factor times 365 days a year, to calculate the annual discharge load from each plant.

Continuing flow increases are anticipated at most of the sewage treatment plants in the Potomac Basin. Therefore, a critical issue for achieving nutrient reductions is lowering the nutrient concentration in plant discharges. If the State is to successfully pursue its strategy, then the sewage treatment plant upgrades will need to be designed and operated to achieve the lower concentration levels contemplated in the strategy. The problem is that as of December 1996, the State's strategy is ambiguous about the appropriateness of the type of nutrient removal system upgrade that is receiving support in some key localities as the preferred course of action.

Alternative Biological Nutrient Removal (BNR) Systems as a Method to Achieve Additional Nitrogen Reductions. BNR technology has been defined by DEQ as:

> ...a modified form of activated sludge wastewater treatment that enhances phosphorus and nitrogen removal by microbial cells instead of a traditional chemical addition system.... Increased phosphorus removal is accomplished by creating environmental conditions that encourage the biomass to accumulate increased quantities of phosphorus, which are then settled and removed in the waste sludge. Nitrogen removal occurs because nitrate-nitrogen contained in the recycle stream is converted to nitrogen gas in this process and released to the atmosphere.

Others have referred to BNR as a technology in which nutrient-eating microorganisms, or "tiny bugs" are fostered in basins on the plant site, and are given controlled access to the sewage in order to reduce these nutrients.

The technology is generally recognized as effective, but it is also somewhat costly (capital costs). Also, there is some uncertainty over the precise nutrient concentrations that will result. Effectiveness may vary from site to site, depending on the design of the system and other factors.

To estimate the reduction results of various scenarios, DEQ uses the figure of 12 milligrams per liter for what it calls seasonal BNR, 7 milligrams per liter for year-round BNR, and 3 milligrams per liter for limit of technology BNR. Limit of technology BNR involves the use of the deepest tanks or basins housing the microorganisms, and the most process stages (five versus three), in order to achieve a very low concentration level. Seasonal BNR is a three-stage process that involves lesser tankage and means a design for the achievement of reductions during the months that are most conducive to greater effectiveness on the part of microorganisms — that is from spring to fall, or when there is the warmer weather that the microorganisms thrive in. A plant can install a BNR system that is designed to achieve seasonal removal, but run the system year-round and possibly gain some additional reductions during the off-season months. This is known as seasonal BNR operated year-round. Year-round BNR as DEQ applies the term is a three-stage process where the system is both designed and operated to achieve microbial reductions throughout the year.

There are differences in costs associated with the two approaches:

> Seasonal nitrogen removal appears more cost effective than annual removal. Costs can significantly increase for annual removal...because at lower temperatures biological activity is reduced. Therefore, longer wastewater retention times are needed requiring larger reactor tank sizes, thereby increasing costs. [*Financial Cost Effectiveness of Point and Nonpoint Source Nutrient Reduction Technologies in the Chesapeake Bay Basin*, Interstate Commission on the Potomac River Basin, 1992]

Proposal of Virginia Association of Municipal Wastewater Agencies Assumes Seasonal BNR Operated Year-round. An association, the Virginia Association of Municipal Wastewater Agencies (VAMWA), has indicated support for greater use of BNR technology in Virginia, under certain conditions, in order to aid the Bay effort. The association's Nutrient Committee developed and distributed a proposal and sent it out for the consideration of its membership on July 26, 1996. The proposal stated that VAMWA would support the installation of BNR or equivalent technologies at public sewage treatment plants "with a design capacity of 0.5 MGD [million gallons per day] or greater discharging to the Potomac tributary," provided that certain issues "related to funding and implementation" are addressed. The proposal stated that this position "seeks to break the current deadlock in Virginia over point source nutrient control for the Potomac by proposing a partnership between the Commonwealth and local governments." VAMWA has indicated that its BNR proposal is for seasonal BNR operated year-round.

Upgrade Approach and Likely Nitrogen Concentrations that Result Will Need to Be Clearer Before the Extent of Progress Will Be Fully Clear. VAMWA has indicated that its seasonal BNR proposal is intended to achieve eight milligrams per liter. DEQ, however, has historically estimated that seasonal BNR operated year-round in the Potomac Basin will achieve about 12 milligrams per liter. Also, a director of a key treatment plant, in indicating support for seasonal versus year-round BNR, has expressed a belief that seasonal BNR operated year-round at that plant would achieve a nitrogen concentration of about 12 milligrams per liter.

> *The Director of the Alexandria Sewage Treatment Plant indicated in an interview with JLARC staff that year-round BNR at that facility would require "a massive capital investment." The director indicated that he believed that with seasonal BNR operated year-round, the facility could achieve a year-round average of 12 milligrams per liter (without BNR, the 1994 concentration figure for the plant was 22.71 milligrams per liter). The director believed that progress could be made through BNR at the plant, but did not support year-round BNR to the 7 milligrams per liter level at the facility.*

The Commonwealth's December 1996 strategy document states the following about the VAMWA proposal:

> [VAMWA] endorses the use of seasonal BNR with the intention of actually operating the system throughout the year to yield an annual average effluent target of 8 mg/l. This might lead to the conclusion that the VAMWA proposal would not achieve the 40% reduction goal. However, with updated flow information from some plant owners, and after examining the long term flow trends (1985-1995), it is apparent that the flow projections used during the Strategy development process were over-estimated. DEQ now estimates that the year 2000 flow projection should be in the range of about 230 to 260 MGD [million gallons per day]. Therefore, based upon these updated flow projections, 8 mg/l effluent nitrogen should be the initial target for implementing this Strategy.

There are two problems with this portion of the strategy document. First, the paragraph implies compatibility between the VAMWA proposal and the 40 percent reduction goal. The problem is that the text does not confront the key issue for assessing the compatibility — whether the intended yield of eight milligrams per liter from the seasonal BNR approach is likely to be realized, in the best judgement of those responsible for the strategy. On the same page of the strategy document containing the text quoted above, DEQ provides its estimate of the nitrogen effluent level expected from seasonal BNR, and that estimate is 12 milligrams per liter, not eight. If a program is undertaken that actually yields an average nitrogen concentration level of 12 milligrams per liter rather than eight, then Virginia will fall far short of its goal. When sewage treatment plant flow in the basin is at 230 million gallons per day (MGD), a basinwide average nitrogen concentration of eight milligrams per liter would produce a 44 percent reduction in the nitrogen loads from sewage treatment plants; at 260 MGD, an average eight milligrams per liter at the plants produces a 37 percent reduction. However, if the average nitrogen concentration is 12 milligrams per liter, only a 17 percent reduction is achieved at 230 MGD. With an average concentration of 12 milligrams, once the flow level reaches 260 MGD, the reduction falls to six percent.

Second, it is recognized by the developers of the strategy that the facility upgrades will not be completed by the year 2000, and that it is unlikely that Virginia will meet the 40 percent reduction by the year 2000. With this recognition, it should be clear that the year 2000 flow projection that is the focus of the strategy remarks is not the appropriate flow benchmark for determining what is required to achieve and maintain a 40 percent reduction. Even setting aside the issue of maintaining a 40 percent reduction, the critical question is what the flow projection is for the year by which the key sewage treatment plant upgrades will be completed.

Conclusion. A number of local governments, including some key local governments in Northern Virginia, have expressed support for the VAMWA proposal. There is currently some uncertainty as to whether year-round or seasonal BNR will be broadly pursued under the strategy at the plants, and there is also some uncertainty as to the nitrogen concentration levels that will therefore be achieved. If the approach pursued does not produce nitrogen concentration levels at the key plants of about 7 or 8 milligrams or less per liter, then the level of point source reduction shown in the strategy will be at risk and the State will have even greater difficulty achieving a 40 percent reduction.

Reduction from 1985 Baseline Nitrogen Load at UOSA Plant Is Not Adequately Explained and Appears Dubious

Another point source issue is what assumptions should be made about one of the major sewage treatment plants, the Upper Occoquan Sewage Authority (UOSA). The following is a description of some of the special circumstances that surround this plant.

> *The Upper Occoquan Sewage Authority (UOSA) plant is a highly sophisticated regional wastewater reclamation plant located in Western Fairfax County that serves Fairfax and Prince William and the cities of Manassas and Manassas Park. The reason that the plant has highly advanced treatment capabilities is that it discharges directly into a reservoir. The UOSA Board of Directors and plant management have been adamantly opposed to installing BNR because it believes that BNR would have a negative impact upon the facility's operations and the reservoir.*
>
> *The UOSA Board of Directors wrote a letter on July 22, 1996 to the Secretary of Natural Resources, stating that "UOSA does not denitrify because nitrates are very beneficial to the biological balance of the*

> *Reservoir.... Of course, consumption of the oxygen in the nitrates results in denitrification in the Reservoir and, based on the data of the Occoquan Watershed Monitoring Laboratory, 42 percent of the total nitrogen entering the Reservoir is removed annually. Denitrification in the UOSA plant would be devastating to the plant processes. A denitrified water would increase chemical usage 150-200 percent...." Plant management is concerned that the latter would result in further aggravating a problem it has with scaling in its pipes.*

In the October 1996 final comment draft, the State strategy did not comment on UOSA's concerns, and its claim that nitrogen is removed in the reservoir. The strategy included large nitrogen reductions in its calculations, based on applying the seven milligrams per liter nitrogen concentration figure that it used for year-round BNR.

The December 1996 strategy document, however, concluded that "retrofitting UOSA with BNR as a component of the Strategy is not an appropriate measure to take at this time." The December document also indicated that "based on monitoring data from 1983-1991, comparing the total input load (nonpoint source, point source, and atmospheric deposition) to all reservoir outputs shows that nitrogen and phosphorus are reduced by about 42% and 56%, respectively." The document indicated that the issue of delivered loads from UOSA:

> ...will be tracked over time, with interaction of the appropriate technical subcommittees of the Chesapeake Bay Program. This is necessary because decisions about the delivered load from this plant will affect the values used for the baseline loads, progress to date, and future forecasts.

Given the magnitude of the projected flows from the facility, several scientific or technical experts — wholly independent of the Virginia tributary strategy effort and the UOSA plant — should be consulted to confirm the appropriateness of assuming the stated highly-reductive qualities of the reservoir in performing the calculations. In the meantime, however, the December 1996 strategy document contains a substantial reduction of the projection of nitrogen loads from the plant, even beyond the reduction levels that had been projected in October 1996 when assuming year-round BNR at the plant. The December 1996 strategy projects the year 2000 nitrogen load from the plant to be 539,000 pounds per year. For comparison, the estimated baseline 1985 load figure for the plant has been and still remains 597,000 pounds per year.

The strategy thus projects about a 10 percent reduction from the baseline nitrogen load, despite an approximate tripling in the plant's flow and no introduction of BNR technology. This appears to be a dubious proposition. The precise figures used to produce this important result (the flow, concentration, and delivery factors applied in the baseline and in the projection) are not provided in the December document.

DEQ Assumptions About Concentration Levels at Plants Without Technology Changes Will Need to Be Scrutinized Over Time

An important source of information on flow values and nutrient concentrations is the monthly discharge monitoring report (DMR) that is provided to DEQ by point source dischargers. For a number of plants, such as large sewage treatment plants in Northern Virginia, DMR figures are available for the 1985 baseline year as well as for 1994, the last year for which the strategy effort has reported estimated progress.

However, for many plants, specific data are not available. According to DEQ staff, for these plants, "flow-weighted defaults that were computed using information from the Hampton Roads Sanitation District and the upper James River facilities on typical nutrient levels in secondary treatment plants." Seventeen of the 33 plants that are part of the 1985 baseline year data had their 1985 concentration figure set to the defaults, which have been defined as: 18.7 milligrams per liter (mg/l) for total nitrogen, 6.4 mg/l for phosphorus prior to the phosphate detergent ban, and 2.5 mg/l after the phosphate detergent ban.

Recent adjustments in the data by DEQ for a number of treatment plants in the Shenandoah Valley have raised some questions as to the validity of the 1985 default values for some facilities, or the validity of the recently-revised concentration level values. Fortunately, the flow levels at these plants are fairly small, so at this time the impact of these changes is limited, even if the changes made are problematic. However, the changes raise the point that DEQ may need to be more cautious in the future in making such revisions.

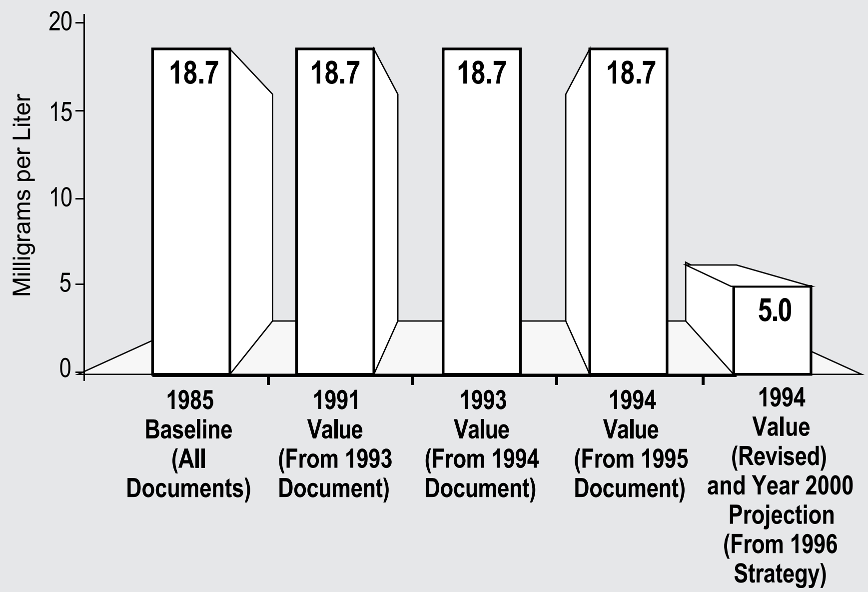
Specifically, there are several plants in the region for which DEQ Potomac papers have long shown a default value of 18.7 milligrams per liter for nitrogen, both in the numbers for 1985 and for more recent years. During the 1996 regional assessment process, however, the 1994 and projected 2000 concentration figures for a few of these plants were stated as being dramatically reduced.

One concern is whether DEQ is sufficiently scrutinizing the information to determine if there is sufficient evidence to support that real changes have occurred since 1985 that fully justify revising the new load figures, especially without revisiting the baseline figure. For example, Figure 3 shows the data for a sewage treatment plant for which the nitrogen concentration default value has long been assumed by DEQ. However, the appendix to the 1996 strategy document now indicates that this facility's flow, which is about 50 percent industry and 50 percent domestic, is:

> ...actually nutrient deficient.... Normally ammonia is below technical limits, although it can spike up to 5 mg/l if industry is off line. Nitrates are typically 1.0-2.0. The N figures below [which included a year 2000 projection of 5.0 milligrams per liter] leave out organic nitrogen.... Cost estimates [for BNR are] not available (or relevant, since plant is nutrient deficient).

Figure 3

Nitrogen Concentrations as Used in DEQ Projections for a Southern Shenandoah Sewage Treatment Plant
(Based on 1993-1996 Potomac Strategy Documents)



Source: JLARC staff analysis of data from Potomac tributary strategy documents.

DEQ used the figure of 5.0 milligrams per liter in its year 2000 nitrogen figures for this facility. This occurred even though the assessment, as quoted above, stated that the nitrogen (N) figures "leave out organic nitrogen." As a result of the use of this figure, the facility was assumed to have the lowest nitrogen concentration level of any facility in the basin, and was not considered as a candidate for upgrade or BNR under the strategy. DEQ records demonstrate, however, that this facility has had major problems, some of which involve ammonia. Between December 1994 and March 1996, it was issued seven notices of violations by DEQ staff. These violations included: ammonia load and concentration maximum violations, dissolved oxygen minimums violated, incorrect reports of ammonia concentrations, insufficient ammonia frequency analysis, and unpermitted discharges. There appear to be questions as to whether a sufficiently stable environment exists at the plant for DEQ to make a determination that the facility's nitrogen concentration figure should be revised at this time to five milligrams per liter.

Another concern is that in the strategy materials, DEQ does not discuss whether it revisited 1985 default values on the basis of these new concentration findings. When JLARC staff inquired about the facility just discussed, DEQ staff indicated that subsequent to producing the strategy document, it did learn from the facility that the industrial process affecting the facility's loads was in operation in 1985, so DEQ is now considering revisiting the 1985 baseline load assumption.

The following, however, is an example of this concern at another facility:

The strategy appendix shows that based on May 1996 samples, the nitrogen concentration of the facility was 6.87 milligrams per liter. The appendix stated that the facility was "lightly loaded; concentrations may increase as load increases in the future....upgrade not necessary until current concentrations can no longer be maintained."

This facility's estimated flow in 1994 was 0.71 million gallons per day. Its estimated flow in 1985 was 0.50 million gallons per day, so that at that time the facility was even more "lightly loaded." In each of the three prior DEQ Potomac documents from 1993 to 1995, the nitrogen concentration assumed for the 1985 baseline as well as recent years was 18.7 milligrams per liter. Clearly, if the new concentration values are to be believed, DEQ should review and comment on the issue of whether the baseline value is credible.

Conclusion: Reductions at a Few Plants Will Be Pivotal to the Point Source Nitrogen Outcome

Under the strategy, year-round BNR at the Alexandria, Lower Potomac, and Arlington plants, plus the new assumptions being made about the UOSA plant, account for about 84 percent of the strategy's nitrogen load reductions from STPs. This figure is based on a comparison of: (1) the projected loads for the facilities based on the reduction assumptions contained in the strategy, against (2) DEQ's October 1996 projection of future loads based on the assumption of no nitrogen reduction upgrades and on the use of the former UOSA assumptions. Alexandria is the largest calculated reduction from what had been projected for the year 2000, at 1,468,649 pounds per year of reduction (about 32 percent of the strategy's STP reductions in the Potomac from the loads projected in October 1996 for the year 2000). UOSA is second, at 1,429,388 pounds annually (about 31 percent of the Potomac STP nitrogen reductions).

Thus, there are reasons for concern if the reduction calculations of the strategy for these facilities are unrealistic, or if the actions that are taken at these facilities do not measure up to strategy expectations. The current UOSA numbers appear to be problematic. Also, the VAMWA proposal has been endorsed by several Northern Virginia localities which have not indicated support for the Commonwealth's strategy. However, seasonal BNR operated year-round at a facility such as Alexandria may not be sufficient to achieve the reductions anticipated by the strategy. If the VAMWA proposal becomes the basis upon which point source progress is sought and funding is provided, then any differences between the assumptions of the strategy and the VAMWA proposal will need to be carefully examined to determine the size of any additional gap from the 40 percent goal that can be expected, beyond the gap that the strategy itself does not close.

MAGNITUDE OF NONPOINT SOURCE REDUCTIONS PROJECTED BY 2000 ARE QUESTIONABLE

Other than in the Northern Virginia region, the Commonwealth's December 1996 strategy document anticipates considerable success in reducing controllable nonpoint source nutrients by the year 2000 (see Table 2). In each of the other three regions, the strategy projections indicate that nonpoint source nitrogen and phosphorus will be reduced by 40 percent or more from the baseline controllable load amounts. In fact, in the Southern Shenandoah region the strategy indicates that nonpoint source nitrogen will be reduced nearly in half. In the Northern Shenandoah, the strategy anticipates that nonpoint source nitrogen will be reduced by more than half. And in the Lower Potomac, the strategy projects that nonpoint source phosphorus will be reduced by more than two-thirds.

Table 2

Nonpoint Source Percentage Reductions Projected by Region in the Commonwealth's 1996 Strategy

Region	Nitrogen Reduction Percent	Phosphorus Reduction Percent
Southern Shenandoah	49.80	43.91
Northern Shenandoah	53.97	43.53
Northern Virginia	19.64	23.24
Lower Potomac	43.54	71.69

Source: *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy*, December 1996.

Because of the relatively lower reductions that are expected in Northern Virginia, across all four regions the aggregate nonpoint source reductions do not quite achieve the 40 percent reduction, at 37 percent for nitrogen and 38 percent for phosphorus. Still, if the nonpoint source reductions projections are credible, they indicate that the State will make major progress in reducing nonpoint source nutrients.

JLARC staff initially assessed the appropriateness of the nonpoint source reduction claimed in the strategy plan by examining in some detail a particular component of the plan. This component was the nitrogen reduction that is claimed for cropland in the Northern and Southern Shenandoah regions. The assessment was conducted to determine if the reductions projected in the plan appear to be appropriate, consistent with furnished documentation, and realistic relative to the difficult issues presented by nonpoint source nutrient control.

The review found credibility problems with the projections of progress under the strategy for Shenandoah Valley cropland. Major nonpoint source reductions, which are typically pursued through voluntary efforts, are difficult to achieve across large numbers of land users. Nonetheless, under the strategy, a key county in the Shenandoah Valley is estimated to achieve an 87 percent reduction in controllable nitrogen runoff, even without full implementation of several best management practices (BMPs). If full implementation were assumed, the calculations would reduce a substantial portion of nutrients that are uncontrollable. These results do not appear practical.

A number of issues need to be examined further to determine how to make the framework calculations produce more realistic outcomes in the Shenandoah Valley. For example, some of the key efficiencies (percentage reductions) assumed for practices such as nutrient management need to be skeptically reexamined.

Also, in the course of assessing the Shenandoah Valley cropland reduction issue, an issue with broader applicability became clear. It was noted that the calculation of changes in nonpoint source nutrients focuses almost exclusively on how much of a reduction might be achieved through the implementation of best management practices. The calculations assume no changes in nutrient impacts by land users not implementing BMPs. The problem is that the potential for any offsetting behaviors, such as increased use of fertilizer nutrients by some, is not recognized in the framework. An examination of fertilizer purchases in Rockingham County provides reason for some doubt as to whether it can be safely assumed that the implementation of animal waste control facilities and nutrient management practices in that county have been dominating factors affecting commercial fertilizer applications in that county. Moreover, in the Potomac Basin as a whole, an analysis of Department of Agriculture and Consumer Services data indicates that tons of nitrogen fertilizer purchased are up by about 20 percent over the baseline timeframe, and tons of phosphate fertilizer purchases are only down by about six percent. Thus, there is reason for concern that the calculations do not address the potential for and impact of increases in nutrient use by some land users.

It was not feasible to make an assessment at a level of detail similar to Shenandoah Valley cropland in other nonpoint source aspects of the strategy. In part, this was because the State's tributary assessment process and this review were conducted concurrently, and little time elapsed between when calculation spreadsheets and the final comment draft of the assessment process were made available and the completion of the JLARC staff analysis of that draft. This posed particular problems for assessing nonpoint source reduction practices for which DCR does not provide data enabling a determination of the percent of progress that has been achieved.

However, there are other aspects of the reductions displayed in the strategy which appear questionable or merit better explanation. There are concerns with the calculation of forestry harvesting reductions, which assume no implementation of nutrient reduction activities in the baseline year and 100 percent implementation by the year 2000. And, the reductions as calculated for the shoreline erosion BMP in the Lower Potomac appear to be very problematic.

Context for Virginia's Nonpoint Source Nutrient Issue

According to the Chesapeake Bay watershed models, in Virginia's portion of the Potomac Basin, nonpoint sources are estimated to have accounted for about 10.3 million of the 20.4 million pounds of the 1985 baseline controllable nitrogen delivered to the Bay, and about 1.6 million of the 2.1 million baseline pounds of the 1985 controllable phosphorus load that was delivered. Of the nonpoint source controllable load, about 5.2 million is attributed to agriculture cropland uses, and about 1.7 million is attributed to each of the following: pasture land, animal wastes, and urban uses.

Therefore, efforts to reduce nonpoint source nutrient loads in the region are likely to have a substantial agricultural component. However, nonpoint source pollution control in general, and agricultural nonpoint nutrient loads in particular, present difficult challenges from a pollution abatement standpoint.

The Difficulty of Nonpoint Source Pollution Control. The literature on pollution control indicates that nonpoint sources pose a number of special abatement challenges. For example, an article within the past year summarized the situation as follows:

> These [nonpoint source] water quality problems have created a challenge for pollution abatement throughout the country. NPS pollution is differentiated from point-source pollution as not coming from a single identifiable source, such as a pipe for sewage or industrial discharge. As such, NPS pollution is not conducive to the kinds of "top-down" pollution abatement practices, such as established discharge limits or enforcement of compliance with individual permits, which have been fairly successful in reducing point-source pollution problems. This is particularly true of rural NPS, whose diffuse sources are generally spread out over larger areas than urban NPS pollution. ["Rural Nonpoint Source Pollution Control in Wisconsin: The Limits of a Voluntary Program?" *Water Resources Bulletin*, 1995]

In general, it appears that studies to assess the success of nonpoint pollution control efforts have found, especially on a micro-level, that implementation of specific nonpoint source best management practices (BMPs) have helped to improve water quality. (BMPs are fairly specific methods of using land or trapping nonpoint source pollutants such that the extent of nonpoint source pollutants impacting water quality is reduced or minimized). However, on a larger-scale, such as a county or watershed, the impacts of nonpoint source best management practice programs have been variable, and it appears that results are often characterized as small or moderate. The following examples describe findings from the ten-year Rural Clean Water Program (RCWP) — first, for the program overall, and then, from a specific study of the effects of nutrient management at a selected site within the Bay region in Pennsylvania.

> The principal focus of the program was to determine which BMPs would improve water-quality in different areas. Only one-third of the

> RCWP projects are projected to result in positive net benefits with respect to off-site water quality (Piper et al., 1989). BMP cost and water-quality effectiveness were found to vary greatly. [*Agricultural BMPs Applicable to Virginia*, Virginia Water Resources Research Center, 1991]

> Nutrient management, an agricultural Best-Management Practice, was promoted in the 5.8-square-mile watershed by the U.S. Department of Agriculture Rural Clean Water Program.... [T]he greatest contamination [in the watershed] was...with intensive row-crop and animal production.... The [study finding of a] small, positive effect of nutrient management on base-flow water quality should be interpreted with caution.... A regression model relating nutrient applications to concentrations of dissolved nitrate plus nitrite showed no significant explanatory relation. [*Evaluation of Agricultural Best-Management Practices in the Conestoga River Headwaters, Pennsylvania: Effects of Nutrient Management on Water Quality*, U.S. Geological Survey Water-Resources Investigations Report, 1996]

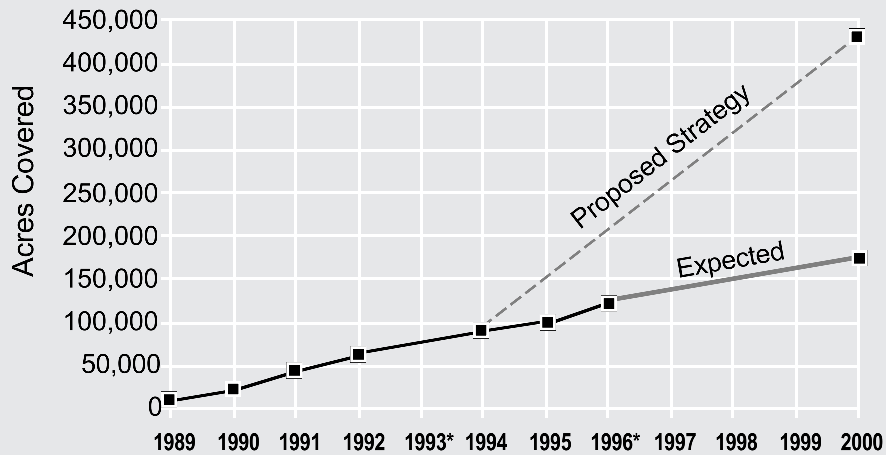
Currently, there is an on-going project in Virginia that involves soil and conservation district staff and agriculture experts from Virginia Tech in assessing nitrogen losses from cropland on five farms in different geographic areas, before and after the use of nutrient management. Indications are that nutrient management on the five farms is resulting in some substantial nitrogen reductions from cropland — about one-quarter to one-third reductions — but nothing much higher than that. The study is not designed to review phosphorus reductions.

Nutrient Management Is a Key Component of the Commonwealth's Nonpoint Source Strategy. The Commonwealth's 1996 draft strategy addresses the 40 percent reduction goal on the nonpoint source side through the varied use of 16 BMPs. Virginia's natural resources agencies worked with local participants in regional assessment processes to determine the mix of BMPs that might be used in each locality to make progress or even achieve or exceed a 40 percent reduction goal.

While each of the 16 BMPs is used in the total strategy to at least some extent, nutrient management is the most prominent BMP in the strategy in terms of nutrient load reductions. Under the strategy, it is projected to achieve almost one-third (31 percent) of the nonpoint source nitrogen reductions, and about 28 percent of the phosphorus nonpoint source reductions. The large reductions that are expected are in part based on the assumption that there will be a dramatic increase in the rate at which plans are written and therefore the rate at which cropland acreage is covered. Figure 4 compares the increase in nutrient management planning that is projected under the strategy compared to the recent history of nutrient management plan growth under current State programs and activity levels. The last year of progress shown in the 1996 strategy for all best management practices, including nutrient management, is 1994. JLARC staff requested that DCR furnish the most recent data available for nutrient

Figure 4

Potomac Strategy: Increase in Acreage Covered by Nutrient Management, Compared to Historical Levels



*Notes: Data for 1993 are included in the cumulative total for 1994 but not separately identified in data provided by DCR. Data for 1996 are for three-quarters of the year.

Source: JLARC staff graphic of data provided by the Department of Conservation and Recreation.

management, and the acreage amounts it reported for 1995 and for three-quarters of 1996 are included in the figure.

After nutrient management, animal waste control ranks second in the magnitude of the reductions from 1985 levels that are expected. While sizable reductions from nutrient management occur in several localities, much of the projected animal waste control reduction (53 percent) comes from one locality, Rockingham County.

Cropland Reductions Projected in the Shenandoah Valley Appear Greatly Overstated

A focus of JLARC staff's assessment of the draft strategy was an examination of the nitrogen reductions that are projected from cropland BMPs. Cropland BMPs include nutrient management, conservation tillage, farm plans, cover crops, and highly erodible land retirement. An assessment was made of whether the projected reductions appear to be appropriate, consistent with furnished documentation, and realistic relative to the difficulty that is entailed in nonpoint source pollution abatement.

The Calculation Framework Produces Reductions Exceeding the Amount of Controllable Nutrients. One of the research activities conducted was to compare the magnitude of the projected cropland nutrient reductions for the counties against the loads that were assumed to exist in the baseline year. A comparison of these loads revealed that under the plan and its supporting calculations, in Shenandoah County, 87 percent of all controllable nitrogen runoff from cropland would be reduced.

Given the difficulty of nonpoint source pollution abatement, this figure seems very optimistic. But it also was somewhat unsettling to observe that this degree of accomplishment was tabulated within a calculation framework which provided substantial room for achieving even higher levels of nitrogen reduction. Specifically, the 87 percent reduction result for Shenandoah County was obtained with conservation tillage at 56.9 percent coverage, with farm plans at 67.4 percent coverage, with nutrient management at 90 percent coverage, and with the cover crop practice assumed on about 17 percent of tilled acres.

The question therefore became: how much of a reduction would be calculated under the framework being used by DCR if “full” BMP coverage were assumed? Full BMP coverage in this simulated calculation was assumed to be 80 percent use of conservation tillage, complete use of cover crops on tilled acres, nutrient management plans on all acres at DCR efficiency (percent reduction) rates, and farm erosion plans on all acres.

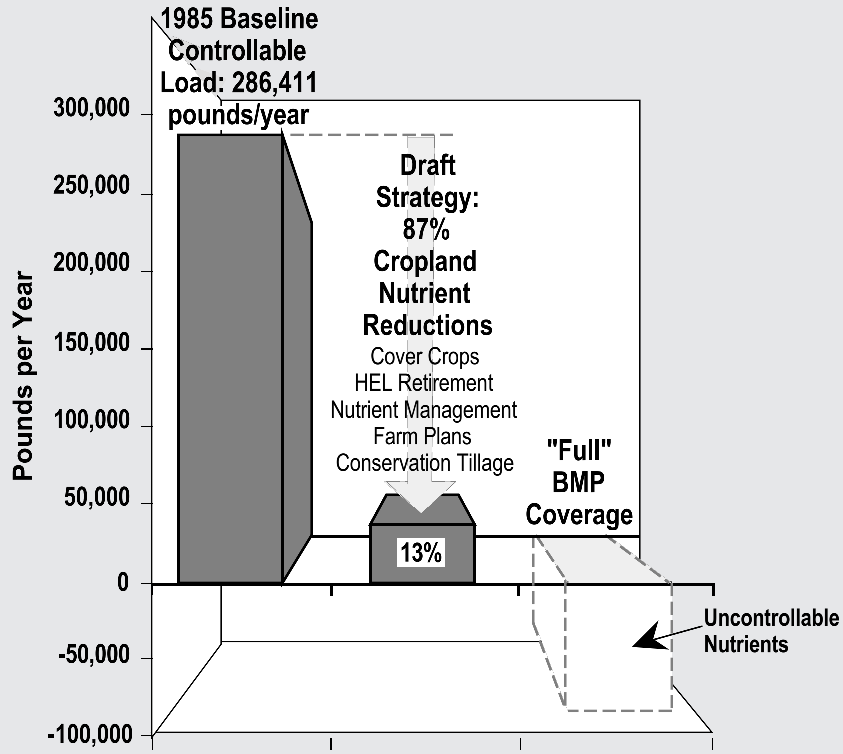
The finding of this assessment was that under the terms of the framework, “full” BMP coverage as defined would reduce every controllable pound of nitrogen from cropland in the county and more (see Figure 5). Controllable pounds of nitrogen on cropland was examined in two ways, as the 1985 baseline load and as the year 2000 load expected without BMP implementation, and the choice of definition mattered little as the year 2000 measure for Shenandoah differed little from 1985 baseline loads (286,411 pounds per year versus 292,488). There is reason for concern that under the calculation framework, an assumption of “full” land use coverage of BMPs (all of which are imperfect in their effectiveness) would mean that over 76,000 pounds of “uncontrollable” nitrogen would be shown as reduced under the DCR calculation framework. In other words, when the framework is applied in a scenario that assumes “full” implementation of the BMPs, the framework yields a cropland reduction amount that is far in excess of the amount of cropland nitrogen that the model indicated was controllable in the first place.

Cropland Nitrogen Reductions Illustrate That Key Efficiencies Used in Virginia and Other States Need to Be Skeptically Reviewed by the Bay Program. The next step in the assessment was to examine what factors might account for the overestimation outcome. One potential factor is the magnitude of the efficiencies that are applied for key best management practices, such as nutrient management. These efficiencies are reconsidered from time to time, and a revision to the BMP efficiencies was under way during 1996. Its release appeared imminent at the end of 1996.

Virginia's tributary strategy documents and the strategy documents of other states have been vague or inconsistent about the source of the nutrient management efficiencies that have been recently in use. The appendix to Virginia’s 1996 draft strategy simply states that “nutrient reductions for this management practice were determined through nutrient management scenario model runs of the WS [Watershed] Model.” Maryland’s March 1996 technical appendix, identified as the “documentation of data

Figure 5

Nitrogen from Shenandoah County Cropland: BMP Reduction Amounts Compared to Controllable Load Amounts



Source: JLARC staff analysis of DCR tributary strategy data.

sources and methodology used in developing nutrient reduction and cost estimates" for its strategy documents, references a 1991 report of the Interstate Commission on the Potomac River Basin (ICPRB) as one of five references in the agriculture area, and no other ICPRB documents. The appendix to Pennsylvania's January 1996 tributary strategy document (entitled "Procedures to Calculate Nonpoint Source Nutrient Reductions") cites that nutrient management reduction efficiencies "are summarized in [ICPRB] Report 8 (Camacho, 1992)," but that:

> ...since the reduction efficiencies for a nutrient management plan applied to conventional tillage land versus conservation tillage land are similar, the higher efficiency was used and applied to the total cropland load available in each model segment.

There is a December 1992 ICPRB report that shows nutrient management reduction efficiencies from the "Chesapeake Bay Watershed Model Nutrient Management Scenario." However, DCR has also recently furnished JLARC staff a revised set of efficiencies from May 1993 that were distributed under ICPRB letterhead to state representatives for use in the calculations. These efficiencies are used in DCR's spreadsheets. Staff of the ICPRB have indicated that the revised efficiencies resulted from meetings of a technical group composed of representatives of the states, who tried to reach consensus about what the efficiencies should be.

There were some key changes between the December 1992 ICPRB report and the May 1993 memorandum that impact Shenandoah Valley cropland. The changes that were made to watersheds 190 and 200 (Shenandoah Valley watersheds) are summarized in Table 3. Of the 63 Bay watersheds for which such nutrient management efficiencies were shown in the December 1992 document, the efficiencies that were shown for conventional tillage (CT) and conservation tillage (CS) land for Virginia segments 190 and 200 were already among the highest available. However, the revised nitrogen efficiencies for segment 200 were greater than the December figures. (On the other hand, relatively smaller increases in these categories were observed in an upward direction for segment 190 nitrogen and in a downward direction for phosphorus).

Table 3

Changes in Efficiencies for Two Key Watersheds Between December 1992 and May 1993 Reports

Use/Segment	1992 Nitrogen %	1993 Nitrogen %	1992 Phosphorus %	1993 Phosphorus %
Crops (CT) 190	36.0	37.8	.318	.309
Crops (CS) 190	39.9	41.5	.373	.360
Hayland 190	None Stated	28.2	None Stated	.306
Crops (CT) 200	40.7	47.6	.372	.395
Crops (CS) 200	43.0	48.6	.417	.439
Hayland 200	None Stated	30.7	None Stated	.355

Source: Comparison of 1992 and 1993 documents of the Interstate Commission on the Potomac River Basin.

Also, much of the cropland in the Shenandoah Valley is classified as hayland in the model. Whereas the December 1992 document did not provide hayland efficiencies from the 1985 baseline for any of Virginia's eight Potomac watershed segments, the 1993 revision provided hayland efficiencies for segments 190 and 200, although not for the other segments. The stated hayland efficiencies for these two segments ranged from 28.2 percent for segment 190 nitrogen to 35.5 percent for segment 200 phosphorus.

JLARC staff examined three questions relative to the hayland efficiencies. First, were the 1985 baseline edge-of-stream loads per acre from hayland in Virginia segments 190 and 200 substantially (on the order of 30 percent) higher than for Virginia's other segments, or must the unique opportunity for the 30 percent reductions rest upon other factors? Second, was there a difference in the relative relationship between forest and hayland edge-of-stream loads in these two segments versus in the other segments that might suggest that a larger proportion of the load from hayland in segments 190 and 200 is controllable? Third, what proportion of Virginia's Potomac's hayland was eligible for calculated reductions through the inclusion of these two segments, compared to the proportion of hayland in the other six segments?

With regard to the first question, an examination of 1985 edge-of-stream loads per acre from hayland in segments 190 and 200 indicates that these per-acre loads were higher than in the other six segments — but only six percent higher for nitrogen, and eight percent higher for phosphorus. And, these are the average results. More specifically, segment 190 nitrogen and phosphorus loads were 13 percent and 15 percent higher, respectively. However, segment 200 per-acre hayland edge-of-stream loads were actually less than those of the other six segments not calculated to achieve any reductions (4 and 3 percent less, respectively).

With regard to the second question, minimal differences were found in the relationship between hayland versus forest edge-of-stream loads in these two segments as compared to the other segments. Per-acre forest loads were divided into per-acre hayland loads as an estimate of the proportion of the hayland edge-of-stream loads that might be considered "uncontrollable". The higher the proportion, the higher the estimated uncontrollable portion of the load.

The finding, again, was of fairly minimal differences between segments 190 and 200 and the other segments. In fact, the proportion of the load from hayland that might be considered "uncontrollable" in segment 190 was higher (43 percent) than the average for the other segments (39 percent), while in segment 200 the uncontrollable portion was somewhat less, at 37.6 percent.

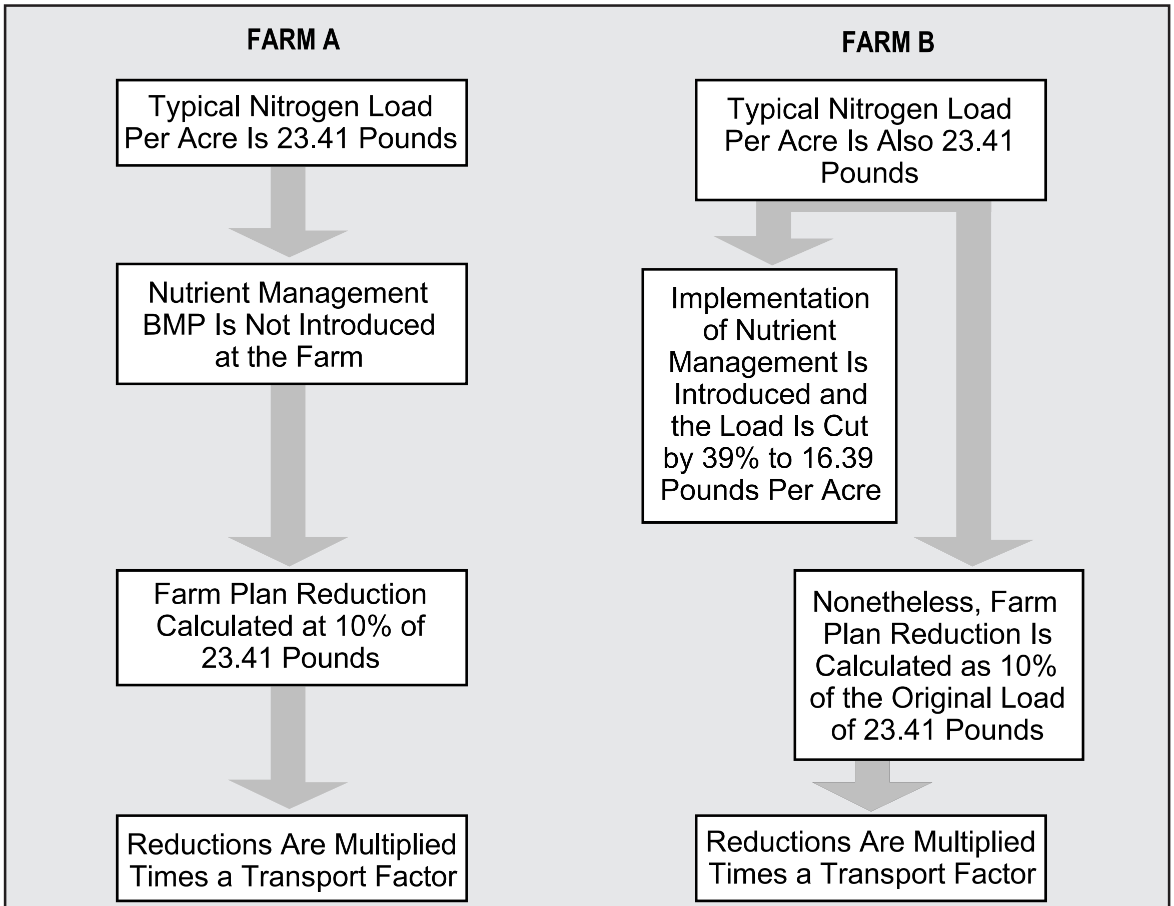
With regard to the third question, it was found that in designating these two segments as available for nutrient management efficiencies, 57 percent of the hayland in Virginia's portion of the Potomac were included in nutrient management reduction calculations. The other six segments account for only 43 percent of the hayland in Virginia's portion of the Potomac.

In conclusion, the high (almost 50 percent) nutrient management efficiencies for segment 200 conservation and conventional tillage in Virginia's Potomac, plus the use of the hayland efficiencies, appear to be among the factors that are contributing to the calculation of impractical reduction results for Shenandoah County. Descriptions of the process used for BMP efficiency determinations as negotiations or consensus-building among state agency actors who are striving to achieve the 40 percent reduction goal also do not inspire confidence in the objectivity of these determinations. It appears that there is a need for a more skeptical reexamination of these efficiencies and their use by the states. Since the content of the recent assessment of BMP efficiencies has not yet been publicly released, it is not yet known if the revision will introduce a degree of greater caution in reduction assumptions and efficiencies, and if the revision will be well-grounded in empirical documentation.

The Interactive Effects Between BMPs May Not Be Adequately Taken into Account. In the calculation of reductions by DCR, the BMPs are assumed to have an additive effect. This assumption is illustrated in Figure 6. The figure shows two farms

Figure 6

Interactive Effects of BMPs Not Recognized: An Illustration of the Calculation for Farm Plan Reductions



Source: JLARC staff illustration of DCR nutrient reduction calculations for nutrient management and farm plans based on DCR spreadsheets.

that have an identical baseline load. However, farm A just implements a farm plan, while farm B implements nutrient management and a farm plan. The graphic illustrates how under the current calculation framework, the calculated reductions for the farm plan BMP would be the same at both farms.

However, the problem is that this fails to recognize that through the implementation of nutrient management, the load per acre of farm B has supposedly been reduced. For farm B, instead of multiplying 10 percent times 23.41 pounds per acre and expecting a 2.34 pound per acre reduction from the farm plan, the 10 percent could be multiplied times the adjusted load of 16.39 pounds per acre, with a 1.64 pounds per acre reduction expected from the farm plan.

This issue needs to be examined further. While the current procedure appears to produce an overestimation, DCR staff comments suggest that a completely interactive procedure could fail to take into consideration differences in the nutrient constituents addressed by each measure, thereby underestimating reduction benefits.

Theoretical BMP Coverage and Actual BMP Compliance Are Different, and an Assumption of 100 BMP Compliance Is Not Realistic. DCR's calculated nonpoint source reductions for nutrient management and farm plans are based on the number of acres that are expected to be "covered" by the year 2000. However, assuming complete implementation of written plans appears to be overly optimistic. There are many factors influencing farmer decisions about nutrient applications, and water quality is only one of those concerns. For example, literature indicates that:

> In most cases, farmers decide what, how much, and in what manner agricultural chemicals and animal waste products will be applied to their land. As a result they strongly influence how much may eventually reach surface or groundwater supplies.
>
> Nitrogen in the U.S. is relatively cheap.... Furthermore, price and weather uncertainty along with the demands of part-time jobs encourage farmers to err on the side of high chemical use. A little extra nitrogen may increase crop yields in a good rainfall year by 10 to 20 percent. [*Theory, Modeling and Experience in the Management of Nonpoint-Source Pollution*, Russell and Shogren, ed., 1991]

There is a substantial body of literature on the subject of the economics of nonpoint source control compliance. The literature indicates that even assuming that a regulatory environment were created for nonpoint source pollution, compliance would likely be a significant problem. For example:

> By definition, nonpoint source pollution implies moral hazard — the incentive problem of inducing polluters to provide socially targeted levels of abatement effort given that their actions cannot be directly observed. Since nonpoint pollution is diffuse...a regulator cannot perfectly monitor a polluter's abatement effort. As such, the polluter has an incentive to shirk on effort since the expected costs of shirking are lowered by this information barrier. The end result can be too little effort and too much pollution — i.e., environmental shirking. ["Budget-Balancing Incentive Mechanisms," *Journal of Environmental Economics and Management*, 1994]

And, of course, while Virginia does have some elements of a nonpoint regulatory program for agriculture in place (the Virginia Pollution Abatement or VPA permit program for that covers waste storage for larger confined animal feeding operations and the agricultural provisions of CBLAD regulations), the existing and planned program in Virginia is mostly a voluntary one, and some of the solutions to shirking discussed in the literature — such as random penalties designed to promote implementation by the "risk-averse" — are not being contemplated. This is not at all intended to argue that such solutions should be pursued. It just means that it is questionable to rely on reduction estimates for a voluntary strategy that are based on an assumption of no "shirking" in the implementation of BMP controls. An assessment of voluntary efforts to reduce rural nonpoint source pollution controls in Wisconsin, for example, found that in many instances, landowners who signed BMP agreements did not install them. For example, in one watershed, the percent of BMP agreements that were met varied, depending on the BMP, from 0 to 84 percent, with 52 percent and 84 percent cited as specific examples for streambank control and barnyard agreements respectively.

Past experience has indicated, at least in the short-term, that implementation has been an issue with regard to farms in the area of Virginia covered by the Chesapeake Bay Preservation Act. The final report of the Chesapeake Bay Preservation Act Program Study Group in July 1992 stated that "agricultural compliance remains a major concern." In recent focus groups conducted as part of regulatory review under Executive Order 15, the number one priority issue of local governments was the difficulty of enforcement of the agricultural and silvicultural provisions of the regulation, and the number one and six priorities of the agriculture/forestry industry focus groups were to have "broad performance criteria established rather than arbitrarily requiring conservation plans" and to "prioritize and target efforts rather than requiring plans for every acre of agricultural land." The summary of this focus group indicated that there was thinking that a focus on nutrient management might be appropriate, but it was indicated that an overarching issue for the regulation was that "the program should shift away from 'planning every acre'." The premise of the strategy and the reduction calculations that in some counties, 70, 80, and even 90 percent plus of the acreage is going to be placed under plans is not necessarily a popular one in the agriculture community.

Impact of Modifying the Reduction Calculations to Take into Account These Issues. JLARC staff estimated the extent to which the cropland nitrogen reductions in the Southern and Northern Shenandoah counties would be reduced if: (1) the December 1992 rather than May 1993 nutrient management efficiencies were used, (2) the nutrient management and farm plan double-counting problem were addressed, and (3) if implementation rates for written plans were assumed at between 70 and 95 percent, rather than 100 percent. While it cannot be confidently concluded at this time that either one of the two sets of nutrient management efficiencies are appropriate, the calculation of the difference made by the May 1993 changes indicates the sensitivity of the results to the heightened reduction assumptions that came from the State process.

Based on these three alternative assumptions, an estimated 315,000 to 540,000 pounds of the 1,170,000 pounds of nitrogen estimated as reduced would no longer be calculated reductions — about 27 to 46 percent of the claimed cropland efficiencies for these counties. Further, the remainder of the reduction that is calculated still depends on a great increase in the number of acres covered by written plans, and efficiencies for nutrient management on tilled acreage of around 40 percent.

Potential for Increases in Nutrient Use by Some Land Users Is Not Addressed

In the strategy calculations, the adoption of BMPs is assumed to be the dominant factor in controllable nutrient trends over time. For example, major reductions are expected through BMPs such as animal waste and nutrient management practices in agriculture, and clearly, considered in isolation, these measures can displace or reduce commercial fertilizer use. However, the strategy does not address the potential for and impact of increases in nutrients based on offsetting behaviors, like the increased usage of fertilizer.

Best Management Practices Are Not the Only Factor in Fertilizer Trends. As previously discussed, after nutrient management, the largest nonpoint source reduction from a single BMP category under the draft strategy is from animal waste control. One county, Rockingham, accounts for the largest portion of these reductions. Under the draft strategy, of the 593,581 pounds of annual nitrogen reductions that are projected by the year 2000, 313,455 pounds (53 percent) are projected from Rockingham. And, of the 128,264 pounds of annual phosphorus reductions that are projected, 68,193 pounds (also 53 percent) are projected from Rockingham. Rockingham is also projected to achieve sizable reductions from nutrient management.

Conceptually, the animal waste storage and nutrient management BMPs are considered to be complementary. Through waste storage and nutrient management, the amount of commercial fertilizer that is applied can be reduced in a way that the crops still have their needs met. Specifically, through the animal waste BMP, the wastes of confined animals do not runoff, but rather are captured, and can go to the cropland on a controlled basis, replacing fertilizer. The storage capability facilitates the nutrient management. Nutrient reductions are achieved through the displacement of fertilizer applications and through the more controlled application of the manure and remaining fertilizer use.

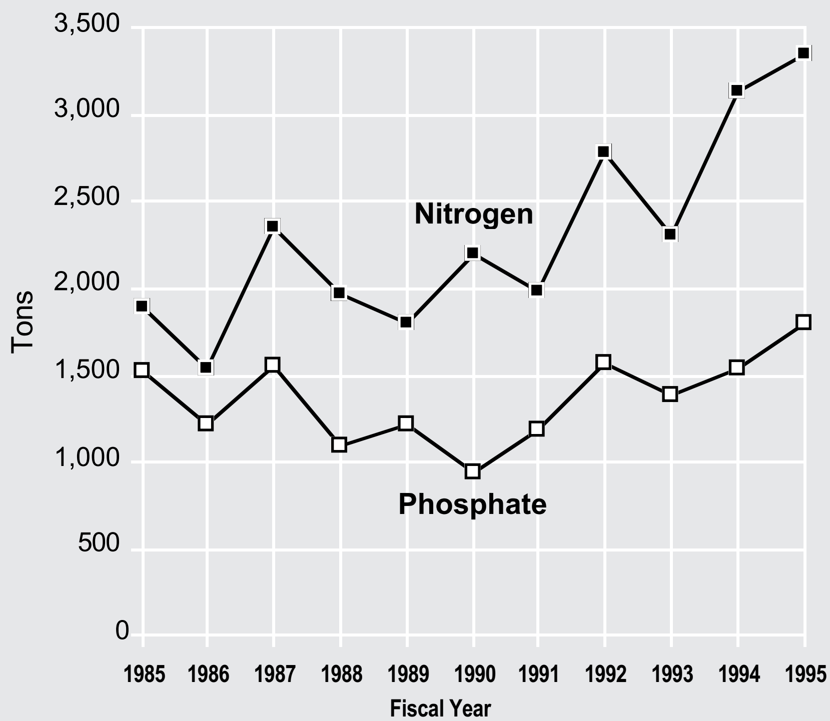
The Commonwealth's draft strategy indicates that through the animal waste control and nutrient management BMPs in Rockingham County, substantial nutrient reductions were already obtained between 1985 and 1994, and substantial additional reductions are projected to the year 2000. More than half, or about 58 percent, of the progress from the BMPs is estimated to have already occurred from 1985 to the year 1994.

Given the framework of the calculations, one would expect that the magnitude of the indicated BMP progress from 1985 to 1994 should contribute to a declining trend across the period in nitrogen and phosphate fertilizer applications in the locality. There are three reasons for this expectation. First, the use of the animal waste control BMP facility should enable some or many farmers to reduce their use of commercial fertilizer. Second, the use of nutrient management plans (the DCR projects that 15,806 acres were brought under such plans from 1989 to 1994) is supposed to help reduce the overuse of fertilizer. Third, the framework suggests that these BMP impacts are the key factors that should matter, because few other change factors are considered.

To examine whether this reduction has occurred, JLARC staff obtained data from the Virginia Department of Agriculture and Consumer Services on fertilizer consumption in the county for the period from 1984-85 to 1994-95. The data obtained from this review for the tons of nitrogen and phosphate fertilizer that were consumed are shown in Figure 7.

Figure 7

Fertilizer Consumption in Rockingham County from FY 1985 to FY 1995



Source: Virginia Department of Agriculture and Consumer Services, Office of Product Regulation, Fertilizer and Lime Usage Reports from FY 1985 to FY 1995.

It appears that there are factors at work that are increasing the use of nitrogen fertilizer in Rockingham County, not decreasing it. Any reductive impact of the two BMPs on nitrogen fertilizer use was being overwhelmed by these other factors. With regard to phosphate, the trend in the data was generally down for a period of time (from FY 1985 to FY 1991, and then back up to about FY 1985 levels in both FY 1993 and FY 1994. In fact, the FY 1994 phosphate fertilizer consumption in the county was almost exactly the same as the FY 1985 figure. The phosphate figure for FY 1995 shows a 17 percent increase over both the FY 1985 and FY 1994 levels.

DCR staff suggest that fertilizer data at the county level may not be fully reliable because some of the fertilizer purchased in the county may be applied outside of the locality. While this is true, it is not likely to be a major portion of the purchases. More importantly, the data used here are trend data, so there would have to be a major change over time in this pattern for this to explain the increase. DCR staff also indicate that of course not all of the fertilizer would be applied as agriculture fertilizer. This is also true, although it should be recognized that Rockingham County is a major agricultural county and also that other types of fertilizer applications contribute to nonpoint source runoff.

The fertilizer measure is not presented here as a perfect and comprehensive measure of nonpoint pollution, but it is an objective indicator that suggests cause for some skepticism as to whether nitrogen and phosphorus levels in Rockingham are being substantially reduced as portrayed in the strategy. In fact, there is some reason for concern that the apparent increase in the consumption of nitrogen fertilizer from the mid-1980s baseline may result in an overall increase in nitrogen runoff, or at least offset some of the BMP gains that may have been made.

Almost Total Focus of Reduction Calculations on BMPs Could Overlook Some Countervailing Trends That May Increase Nutrients. The issue of the BMP calculations for Rockingham brings out a major point with broader applicability to the reductions that are shown in the Commonwealth's strategy. The changes in nutrient loads are almost totally a function of changes that operate in one direction. They are BMP-driven, in the direction of achieved reductions, except for generally small changes that are made in the number of units (for example, number of cropland acres) that are assumed to exist in the locality. Countervailing factors, such as those that appear to be at work in Rockingham nitrogen fertilizer applications, are not taken into account in the strategy assessment.

Table 4 shows the nonpoint source reductions that are claimed under the strategy from 1985 to 1994 for nitrogen and phosphorus. The percent change in the summed fertilizer data between two time frames is also shown — that is, the sum of FYs 1985 and 1986 tonnage compared to FYs 1994 and 1995 tonnage.

For nitrogen, basinwide the percentages for BMP reductions and fertilizer purchases are almost polar opposites. Specifically, the calculations show annual nitrogen loads down about 20 percent, while fertilizer purchases are shown as up about 20 percent. For phosphorus, BMP calculations show phosphorus down in all four regions, but phosphate fertilizer purchases are shown as down in two regions and up in two regions. The aggregate basinwide phosphorus figures are down, although the BMP calculation is down about 21 percent while the tons of phosphate fertilizer purchased is down only 6 percent.

Other Nonpoint Source Reduction Amounts Contained in the Strategy Are Questionable

All of the BMPs in all of the regions could not be examined in detail within the timeframe of the review. However, a perusal of the information for the regions indicated

Table 4

Nonpoint Source Reductions Versus Changes in Quantities of Fertilizer Nutrients Purchased

(Percent Changes from the Baseline)

Region	BMP Nitrogen Reductions	Nitrogen Fertilizer Purchases	BMP Phosphate Reductions	Phosphate Fertilizer Purchases
Southern Shenandoah	-27.2	+25.4	-24.5	+7.4
Northern Shenandoah	-24.1	+11.0	-20.0	-2.5
Northern Virginia	-12.2	+14.5	-14.8	-22.4
Lower Potomac	-25.3	+31.7	-42.6	+9.7
Total Potomac	-20.2	+20.6	-21.4	-6.0

Source: JLARC staff analysis of spreadsheet data furnished by DCR on nonpoint source reduction progress to 1994 compared to Department of Agriculture data on tons of fertilizer nutrients purchased.

some areas, such as forest harvesting and shoreline erosion protection, in which the level of reported reductions may also be questionable.

Baseline for Forestry Harvesting Loads and Best Management Practices Is Unclear. The State's 1995 Potomac tributary strategy paper indicates that the first step in developing reduction targets for each region is to determine the nutrient load if each region were 100 percent forest. The uncontrollable load of each region is equal to the amount of the load that would stem from the acreage, if that acreage contained 100 percent forestland.

Thus, in the strategy paper, within the category of forest land, the controllable load is set to zero. The uncontrollable load amount is set to equal the amount that is calculated as delivered from forest land, and when the two figures are subtracted, there is no remaining load.

However, this raises the question of whether and where the nutrient loads are located in the data for forest harvesting activities that are controllable. The 1996 draft Potomac strategy calculates 242,542 pounds of annual nitrogen reductions from forestry harvesting BMP activities, so it is important to know how this activity is captured in the baseline from which the reductions are calculated.

DCR staff indicate that the Chesapeake Bay models are carefully calibrated so that a load such as this is not ignored, it just is not separately identified at this time. For example, septic system loads from throughout the basin also have not been separately identified, but septic pumping reductions are included in the reduction calculations. DCR indicates that the load amounts are simply spread among the other land use categories.

With the lack of information about what the load is that is contained in the baseline year, it is difficult to fully assess the appropriateness of the strategy's forestry harvesting reductions. There are indications that the reduction estimates are problematic, however, in terms of reflecting the history of the forestry BMP effort, and in assuming 100 percent appropriate implementation by the year 2000.

For example, DCR staff indicate that "the assumption for forest harvesting is that 0% of harvested acres were being adequately treated in 1985." Thus, there is not a deduction from existing and future practices based on any pre-existing level of activity. This appears to be inconsistent with the forestry accomplishments that were reported at the time, however.

Data for calendar year 1984 on BMP forestry accomplishments statewide were reported by the Virginia Division of Forestry in the Virginia Water Control Board's *1985 Annual Report: Best Management Practices Program for the Abatement of Nonpoint Source Pollution in Virginia*. These forestry accomplishments reported by the Virginia Division of Forestry in calendar year 1984 included: 1,188 log road stabilization projects, with 610 miles of log road stabilized; 52,800 linear feet of fire line seeded; and 5,189 "other water quality" practices. According to that document, the figure of 5,189 other water quality practices was a best but "very incomplete" estimate for a category that included: "skid trail layout and stabilization, log deck location and stabilization, prescribed burn fire line location and stabilization, wildfire control line stabilization, construction of bridges, culverts and water bars, seeding of cuts, fills and other critical areas, and all other measures." While these data were not further shown in the report by geographic region, given the emerging focus on the Bay watersheds, it is reasonable to assume that some of this activity was in the Shenandoah/Potomac basins.

The Treatment of Shoreline Erosion Reductions Is Problematic. During a review of the regional assessment results, JLARC staff requested an explanation from DCR on why the reported figures on the linear feet of shoreline protection that was in place in 1994 had changed between the 1995 and 1996 documents (see Table 5). In the Northern Neck, the figure increased by 8,714 linear feet.

DCR staff responded as follows:

> The data utilized for shoreline protection coverage was taken from a VIMS study which simply identified the total BMP coverage below the fall line in the Potomac. Without any additional data, this BMP coverage was distributed to the below fall line areas based on aerial proportion. Since the time the "Blue" document [the 1995 document] was developed, additional data has been utilized to distribute the BMP coverage more accurately. This data indicates that the majority of the shoreline protection has occurred in the Northern Neck region as compared to the Northern Virginia region. Therefore, the coverage in Northern Neck has been increased with a corresponding decrease in Northern Virginia.

Table 5

Increases in 1994 Best Management Practice Data Between Drafts: Shoreline Erosion Protection

Location	1994 Linear Feet as Reported in 1995	1994 Linear Feet as Reported in 1996
Northern Virginia	3,722	6,885
Northern Neck	11,165	19,879
Total	14,887	26,764

Source: JLARC staff comparison of data from Virginia's 1995 Tributary Nutrient Strategy document against the 1996 regional assessments as contained in the appendix to the October 1996 final comment draft.

However, this explanation was clearly inadequate to address the concern. There was no "corresponding decrease" in Northern Virginia. As the table indicates, the data in both Northern Virginia and Northern Neck both increased from one document to the next — in fact, Northern Virginia's coverage is shown to have nearly doubled.

Further, JLARC staff found that the highest percent reduction for a nutrient in the regional assessments was for phosphorus in the Lower Potomac region, and that this high percentage was substantially impacted by the shoreline erosion assumptions. As an additional check on the credibility of the nonpoint source reductions claimed in the strategy, the phosphorus reductions that stem from Lower Potomac BMPs were examined in more detail.

Data reported in the October 1996 final comment draft of the strategy indicated that one BMP, the shoreline erosion protection BMP, accounted for a major portion of the phosphorus reduction expected. This single BMP accounted for almost half of the expected reductions, while the other 15 BMPs shown in the strategy document accounted for slightly more than half.

The text of the October strategy document and the appendixes containing the regional assessment reports were reviewed for a discussion of the rationale for the Lower Potomac reduction results across BMPs, and for the shoreline erosion protection BMP in particular. In the regional assessment report, several paragraphs were found that provided a discussion of several BMPs with minor impact on the reduction results. For example, there was a discussion of urban nutrient management, which is called "a critical component of an effective nutrient reduction strategy" in the region. Less than one half of one percent of the calculated nonpoint source reductions for the Lower Potomac (19 pounds of phosphorus per year and 215 pounds of nitrogen per year) were credited to this BMP. However, no discussion was found in the Lower Potomac regional assessment on the shoreline erosion protection BMP, to which the strategy projected annual reductions of 34,605 pounds of phosphorus and 53,102 pounds of nitrogen.

A review of DCR spreadsheet data indicated that shoreline erosion protection BMP progress and calculated reductions were rooted in the difference between: (1) linear feet of shoreline that is expected to be "defended" (protected) in the year 2000, versus (2) linear feet of shoreline that was already defended in the 1985 baseline year. A subtraction of the 1985 baseline quantity from the amount expected by the year 2000 produces the amount of BMP progress, or the linear feet of shoreline that are newly defended. For phosphorus, the reduction calculations were based on the assumption of 1.044 pounds reduced per year per linear foot of newly defended shoreline. Multiplying 1.044 times the quantity of newly-defended shoreline produced a phosphorus reduction amount that was credited against the baseline (the 1985 nonpoint source controllable load) of 105,624 pounds for phosphorus.

A problem became apparent, however, when the amount of linear feet that is "not defended" in the baseline year was considered. The use of the shoreline erosion protection BMP to its maximum potential on undefended shoreline would be calculated to achieve a reduction that is 275 percent larger than the controllable load. Specifically, DCR data for the Lower Potomac region indicates that the baseline quantity of shoreline that is "undefended" is 378,746 square feet (476,660 total linear feet minus 97,914 linear feet that was defended in the baseline year). Multiplying the linear footage of undefended shoreline times the BMP reduction assumption of 1.044 pounds of phosphorus per year produces a potential reduction figure of 395,562 pounds of phosphorus through the shoreline erosion BMP, if it is fully implemented. The problem, however, is that the total nonpoint source controllable load figure for Lower Potomac phosphorus is only 105,624 pounds.

The calculations for Northumberland County illustrate the practical significance of this issue at the locality level. Through an increase of about eight percentage points in the proportion of shoreline that is defended (from 19.6 percent in the baseline to 28.0 percent in the year 2000), DCR calculated a 39.9 percent reduction in Northumberland's controllable nonpoint source load. Thus, this action alone, which the regional assessment process assumed could be done at no cost, was approximately calculated to be sufficient to meet Northumberland's nonpoint source goal. After DCR includes the region's assumptions for the other 15 BMPs, about a 78 percent reduction in the nonpoint controllable phosphorus load was calculated.

If DCR had assumed a 13.1 percentage point increase in the proportion of shoreline defended (from 19.6 to 32.7 percent), then the framework applied in the October final comment draft would have indicated that Northumberland will completely eradicate the runoff of controllable nonpoint source phosphorus, even though:

- about 7,860 acres (30 percent) of all tilled cropland acres would still be under conventional tillage,

- about 6,589 acres (about 20 percent) of cropland acres would not be covered by farm or erosion control plans,

- about 16,070 acres (50 percent) of cropland acres would not be under nutrient management,

- about 25,130 acres of all tilled cropland acres would be cultivated without the use of the cover crop BMP during the winter months, and

- over 67 percent of the shoreline would still be left undefended against erosion.

This finding indicated that the treatment of the shoreline erosion protection reduction in the calculations was problematic, and more generally, the finding again indicated the unrealistic nature of the calculation framework that is used. Under the framework, scenarios providing for substantially less than 100 percent BMP implementation can be used to calculate reductions far in excess of the baseline controllable load.

Since the time that this concern was brought to DCR's attention, DCR has revised its shoreline erosion numbers. The changes made do not appear to be intended to be responsive to this concern, however. The net result of the changes is the calculation of an even higher and less credible percentage reduction for Lower Potomac nonpoint source nutrients. The following changes were included in the December 1996 document.

(1) The linear feet of shoreline erosion protection in the Northern Virginia region were set to zero, because "the tidal shore in this region does not experience high-energy wave action that can be found along the shores of Northumberland and Westmoreland counties."

(2) The linear feet assumed in the Lower Potomac region was reduced, based on an assumption that "the tidal shore of King George County experiences only a portion of the high-energy wave action and the significant corresponding erosion rate that can be found extensively along the shores of Northumberland and Westmoreland counties."

(3) However, the phosphorus reduction per linear foot was increased, from 1.044 to 1.769 pounds per linear foot.

In the Lower Potomac, the increase in the reduction efficiency per linear foot more than offset the linear footage decrease, resulting in a greater phosphorus reduction (a similar change also impacted the nitrogen calculation). The December 1996 document assumes that 10,831 fewer feet will be protected than were assumed in the October draft, but that the level of protection afforded will reduce phosphorus by 4,848 pounds more than had been shown in October. As a result, the overall nonpoint source phosphorus reduction in the Lower Potomac region expected by the December 1996 strategy reflects an increase from the 67.1 percent that had been calculated to a new reduction figure of 71.69 percent.

In summary, the December 1996 strategy states that high-energy wave action and the significant corresponding erosion rates "can be found extensively along the shores of Northumberland and Westmoreland counties". However, the strategy framework provides that a small increase in the percentage of shoreline defended can nearly achieve a 40 percent reduction in the controllable nonpoint source phosphorus load. The treatment of shoreline erosion in the calculations is problematic, and needs to be revisited by DCR or the Bay Program.

Conclusion

The reduction calculations that appear in the State's Potomac strategy document are performed with an elaborate set of linked spreadsheets. There are numerous files and data points. The problems with the strategy numbers do not appear to be related to the mechanical aspects of this work. Rather, it is the degree to which realistic and integrated assumptions (about BMPs and their efficiencies) are guiding the calculations.

As the year 2000 has drawn near, the number of best management practices that states have been enabled to recognize in their reduction calculations has increased. Determinations are also being made that in some cases, the efficiencies of practices can be increased. It is not clear the extent to which the interactive and cumulative impact of these BMP determinations, as they are getting applied by the states in tributary strategies, has received or will receive skeptical scrutiny from those who have no professional or organizational stake in the achievement of the reduction goal.

It is imperative that DCR take steps to ensure that careful and conservative assumptions are accurately applied, in order to promote more credible and realistic outcomes from its nonpoint source reduction calculations for use in the tributary strategies. This needs to be done regardless of the impact of these changes for the achievement on paper of an aggregate 40 percent nonpoint source nutrient reduction.

Recommendation (4). **In the short-term, the Department of Conservation and Recreation should recalculate the impact of its regional nonpoint source strategies, and the overall strategy, on nutrient reductions. The assumed nutrient management efficiencies used in the calculations should be skeptically reexamined. DCR should review other data, such as county fertilizer consumption rates, to assess whether the reduction amounts it is calculating are compatible with other available data. The calculations should take into account the interactive effects between best management practices, such as in agriculture. The calculations should be calibrated so that 100 percent BMP implementation yields a reduction amount that is credible relative to the size of the controllable nonpoint source load.**

The assumptions and calculations for the Lower Potomac should be revisited with regard to the shoreline erosion protection best management practice. The rationale, quantities, and efficiencies for this measure should be reexamined. DCR should also prepare and present reduction projection scenarios, rather than just one projection that assumes 100 percent voluntary

compliance by landusers for acres that are "covered" by a plan or BMP agreement.

Recommendation (5). **If the problems with Virginia's calculations, (specifically, the focus on counts of BMPs multiplied times efficiencies without regard to whether there are changing practices that may be working to increase nutrient loads, the lack of a systematic accounting for the interactive effects between BMP strategy decisions, and the use of a framework and a set of BMPs and efficiencies that enable calculations of reductions in excess of controllable amounts), then in the longer-term DCR should work within the Chesapeake Bay Program on developing a consistent set of assumptions that will produce more conservative and credible estimates and projections of nonpoint source reductions.**

IV. Key Issues Impacting Virginia's Future Nutrient Reduction Progress

Virginia's natural resource agency staff assigned to the Potomac strategy effort, and local participants in the regional assessment process, made a substantial effort in 1996 to produce a strategy that would accomplish nutrient reductions in the Basin. The resulting strategy contains some provisions which if implemented could provide the basis for some legitimate progress.

However, based on the information that has been examined for this review, three major conclusions about the future of Virginia's Potomac nutrient reduction effort have been drawn. First, there are a number of areas of uncertainty that will need to be monitored to assess Virginia's progress and the legitimacy of future claimed reductions. Second, and related to these uncertainties that exist with regard to the Commonwealth's strategy, the prospects for reaching and maintaining a 40 percent nutrient reduction goal in the Shenandoah and Potomac Basins are currently bleak.

Third, and from purely a progress standpoint, there are some areas which the draft strategy does not substantially address: point source actions directed at phosphorus from plants and industries above the fall line; limits of technology nitrogen removal; and urban nonpoint source controls that cut more into baseline loads, as opposed to just focusing on minimizing the impact of new development. If substantial progress were possible in these areas, the outlook for achieving the goal could be considerably improved. The technological and cost implications of these issues, however, has been beyond the scope of this review, and thus the mention of these areas clearly does not constitute a recommendation. However, from a progress standpoint, it appears that now is the time, if ever, for a debate to occur about whether these issues are going to be further addressed in Virginia's strategy.

In addition to these conclusions about the Potomac strategy, the preparation of strategies for achieving nutrient reduction progress in Virginia's lower tributaries has been a lower priority of the Commonwealth. Virginia's natural resource agencies have not released any progress reports to update the information it provided in 1993 on nutrient reduction progress in these tributaries from 1985 to 1991 and projected to the year 2000. A recent report of the Secretary of Natural Resources calls into question whether or not these strategies can and will be produced within the schedule that was provided in House Bill 1411 and enacted into law.

This chapter discusses the areas of uncertainty, the prospects for meeting the goal, and some areas in which more action may be needed relative to the draft Potomac strategy. The chapter concludes with a discussion of the lower tributary strategy effort.

SEVERAL AREAS OF UNCERTAINTY WILL NEED TO BE MONITORED TO ASSESS VIRGINIA'S ONGOING PROGRESS

There are many areas of uncertainty that surround any projections of accomplishments for the future. This review found that the issue of nutrient progress for the Bay is no exception. In fact, there are numerous areas of ambiguity and uncertainty. These areas of uncertainty at this time include, but are not limited to:

- whether the State will provide substantial funding for its commitment to achieve a 40 percent reduction;
- whether State agencies are committed, beyond the teams which have been assembled to develop the strategies, to follow-through and pursue the goals, or at least to avoid taking actions that work at cross-purposes against the strategy;
- the extent, ultimately, of locality "buy-in" to the strategy;
- what the extent of implementation of BNR might be, in terms of which plants install it and what improvements in concentration levels will result;
- land-user response to participating in the effort and following-through over the long-term with nutrient abatement actions; and
- the impact of technical issues on progress calculations, such as possible revisions in flow projections for sewage treatment plants, and whether DCR makes the adjustments needed to obtain more conservative and credible nonpoint source reduction estimates.

To a significant extent, the future success of Bay nutrient reduction programs will depend on the long-term commitment and leadership of State and local officials. Without this leadership, the Bay's water quality will likely be at risk.

Will the State Demonstrate a Long-Term Commitment to Reducing Potomac Nutrients Through Its Funding Over Time?

It is clear from the October draft strategy and its appendixes that participants in the regional assessments expected that substantial costs will be involved and that State funds would have to be available if they were to fulfill the responsibilities at the local level. For example, the Southern Shenandoah assessment states that:

> The region's strategy calls for increased state funding of the voluntary incentives program, which provides cost-sharing for implementation of agricultural Best Management Practices. Seventy-five percent (75%) cost-share funding would be offered on all animal waste control

> facilities.... Grant funding for BNR should be included.... The strategy assumes the availability of outside (non-local) funding.... Willingness to add BNR technology depends on the availability of satisfactory funding.

The Commonwealth's October draft strategy document also stated that:

> The time needed to fully implement the Strategy is largely dependent on the availability of local and state funding. If a five year funding program were endorsed, and if the Commonwealth were to proceed with a cost share program requested by the local governments and stakeholders, the annual financing need would be approximately $16-20 million for the state and $15-19 million for local government and citizens.

For the 1997 General Assembly session, the Governor's budget contains funding for Potomac strategy implementation. Also, the General Assembly is considering several bills with proposed approaches to establish nutrient reduction funding. A long-term commitment will be needed to achieve long-term progress.

Are State Agencies Committed to Act Consistently With the Goals?

Another area of uncertainty is whether the key agencies of State government will follow through with the kind of agency-wide commitments that will be necessary to move forward towards the goals. The Potomac tributary assessment process involved pulling selected staff from these key agencies to work on developing the strategy. However, there is a concern that a disconnection may exist between the attitudes and activities of staff that developed the strategy, and the attitudes and activities of managers and staff who control the regulatory mechanisms of those agencies. For example, when the potential exercise of its regulatory machinery is at issue, DEQ has expressed disbelief that a link between upstream sources and Bay dissolved oxygen levels has yet been established. Also, CBLAD is reconsidering the direction of a nutrient reduction effort (agriculture farm plans) that is an important part of the State's strategy.

DEQ Has Spoken and Acted Inconsistently on the Subject of Tributary Nutrient Reductions and the Bay. In its February 1996 statement explaining its proposed regulation "Policy for the Potomac River Embayments," DEQ staff indicated that the need for nitrogen reductions had not yet been adequately demonstrated. DEQ's summary for the regulation stated that the proposed regulation will "require wastewater treatment for total nitrogen if and when it is determined by the Chesapeake Bay Program studies that nitrogen removal is needed to protect the Bay" (emphasis added).

Similarly, a DEQ staff permit writer recently represented that DEQ's agency view is that current evidence is unconvincing that upstream Potomac nitrogen contributes to water quality problems in the Bay. This statement was made in a letter to a local government official, on a permit matter that was elevated in importance because EPA had become involved with the permit. The regional permit staff member wrote:

> EPA [has] stated its position that Total Nitrogen discharged by [this Potomac Basin sewage treatment plant] and other wastewater dischargers within the Bay drainage area contributes to violations of the Dissolved Oxygen (D.O.) Water Quality Standard in the Bay. EPA has cited the results of a “supermodel” to support their position.
>
> As you are probably aware, Virginia has not adopted a Water Quality Standard for Total Nitrogen. Additionally, the “supermodel” notwithstanding, DEQ is currently unconvinced that a clear cause-and-effect relationship exists between Total Nitrogen discharged far upstream of the Chesapeake Bay and violations of the D.O. Standard in the Bay. [emphasis added].

In contrast, the Potomac Tributary Strategy process within which other DEQ staff have participated has unfolded since 1993 on the foundation that studies have indicated that nitrogen needs to be reduced for the health of the Bay and that upstream sources of nutrients make a difference. DEQ stated in its 1993 Potomac paper that:

> ...in an average hydrologic year, we can expect that roughly 40 percent of the total nitrogen load and 22 percent of the total phosphorus load from tributary point and nonpoint sources will be transported to the Bay with the majority of the loads occurring during the spring.... LOT (limits of technology) controls in just the upper and middle portions of the Bay improve oxygen levels in the Bay by over 29 percent. LOT controls in just the middle region of the Bay, including the Potomac River Basin, result in a 21 percent improvement. However, if the Potomac River Basin is removed from this analysis, dissolved oxygen conditions in the main Bay improve by only 12 percent. Therefore, we can see that the Potomac Basin has a significant impact on water quality conditions...”

Similarly, DEQ’s 1995 Potomac paper did not appear to question that a linkage between Potomac nutrients and the health of the Bay has been well-established. That document stated:

> Reducing nutrients will improve habitat for fish, shellfish and aquatic vegetation in the Potomac River and the Bay, principally by increasing levels of dissolved oxygen.... Scientific studies have shown that reducing the annual level of nutrients entering the Bay from the Potomac River and other tributaries by 40%, relative to the 1985 baseline year, will help to reverse these problems.

With regard to the issue of upstream sources and the Bay model, there is some literature on the subject which has raised some questions about the relative importance of far-upstream pollutant loads relative to coastal loads. And, to some extent, the Bay model uses delivery rates that are reduced the further upstream the source. However, in each Potomac strategy document since 1993, DEQ has accepted the use of the model and incorporated the concepts of the model into its calculations. The sewage treatment plant in question on the described permit matter, as well as other upstream dischargers, have been included in DEQ's estimates of nutrient loads delivered to the tidal portion of the River. In fact, in DEQ's documents, the estimated delivery rate to the tidal portion of the River for the sewage treatment plant in question has been shown at over 80 percent. DEQ staff engaged in the Tributary Assessment Process have been explaining the need for the 40 percent reduction in all regions of the Potomac on the basis of the health of the Bay as well as the Potomac.

Virginia's natural resource agency management and staff should reflect on the state of the science on nutrient impacts upon the Bay, and the relative role of upstream sources. However, a great deal of uncertainty is introduced when different units of the same agency speak at the same time with clearly conflicting perspectives on the core premises of a major initiative of the State.

In addition to inconsistencies in its statements, DEQ has also been taking actions on the regulatory front that appear counterproductive to the State's ability to be well-informed and address certain nutrient pollution issues. DEQ has substantially reduced its inspections of animal waste storage facilities, and has not dealt seriously through enforcement with flawed sewage treatment operations.

For example, animal waste storage structures for liquid waste can leak, and potentially contaminate the soil and ultimately the groundwater, Virginia has a Virginia Pollution Abatement (VPA) Permit program that contains waste storage and disposal requirements for larger facilities. However, as indicated in the JLARC DEQ report, VPA water inspections statewide have declined precipitously since FY 1992 (from 539 to 176). This pattern is in evidence in each of the six DEQ regions of the State. In the Valley region, the decline began in FY 1993; while the number of inspections labeled as "priority" inspections were 23 in FY 1993 and 17 in FY 1996, the number of "other" inspections dropped from 69 to 5.

In addition, the JLARC DEQ report documents that the agency has been particularly weak in the enforcement of regulations pertaining to local government, which is predominately sewage treatment plant waste. The report documents sewage overflows and discharges of untreated sewage that resulted in no formal enforcement by DEQ or minimal civil charge penalties (for example, $1,000 for a serious violation). Obviously, to the extent these incidents occur, and as egregious cases appear to be tolerated, actual nutrient releases may be different and higher than is reflected in the typical operation values that are used by DEQ bay program staff in their calculations.

CBLAD Is Considering Major Changes to Its Regulatory Provisions for Farm Plans and Septic Tank Pumpouts. The August 1995 Tributary Strategy included farm plans and septic tank pump out as two of "Virginia's Core Nonpoint Source Programs." These programs were described as follows:

> Soil and water quality conservation plans, also known as farm plans, are comprehensive natural resource management plans that typically focus on the use of erosion and sediment control practices to reduce nutrient loadings associated with sediment loss from cropland.... Approximately 55% of all cropland in the Potomac River Basin is currently covered under these plans. Further implementation of soil and water quality conservation plans will be achieved as a result of the Chesapeake Bay Preservation Act's requirement that all farms in Tidewater Virginia prepare conservation plans....
>
> Septic tanks release nutrients to groundwater and sometimes to surface waters. The Chesapeake Bay Preservation Act Regulations require on-site sewage treatment systems, not requiring a Virginia Pollutant Discharge Elimination System (VPDES), to have pump-out accomplished at least once every five years.

However, the CBLAD regulatory committee and regulation advisory committee began a process in October 1996 for revising the agency's regulations for which two of the "big issues" identified were the agricultural requirements (farm plans) and the septic system requirements (the other issue was stormwater management). In May of 1996, the agency director of CBLAD at that time had indicated that the agriculture and septic system requirements would be revisited. The director said that the agriculture conservation regulations "do not work." The director said that far more tracts are now covered by the requirement than had been intended, that the 1995 deadline had obviously proven unworkable, and that farm plans are being written "that will not be used." The director said that there is no requirement that the plans be implemented, so a lot of plans are written but not implemented.

These candid comments were made within the context of regulatory review and eliminating or amending burdensome or unnecessary requirements, not in the context of the tributary strategy effort. There is a contradiction, however, between considering State relaxation of farm plan requirements on the one hand (because they are said not to work and are not being implemented), and the reliance by the Commonwealth on a tributary strategy that has as a centerpiece the placement of plans on farms for voluntary implementation.

Will All Localities Be Engaged in the Effort?

The achievement and maintenance of a 40 percent basin-wide reduction in nutrients is such a difficult challenge that non-participation or restricted participation by a locality, or especially any sizable locality, could be a major threat to progress. Based on the strategy document dated December 1996, it appears that as of the end of 1996 there were 12 county boards or city councils that had endorsed the strategy, but 14 had not. There have been some clear trouble spots with regard to local involvement in the process.

In the Northern Shenandoah Valley region, Frederick County went on record on July 10, 1996 as not supporting the regional framework for the region. The county administrator wrote to DEQ staff:

> Frederick County has grave concerns about the inadequacy of the public process which produced this document. Many of the measures suggested in the strategy have unknown costs and provide no mechanism for compensating localities or affected individuals for these costs.... At this point in time, there are numerous unanswered questions regarding what effect the various control measures would have on the agricultural community and the economy of the County as a whole.

Since that time, DEQ staff indicate that the team leader for that regional effort has met with county Farm Bureau representatives and brought them into the process. However, funding and issues related to maintaining the reduction continue to be concerns of the county.

In Northern Virginia, local staffs did not feel empowered to contribute suggestions to State staff about how the 40 percent reduction might be achieved. As a result, State staff developed what they called a "strawman" assessment document for the region to react to. That assessment became the region's strategy. The local governments in that region, however, have not endorsed the content of this strategy. The October 1996 final comment draft on the strategy notes that "given the limited time frame and complexity of this topic, local elected officials have not yet fully reviewed and concurred with the 'strawman assessment'."

The full projected reductions from the process for all localities are included in the reductions shown in the strategy document, however. Whether or not all localities ultimately decide to fully participate could have a significant impact on the amount of progress that is achieved.

Nutrient Removal Upgrades: Which Facilities and How Much Removal?

Chapter III of this report noted that some differences in assumptions appear to exist about the potential of BNR at several large sewage treatment plants. If reductions cannot be obtained from these facilities based on achieving a nitrogen concentration of seven or eight milligrams per liter or less, then the progress suggested by the strategy will be at serious risk.

While it is possible that lesser flow increases at these plants than projected might help the State avoid falling far below the 40 percent goal in the short term, in the long term higher nitrogen concentrations than DEQ is assuming could be a major obstacle to the State's progress toward the goal. For this reason, in discussions of the plant designs and expected costs for BNR under either the strategy or VAMWA's proposal, it will be important to consider the resultant nitrogen concentrations that are expected from these designs and costs.

Among the expected reductions that are contained in the strategy is the reduction of nitrogen loads from Virginia's portion of Blue Plains. This extremely large District of Columbia sewage treatment plant also treats Maryland and Virginia loads. The District and the facility have been much-criticized recently by Virginia for problems alleged to impact the Bay. Since the time of Virginia's 1995 Potomac strategy, however, DEQ has projected the nitrogen load delivered from Blue Plains in the year 2000 as 936,061 pounds per year, compared to 1,141,844 pounds per year in 1994. This was expected in part because DEQ projected a 7.5 milligram per liter nitrogen concentration at Blue Plains in its 1995 document, or a lower concentration level than DEQ was able to project at that time for 23 of Virginia's 25 sewage treatment plants (the small federally-owned Quantico STP and the small Aquia STP were projected at 7.0 milligrams per liter).

The State's strategy applies the 7.5 milligram per liter concentration level at Blue Plains in its calculation of the expected year 2000 load, irrespective of the implementation of the State's strategy. Because Blue Plains is applying its reduction technology on a pilot basis, and because there have been some past concerns about the management of Blue Plains, the progress that is achieved at Blue Plains will need to be monitored for its impact on Virginia's loads from the plant.

What Will Be the Response of Land Users to the Effort?

It should be recognized that this strategy effort of the Commonwealth is not the first time that the State will have indicated its intent to mobilize a major effort to reduce nonpoint source pollution. For example, the State's *1985 Annual Report Best Management Practices Program for the Abatement of Nonpoint Source Pollution* stated:

> Planning for a program to reduce agricultural and urban nonpoint source in the Chesapeake Bay Drainage Basin of Virginia began in 1983. A 35-member advisory committee representing agricultural, soil conservation and water quality interests assisted [State agencies] in this effort.... [L]eaflets for distribution to farmers and land owners... describe specific water quality problems and solutions and are being used to help farmers implement water quality improvement practices.... [T]he supply of 96,410 BMP leaflets at the Extension Distribution Center is now exhausted.... Example topics are: (1) no-tillage practices; (2) fertility management; and (3) general information about the Chesapeake Bay program. Attendance by all farmer meetings and tours for FY 1985 totaled 13,010. Extension agents reported during FY 1985 that 5,800 farm visits were made as part of nonpoint pollution education programs. During the last four months the agents noted 777 farmers had implemented practices to improve water quality.

If this description is accurate, it appears at that time there was more of a major educational and awareness campaign under way then than there is today, or than is stated in the tributary strategy document. Still, based on findings like subsequent assessments of changes in nitrogen levels in the Potomac Basin, it appears that there is little reason to believe that this effort led to an explosion in the effective implementation of BMPs on agriculture land.

The difficulties of achieving effective land owner response to nonpoint pollution control has been discussed in some detail earlier in this report. The difference between a strategy plan and achieving actual implementation is further underscored within the strategy documents as well. In the October strategy appendix, under the heading "Not a Commitment to Final Implementation," the Northern Shenandoah assessment stated:

> This document does not impose any commitments to implement nutrient reduction practices on individuals who were involved in the assessment process, nor on any third party, except where such commitments have been voluntarily assumed. The assessment is not an effort by the Commonwealth of Virginia to require the development and operation of these practices by citizens, farmers, businesses or local governments. Rather, the assessment is an effort to identify the types of practices that would be cost-effective, practical and equitable....

Consistent with that spirit, it seems inappropriate to assume in the reduction calculations that landusers will fully implement all of the BMPs that are hypothesized for the future from the assessment process. Actual implementation is an issue that will need to be monitored over time.

Will the State's Calculations of Progress Be Credible, and Will Accurate Information Be Provided to Policymakers?

One of the aspects of progress that will need to be monitored over time is the credibility of the numbers that are produced on reduction amounts. Chapter III of this report has documented a number of ways in which there is reason for concern about the current state of these calculations.

Also, the calculations for nonpoint sources are fairly involved, and it may be that the only way such monitoring can be accomplished in the future will be to obtain the actual spreadsheets that DCR uses in the calculations. There were many limitations in the accuracy or inclusiveness of DCR explanations in response to written questions for this review.

For example, JLARC staff asked if DCR had figures it used in generating tables showing 1994 and 2000 progress for farm plans and nutrient management that were broken down by type of cropland (between conventional tillage, conservation tillage, and hayland). The DCR response was no. But clearly, if differential nutrient load rates per acre and different percent efficiencies were to be applied by type of crop in calculating the reductions, this response had to be in error. When the DCR spreadsheets for the farm plan and nutrient management calculations were obtained, the data were broken down very specifically by type of cropland in the farm plan file and the nutrient management file.

JLARC staff also requested documentation of the nutrient management efficiencies that were being used. DCR's written August 1996 response stated a range of efficiencies being used. The maximum value stated turned out to be less than the maximum values used in the spreadsheet. Further, the response stated that:

> Attachments have been included, which show the efficiencies for each watershed segment. (Maryland and Pennsylvania are also utilizing these percent reductions from the nutrient management scenario runs in the development of their tributary strategies).

The attachment provided a table from the December 1992 ICPRB report previously mentioned in Chapter III. However, later it was found that DCR was actually using a revised set of efficiencies which differed from the furnished attachments, based on the May 1993 ICPRB memorandum.

JLARC staff requested clarification on how progress can be assessed for the animal waste measure between the 1985 baseline unit measure of "manure acres" and the new measure of "systems" that it started to display in its 1995 document. To this point, JLARC staff have still not received an adequate response to this question that makes sense in relation to the magnitude of the number of "systems" that have been reported as installed. A translation of the number of systems given in the strategy to manure acres based on the stated value of 1.03 manure acres per system does not appear plausible relative to the 1985 baseline quantities for manure acres.

JLARC staff also asked if the "numbers shown" in a table providing 1985 baseline year acreage amounts in the four regions had been updated since the 1995 report. DCR stated that the table "has not been revised." However, JLARC staff did not know at that time, but DCR would have known, that it had a working draft of the Lower Potomac Regional Assessment containing major changes in baseline acreage amounts for that region. For example, the 1995 report table had a baseline figure for the three types of cropland that summed to 36,501, whereas the Lower Potomac paper had 63,513 acres of cropland as the base. All of these problematic responses came within the span of answering six initial written questions from JLARC staff.

With regard to the prospects for more conservative and credible reduction calculations, there is reason for concern that DCR may exert leadership, or be pulled, in the opposite direction. DCR participates in the Tributary Strategy Workgroup of the Nutrient Subcommittee of the Chesapeake Bay Program. This workgroup, heavily composed of representatives of agencies from the various Bay states who have committed to meet the 40 percent goal, has added new BMPs and found additional or higher efficiencies. For example, a member of the EPA's Chesapeake Bay Program staff indicates that instead of the 75 percent efficiency previously assumed for animal waste control, through the use of extensive guttering, another 15 percent can in theory be captured and returned. Due to the dynamics of the multi-state process, the type of question that needs to be raised in such situations is whether each state, including Virginia, are performing an analysis of the extent to which BMPs already implemented or planned have this guttering, or whether each state plans to fold this entire reduction into the calculations, regardless of whether there is substantial evidence that existing or planned facilities have such gutters.

At least if DCR's current calculations are a reflection of the general methodology being employed in the other states as well, then it does not appear that the subcommittee has successfully dealt with issues that relate to the potential overestimation of reductions.

Over Time, How Does Reality Compare to the Calculations of the Strategy?

There are a number of indicators that will need to be reviewed over time to monitor the State's progress and determine how well the projections that the State has made are being met. These indicators include: (1) trends in sewage treatment flows, (2) indicators of potential progress or regress in moving toward the goals, such as BMPs implementation and fertilizer use trends, and (3) extent of measured changes in water quality data over time for nitrogen and phosphorus.

Sewage Treatment Plant Flows. One of the most important indicators to monitor are sewage treatment plant flow changes over time, and how actual and revised projections of flow levels compare to strategy assumptions. The amount of the flows has a major impact on the amount of point source nutrients that are calculated. Between 1994 and year 2000, the projection used in the strategy is that sewage treatment flows in the Potomac will increase by about 3.7 percent per year. Actual increases and revised flow projections between now and then will need to be monitored.

Indicators of Possible Progress or Regress in Meeting Nonpoint Source Goals. There is also a need to review data on the implementation of best management practices over time and other data that might relate to the success of the Commonwealth's effort. For example, the strategy is predicated on major increases in the writing of nutrient management plans. The number of plans that are written should be monitored over time, and the percentage of written plans which receive fairly constant implementation should be assessed. The consistency of BMP implementation assumptions and their projected results should also be compared with other indicators of nutrient use, such as fertilizer consumption trends.

As part of the 1996 Potomac tributary strategy process, DCR has not promoted maximum disclosure of this type of information. Whereas the August 1995 tributary document showed progress through 1994, the October 1996 document does not disclose what progress has been made through 1995.

Water Quality Data. Also, monitoring data for nitrogen and phosphorus levels in the tributaries and the Bay will obviously need to examined to see if those measurements are consistent with the level of reductions that are being indicated by the model. This analysis will need to be sensitive to a variety of issues, such as sorting out the impact of Virginia's improvements from those of other states, and taking into account the point that nonpoint source progress is indicated to be relatively slowly reflected in water quality data.

REACHING AND MAINTAINING THE 40 PERCENT REDUCTION GOAL IN VIRGINIA'S PORTION OF THE POTOMAC IS UNLIKELY

The two most significant issues which are given inadequate attention in the 1996 Commonwealth tributary strategy are: (1) population growth, and (2) what it means to maintain the 40 percent reduction after the year 2000, if indeed the goal were met. The year 2000 reduction goal is not a static goal, waiting to be achieved. If the State has a plan that falls short by a few percentage points for the year 2000, that does not mean that with a little more effort and within a few more years, it can simply close that percentage and meet the goal. It is not a static goal because at a minimum, population growth will mean increases in sewage treatment plant flows, and therefore more nitrogen and phosphorus loads.

The Commonwealth is already seeing this process operate, relative to the phosphate detergent ban the State enacted in 1988. DEQ has estimated that through this ban, point source phosphorus loads in 1991 were down 41 percent from 1985 levels. However, DEQ in 1995 also projected that by the year 2000, absent further point source action, the reduction progress will have been more than sliced in half, to about an 18 percent reduction. Little has been seen in the way of new inexpensive technologies to offset the impact of population growth upon achieving the phosphorus goal, nor has much been seen in terms of a State will to apply stringent phosphorus controls above Virginia's fall line.

The Commonwealth's strategy calls for year-round biological nutrient removal (BNR) or its equivalent, an approach that if fully implemented by the year 2000 would reduce nitrogen around the 40 percent level. However, time is probably no longer available to accomplish this by the year 2000. The Commonwealth's strategy states that "due to construction schedules for major wastewater treatment plant projects, the time needed to put into place all of the Strategy's recommended nutrient controls is anticipated to range from five to nine years." The further implication that the strategy does not draw, however, is that in five to nine years from the end of 1996, flows could surpass the current projection that is specifically for the year 2000, and therefore BNR may not come so close to accomplishing the 40 percent reduction. Further, flow increases from that point could further erode progress. These points are demonstrated in the projections in Chapter II of this report.

Not long after the year 2000, then, the State may be faced with projections indicating more growth in flow, and it will have just completed a systematic, major, and fairly expensive upgrade across plants. As the VAMWA position paper indicates, also at that point there will probably be little willingness to consider further (and especially immediate) STP changes. In addition, the State's strategy, which in the short-term will have relied heavily on agriculture BMPs, will, if successful, have largely tapped the progress that can be made cost-effectively.

In addition, this report has also indicated that there are reasons to think that: (1) complete installation of BNR appears unlikely, especially at the effectiveness levels expected in DEQ's numbers, and (2) the nonpoint source reduction progress calculations appear to be overstated. For all of these reasons, it is JLARC staff's conclusion that the outlook for reaching and maintaining a 40 percent reduction goal is currently bleak, although some good progress can be made.

ACTIONS THAT MAY BE NECESSARY IF VIRGINIA WISHES TO REACH THE GOAL AND MAINTAIN ITS PROGRESS

This report has indicated that several items will be critical to determining how much progress Virginia makes towards its nutrient reduction commitments. It needs to be kept in mind that these items have been identified as critical from a progress standpoint, but from a technology, cost, and public policy standpoint, many issues are involved in terms of deciding what actions should be undertaken or what actions are justified to pursue the goal. It may be the case that, as more is known about what exactly is entailed in meeting and especially maintaining a 40 percent goal in the face of rising sewage treatment plant flows, the State may need to reassess its commitment to the goal.

Extension of Greater Phosphorus Controls to Sewage Treatment Plants Above the Fall Line

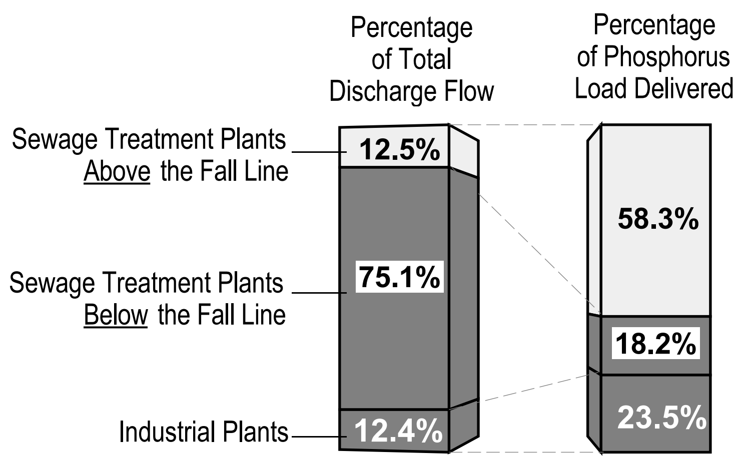
The figure for 1985 controllable baseline loads to the Bay is the figure against which progress is measured toward achieving the 40 percent reduction goal. According to DEQ estimates, the annual baseline load in pounds per year for phosphorus was about 578,504 pounds.

There are three principal categories of point source contributors to the baseline load: sewage treatment plants above the fall line (generally, STPs from the Northern and Southern Shenandoah Valley), sewage treatment plants below the fall line (Northern Virginia and Lower Potomac STPs), and industry plants. Some important findings emerge when the data for these categories are examined with regard to the volume of the discharge flow from these categories, the phosphorus concentration levels of these flows, and the estimated phosphorus loads that are then (according to the model) delivered to the Bay.

Specifically, the sewage treatment plants below the fall line accounted for by far the greatest proportion of the discharge flows (see Figure 8). This is to be expected given the large populations that these plants serve. However, due to the Potomac Embayment Standards, which required stringent phosphorus controls at several of these plants since 1971, and the minimal phosphorus concentration levels that therefore existed at several of these plants in 1985, these plants are estimated to have accounted for a small proportion of the phosphorus loads that were delivered to the Bay.

Figure 8

Comparison of 1985 Discharge Flows and Phosphorus Loads from Potomac Point Sources



Source: JLARC staff analysis of DEQ point source flow and phosphorus load data for 1985.

On the other hand, the loads of sewage treatment plants and industrial plants above the fall line had a disproportional impact because the concentration levels are much higher. Based on DEQ's figures for 1985, the average flow-weighted concentration for point source phosphorus above the fall line was about 6.4 milligrams per liter, compared with about 0.25 milligrams per liter below the fall line. The concentration above the fall line was reduced to 2.5 milligrams per liter through the phosphate detergent ban, but this is still about ten times the concentration of the plants below the fall line.

In 1993, DEQ's first Potomac nutrient reduction paper stated that:

> [P]oint source phosphorus has already been reduced slightly more than 40% in the Potomac Basin.... However, as wastewater flows continue to increase, phosphorus loads will also increase if additional phosphorus treatment is not provided. One option to offset these increasing loads is extending the application of the Point Source Policy

> to areas of the basin where it does not currently apply. Additional treatment plants would then have to install phosphorus removal to comply with Policy requirements.

Since the time of that DEQ paper, DEQ has not pursued the application of more stringent phosphorus removal within a broader portion of the basin. Further, the 1996 draft strategy contemplates only that through BNR, some of these plants may reduce phosphorus concentrations from 2.5 to 1.5 milligrams per liter. This is an area in which additional action could be used to bring additional reductions. Chapter II indicates how the use of phosphorus controls somewhere between the limits of technology and the levels in the strategy could be used to help meet the goal.

Nitrogen Removal at Higher Reduction Efficiencies Than Under Current Discussion

The State strategy does not call for nitrogen removal at the limits of technology (three milligrams per liter) at any facility. Yet to meet and maintain the goal, Chapter II of this report has indicated that the use of LOT at some facilities may be essential. This is an area in which desires to achieve the goal and cost and other realities may be in particular conflict. As was indicated in Chapter III, officials of some key sewage treatment plant facilities as well as local governments may not be interested in or feel that is feasible to utilize BNR technology in a way that achieves seven milligrams per liter, let alone three milligrams per liter. However, the State may find that it either needs to be willing to promote the use of such expensive technologies, or to lower the percent reduction to which it is able to commit itself.

More Reductions from Baseline Urban Nonpoint Source Loads

This report has indicated that much of the nonpoint source reductions that are contemplated in the strategy come from agricultural cropland and animal waste storage management measures. It appears that in many instances these estimates are extreme, producing a nutrient runoff reduction in one county of 87 percent from cropland without even obtaining full BMP implementation.

The current strategy projects little success in addressing nitrogen runoff from urban nonpoint sources. For example, based on data reported in the strategy, the nonpoint strategy is projected to accomplish about a 9 percent reduction in baseline loads for nitrogen from urban sources. This is an area in which additional measures and expense may need to be considered if the 40 percent reduction goal is to be met. The strategy document recommends that an evaluation be conducted of urban and suburban nonpoint-source nutrient reductions, “to look at the variety of nutrient-reduction techniques or programs that may be available, particularly with respect to managing residential nutrient loadings.”

PURSUIT OF INTERIM NUTRIENT GOALS FOR LOWER TRIBUTARIES HAS NOT BEEN A PRIORITY

EPA and Virginia's natural resource agencies concur that the nutrient loads from Virginia's lower tributaries, including the James, do not have a great impact on the water quality conditions of the Bay. The former director of CBLAD (now director of DCR), for example, has indicated that the lower tributaries are responsible for less than one percent of the dissolved oxygen problem in the main stem of the Bay.

However, in December 1993 the Commonwealth committed to Directive No. 93-1 of the Chesapeake Executive Council, which was a joint tributary strategy statement. In this directive, the Commonwealth made a commitment to nutrient reductions in the lower tributaries. This commitment was based on interest in protecting the living resources of these rivers that are a part of the Bay watershed. This directive stated in part that in Virginia's lower tributaries:

> ...nutrient reductions which may have little influence on the main stem will still improve local conditions. For this reason, the Chesapeake Bay Program and Virginia will conduct long-term monitoring and computer modeling of these tributaries to determine the level of reduction necessary to improve living resource conditions. Between now and 1997, when this special study is completed, Virginia will implement an interim 40 percent reduction strategy. [emphasis added]

Shortly after the commitment was signed, however, DEQ's 1993 Potomac tributary paper signaled that the interim reduction figure had no weight. DEQ's 1993 Potomac paper did not mention the interim reduction figure, and instead emphasized that:

> For Virginia's rivers below the Potomac, the problems are mainly in the rivers themselves, and we don't yet know their appropriate reduction goals. Therefore, we will...develop customized reduction targets for each river.

Virginia Has Taken a Phased Approach

By October 1994, it was clear that the State had decided that it was not going to pursue the development of specific nutrient reduction plans for other tributaries while working on the Potomac, as was being done in Maryland. Virginia's 1994 Potomac document indicated that a phased approach would be employed:

> Specific action-plans and targets...will be fully developed for each tributary following completion of the Potomac Basin Tributary Strategy. We have already begun to develop nutrient-reduction goals for

> each tributary... and we expect to have nutrient-reduction goals for the lower tributaries by late 1997 or early 1998.... [W]e view the development of the Potomac Strategy as a possible prototype for our future lower tributary strategies.

Reasons given for the delay on the lower tributaries have included a lack of staffing, the benefits of the opportunity to learn from a prototype effort, and the desire for modeling to determine the specific goal before commencing the effort. There is a risk that in striving toward an interim 40 percent goal, for example, Virginia might develop plans that would exceed the minimum reduction actually necessary.

As a result, Virginia's natural resource agencies have performed so little work in the lower tributaries that updated (from the time of the 1993 paper) estimates and projections of progress achieved are not available. For example, in August 1996 JLARC staff posed the question to DCR of whether any more recent nonpoint source estimates and projections for the lower tributaries had been made since 1993, and received the following response:

> No more recent estimates have been made for nonpoint progress in the lower tributaries. This will be the first step in the development of the strategies for the lower tributaries and will involve substantial local involvement. Most of this work will be accomplished in early 1997.

Report States that Acceptable Products Cannot Be Produced Within *Code of Virginia* Deadlines for Remaining Tributaries

In November 1996, the Secretary of Natural Resources provided the *First Annual Report on the Development and Implementation of Nutrient Reduction Strategies for Virginia's Tributaries to the Chesapeake Bay*. In a letter to the Chairman of the House Committee on Appropriations, the Secretary indicated that "I direct your attention to our concerns over producing satisfactory tributary strategies for these river basins by the current legislative deadline." The body of the report states that:

> We have concluded that the strategies for those tributaries [the Rappahannock, York and James] cannot be completed in any acceptable fashion by that [January 1, 1998] deadline. It is not known at this time... how appropriate the January 1, 1999 legislative deadline for the coastal basin nutrient reduction strategies might be. That question will be examined in detail in the 1998 report on tributary strategies.

There were two reasons cited for the concern with the existing deadline. First, there is a concern with the amount of time that will be required to define, run, and interpret Chesapeake Bay water quality modeling scenarios. Second, there is a concern with the complexity of the strategy process that is involved for the lower tributaries. The report indicates that the process is made even more complicated and unpredictable than it was for the Potomac "by the need to establish nutrient reduction goals for each of the tributaries instead of starting with the goals in place."

Estimates and Projections of Lower Tributary Nutrient Reduction Progress that Were Made in 1993

Table 6 is provided to summarize the estimates of nutrient reduction progress in the lower tributaries that were made in the State's 1993 discussion document for the lower tributaries. The information is obviously dated, but it does provide an idea of the extent of progress that was expected at that time.

Table 6

Percent Changes in Nitrogen and Phosphorus Loads in Virginia's Lower Tributaries (1985-1991)

Tributary	*Nitrogen*			*Phosphorus*		
	Total	Point	NPS*	Total	Point	NPS*
Rappahannock	-3.7	+10.9	-4.9	-16.8	-58.7	-5.7
York	-3.6	-1.4	-4.5	-29.3	-54.6	-4.7
James	-9.9	-12.5	-5.1	-30.3	-41.9	-6.3
Western Coastal	-5.6	-10.6	-3.2	-39.9	-62.5	-4.2
Eastern Coastal	-18.7	-59.2	-3.7	+20.0	+279.0	-4.0
Average	-8.4	-12.0	-4.8	-28.9	-44.7	-5.6

*NPS is used to designate the nonpoint source estimates.

Source: DEQ's 1993 *Discussion Paper: Reducing Nutrients in Virginia's Tidal Tributaries.*

The document showed estimated progress in total, and by point and nonpoint sources, from 1985 to 1991. The last row of data in the table shows the results across the tributaries, based on average loadings across all of them. (The average results are very similar to those for the James, however, because the James has by far the largest nitrogen and phosphorus loadings among the group).

As with the previously-discussed progress in the Potomac to 1991, in the lower tributaries point source phosphorus was the area of greatest reduction, or an estimated 44.7 percent. The 1993 DEQ paper noted that "we have made very good progress in reducing phosphorus, primarily as a result of the phosphate detergent ban which went into effect in January 1988." Estimated reductions in point source nitrogen, nonpoint source nitrogen, and nonpoint source phosphorus were much smaller, at 12.0 percent, 4.8 percent, and 5.6 percent, respectively.

The 1993 paper did not provide projected total or point source reductions to the year 2000. It did provide projections for nonpoint sources, indicating a projected range from a low of a 10 percent reduction in Western Coastal nitrogen to a high of a 23 percent reduction in Eastern Coastal phosphorus. In the James, 14 and 15 percent reductions in nonpoint nitrogen and phosphorus were projected respectively. At that time, then, expected nonpoint source progress in each of the other tributaries was expected to fall short of Potomac nonpoint progress in the year 2000, which was then projected at 26 percent for nitrogen and at 25 percent for phosphorus.

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