Baywide Nutrients Reduction Strategy

An Agreement Commitment Report from the Chesapeake Executive Council

Annapolis, Maryland
July 1988

ADOPTION STATEMENT

We, the undersigned, adopt the **Basinwide Nutrient Reduction Strategy,** in fulfillment of Water Quality Commitment Number 1 of the 1987 Chesapeake Bay Agreement:

> *"...by July 1988, to develop, adopt, and begin implementation of a basinwide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay. The strategy should be based on agreed upon 1985 point source loads and on nonpoint loads in a average rainfall year."*

The Strategy establishes the baseline nutrient loading conditions and the year 2000 nutrient loading target for each jurisdiction. The Strategy outlines a phased approach toward meeting the 40% reduction of nutrients by the year 2000 so that the most environmentally effective and cost effective control programs are implemented.

The Strategy also identifies additional information that is needed during the next several years in order to refine the strategy in the coming years. A Basinwide Nutrient Strategy Progress Report will be produced on an annual basis to report on progress and incorporate any necessary refinements to the Strategy.

The Chesapeake Bay Program has under development a sophisticated water quality model of the Bay that is scheduled to be completed in time to be used during the December 1991 reevaluation of the 40% reduction commitment. This model will allow managers to evaluate alternative nutrient control strategies for each major river basin in the Bay watershed and select an equitable mix of programs and tributary reduction targets to meet the overall nutrient reduction goal for the Bay.

For the Commonwealth of Virginia

For the State of Maryland

For the Commonwealth of Pennsylvania

For the United States of America

For the District of Columbia

For the Chesapeake Bay Commission

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CHAPTER 1: BACKGROUND AND UNDERLYING ASSUMPTIONS

Introduction

On December 14, 1987, Governor Casey of Pennsylvania, Governor Schaefer of Maryland, Governor Baliles of Virginia, Mayor Barry of the District of Columbia, EPA Administrator Lee Thomas and Pennsylvania Representative Kenneth Cole (for the Chesapeake Bay Commission) signed the 1987 Chesapeake Bay Agreement. The Agreement contained statements of goals, objectives and specific commitments in six major areas, one of which was water quality.

The goal stated for the Bay's water quality is to "Reduce and control point and nonpoint sources of pollution to attain the water quality condition necessary to support the living resources of the Bay." The Agreement adds, "The improvement and maintenance of water quality are the single most critical elements in the overall restoration and protection of the Chesapeake Bay." Consequently, specific commitments are made in the pact to prepare baywide "strategies" for the control and reduction of inputs of nutrients, toxics and conventional pollutants to the Bay.

This document was prepared by the three states and the District of Columbia, working through a Water Quality Task Group, to fulfill the specific commitment in the Agreement to prepare a basinwide nutrient load reduction strategy by July 1988.

Background

Water quality investigations and living resource assessments conducted by EPA and the states since before 1970 have demonstrated that the Chesapeake Bay ecosystem is deteriorating, and that high levels of nutrient inputs are a major cause of these trends. Excessive amounts of nutrients, primarily phosphorus (P) and nitrogen (N), continue to enter the Chesapeake Bay system from a variety of sources: municipal and industrial point source discharges, nonpoint source runoff from agricultural and urban areas, and atmospheric deposition. Scientific research, monitoring, and modeling now relate these excessive levels of nutrients to many of the Bay's water quality and living resource problems. Excess nutrients promote excessive levels of algae, which in turn cause problems of aesthetics, low dissolved oxygen concentrations, reduction in the amount of light reaching submerged aquatic plants, and shifts to algal species that do not support desirable aquatic life. The EPA Chesapeake Bay Program has produced a number of reports (starting in 1983) which document these problems in some detail.

The Water Quality section of the 1987 Chesapeake Bay Agreement contains the following commitments relating to nutrient enrichment:

- By July 1988, to develop, adopt, and begin implementation of a basinwide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay. The strategy should be based on agreed upon 1985 point source loads and on nonpoint loads in a average rainfall year.

- By December 1991, to reevaluate the 40 percent reduction target based on the results of modeling, research, monitoring and other information available at that time.

The 40% nutrient load reduction target is an ambitious one which is without precedent in the history of Chesapeake Bay protection efforts. This report documents the estimates developed by the Water Quality Task Group to define the 1985 "baseline" loading conditions and to set the allowable year 2000 loading goals for N and P. It then discusses the actions and programs that are being implemented within the point source and nonpoint source categories to achieve the necessary load reductions. Lastly, it describes the information that we need to gather over the next few years in order to more accurately measure our progress towards the year 2000 target.

<u>Organization of This Document; Supporting Materials</u>

In the spring of 1988, representatives of the point and nonpoint source management agencies from each of the four jurisdictions agreed to prepare strategies that would outline their respective jurisdictions' plans for achieving their "share" of the baywide 40% nutrient load reduction. The first public draft of this document (April 1988) was essentially a compilation of the four separate "state" (including D.C.) plans.

Because each state has a different "mix" of point source and nonpoint source inputs, and because each employs a different set of programs and policies to try to reduce nutrient loadings to the Bay, each of the four plans was unique. The Water Quality Task Group decided to keep the four plans distinct and intact; they are attached as appendices to this document. The main strategy document summarizes the major common elements from the four plans and thereby attempts to present a "baywide" perspective. (Several of the jurisdictions have prepared technical supplements which provide the technical details behind the estimates presented in their respective plans; these are available from those states, as noted in their plans, but are not considered a part of this document.)

Public comment from several groups and individuals indicated that the four components of the earlier baywide draft were much too dissimilar to constitute a "baywide plan" for nutrient load reduction. Some of the differences arise from significant differences in the data bases available to the respective states. Other differences are due to the different stages of the various programs that the states have developed over time. However, the important point is that through the process of developing this Strategy the jurisdictions, essentially for the first time, have begun to identify areas where they need to work towards more consistency. Such major differences could not be overcome in the time available to produce this Strategy. Therefore, Chapter 4 reviews the areas needing additional work that has been identified so far. In the final analysis it is not essential that the states set forth identical strategies or plans of action. It is essential that the states estimate their present and future load reductions responsibly and accurately. More consistency among the programs is needed, and this Strategy points out areas where future efforts in this regard will be directed.

With this view in mind, the Strategy has been structured to place emphasis on common approaches, assumptions and remaining technical concerns of the four jurisdictions. As noted below, the baywide strategy will be refined in the coming months and years; we recognize that there are a number of areas needing improvement. The present document is organized as follows:

- Chapter 1 - Background, underlying assumptions, caveats and limitations
- Chapter 2 - Defining "baseline" (1985) conditions and establishing year 2000 loading goals
- Chapter 3 - Phased Approach To Nutrient Reduction
- Chapter 4 - Steps Toward Refining Basinwide Strategy
- Appendices - Individual strategies of Pennsylvania, Virginia, the District of Columbia, and Maryland

Origin of the 40% Goal: Future Review Needed

The federal/state Chesapeake Bay Program developed a two-dimensional, steady-state, water quality model of the mainstem Chesapeake Bay during 1985-87. The model was run under a variety of hypothetical conditions or "scenarios". The model runs suggested that a significant improvement in the Bay's water quality (particularly dissolved oxygen in the deeper waters) could be realized, if overall nutrient inputs to the Bay from point sources and "controllable" nonpoint sources could be reduced by 40%.

It is believed that significant reductions in nutrient inputs will not only improve dissolved oxygen in the Bay bottom waters, but decrease algal counts and possibly help in the reestablishment of rooted aquatic plants, which provide multiple benefits to the Bay ecosystem. The likely response of rooted aquatics and fish populations cannot be quantified, but they are expected to occur, nonetheless.

We face many uncertainties in this effort. Disagreement continues over the relative importance of nitrogen vs. phosphorus in causing the Bay's problems. The role of atmospheric inputs of nitrogen is poorly understood even though it was the largest external source of nitrogen input to the steady-state model. (The atmospheric source of nitrogen loading was placed in the "uncontrollable" category during the modeling analysis. Therefore, its input was not reduced when predicting water quality improvements expected from a 40% reduction of "controllable" nutrient sources.) Even with the steady-state model, the response (in terms of algae and dissolved oxygen levels) to specific nutrient load reductions in a dynamic system such as the Bay can be estimated only with imprecision.

In hopes of being able to make predictions with more confidence, the Chesapeake Bay Program has authorized the development of a more detailed, "second generation" model of Bay water quality. Completion of this three-dimensional, time variable model through the sponsorship of the Chesapeake Bay Program and the Army Corps of Engineers is scheduled for 1991. The new model will incorporate hydrodynamic, water quality and sediment models into a management tool with unprecedented capabilities for predicting the Bay's response to alternative nutrient control strategies. It is conceivable that projections made with the 3-D model will indicate that the 40% reduction is not enough (or possibly more than we need), or that the different states need to reduce nitrogen and phosphorus inputs in different proportions. This is the main reason that the 1987 Bay Agreement contains a separate "commitment" to reevaluate the 40% load reduction goal by December 1991.

<u>A Common Approach: Underlying Assumptions</u>

Given only the language of the commitment "to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay," the states (including D.C.) had to agree on certain major assumptions about how to interpret the commitment. These included the following:

- Each jurisdiction would estimate its 1985 point source and "controllable" nonpoint (NPS) source N and P inputs to the Bay. Each jurisdiction would be responsible for reducing its own N inputs by 40% and its own P inputs by 40% (as opposed to different states removing different percentages of N and P). The District of Columbia would be given "credit" for major reductions in P realized at the Blue Plains wastewater treatment plant prior to 1985.

- o Each state would determine the "mix" of point source controls and nonpoint source (NPS) controls that it would employ to achieve its required N and P reductions by the year 2000.

- o Baseline conditions would be defined as actual (observed/calculated) N and P inputs from point sources in 1985, and estimated NPS inputs of N and P from the 1985 landscape in an "average rainfall year".

- o The goals would be expressed as allowable year 2000 N and P input "caps" for each jurisdiction, equivalent to 60% of that state's respective 1985 N and P inputs. The goal for any one state is not expressed as a "total pounds saved", equal to 40% of 1985 inputs, because that would allow actual loadings to increase above the 60%-of-1985-inputs level, due to new growth and increasing sewage flows. The goals are set once, and held constant or "flat" over time, regardless of population growth before the year 2000.

- o The concept of "controllable" vs "uncontrollable" nonpoint sources (NPS) was used in order to be consistent with the approach used in developing and applying the 2-D steady state model which provided the basis for the 40% reduction target. The relative contribution of nitrogen and phosphorus used to derive the loads simulated in the 2-D model are shown in Figure 1.1. The definition of each varied somewhat among the jurisdictions. The states interpreted the "commitment" language to mean that the desired load reduction from NPS would be 40% of the "controllable" portion of the total NPS inputs. The Strategy is not attempting to be accountable for reducing the "background" NPS inputs of N and P that would have come from a pristine or forested Bay watershed.

As the members of the Water Quality Task Group have worked intensively this spring to develop the present document, we have become more and more aware of the limitations of the data presently available to us to estimate and project our progress. Therefore, we have agreed to the principle that this plan will have to be the subject of continuing review and refinement, and that there will be an annual report prepared on our progress. As is explained below and in Chapter 4, we are committed to gathering the kinds of improved data (in a more consistent fashion from state to state) that will allow us to estimate our progress with more accuracy. We expect that this new data will play a very important role in the 1991 reevaluation of the baywide nutrient reduction goals and of our joint progress toward those goals.

Differences in Procedures; Caveats and Limitations on Data

The present document has essentially been prepared during the past four months. The staff members of the respective states' point source and NPS control agencies did not have the time to generate new data; all calculations had to be based on data bases or file data already on hand. Each jurisdiction has done the best it could do to estimate 1985 N and P input loads from the data available, and to estimate the load reductions that will result from proposed control measures. At the same time, the structure of each state's existing control programs also strongly influenced the form that the load reduction strategies could take.

Differences among the jurisdictions' estimates and strategies include the following areas:

- The methodologies used to estimate each state's 1985 "baseline" NPS loads of N and P varied among the jurisdictions, largely because of significant differences in the available data bases.

- The definition of which sources (types) of NPS pollution would be defined as "controllable" vs. "uncontrollable" varied from state to state.

- The major categories of NPS pollution included in the baseline estimates and the projected load savings varied among the jurisdictions (for example, some states did not include the urban/suburban NPS component).

- Different states handled agricultural NPS loads delivered via groundwater flows (as opposed to surface runoff) differently.

- Load reducing efficiencies of specific point source controls and NPS controls were estimated by the states using different techniques and numbers.

- Assumptions concerning the effective "working life" of different agricultural NPS best management practices varied among the jurisdictions.

- In order to project the net changes in point source nutrient loads after new controls are applied, the states had to predict increases in municipal sewage flows due to growth between 1985 and 2000. The availability and the accuracy of the population projections used for this purpose varied significantly among the states.

- Each state has selected a different "mix" of point source controls and nonpoint source controls to achieve its desired load reductions of N and P over the coming 12 years. These pronounced differences in the four strategies arose because each jurisdiction targeted its future efforts to those sources of N and P which it believed would be most cost-effective to control and would produce the largest reductions.

Some of these points of difference arise from honest differences in approach that may be resolved over time by negotiations among the jurisdictions. Other points of difference can be resolved only by further field studies and by compilation of significantly improved data bases. The states, the Chesapeake Bay Program and other federal agencies (such as the SCS) are continuing to work on gathering the missing information and on developing methods to track progress (such as NPS "best management practices" actually applied) more accurately and consistently. Chapter 4 discusses in more detail the steps that will be taken between now and 1991 to improve all the relevant data bases and to resolve the differences in the states' methodologies for load estimation.

Explanations of the different methodologies are contained in the states' individual strategy documents, included as appendices to this report. The projected load reductions from different sources within individual states appear to be in the proper proportions. However, the Water Quality Task Group believes that the load reduction totals for N and P for the different states cannot properly be added together, because they are based on such dissimilar estimating methodologies. This is another reason to strive for improved consistency among the states' estimates in the coming years.

The 1991 reevaluation of the baywide program (and the individual states' efforts) is expected to be comprehensive and highly significant. By that time, we expect to have available to us: projections from the new 3-D model of the Bay; better information about atmospheric inputs of nitrogen; improved data bases on actual point source discharges, land cover, and NPS best management practice application in all the states, and much better information about the costs and effectiveness of different point source control technologies and NPS control practices. Taken together, these tools and new data should equip the federal agencies and the states to predict with far more confidence the full set of policies and actions that will be needed to restore the Bay's water quality to acceptable levels by the year 2000.

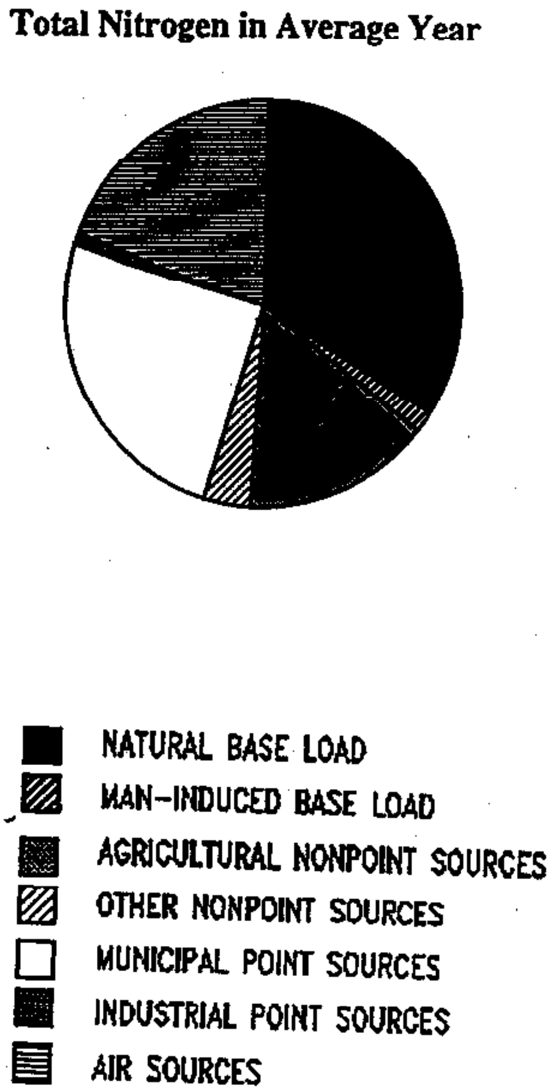
Conclusion

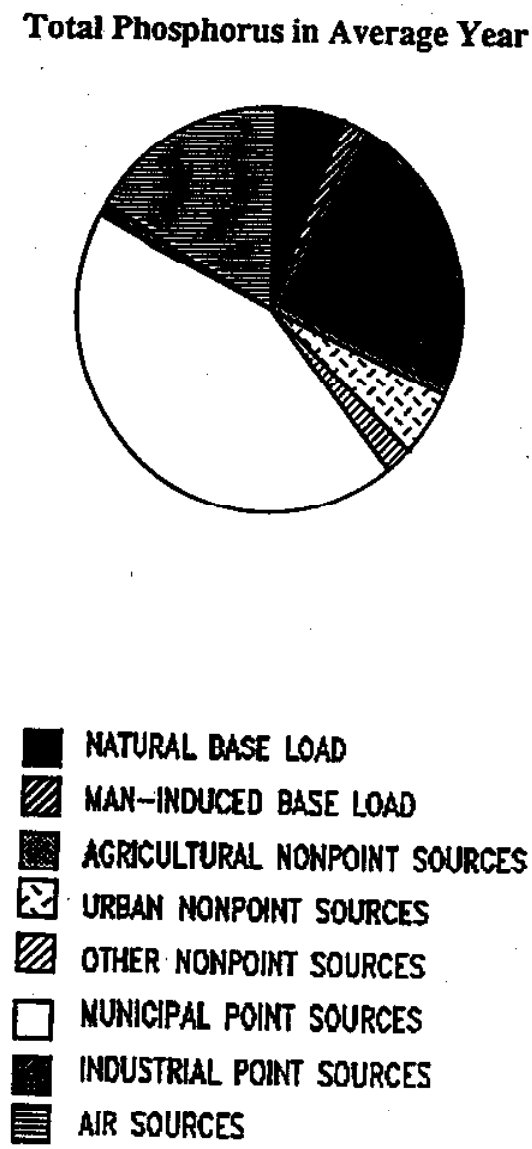
Chapter 1 has described the background and the format of the present baywide nutrient strategy document, has identified the major assumptions agreed to by the four jurisdictions, and has noted the principal areas where differences in data, assumptions or methodologies remain. The ensuing chapters describe the actual definition of the 1985 "baseline" loading conditions and the major actions committed to by each state during each phase of the planning period. The final chapter discusses the new information that will be gathered to refine the entire baywide load reduction effort in the coming years.

FIGURE 1-1

CHESAPEAKE BAY NUTRIENT LOADS

USED WITH 2-D MODEL





CHAPTER 2: BASELINE CONDITIONS AND YEAR 2000 TARGET

The commitment to achieve at least a 40% reduction in the amount of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay by the year 2000 is based on agreed upon 1985 point source loads and on nonpoint loads in an average year.

Baseline Conditions - Figures 2-1 and 2-2 present the base loads for point and nonpoint sources that each of the jurisdictions has developed for the Basinwide Strategy.

Due to a number of reasons, including data availability and the structure of existing programs, the Bay jurisdictions have developed nutrient base load calculations using many common, but some unique, criteria. Detailed explanations of the methodologies used by each jurisdiction are contained in the individual jurisdiction strategies contained in the Appendices. In general, the approaches used to develop these base loads were as follows:

> POINT SOURCES - Nutrient loads from point sources were calculated using measured flows and nutrient concentrations where available. Although there are several thousand point source discharges within the Bay watershed, the major discharges, over 1 million gallons per day (MGD), generally account for greater than 90% of the point source pollutant loading to the Bay. Each jurisdiction included in their analysis these major discharges and any other discharge judged to be significant.
>
> All of the jurisdictions used measured annual average 1985 flow values available from NPDES permit monitoring reports.
>
> Except for the District of Columbia, the jurisdictions do not have measured 1985 nutrient concentrations for all of their major discharges. Using the measured values they do have, the state water quality agencies developed average default values for those discharges where measurements were not available. These default values may vary depending upon regional waste characteristics and the amount of extraneous water in sewer systems from infiltration and inflow.
>
> The point source loadings from the District of Columbia include the entire loading from the Blue Plains treatment plant. The State of Maryland also included in its loading estimates the portion of Blue Plains loading that originates from Maryland. For phosphorus the loading is about 46,000 pound per year, while for nitrogen the loading

is 5.156 million pounds per year. For this reason the reader is cautioned not to add the loadings presented in Figures 2-1 and 2-2 since this will result in double counting of these loadings.

NONPOINT SOURCES - Nonpoint sources of pollution are a result of rainfall draining the land surface and relocating sediment and other constituents to tributaries of the Bay. Direct deposition of nitrogen from the atmosphere also occurs. For the purpose of this report, the "average rainfall year" is the benchmark for flow. It was determined early in this process that an "average rainfall year" does not exist on record for the entire Bay drainage. Therefore, the jurisdictions established the average year based upon localized basin and sub-basin rainfall data. Actual basin loads were calculated by each jurisdiction using a combination of fall line measured loads and soil characteristic and land use information, adjusted by point source and background load data.

Each jurisdiction partitioned this overall "corrected" nonpoint basin load to a general variety of impacts, i.e. agricultural cropland, pastureland, animal waste and urban runoff.

In some cases partitioning was accomplished relative to surveyed land use; in other cases the proportions calculated by the watershed model were used to distribute the basin load among sources. The end result is source identified loads by river basin which are subject to control by reduction measures described in each of the three phases in Chapter 3.

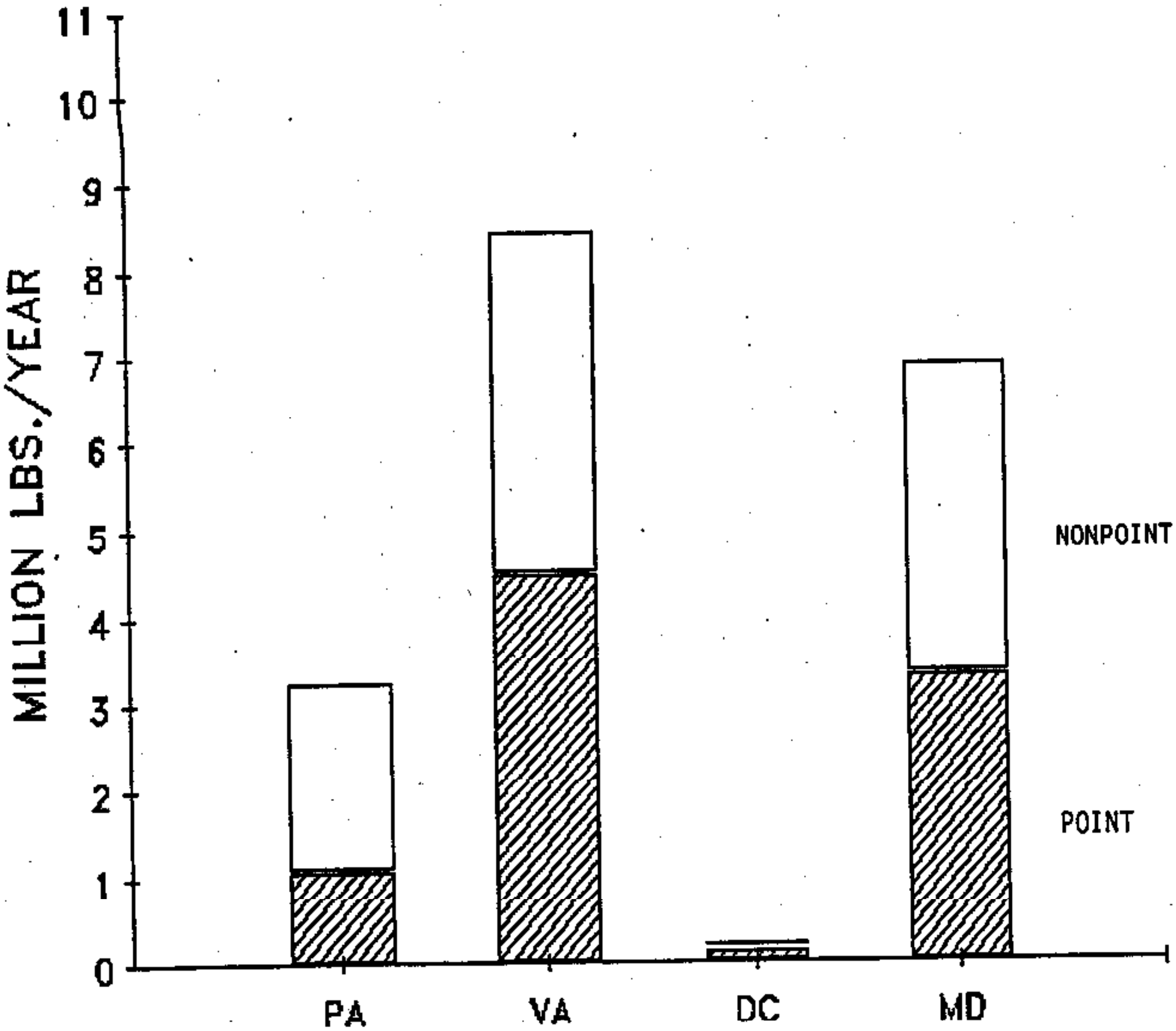
Year 2000 Target - The 1987 Chesapeake Bay Agreement calls for a Basinwide Strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay. In order to meet the July 1988 date for development of the Baywide Strategy the jurisdictions agreed to proceed using the following approach at this time:

> To meet a Baywide 40% reduction of phosphorus and nitrogen each jurisdiction would meet a 40% reduction of its portion of the baseline nutrient loads.

Although this is the agreed upon approach at this time, it does raise questions whether it is an equitable approach given previous nutrient control programs and whether it will be an equitable approach over the long term. Major point source phosphorus reductions occurred prior to 1985 in the Washington, D.C. area treatment plants. Therefore, the Strategy assumes no further point source phosphorus removal is needed from the District of Columbia. Other sections in the Strategy describe how more equitable approaches to a Baywide 40% reduction will be evaluated in the future.

The year 2000 target loadings are presented for each jurisdiction at the bottom of Figures 2-1 and 2-2.

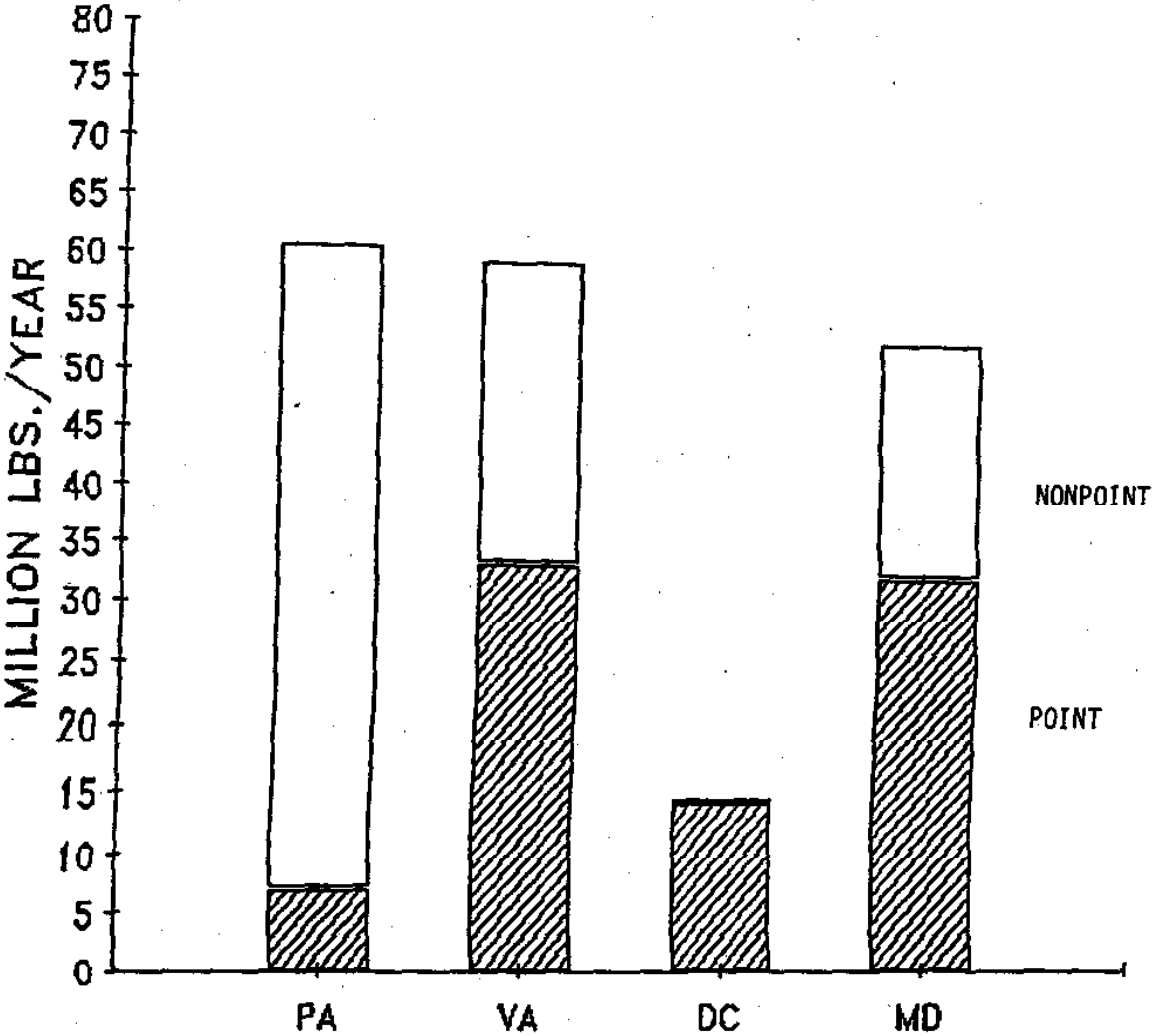
FIGURE 2-1
BASELINE PHOSPHORUS LOADS
POINT SOURCES: *1985*
NONPOINT SOURCES: *AVE. YR. (CONTROLLABLE)*



(MILLION LBS./YEAR)

	PA	VA	DC	MD
TOTAL BASELINE LOAD	3.254	8.456	0.225	6.895
YEAR 2000 TARGET	1.950	5.073	0.179	4.137

FIGURE 2-2
BASELINE NITROGEN LOADS
POINT SOURCES: *1985*
NONPOINT SOURCES: *AVE. YR. (CONTROLLABLE)*



(MILLION LBS./YEAR)

	PA	VA	DC	MD
TOTAL BASELINE LOAD	60.860	59.641	14.538	52.910
YEAR 2000 TARGET	36.540	35.784	8.723	31.746

CHAPTER 3: PHASED APPROACH TO NUTRIENT REDUCTION

In order to reach the year 2000 target loads for phosphorus and nitrogen presented in the previous Chapter, a broad range of nutrient control programs will have to be implemented within the Chesapeake Bay basin. Fortunately, many of these point source and nonpoint source control programs have already been initiated at the federal, state, or local government levels. Many are common to the four major jurisdictions signatory to the Agreement. However, since many of these programs were started at different times and operate under different laws, regulations, and funding levels, they cannot be expected to be identical - either in how they are implemented throughout the Bay watershed or in the results they achieve.

The goal of the Basinwide Nutrient Reduction Strategy is to equitably achieve the year 2000 target loads for phosphorus and nitrogen using a mix of control programs - some underway, some planned, and some yet to be developed - implemented by cooperating, independent jurisdictions. The Strategy adopted in July 1988 cannot possibly foresee events of the mid-1990s and select the best course of action for current or new programs for that time. Therefore, the Strategy has been developed based upon using a phased approach.

The Basinwide Nutrient Reduction Strategy is presented in the following three phases:

PHASE I

The period between the bench mark loading year 1985 and the present. Significant nutrient reductions occurred during this period which must be accounted for in reaching the 40% reduction goals.

PHASE II

The period between the adoption of this strategy and the reevaluation date (December 1991) contained in the Agreement. This will allow the signatories to gauge progress to the point the reevaluation will occur.

PHASE III

The period following the reevaluation (December 1991) till the year 2000. This represents the period of time following the major "mid-course correction" in the baywide effort made in 1991.

The current programs to be used by the states (MD, VA, PA, and

DC) in achieving the goals are listed in Phase I and new programs or modifications of programs are listed in Phases II and III.

The individual state strategies are included in the Appendices in more detail. Of the nearly 40 programs and initiatives listed in the three phases, over 80% are common to at least two of the signatories. This large percentage of programs common to the jurisdictions indicates the success of the partnership in achieving cooperation and mutual support for restoring the Bay.

PHASE I

Point Source Programs

* Municipal Wastewater Treatment Plant Phosphorus Removal
* Permit Compliance Programs
* Phosphate Detergent Bans
* Dual Biological Nutrient Removal Demonstration Projects
* Water Quality Standards
* Patuxent River Basin Nitrogen Removal

Nonpoint Source Programs

Agricultural

* Agricultural Conservation Program
* Watershed Protection Projects
* Conservation Reserve Program
* Rural Clean Water Projects
* Education Assistance Funding Program
* Technical Assistance
* Animal Waste Control Programs
* State Agricultural Cost Share Programs

Urban

* Soil Erosion and Sedimentation Laws
* Storm Water Management Regulatory Programs
* Retrofit and Demonstration Projects
* Combined Sewer Overflow Controls

Other

* Critical Areas/Riparian/Wetlands Laws

PHASE II

Point Source

* Continued Installation of Phosphorus Removal
* Policies Encouraging Nitrogen Removal
* Coupled with other permit required upgrades
* State Revolving Loan Fund Programs
* Nitrogen Removal Feasibility/Targeting Studies

Nonpoint Source

Agriculture

* Increased Staffing For Existing Programs
* Nutrient Management Plans (Manure and Fertilizer)
* Forested Buffer Strips
* Targeting of Control Program
* Incentives for Conservation Compliance
* Increased Inter-Program Coordination
* Improved Geographical Information Systems.

Urban

* Expanded stormwater management regulatory authority
* Stormwater utility (grant) program for targeted installation and maintenance of BMP's
* Combined Sewer Overflow Effectiveness Evaluation
* Increased implementation/enforcement of existing and new storm water laws.

Other

* Improved/Increased nutrient monitoring and reduction tracking.
* Chesapeake Bay Preservation Areas

PHASE III

Point Source

* Regulatory Programs for Nitrogen Removal
* Financial Assistance Programs.

Nonpoint Sources

* Expansion of Agriculture Control Programs
* Expansion of Urban Control Programs

The ability to describe the Phase III programs is limited due to several factors. One is the ability to project funding of programs that far into the future. Second is the amount of new information that the signatories are working diligently to gather that will greatly improve the decision making ability. The watershed model and time variable 3-D model will provide information on a geographical and seasonal basis thereby allowing trading of point and nonpoint source controls on an interstate and intrastate basis. Increased fall line monitoring will provide refinements of the nutrient loads to the Bay and information from wastewater treatment plants using biological nutrient removal will be available.

Figures 3-1 and 3-2 present a summary of the estimated loading reductions for phosphorus and nitrogen resulting from the various nutrient control programs mentioned above and described in greater detail in the Appendices. The total height of each bar represents the total projected loads in the year 2000 for the jurisdictions <u>if no nutrient control programs were implemented.</u> The loading reductions estimated to have been accomplished during Phase I and projected reductions for Phases II and III are shown. The total reductions during the three Phases is shown to reach the target loads for each jurisdiction. (NOTE: Figure 3-1 shows the states will exceed the 40% reduction for phosphorus, i.e. the resulting year 2000 phosphorus loads will be below the target. The dotted line next to the "T" indicates the target load for those states.)

Keeping track of the reductions in nutrient loads is one way of measuring progress in the Bay cleanup. Another important measure is the projected improvement in the water quality of the Bay due to the implementation of these nutrient reduction programs. As mentioned in the Introduction, a 2-D, steady state water quality model of the Bay, which was developed by the Chesapeake Bay Program, was the management tool used to derive the 40% nutrient reduction goal. In order to evaluate the progress due to this Basinwide Nutrient Strategy this model was used to simulate water quality conditions at the end of Phase II when the reevaluation is scheduled. Figures 3-3 through 3-6 illustrate the projected improvements in water quality from 1985 to 1991, and the further improvements expected from implementation of the full 40% reduction target by the year 2000. An explanation of these Figures is as follows:

FIGURE 3-3:

- Minimum Summer Average Dissolved Oxygen - In the deepest portions of the Bay the lowest summer dissolved oxygen (D.O.) levels in 1985 averaged less than one half of a milligram per liter. After implementation of the Phase I and II reductions this concentration will more than double. Full implementation of the 40% target will result in the average lowest dissolved oxygen increasing to 1.67 mg/l.

FIGURE 3-4:

- Anoxic Waters - In 1985 about 1.35 billion cubic meters of water in the Bay went anoxic, i.e. had no dissolved oxygen sometime during the summer. The Strategy will reduce this to about 0.31 billion cubic meters by 1991. When the full 40% reduction takes place in the year 2000, there will no longer be any anoxic water in the Bay under average circulation conditions according to the model.

FIGURE 3-5

- Peak Summer Average Chlorophyll - In 1985 the peak chlorophyll concentration in the mainstem of the Bay was 13.6 micrograms per liter (ug/l). By the year 2000 it will be reduced to 8.8 ug/l. The Strategy will achieve most of this reduction by 1991.

FIGURE 3-6

- Total Mass of Algae - Full implementation of the 40% load reduction will reduce the total mass of algae generated by nutrients in the Bay and its tributaries by 30%. According to this Strategy we will achieve well over half of this reduction by 1991.

Whichever water quality indicator is used to measure progress, the nutrient reductions projected for 1991 in the Basinwide Nutrient

Reduction Strategy will result in substantial improvements in water quality.

Due to the limitations of the 2-D model, the following caveats should be noted when interpreting these model projections:

1. Although the 1991 loading projections were used, the model must use the 1985 flow and circulation conditions of the tributaries and the Bay. Therefore, if actual flow and circulation conditions in 1991 are substantially different from 1985, then actual water quality conditions will also differ from these model projections.

2. The model cannot predict how long it will take the Bay to respond to the reduction in nutrient loadings. The water quality in the mainstem of the Bay is controlled in large part by the release of nutrients from the Bay's sediments. However, the 2-D model does not include any mechanism relating the time period between the reduction in nutrients discharged into the Bay and the corresponding reduction in nutrients released from the sediments.

3. For nonpoint source inputs to the Bay the 2-D model uses a baywide average percent reduction in order to project any response in water quality.

Since these same caveats also apply to the year 2000 projections, the information in the figures can still be used to compare projected progress in 1991 against projected progress in the year 2000 from the 40% reduction.

The 3-D, time variable model will overcome these limitations and allow managers to make more confident projections of the expected changes in water quality due to nutrient control programs.

FIGURE 3-1
BASINWIDE PHOSPHORUS REDUCTION STRATEGY
PROJECTED YEAR 2000 LOADS

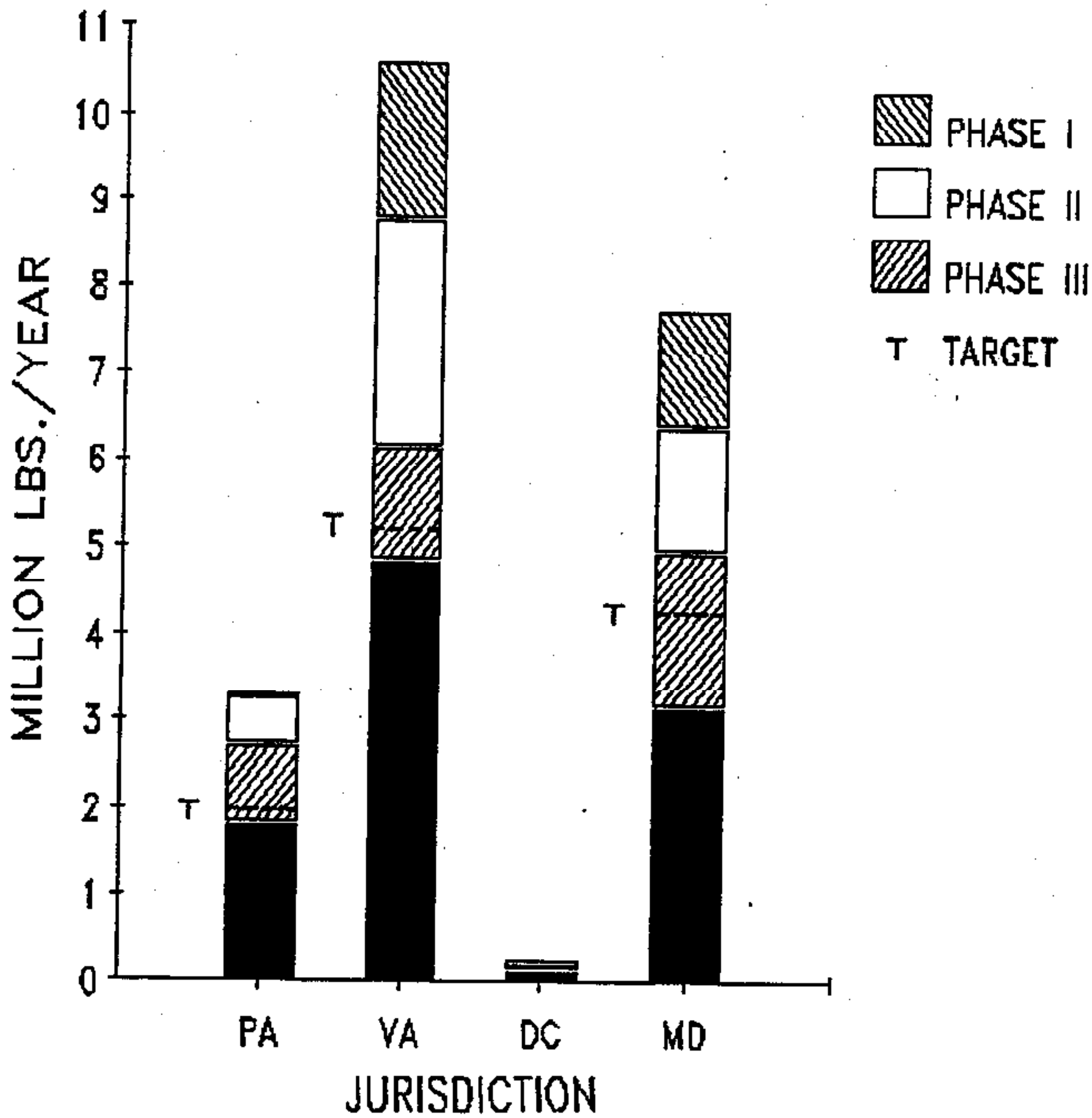
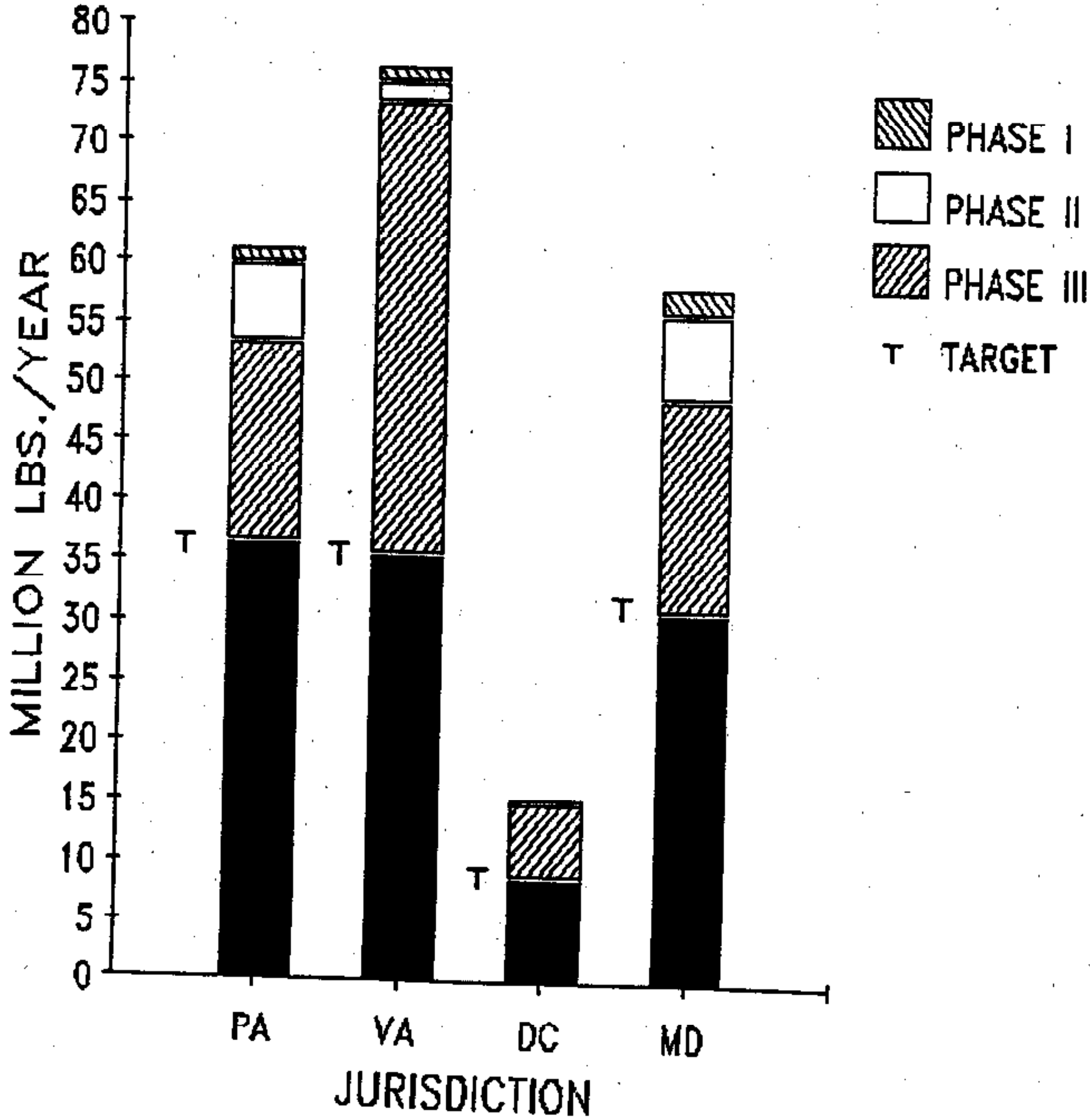


FIGURE 3–2
BASINWIDE NITROGEN REDUCTION STRATEGY
PROJECTED YEAR 2000 LOADS



BASINWIDE NUTRIENT REDUCTION STRATEGY

WATER QUALITY CHANGES: DISSOLVED OXYGEN

FIGURE 3-3

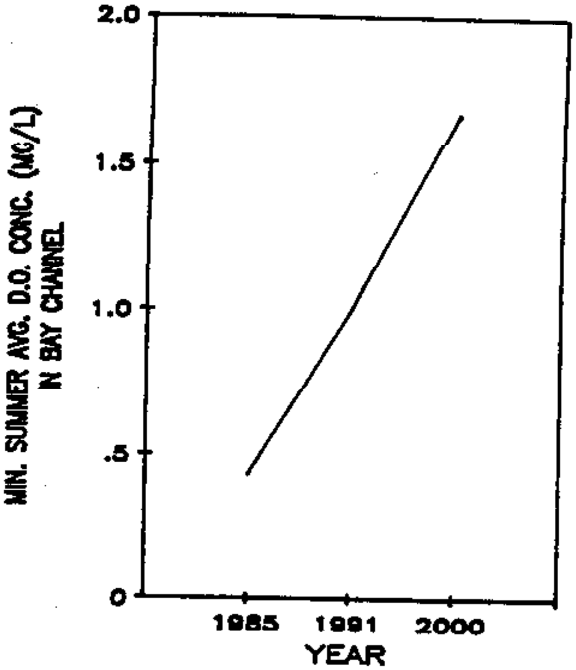
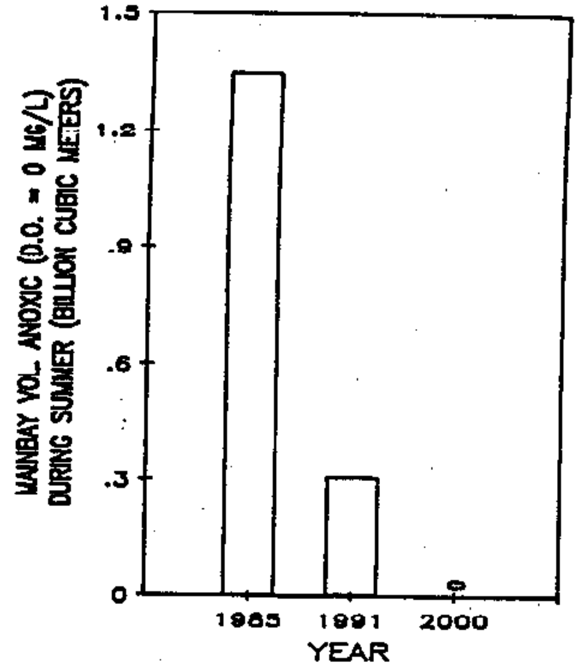


FIGURE 3-4



BASINWIDE NUTRIENT REDUCTION STRATEGY

WATER QUALITY CHANGES: CHLOROPHYLL

FIGURE 3-5

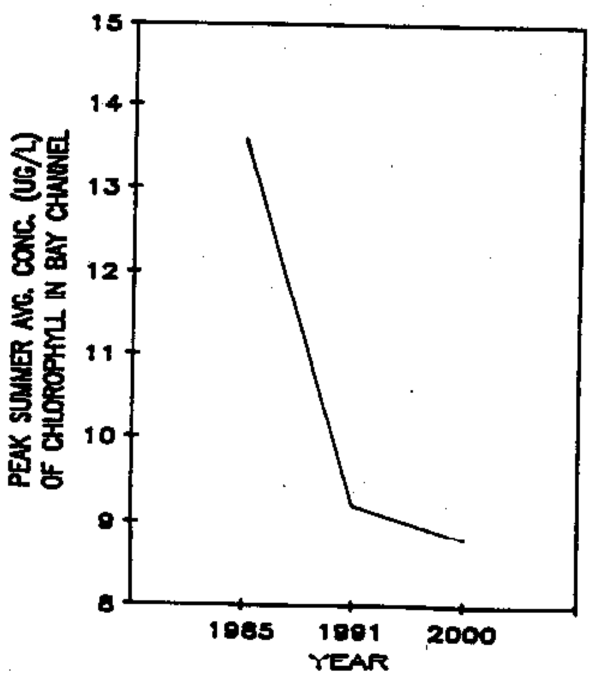
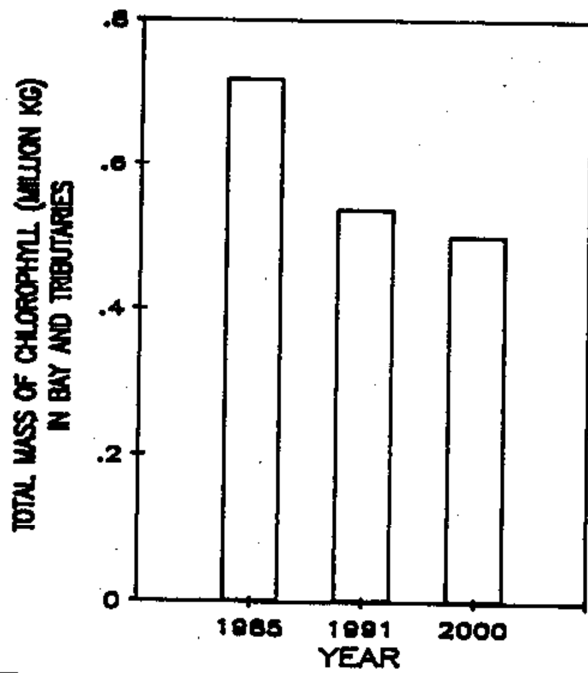


FIGURE 3-6



CHAPTER 4: STEPS TOWARD REFINING THE BASINWIDE STRATEGY

The nutrient control measures that have already been taken in Phase I, and that are planned for the near future in Phase II, are clearly necessary as we proceed toward attaining the Water Quality goal of the Agreement. The jurisdictions agree that additional control measures best suited for the future (Phase III and beyond) will be identified as we develop new understanding about the Bay and its resources and develop new point source and nonpoint source technolgies. The Phase II implementation programs will proceed toward the nutrient reduction goals while new technical information is developed. Control program implementation will be paralleled by technical studies to address the issues described below.

The commitment to reevaluate the 40% reduction target by December 1991 provides an appropriate time to review reduction targets, program implementation, the effectiveness of control measures, and incorporate any new technical information into the Strategy.

As more information from research, monitoring, and modeling becomes available, the jurisdictions recognize that refinements to the Basinwide Strategy will be necessary. Therefore, a <u>Basinwide Nutrient Strategy Progress Report</u> will be produced on an annual basis by the jurisdictions in order to:

1. Provide information on the point source and nonpoint source management programs and document progress toward the year 2000 target;

2. Report on new information that is collected that fills in the gaps that were identified during the development of this Strategy; and,

3. Incorporate any necessary adjustments to the approaches outlined in this Basinwide Strategy.

The process of developing this Strategy has identified: 1. key areas where the jurisdictions need to arrive at a common means of organizing and using existing information and data; and, 2. areas where additional information is needed. The jurisdictions need to develop a consensus on water quality monitoring to satisfy the need for consistent baseline data and nutrient reduction measurements. Point source, nonpoint source, and ambient stream monitoring needs must be addressed. The effort must maximize the use of ongoing monitoring programs where possible and utilize the methodologies developed by the Bay Program's Fall Line Monitoring Ad Hoc Work Group.

Similarly, a consensus must be reached on load calculation methods for point source, nonpoint source (including agricultural, urban, and atmospheric sources), and ambient stream nutrient loads, to improve the consistency of nutrient load information from a basinwide perspective. Both the monitoring and load calculation procedures must address the concerns about seasonal load variations, variability of loads throughout the basin, the definition of controllable vs uncontrollable sources, and the need to redefine "an average rainfall year" along the lines of "an average runoff year" or "average load year" for each of the bay's tributary watersheds.

A consensus must also be reached on the appropriate nutrient load reduction factors to be assigned to each BMP. Present load reduction estimations must be improved on the basis of monitoring results and ongoing and planned technical studies by the jurisdictions, EPA, and other parties. These efforts will be coordinated through the Nonpoint Source Subcommittee. The need for research on the effectiveness of BMP's has been identified in the Comprehensive Research Plan being prepared concurrently with this strategy.

Table 4-1 presents an outline of the steps the Bay Program participants will take during the next three years in order to be ready for the 1991 reevaluation. The results of these studies and agreements will be presented in the Annual Progress Reports, beginning with the first report in the summer of 1989.

Completion of the milestones listed in Table 4-1 will allow the jurisdictions to conduct an in-depth reevaluation of the Basinwide Strategy at the end of 1991. Based upon this information the jurisdictions commit to take the following action:

BY DECEMBER 1991: Develop a tributary based basinwide strategy to achieve the required levels of nutrient reductions for the Chesapeake Bay.

The jurisdictions will refine the present basinwide nutrient strategy incorporating the data and modeling information that has been developed, so that the strategy recognizes the variations among the tributary watersheds in determining the equitable reduction goals. The refined strategy may set different load reduction goals for different tributaries to provide optimum benefit for the Bay. While we are fully committed to the current strategy, we realize that new and better information will allow us to improve it. The refined strategy will be developed using the nutrient load and reduction data described above, in the following sequence.

The three-dimensional bay model and the results of technical studies will be used to define proper levels of nutrient reductions to maintain and improve habitat for the living resources of the bay. The three dimensional bay model, the improved watershed model, and the results of technical studies will be used to assign target nutrient reduction levels to each tributary watershed. Alternative point and nonpoint source policies and programs will be identified, with cost and nutrient reduction estimates that are appropriate for the situation in each tributary watershed.

On the basis of the target nutrient reduction levels and alternative control programs, the jurisdictions will cooperate in the development of tributary control programs for point and nonpoint sources. The basinwide strategy will then consist of a set of tributary watershed strategies, with equitable load reduction goals based on increased knowledge of the bay's needs and the most effective means of meeting them.

Finally, since the strategy and specific control programs must remain dynamic and responsive to changes, the jurisdictions will continue to monitor improvements and modify the tributary watershed control programs as necessary to meet the goals for the Chesapeake Bay contained in the 1987 Agreement.

TABLE 4-1

STEPS TOWARD REFINING THE NUTRIENT STRATEGY

BAYWIDE MILESTONES

TABLE 4-1

STEPS TOWARD REFINING THE NUTRIENT STRATEGY

BAYWIDE MILESTONES

1989

* Continue development of consistent baseline data (both fall line and basinwide)

* Develop consistent methodologies for estimating loads and/or load delivery calculations, for:

  - point sources, including projected increases
  - cropland and pastureland
  - nutrient management impacts
  - transport conversions
  - animal waste production and storage
  - developed land uses

* Survey and locate to the extent possible all significant nutrient sources in the Bay basin, both point source and nonpoint source (including agriculture, urban, forest, and shoreline erosion), and identify actions needed to improve the resolution and accuracy of our estimates

* Identify and evaluate the necessity of new and expanded monitoring programs; for example:

  - upland watersheds
  - nonpoint source loads below the fall line
  - edge of field
  - point source nutrients
  - atmospheric inputs
  - shoreline erosion

* Develop consistent accounting for loads delivered via groundwater flows

* Develop consistent approaches for defining controllable and uncontrollable nonpoint source components

1989 (cont.)

* Identify informational and other needs to be addressed by the Nonpoint and Living Resources Subcommittees as well as other work groups

* Evaluate the effectiveness and feasibility of application of biological nutrient removal (BNR) at plants throughout the Basin

* Develop specific point and nonpoint source implementation plans for each state

1990

* Implement necessary new and expanded monitoring programs for point sources

* Implement necessary new and expanded monitoring programs for nonpoint sources

* Quantify and characterize non-agricultural (urban, forest, shoreline erosion) nonpoint source loadings into the Bay basin

* Develop consistent load reduction accounting methodologies for BMPs (to include the effective "working life" of various BMPs)

* Complete development of the basinwide watershed model

* Identify performance capability and refine cost information for wastewater treatment processes such as BNR

* Complete refinement of habitat requirements for living resources that will be used with the 3-D model

* Evaluate approaches that may be used for nitrogen reduction (e.g., available technology, regulatory actions, incentive programs)

* Evaluate the effectiveness of the voluntary programs for the implementation of BMPs

* Update state implementation plans

1991

* Complete development of the 3-D Model and input data (fall line, point source, and nonpoint source) for the 3-D model

* Utilize 3-D model, habitat requirements, scientific research, and other available information to develop appropriate reduction levels for nitrogen and phosphorus

* Develop additional regulations to reduce phosphorus where needed

* Develop additional regulations to reduce nitrogen where needed

* Develop tributary based reduction goals to provide optimum benefit for the Bay

* Identify additional control programs that are needed in light of the tributary based reduction goals, the new load reduction data on effectiveness of control measures, the evaluation of voluntary BMPs, and cost effectiveness data gathered during Phase II

* Refine cost estimates for point source and nonpoint source control programs

* Update state implementation plans

APPENDICES

COMMONWEALTH OF PENNSYLVANIA

COMMONWEALTH OF VIRGINIA

DISTRICT OF COLUMBIA

STATE OF MARYLAND

PENNSYLVANIA
CHESAPEAKE BAY PROGRAM
NUTRIENT REDUCTION STRATEGY

INTRODUCTION

Nutrient enrichment has been identified as a major factor in the decline of the Chesapeake Bay. Nutrients - primarily nitrogen and phosphorus from wastewater and run-off from farmland - drive the process of excess productivity, decomposition, and recycling that contributes to oxygen depletion of bottom water in the Bay. Only a reduction in phosphorus and nitrogen can slow this process and bring about the improved water quality in the Chesapeake. To achieve this end, the 1987 Bay Agreement calls for a 40% reduction by the year 2000 in nitrogen and phosphorus entering the main stem of the Bay. Reductions will be calculated from point source loads for 1985 and nonpoint source loads in a year of average rainfall.

The Pennsylvania portion of the Chesapeake Bay basin is divided into the eight subbasins shown in Figure 1, for the purposes of data collection and program development. Five of the subbasins are in the Susquehanna River Basin. The other subbasins are the Potomac River, Eastern Shore (Elk Creek) in Chester County, and West Chesapeake (Deer Creek) in York County. The Susquehanna and Potomac subbasins are all above the fall line, and the others are below the fall line, as defined by EPA for their delineation of subbasins for computer models of the bay and its tributaries.

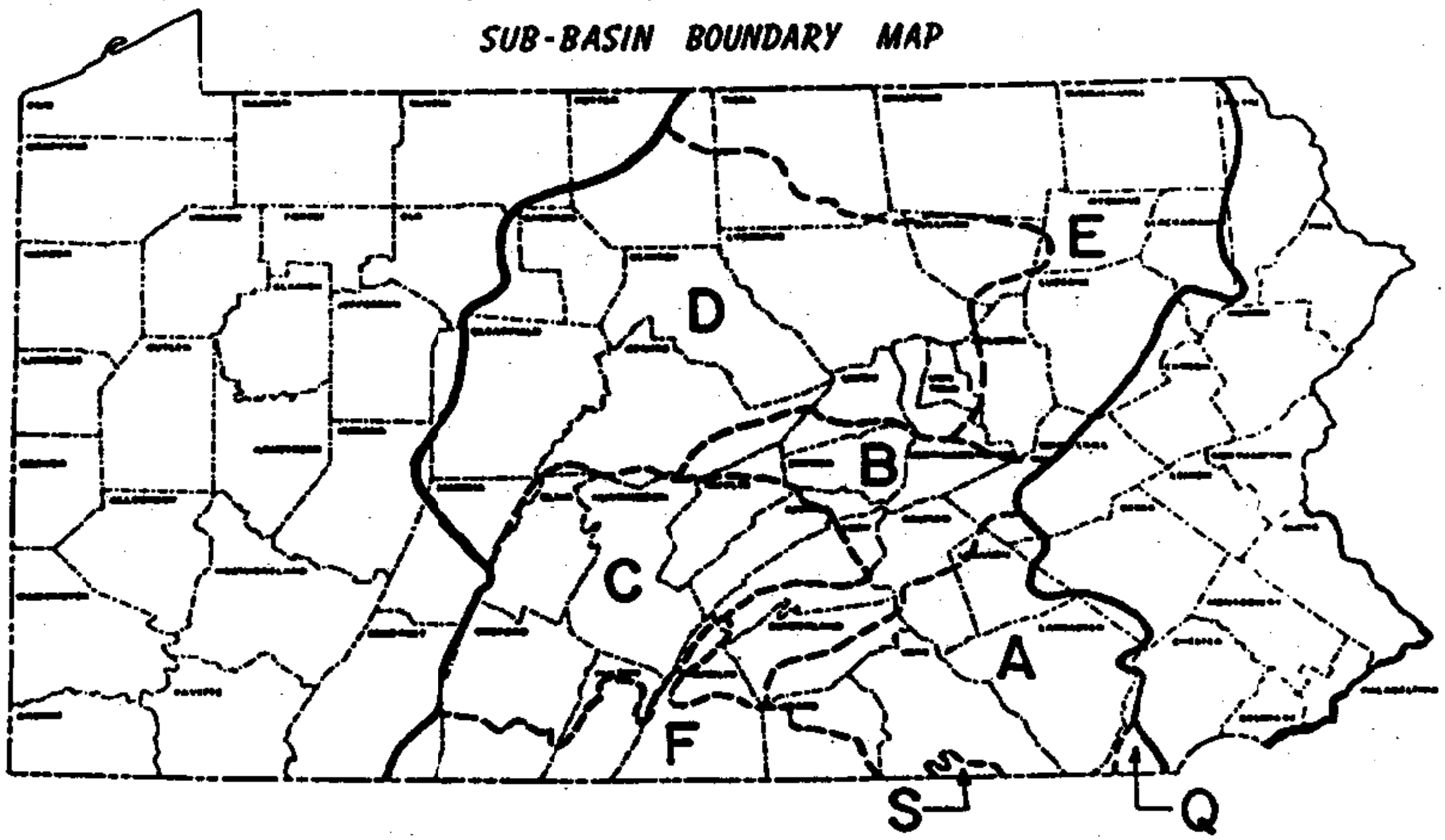
Regulation of point and nonpoint sources in Pennsylvania is shared by several programs within the Department of Environmental Resources. Programs to regulate point sources of municipal and industrial waste include state and federal permit requirements. The nutrient loadings from these sources are fairly well defined. The fall line loads from point sources are calculated using the Chesapeake Bay Program (CBP) watershed model.

The nutrient loads resulting from nonpoint sources are not as well defined. The sources of these loads, the portions which are controllable, and projections of fall line loads from these sources are estimates at best. Based on these estimates, 33% of controllable phosphorus and 12% of controllable nitrogen load at the fall line from Pennsylvania are from point sources.

PENNSYLVANIA

CHESAPEAKE BAY PROGRAM

SUB-BASIN BOUNDARY MAP



SUB-BASIN	DESCRIPTION	SUB-BASIN	DESCRIPTION
A	LOWER SUSQUEHANNA	E	NORTH BRANCH SUSQUEHANNA
B	MIDDLE SUSQUEHANNA	F	POTOMAC
C	JUNIATA	S	WEST CHESAPEAKE
D	WEST BRANCH SUSQUEHANNA	Q	EASTERN SHORE

The remaining controllable nutrient loads are from urban, agricultural, and anthropogenic nonpoint sources.

Phosphorus controls are in place for point source discharges on the Lower Susquehanna where the impact on the Bay from Pennsylvania discharges is the greatest. The Chesapeake Bay Financial Assistance Program to control nutrient loads from agricultural nonpoint sources also has been focused in the lower portion of the Susquehanna basin. That program is now being extended to other parts of the Basin.

Much has already been accomplished through education, financial grants, permitting, monitoring, and enforcement actions directed at both point sources and nonpoint sources to reduce nutrient load to the Bay from Pennsylvania. This nutrient reduction strategy is premised on the continuation of both voluntary and regulatory programs. Point source discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) program, including a phosphorus removal program in the lower Susquehanna Basin, as described later in this document. Nonpoint source manure and sediment discharges to waters of the Commonwealth are regulated under authority of the Pennsylvania Clean Streams Law. Rules and regulations contained at 25 PA Code, Chapter 101 empower the Department of Environmental Resources (DER) to issue permits and take enforcement actions on violations involving animal manure storage facilities and land application of animal manure. Similarly, 25 PA Code, Chapter 102 empowers DER to issue permits for earth disturbance activities over 25 acres in size and to initiate enforcement actions for erosion and sediment pollution control violations. These programs have resulted in the use of nutrient control technologies, the imposition of fines for violations, and the correction of non-compliant activities.

Pennsylvania's strategy for achieving the reduction goal is based on an evaluation of the problem, including the sources and geographic distribution of nutrients, on a consideration of accomplishments already achieved, and on projections of further accomplishments using existing, expanded, and new nutrient reduction programs. The strategy was developed using the best available information. Recognized shortcomings in the available data and the means of dealing with them are acknowledged in this document. Several assumptions were made in projecting future program accomplishments. These include the continuation of Chesapeake Bay Program funding from state and federal sources, the authorization to satisfy staffing needs identified later in this document, the successful completion of the federal Food Security Act mandate to apply conservation treatment to all highly erodible lands owned by farmers who wish to remain eligible for other USDA programs, and a sustained 80% best management practices (BMP) success rate. The dynamics of land ownership, changes in farm enterprises, fluctuations in farm commodity prices, and the life span of conservation practices, all of which can alter the long term sustained effectiveness of the BMP's, are the reasons for making the 80% adjustment.

BENCHMARK LOADS

The nutrient reduction strategy is based on the nitrogen and phosphorus loads delivered to the Bay from all the subbasins. The 1985 delivered loads (129.995 million pounds nitrogen, 4.010 million pounds phosphorus) were supplied by EPA (See Tables 1 and 2). For the subbasins below the fall line, the loads were determined using the Chesapeake Bay watershed computer model. This included partitioning of the total subbasin loads to the various point and non-point sources. For the two rivers above the fall line, EPA provided total delivered loads calculated from water quality monitoring data, and the loads from major source categories. This did not include load data for the individual subbasins in the Susquehanna River Basin.

A major portion of the nutrient reduction strategy development was the allocation of nutrient loads to the various point and nonpoint sources. The allocation process is described below. A more detailed description is available in the form of a separate Technical Supplement.

The point source portion of the benchmark loads was developed using 1985 permit and discharge monitoring data. Where no actual data existed, as with nitrogen where no permit limit or monitoring data was available, default data for typical point source effluent was assigned to the discharge. The CBP watershed model was used to calculate point source delivered nutrient loads for Pennsylvania at the fall line. Total point source nitrogen load is about 7.060 million pounds, and phosphorus is about 1.086 million pounds. Population projections for the county in which the point source is located were used to proportionately increase control loads and flows to project future loads and flows. This process was used to project loads and flows for each municipal point source. This model and its delivery ratios are under review. Changes could affect the point source fall line loads.

The 1987 Bay Agreement states that the nonpoint source nutrient loads should be based on "an average rainfall year." Since more than half of Pennsylvania is in the Chesapeake Basin, it is unlikely that the entire area would experience average rainfall in any one year. In the absence of nutrient load information for an average rainfall year, EPA provided fall line monitoring data for 1985 as benchmark nutrient loads. While 1985 was not a year with normal annual flow, the integrity of the nutrient reduction strategy is not jeopardized by the use of fall line loads for that year. Nutrient source loads and edge-of-field reductions were determined independently from the fall line load values, and were then equated to the fall line values using approximate transport factors as described later. In the absence of a reliable watershed model to simulate the transport process, a revision of benchmark fall line loads would only result in a change in the approximate transport factors.

As additional monitoring data and improved load calculation methods become available, a better representation of "an average rainfall year" will be possible. A better characterization of the nutrient problem would be the "normal annual nutrient load," unique to each river basin. This load would be best determined by considering the mean monthly flows as representing average conditions. Use of the mean monthly flows would also account for seasonal variations in flow and loads, and be an improvement on the use of gross annual total flows which can mask fluctuations within the year. An ongoing effort by the Fall Line Monitoring Ad Hoc Work Group with participation by the U.S. Geological Survey, the Susquehanna River Basin Commission, and the four jurisdictions, will resolve this issue.

Since there are five subbasins in the Susquehanna River Basin, with varying land uses and distances from the Bay, there was a need to identify the relative contributions from the subbasins and the source categories within them. The total delivered nitrogen and phosphorus loads, and the uncontrollable source contributions were accepted as reported by EPA. The uncontrollable sources include the natural sources (base flow, air, and forests), pasture and cropland not needing treatment. The strategy addresses the point source and controllable nonpoint source loads. Point source loads, known from monitoring programs, were computed as delivered to the Bay, as described above. The nonpoint source nutrient loads from each subbasin were calculated for animal waste, cropland eroding at more than tolerable soil loss rates, and urban land. These were calculated as loads delivered to the nearest stream. Animal waste nutrient contributions were calculated from animal population data for each county in the basin and average animal weights and manure production rates. Land use data is based on Natural Resources Inventory data from the Soil

Conservation Service for each county in the basin. The data was weighted by the percentage of each county in a given subbasin.

To account for the transport of nutrients from subbasins to Bay, the nonpoint source loads were weighted by the proximity of the subbasin to the Bay. This procedure will be replaced with a more accurate delivery ratio approach when EPA's watershed model is recalibrated. The nonpoint source loads were also weighted so that the total delivered point source and controllable nonpoint source loads from the Susquehanna River Basin equal the fall line load values provided by EPA. The delivered point source and nonpoint source loads were reduced by the amount delivered from New York State (10.75 million pounds of nitrogen and 0.302 million pounds of phosphorus), since they are uncontrollable by Pennsylvania programs.

The original Potomac River Basin loads have been adjusted by EPA in an attempt to discount the atypical loads resulting from an extreme flood event included in the original calculated loads. This was only an estimation technique and is subject to revision as normal annual nutrient load data become available from the ongoing fall line monitoring program and proposed tributary monitoring. Allocation of loads to various nonpoint source categories was accomplished in a manner similar to that described for the Susquehanna River subbasins.

The loads delivered from point sources and controllable nonpoint sources to the Bay were then summed from all subbasins. The 40% reduction goals are based on these loads of 60.860 million pounds of nitrogen and 3.254 million pounds of phosphorus.

The reduction goals for Pennsylvania are 24.344 million pounds of nitrogen and 1.302 million pounds of phosphorus. Tables 1 and 2 illustrate the nutrient budgets for Pennsylvania.

The load partitioning process revealed two aspects of the nutrient problems that are instrumental in formulating the strategy to achieve the 40% reduction. The first is that animal waste is a dominant source of nutrients. Manure is the source of more than one-half of all the controllable nonpoint source nitrogen and phosphorus. A successful nutrient reduction program must therefore place emphasis on manure nutrient management. The other aspect is that the nutrient load contributions originate throughout the Pennsylvania portion of the basin. Subbasin A (Lower Susquehanna) is the major contributor of nitrogen and phosphorus on both a per acre and total load basis. This is due to its proximity to the Bay and its relatively high contribution from animal waste, cropland erosion, and urban sources. Subbasin B (Middle Susquehanna) is the second highest contributor of nitrogen and phosphorus per acre. Subbasin F (Potomac) contributes the third highest amount of nitrogen per acre. Subbasin E (North Branch of Susquehanna), despite its distance from the Bay, contributes significant amounts of both nitrogen and phosphorus.

The contribution of nutrients from throughout the basin is also evidenced by the preliminary results of the water quality monitoring program being conducted by the Susquehanna River Basin Commission on the river and its tributaries as part of the CBP. The instream nutrient loads calculated as described above agree reasonably well with the monitoring data. This adds credence to the calculated load data and, more importantly, supports the conclusion that the nonpoint source nutrient problem is widespread throughout the basin.

To adequately and efficiently address the problem, the nutrient reduction program has and will continue to place emphasis on the high priority watersheds throughout the basin.

TABLE 1

BENCHMARK NITROGEN LOADS FOR PENNSYLVANIA
(MILLIONS OF POUNDS PER YEAR)

SOURCE CATEGORY	SUSQUEHANNA	EASTERN SHORE	WEST CHESAPEAKE	POTOMAC	TOTAL
POINT SOURCES					
MUNICIPAL	6.745	0.000	0.000	0.180	6.925
INDUSTRIAL	0.120	0.000	0.000	0.015	0.135
a.) SUB-TOTAL	6.865	0.000	0.000	0.195	7.060
CONTROLLABLE NONPOINT SOURCES					
ANIMAL WASTE	25.172	0.100	0.180	2.515	27.967
CROPLAND NEEDING TREATMENT	20.173	0.090	0.210	1.276	21.749
URBAN & INDUSTRIAL	2.965	0.025	0.0120	0.135	3.137
ANTHROPOGENIC FLOW	0.875	0.0100	0.0130	0.049	0.947
b.) CONTROLLABLE NONPOINT SOURCES SUB-TOTAL	49.185	0.225	0.415	3.975	53.800
c.) TOTAL (a.+ b.)	56.050	0.225	0.415	4.170	60.860
d.) REDUCTION GOAL (0.4 * c.)	-22.420	-0.090	-0.166	-1.668	-24.344
e.) NATURAL & OTHER SOURCES	64.740	0.4050	0.610	3.380	69.135
f.) 1985 TOTAL LOAD (c.+ e.)	120.790	0.6300	1.025	7.550	129.995
2000 TOTAL LOAD (f.- d.)	98.370	0.540	0.859	5.882	105.651

NOTE: All values are average annual loads or load reductions, represent annual incremental changes.

TABLE 2

BENCHMARK PHOSPHORUS LOADS FOR PENNSYLVANIA
(MILLIONS OF POUNDS PER YEAR)

SOURCE CATEGORY	SUSQUEHANNA	EASTERN SHORE	WEST CHESAPEAKE	POTOMAC	TOTAL
POINT SOURCES					
MUNICIPAL	0.907	0.000	0.000	0.020	0.927
INDUSTRIAL	0.158	0.000	0.000	0.001	0.159
a.) SUB-TOTAL	1.065	0.000	0.000	0.021	1.086
CONTROLLABLE NONPOINT SOURCES					
ANIMAL WASTE	0.865	0.010	0.020	0.686	1.581
CROPLAND SEEDING TREATMENT	0.279	0.009	0.020	0.148	0.456
URBAN & INDUSTRIAL	0.079	0.003	0.002	0.030	0.114
ANTHROPOGENIC FLOW	0.010	0.001	0.001	0.005	0.017
b.) CONTROLLABLE NONPOINT SOURCES SUB-TOTAL	1.233	0.023	0.043	0.869	2.168
c.) TOTAL (a.+ b.)	2.298	0.023	0.043	0.890	3.254
d.) REDUCTION GOAL (0.4 * c.)	-0.919	-0.009	-0.017	-0.357	-1.302
e.) NATURAL & OTHER SOURCES	0.612	0.010	0.024	0.110	0.756
f.) 1985 TOTAL LOAD (c.+ e.)	2.910	0.033	0.067	1.000	4.010
2000 TOTAL LOAD (f.- d.)	1.991	0.024	0.050	0.643	2.708

NOTE: All values are average annual loads or load reductions, represent annual incremental changes.

PHASE I - PROGRESS TO DATE

Point Source Programs

A point source nutrient control program for the Lower Susquehanna River was adopted into regulation in 1970. This regulation required 80% phosphorus removal (i.e., effluent limits of 2.0 mg/l) for all new and modified dischargers to the Susquehanna and its tributaries from the mouth of the Juniata River to the Pennsylvania-Maryland border. That regulation was replaced in 1983 with a statewide nutrient control regulation which provides for imposition of phosphorus controls where they have been determined to be needed to achieve the designated uses. The Susquehanna River has been determined to be a water body on which phosphorus controls are required due to documented nutrient-related problems in the lower river impoundments. Thus, the controls which were implemented under the old regulation will continue to be in effect, and additional or more stringent controls will be imposed in the future if the Department determines that current levels are not effective in preventing impairment of designated uses in the river. The beneficial effects of such nutrient controls to protect waters will, of course, extend to the Bay.

National Pollutant Discharge Elimination System (NPDES) permits in the lower portion of the Susquehanna Basin in Pennsylvania have included phosphorus limits based on the regulations adopted in 1970. This has resulted in a 34% reduction in point source phosphorus load delivered to the Bay. Compliance statistics and actions under the National Municipal Policy for municipal discharges in the lower portion of the Susquehanna Basin reflect violations of phosphorus limits as well as conventional pollutant limits.

In 1985, there were 107 municipal dischargers in the Pennsylvania portion of the Chesapeake Bay Basin in violation of their NPDES permits. Many of these discharges are small and many are a long distance from the Bay. Only 13 of these are major dischargers required to have phosphorus limits based on water quality standards. Of the 13, eight have come into compliance and the remaining five will achieve compliance prior to 1991.

Since not all of the 107 cases have provided costs for achieving compliance, the total cost of upgrading these treatment facilities is unknown at this time. The actual or projected costs where they are known total more than $250,000,000. An additional $100,000,000 may be necessary to achieve compliance by all municipal dischargers in Pennsylvania's portion of the Bay basin. Since compliance with permit limitations is required regardless of the availability of grant assistance, a large portion of the construction cost is paid through local funds.

Nonpoint Source Programs

Pennsylvania's Chesapeake Bay Program consists of four components: 1. the Financial Assistance Funding Program; 2. the Technical Assistance Funding Program; 3. the Educational Assistance Funding Program; and 4. the Planning Assistance Funding Program.

Financial Assistance Funding Program

The focus of the nonpoint source nutrient reduction efforts has been the agricultural Chesapeake Bay Financial Assistance Funding Program. Six conservation districts in Subbasin A have actively participated in the program since 1985. Seven additional districts in Subbasins A, B, D, and E are now involved. Program eligibility is established by conducting a watershed assessment through the Planning Assistance Funding Program to identify nonpoint nutrient sources and prioritize subwatershed areas for the Financial Assistance Funding Program. The watersheds to be assessed are selected on the basis of a four-phase priority system, which uses the watershed priority rankings from the 1979 agricultural nonpoint source 208 study.

The baseline conditions for the nonpoint source nutrient budget were calculated as of 1985. More than two years of Chesapeake Bay Program financial assistance have been provided since then. A total of $1,210,053.90 in financial assistance has been provided for installed best management practices (BMP's) through this program as of September 30, 1987. That expenditure has been matched with $621,910.91 by landowners. The combined construction expenditures have achieved an estimated reduction of 186,000 pounds of nitrogen per year and 13,500 pounds of phosphorus per year delivered to the Bay from agricultural sources. This effort was focused entirely within Subbasin A (Lower Susquehanna).

The Pennsylvania State Conservation Commission has approved the use of 15 BMP's to reduce nutrient loadings to the Chesapeake Bay. The combination of BMP's to be used on an individual farm is based on site-specific needs to develop a complete resource management system. The emphasis of the BMP's is on nutrient management. About 75% of the financial assistance provided in Phase I has been for BMP's which focus directly on nutrient management. These BMP's are animal waste management, soil and manure analysis, and fertilizer management. A recently adopted BMP, transportation of excess manure, will be used to address situations where manure cannot be utilized in an environmentally safe manner on the farm where it is produced. The remaining BMP's are used to prevent erosion or trap sediment which is laden with nutrients. Installation of BMP's is facilitated through the Technical Assistance Funding Program. The emphasis of Pennsylvania's Chesapeake Bay Program has been and will continue to be on nutrient management.

Other agricultural programs also have contributed to nutrient reduction. USDA programs including the Agricultural Conservation Program (ACP), Public Law 566 (PL-566) Watershed Protection Projects, the Conservation Reserve Program (CRP), and the Rural Clean Water Project (RCWP) have assisted in the treatment of 102,000 acres, with an estimated reduction of 1.17 million pounds of nitrogen per year and 0.016 million pounds of phosphorus per year. The ACP and CRP programs are dispersed throughout the basin. PL-566 projects are being installed within Subbasins C (Juniata River), D (West Branch of Susquehanna), and F (Potomac). The RCWP is located in Subbasin A.

Participation in CRP is being encouraged within the Chesapeake Basin through the establishment of a special bid pool for nine priority counties. Participating farmers in those counties receive higher rental rates than elsewhere in the state. There are now about 35,000 acres protected under CRP in the Chesapeake Basin.

Educational Assistance Funding Program

The Chesapeake Bay Education Assistance Funding Program has been an important part of Pennsylvania's total nutrient reduction effort. The goal of the Education Program is to provide information to landowners and the public to foster the need for nutrient management, erosion control, and water quality management. The purpose of the Education Program is to accelerate the adoption of and demonstrate the use of soil and water conservation and nutrient management techniques. Financial assistance is provided to conservation districts and other cooperating organizations to conduct education activities.

The Education Program is a cooperative effort among the Pennsylvania Association of Conservation Districts (PACD), the USDA Soil Conservation Service, Pennsylvania State

University, the Pennsylvania Departments of Agriculture and Environmental Resources, the State Conservation Commission, and local conservation districts. Projects include newsletters, brochures, fact sheets, conference exhibits, audio-visual presentations, television and radio spots, meetings, and support of an interstate information center. Also, nutrient management has been incorporated in several environmental education curriculums, environmental education training programs, and workshops at state park environmental education centers. Soil chemistry and plant tissue nutrient analysis, nutrient management programming, and alternative manure utilization methods have been developed and disseminated. Demonstration projects are being used to promote the use of state-of-the-art procedures to control excess nutrients from cropland and livestock.

While it is difficult to quantify the results in terms of nutrient reduction, these educational programs are believed to be important and necessary to achieve the 40% nutrient reduction goal, especially since Pennsylvania must rely so heavily on agricultural nonpoint source programs to meet that goal.

Regulatory Programs

The nutrient reduction program also has a regulatory component. The Chesapeake Bay Program funded the revision of the state's Manure Management Manual. Use of manure management practices and procedures specified in this manual is required in lieu of a permit for animal manure storage facilities and land application of animal manure. As such it is a regulatory publication. The Bureau of Water Quality Management enforcement program has taken 19 actions for violations of the Clean Streams Law resulting in total penalties of $33,400.

During Phase I, the Bureau of Soil and Water Conservation (BSWC) and county conservation districts have collected $79,400 in penalties from 20 violators of the Chapter 102 Erosion and Sediment Pollution Control regulations within the Chesapeake Basin. Proposed revisions to Chapter 102 will: 1. close loopholes which are currently used to circumvent the requirement for an earth disturbance permit; 2. require permits for all agricultural plowing and tillage operations on more than 25 acres (these are currently exempted from the permit requirement); 3. require more strict erosion and sediment controls in special protection watersheds (those with exceptional value and high quality streams); and 4. require 75 foot wide buffer strips in special protection watersheds unless there is a permit for earthmoving activity.

Improvements in the administration of the Erosion and Sediment Pollution Control (E & SPC) Program have included: 1. development of an administrative manual for the program in 1988; 2. revision of the procedures for delegation of E & SPC Program authority to county conservation districts; and 3. revison of the guidelines used by the state to provide financial incentives and rewards to conservation districts that are involved in the E & SPC Program — particularly for those who assume enforcement responsibilities.

The technical capabilites of conservation districts in administering the E & SPC Program have been enhanced through the establishment of five new engineering positions funded through the Chesapeake Bay Program. An engineer has been assigned under an intergovernmental personnel agreement with the Soil Conservation Service to supervise and train the conservation district engineers.

DER has taken other regulatory initiatives to deal with nutrient problems. The Environmental Quality Board took action at its December 15, 1987 meeting to review waste management regulations to require nutrient management plans for all sites where sewage sludge will be applied. These regulations, published in the April 9, 1988 issue of the Pennsylvania Bulletin, require the consideration of all nutrients (fertilizer, manure, and sludge) being applied to the land in determining the allowable sludge application rate. DER has established a Nitrate Ground Water Task Force in Lancaster County. The task force's efforts have resulted in a moratorium on the issuance of permits for on-lot septic systems or land application of sewage sludge in areas with high nitrate levels in ground water. DER has also developed streamlined enforcement procedures.

On the local level, the Lancaster Conservation District and the Lancaster County Planning Commission have prepared a model ordinance for municipalities' use in requiring permits for expansion of livestock operations. The basis for a permit is a nutrient management plan which provides for the use or disposal of manure in an environmentally safe manner.

DEVELOPMENT OF STRATEGY FOR PHASES II AND III

Consideration of Alternatives

Pennsylvania is committed to achieving the 40% nutrient reductions from point sources and controllable nonpoint sources by the year 2000. In fact, phosphorus reductions totaling 44% will exceed the goal. Nutrient reduction estimates were developed for a three phase program from 1985 to 2000. During Phase I (1985-87) nitrogen loads were reduced by 2.2% and phosphorus by 0.9%. Therefore, the bulk of the reductions are planned for Phase II (1988-91) and Phase III (1992-99). Based on current data, it appears that the most cost effective means of meeting the nutrient reduction goal is the Agricultural Nonpoint Source Control Program. This program consists of two sub-programs: 1. the Agricultural Nutrient Management Program; and 2. the Erosion and Sediment Pollution Control (E & SPC) Program.

The Agricultural Nonpoint Source Control Program must be an essential part of Pennsylvania's nutrient reduction strategy since nitrogen and phosphorus from animal manure and cropland needing treatment comprise more than 90% of the total controllable nonpoint source nutrient loads. Agricultural nonpoint sources contribute 82% of the total controllable nitrogen load and 63% of the controllable phosphorus load. A strong agricultural program is necessary to achieve the 40% nutrient reduction goal, because so many of the nutrients have agricultural sources. The strategy for meeting the nutrient reduction commitment was developed based on the results of the nutrient allocation procedure and the progress to date in the Agricultural Nutrient Management Program. The strategy, therefore, is premised on the assumptions and limitations already described.

The determination that the Agricultural Nonpoint Source Control Program is more cost effective than additional point source control programs was made by comparing the cost per pound of nutrient reduction for that program with the lowest cost per pound for additional point source controls. Total cost, including staff, technical, administrative, and financial assistance, and landowners' costs divided by estimated nutrient reductions yields a unit cost of about $6.00 per pound of nutrient reduction for the Agricultural Nonpoint Source Control Program. This calculation is based on CBP records and future projections for manure and fertilizer management BMP's.

The unit cost for additional point source controls is based on the tightening of phosphorus removal requirements in the lower Susquehanna basin. This would consist of changing the 2.0 mg/l phosphorus limit to 1.0 mg/l, and would cost at least $7.60 per pound of additional reduction. This cost includes changes in plant operation and chemicals, but does not include the cost of increased sludge disposal. This would be the least costly point source control, since it would use existing facilities. To extend the phosphorus removal program area upstream into sub-basins D and E would cost at least $10.80 per pound of phosphorus removed from the discharge. This would include capital costs as well as the items listed above.

No cost analysis was done for urban nonpoint source controls, since their effectiveness is not well documented. Due to urban land values and the reliance on structural BMP's in most cases, urban controls are expected to be at least as costly as agricultural BMP's.

Short-term and long-term nutrient reductions were estimated based on projections of USDA and Chesapeake Bay program accomplishments. The Soil Conservation Service provided estimates of cropland which will receive conservation treatment before 2000. That acreage was then used, with basin-wide soil loss data, to estimate reductions in sediment entering Chesapeake Basin streams. Nutrient reductions were then calculated based on those sediment reductions.

The projected impacts of nutrient management BMP's were based upon calculated reductions accomplished to date. Nutrient management reductions are the difference between nutrient levels before and after a nutrient management plan is implemented. The goal of the nutrient management plan is to reduce or eliminate the application of excess nutrients beyond those needed to maintain crop yields. A nutrient tracking system is maintained to measure the progress of BMP implementation. Data from that system was used to project future accomplishments.

An undetermined level of nutrient reduction is taking place as landowners install BMP's on their own. The effects of these private efforts are not factored into the strategy development, since they cannot be quantified. At least some of these BMP's are undoubtedly the result of the Chesapeake Bay education programs, which will continue to be an important part of the total Chesapeake Bay Program. The impact of educational programs is recognized in the Bay-wide Communications Plan completed in May, 1988. The educational programs will be guided by the direction given in that plan.

In some areas with high concentrations of animals, conventional on-farm solutions are not adequate to solve nutrient problems. Excessive quantities of manure produced on some farms cannot be addressed through typical nutrient management plans. Innovative and alternative agricultural nutrient control programs are being investigated, demonstrated, and encouraged. Chesapeake Bay Program funds have been used to explore manure composting, fermentation, and the use of manure for the fertilization of reclaimed strip mines. Also, biogas generation and incineration of manure to generate electricity have been promoted in cooperation with the Governor's Energy Council. DER will explore the establishment of a policy for the utilization of excessive quantities of animal manure in cooperation with the Governor's Energy Council and other interested parties. A new BMP for the transport of manure from farms with excess amounts is now available under the Financial Assistance Program. Since these options are new, affected by economic conditions and require large capital investments, their impacts on basin-wide nutrient reductions are difficult to quantify. The strategy to accomplish the 40% nutrient reductions is founded on the more conventional BMP's which have widespread applicability. This is our best basis for projecting nutrient reductions in Phases II and III until more specific plans develop for utilizing large quantities of manure.

The Erosion and Sediment Pollution Control (E&SPC) Program will continue to be an integral part of the nutrient reduction strategy. The activities described under Phase I will be continued and improved to provide the regulatory component needed to meet the nutrient reduction goal. Specific E&SPC Program enhancements are described under Phase II.

Resource Needs

As shown in Table 3, most of the reductions of nitrogen and phosphorus will be accomplished during Phases II and III of the program. It is important to note that Phases II and III of the program depend heavily on federal conservation programs to achieve the reduction goals. For instance, during Phase II federal programs account for nearly two-thirds of the overall nitrogen reduction. Therefore, the total resources needed to accomplish the nutrient reductions go far beyond those shown in Table 4.

Table 3

Chesapeake Bay Program
Projected Nutrient Reductions[1]

Phase	Nitrogen Reductions: Agricultural Nutrient Management Program	Nitrogen Reductions: Other Programs[2]	Nitrogen Reductions: Total	Phosphorus Reductions: Agricultural Nutrient Management Program	Phosphorus Reductions: Other Programs[2]	Phosphorus Reductions: Total
I	0.3%	1.9%	2.2%	0.4%	0.5%	0.9%
II	3.9%	6.6%	10.5%	5.4%	10.7%[3]	16.1%
III	16.2%	11.1%	27.3%	24.2%	2.8%	27.0%
Totals	20.4%	19.6%	40.0%	30.0%	14.0%	44.0%

1 Based on funding and staffing levels identified in the strategy.

2 Erosion and Sediment Pollution Control (E&SPC) Program, Agricultural Conservation Program (ACP), Food Security Act (FSA), PL-566 Watershed Protection Projects, and Rural Clean Water Program (RCWP)

3 Includes 5.0% reduction due to point source phosphorus controls, and 4.0% reduction due to the phosphate detergent ban.

Agricultural Nonpoint Source Control Program implementation is currently being hindered by an imbalance of staff and financial assistance funds. To meet the 40% reduction goal, the Bureau of Soil and Water Conservation (BSWC) will need 25 new staff positions between Fiscal Years 1988-89 and 1991-92 to provide technical and administrative support for this program. Six of the needed positions will be added to the BSWC staff for the Agricultural Nonpoint Source Control Program in fiscal year 1988-89. (See Table 4)

Nutrient reductions will undoubtedly be more difficult to achieve in the future than they have been during Phase I. It is expected that regulatory programs will be needed in Phases II and III to achieve the nutrient reduction goals. (See Phase II Nonpoint Source Programs for discussion of additional regulatory initiatives.) As shown in Table 4, additional personnel are needed in the Erosion and Sediment Pollution Control (E&SPC) Program to achieve the phosphorus reduction goal.

Table 4

Additional Staff Requirements to Achieve Projected Nutrient Reductions

Phase	Fiscal Year	Agricultural Nutrient Management Program	Erosion & Sediment Pollution Control Program
II	1988-89	6	0
	1989-90	5	6
	1990-91	0	4
III	1991-92	4	0
	TOTALS	15	10

The success of the nutrient reduction strategy is premised on the continued availability of Chesapeake Bay Program funds from EPA. While those funds will be targeted specifically to the Chesapeake Basin, the nutrient reduction effort would also benefit from other programs. For instance, providing funds for the Nonpoint Source Management Program authorized by Section 319 of the Water Quality Act of 1987 would result in additional BMP installation in the Chesapeake Basin, and thereby help to achieve the 40% nutrient reduction. DER Secretary Arthur Davis has encouraged the entire Pennsylvania Congressional delegation to support $100 million in the federal Fiscal Year 1988 budget for this program.

The strategy is dynamic, and will change between now and the 1991 reevaluation. Revisions will be based on increased knowledge that will be gained through monitoring, modeling, and technical investigations as described under Short-Term Programs. Technical advancements and program changes will be addressed in the annual work plan, which will be prepared as part of the Chesapeake Bay Agreement commitments.

The reductions that can be expected with the described resource commitments are displayed in Figure 2 for point source controls and in Figure 3 for nonpoint source controls. The total nutrient reductions will be 40% of the nitrogen load and 44% of the phosphorus load, with an emphasis on nonpoint source controls. The Agricultural Nonpoint Source Control Program and related USDA programs will reduce nonpoint source loads by more than 40% to achieve the overall nutrient reduction goal. The following sections describe the strategy in greater detail.

PENNSYLVANIA
CHESAPEAKE BAY PROGRAM
NUTRIENT CONTROL STRATEGY
POINT SOURCES

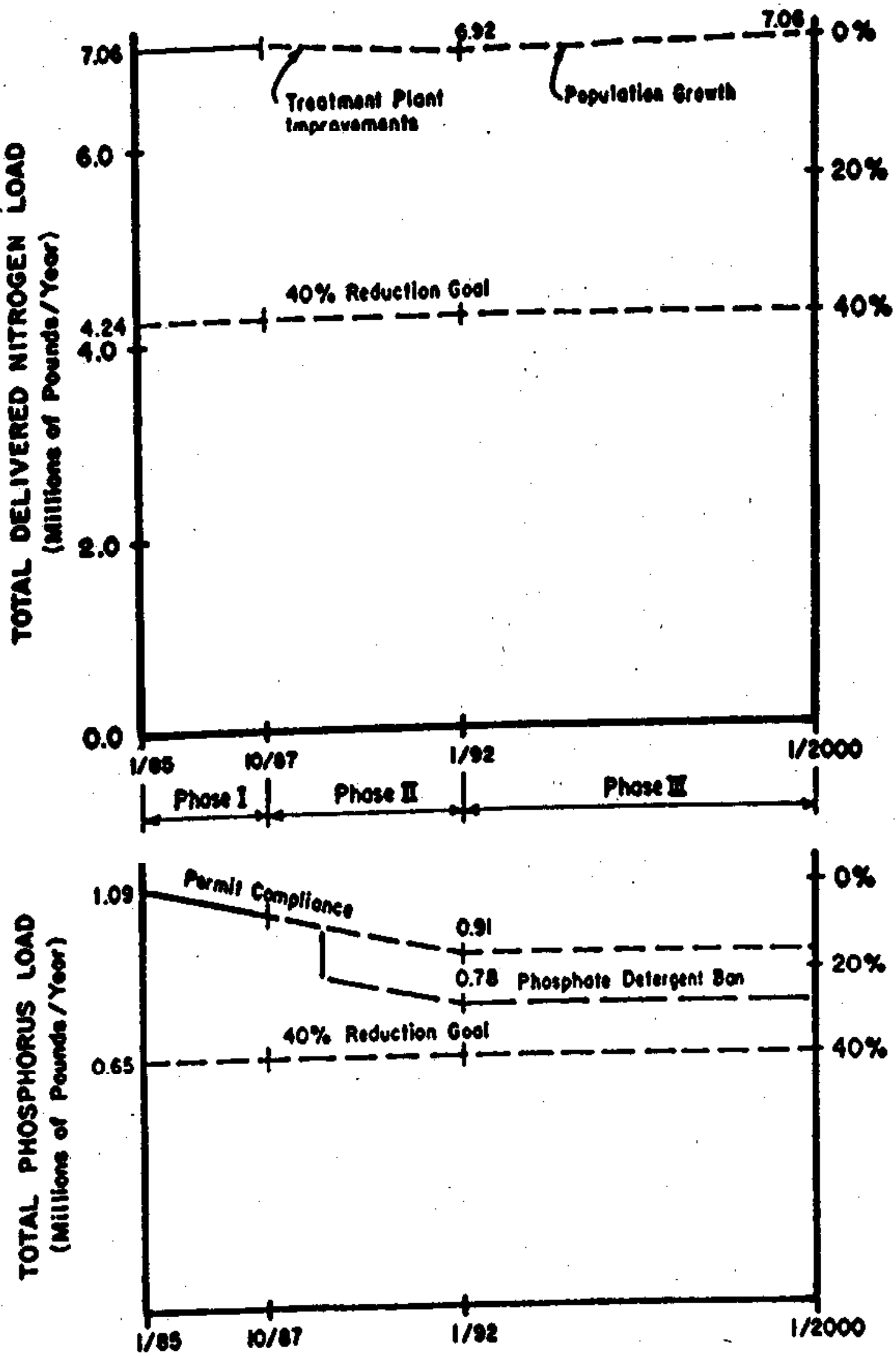
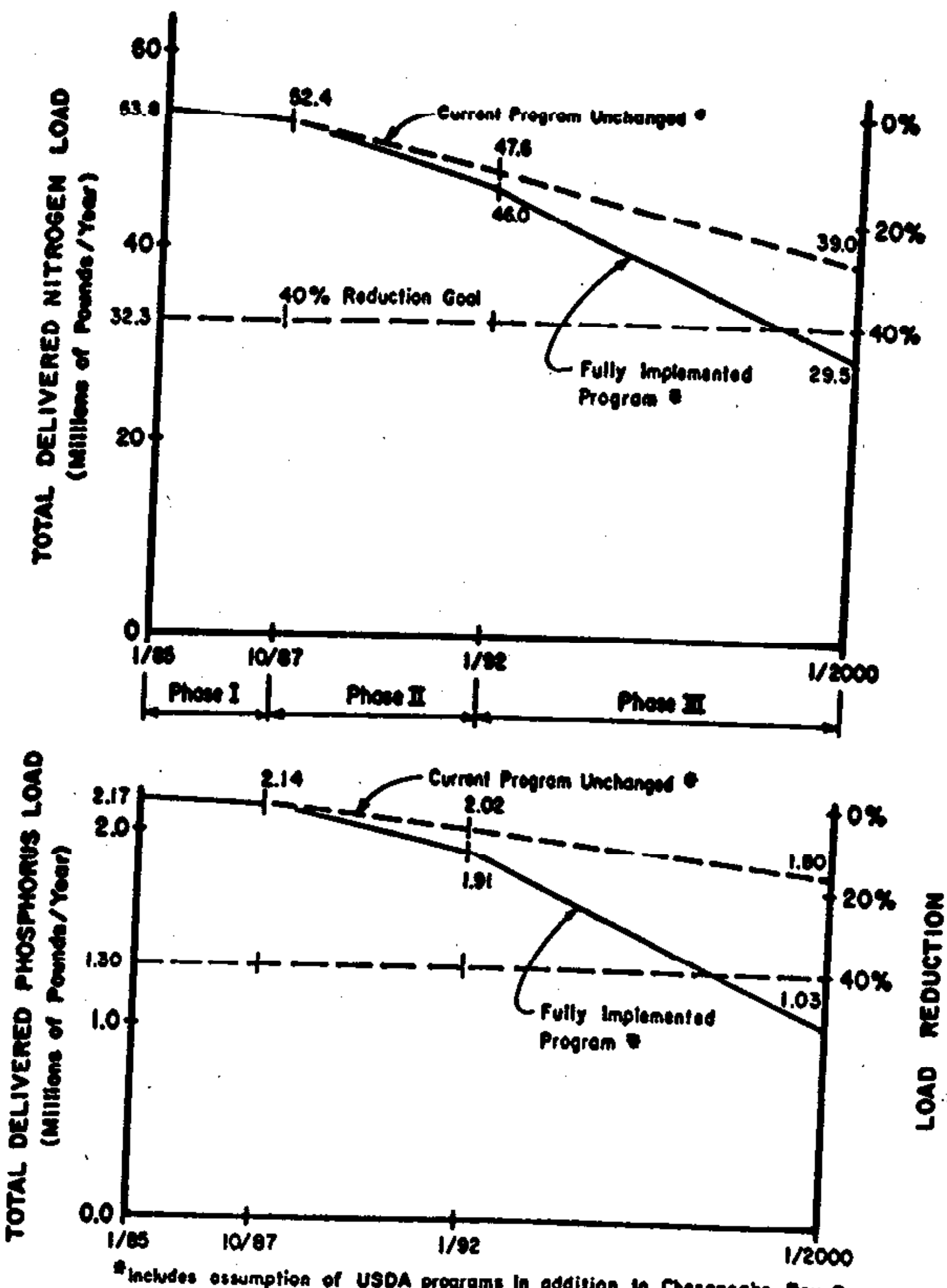


FIGURE 3

PENNSYLVANIA CHESAPEAKE BAY PROGRAM NUTRIENT REDUCTION STRATEGY CONTROLLABLE NONPOINT SOURCES



*Includes assumption of USDA programs in addition to Chesapeake Bay Program

PHASE II - SHORT TERM PROGRAMS (1988-1991)

Point Source Programs

Pennsylvania has set a goal of achieving compliance with 107 municipal dischargers in the Chesapeake Bay Basin by 1991. Full compliance by these treatment plants represents a 20% reduction in point source phosphorus loads and a 5% reduction in total phosphorus loads at the fall line from Pennsylvania.

Achieving one hundred percent (100%) compliance at all treatment plants may seem optimistic. However, once the facilities are in place, even if some dischargers are not in full compliance, others will be discharging lower levels of phosphorus than their permit limits. This is because actual flows are often less than design and because some treatment facilities remove nutrients to a greater extent than is required by their permits. With nutrient removal facilities in place for all point sources where they are required, the net loads should be close to the equivalent 100% compliance levels. In 1985, of those plants meeting the phosphorus limit of 2.0 mg/l actual effluent concentrations ranged as low as 0.81 mg/l. Because significant phosphorus limitations have already been imposed on point source discharges, Pennsylvania has no plans at this time to impose additional phosphorus limits in its point source discharge permits.

On March 1, 1988, Governor Casey signed into law an Environment Infrastructure Investment Program (PENNVEST) designed to fund the repair, rehabilitation, improvement, and construction of drinking water and sewer systems in Pennsylvania. This legislation establishes an authority known as the Pennsylvania Infrastructure Investment Authority which will make funds available to local sponsors for water and sewer infrastructure projects. Funding for the Authority will come from several sources, including a General Obligation Bond authorized by a 1981 referendum and a new $300 million referendum, revenue based bonds, capitalization grants under the Federal Clean Water Act, state General Fund appropriations, and repayments of principal and interest on issued loans. The Authority will issue loans, grants, and other forms of financial assistance, including loan guarantees. PENNVEST funded infrastructure improvements will reduce point source nutrient loads from those plants needing to reach compliance by 1991.

The Pennsylvania General Assembly is now considering House Bill 2567, which would ban the use of high phosphate detergents in the state. Passage of this bill, which has the support of the Administration, is anticipated. The Chesapeake Bay Commission has funded a Pennsylvania State University study of the water quality impacts of such a ban. The study concluded that a phosphate detergent ban will reduce the controllable phosphorus load by 4.0%. The phosphate ban will reduce treatment costs. The actual treatment cost savings as the result of a ban will depend on how much less phosphorus will have to be removed to meet discharge limits. The effects of the phosphate detergent ban are included in the total phosphorus reduction of 44%, as shown in Table 3.

For the most part nitrogen limits have not been placed in Pennsylvania point source discharge permits. Pennsylvania presently has no plans to impose nitrogen limits on its municipal discharges because of technical limitations and expenses of removing nitrogen from sewage. Some point sources have provided and will provide nitrogen removal as a result of increased treatment to meet other discharge requirements. It is assumed that the increases in nitrogen loads as a result of population growth between 1985 and 2000 (4%) will be offset by construction of facilities between 1985 and 1991.

Nonpoint Source Programs

During Phase II, the Chesapeake Bay Financial Assistance Funding Program will gradually increase as technical investigations funding decreases. For fiscal year 1988-89, a net increase of $600,000 in Chesapeake Bay funds has been targeted to increased technical and financial assistance. Average annual program funds for financial assistance to farmers now exceed $2,000,000. That level of funding is expected to continue through 1991. Program emphasis will continue to be on nutrient management, with erosion control being used where necessary to install a complete nutrient management system. Nutrient management BMP's address the manure and fertilizer nutrient problems directly and are more cost effective in achieving nutrient reduction than erosion control BMP's and point source controls, as described earlier.

In light of the indications that nutrient loads originate throughout the Basin, expansion of the Financial Assistance Funding Program is necessary to achieve the nutrient reduction goals. Another seven conservation districts is Subbasins A, B, C, and E will complete watershed assessments in 1988, and six more in Subbasins C, E, and F will be completed in the following year. These last six districts, which will comprise the last phase of the four-phase priority system, have been selected on the basis of the original priority system modified by the nutrient load contributions generated in developing this strategy. The most significant impact of this modification will be the inclusion of two watersheds from Subbasin F (Potomac River). In addition to the priority watersheds selected through this process, other watersheds in the Chesapeake Basin may rank high on a statewide basis. This will be determined through a statewide agricultural nonpoint source watersheds assessment, which will be funded by an EPA 205(j)(5) grant.

As more conservation districts become eligible for the Financial Assistance Funding Program, cost share funds will be allocated to them where possible. While counties may qualify for the program, and adequate funds may be available, additional state staff is essential to administer the program and conduct mandated compliance checks, over an expanded program area. To meet increasing program needs and achieve the nutrient reductions goal, five new Bureau of Soil and Water Conservation staff positions are proposed for Fiscal Year 1989-90.

It is anticipated that over the four-year period, the annual nitrogen load will be reduced by 6.411 million pounds and the annual phosphorus load will be reduced by 0.229 million pounds by nonpoint source efforts. Of these reductions, 2.387 million pounds of nitrogen and 0.174 million pounds of phosphorus will be accomplished through the implementation of nutrient management BMP's. The conservation treatment of 352,000 acres of cropland through USDA programs will achieve an estimated annual reduction of 4.024 million pounds of nitrogen and 0.055 million pounds of phosphorus. Much of this will occur starting in 1990, when the Soil Conservation Service will switch its Food Security Act (FSA) emphasis from planning to field application. This is premised on the assumption that federal funding levels are at least maintained and other priorities do not take precedence. The main objective of FSA is to control erosion on highly erodible land. This will have the indirect benefit of reducing nutrients. FSA emphasis on erosion control practices will complement the CBP emphasis on nutrient control practices.

Further enhancements of the Erosion and Sediment Pollution Control (E&SPC) Program will be needed in the near future to meet the 40% nutrient reduction goal. Six BSWC positions are proposed for Fiscal Year 1989-90 to strengthen this program. These positions will be used to process earth disturbance permit applications, initiate enforcement actions, audit the performance of conservation districts in administering the program locally, provide training to the conservation districts to improve their performance of delegated responsibilities in this program, and provide technical expertise to conservation districts. The technical capabilities of the conservation districts will also be supported through the continued funding of five conservation district engineers and an engineering supervisor. Four additional BSWC staff positions will be requested for Fiscal Year 1990-91 to provide additional technical expertise in the E & SPC Program and address other program deficiencies.

In addition to staff increases, the E & SPC Program will benefit from the development of a design manual which will be undertaken in Fiscal Year 1988-89 and the development of a reporting system to track the number of erosion and sediment control plan reviews, site inspections and other aspects of the program. Also, the BSWC will insure that the proposed enforcement procedures developed in Phase I are applied to the E & SPC Program.

The Pennsylvania General Assembly will be considering new legislation which would require all farmers in priority watersheds to have nutrient management plans completed by an established deadline. House Bill 2616 was introduced in the General Assembly on June 30, 1988. This initiative would regulate nutrients applied by farmers in the form of animal manure and fertilizers and would provide a comprehensive statutory framework for nutrient management programs begun through the Chesapeake Bay Program.

DER plans to promote the "Agricultural Lands Fertilizer Agreement" developed by the State Conservation Commission. This agreement between a municipality and landowner is intended to facilitate the use of farmland for spray irrigation of effluent from sewage treatment plants.

Research is needed to better understand the urban nonpoint source nutrient problems and to identify cost effective means of dealing with them. Coordination among existing erosion and sediment pollution control, storm water management, and wetlands protection programs will be evaluated. The DER Bureau of Dams and Waterway Management (BDWM) is currently addressing nonpoint source pollution through county prepared watershed storm water management plans. Counties, in preparing watershed storm water management plans, identify water quality concerns and determine the need to address nonpoint source pollutants. Although such planning efforts involving water quality components have been undertaken outside the Chesapeake Basin, current and future plans for watersheds within the basin may incorporate water quality components. Through funding of storm water management plans, the BDWM plans to evaluate water quality associated with storm water runoff in several counties in the Chesapeake Basin.

Typical tasks to address water quality within a storm water management plan may include:
a. identification of critical nonpoint source sub-watersheds based on annual loadings;
b. estimation of annual pollutant loadings under existing and future land use conditions;
c. identification of BMP's applicable to the watershed; and d. evaluation of the effectiveness of BMP's.

The Bureau of Dams and Waterway Management anticipates use of an EPA grant to fund a research effort by Penn State University concerning identification and evaluation of nonpoint source pollutants from storm water in developing watersheds. This research effort will include identification and prioritization of pollutants and modification of the existing Penn State Runoff Model to accept urban pollutant load parameters. The effectiveness of the BMP's will also be evaluated through monitoring of NPS pollution control structures. It is expected that by December, 1991, urban BMP's will be available through an Urban Nonpoint Source Control Program.

Water quality monitoring and technical investigations will continue to be funded to expand and refine our knowledge of nonpoint source nutrient problems and solutions. The Pennsylvania water quality monitoring program will be coordinated with the fall line monitoring program through the Fall Line Monitoring Ad Hoc Work Group. The monitoring program will be extended to the Potomac River basin. Both monitoring and technical investigations will be used to identify spatial and seasonal trends in nutrient movement. The results of these efforts will be used to improve nutrient management programs and be incorporated into the enhanced watershed and bay computer models being developed by EPA. The need for the watershed model to provide nutrient load output data at intermediate points above the fall line will continue to be coordinated through the Modeling Subcommittee. The models will also address the issue of atmospheric deposition of nutrients.

The existing agricultural nonpoint source nutrient tracking system will be revised to be compatible with the methodologies in this strategy. The effectiveness of BMP's in reducing nutrient loads will be incorporated into the tracking system as more data become available. The data will come from ongoing BMP monitoring being conducted by the U.S. Geological Survey on two small watersheds and by DER on a third watershed, as well as from computer modeling being conducted by the Interstate Commission on the Potomac River Basin and the University of Maryland. Additional modeling will be done through planned contractual technical investigations in the 1988-89 fiscal year. The need for research on the effectiveness of BMP's has also been identified in the Comprehensive Research Plan being prepared concurrently with this document. The tracking system will be used to monitor progress, prepare EPA grant applications, and manage funding allocations to conservation districts for the Financial Assistance Program.

PROGRAM REEVALUATION

The 1987 Chesapeake Bay Agreement contains a commitment to reevaluate the 40% reduction target by December, 1991. This will be done based on the results of the computer modeling, research, and monitoring programs discussed above. Issues to be resolved in the reevaluation process include the total fall line loads, allocations to subbasins above the fall line and to source categories within the subbasins, fate and transport (delivery ratios) of nutrients from their sources to the Bay, and equitable reduction goals for each of the point and nonpoint source categories. The levels of nutrient contributions from forested land will be reevaluated, based on preliminary monitoring results which indicate much higher nutrient loads than are currently assigned to this uncontrollable source. These refinements will help fine tune the nutrient reduction strategy and possibly result in adjustments to the areas of emphasis between 1992 and 2000.

As Geographic Information System (GIS) data become available, they will be used to more closely represent the land use distributions throughout the basin in calculating nutrient loads and integrate that data with hydrologic boundaries, soils, geology, and human and annual population data. Also, the effects of land use changes through 1999 on the delivery of nutrients to the Bay will be evaluated.

Similarly, projections of animal populations will be considered. An attempt was made to project animal populations in developing this strategy, but no statistically significant conclusions could be drawn due to the high variability of population data.

Urban BMP's and additional point source controls will be evaluated and incorporated as necessary in the program revisions.

It is expected that compliance with current point source permits will be achieved with present technical and legal resources. If the 1991 reevaluation indicates that additional point source controls are required or that nonpoint source enforcement efforts must be expanded, additional technical and legal resources will be required. The strategy will be revised to include additional staff as required at that time.

PHASE III - LONG TERM PROGRAM (1991-1999)

Point Source Programs

Depending on the success of nonpoint source control strategies it may be necessary at some time in the future to reconsider point source nutrient controls. Possible options for phosphorus include extending the phosphorus limitation to point source dischargers in the upper Susquehanna and Potomac subbasins, reducing limits in the lower Susquehanna basin to 1 mg/l, and applying the 1 mg/l to the entire Bay basin. Nitrogen limits could also be established for point source discharges based on the demonstrated effectiveness of biological nutrient treatment. Each of these options represents a considerable expense to the residents of Pennsylvania and would only be considered if nonpoint source control options proved more costly or ineffective. Consideration of new point source discharge limitations will also include the necessary additional resources to implement the new requirements. It will also be necessary to develop better tools to predict the benefits of the various nutrient control options so that relative costs can be compared within Pennsylvania and with options in other states. This will help to address equity concerns.

Nonpoint Source Programs

Based on current knowledge, nonpoint source program projections beyond 1991 are difficult. Estimates of the financial and personnel resource needs to achieve the nutrient reduction goal have been made using the best available information.

To achieve the 40% reduction goals, the Chesapeake Bay Financial Assistance Program will have to be expanded to provide sufficient funds for agricultural BMP's. The BSWC will also need four more technical staff to implement the program expansion. Nonpoint source control options could include alternative agricultural nonpoint source programs and an urban nonpoint BMP program. The merits of these options will be assessed in the 1991 program reevaluation on the basis of program accomplishments and monitoring, modelling, and technical investigation in Phase II.

A major component of the Phase III agricultural nonpoint source nutrient reduction effort will be the implementation of conservation plans prepared under the USDA Food Security Act program. Installation of BMP's under that program is to be completed by 1995.

The need for additional funds and staff resources for the Erosion and Sediment Pollution Control Program will be identified and requested as needed to support the continuation of Phase I and II initiatives.

COMMONWEALTH OF VIRGINIA

NUTRIENT MANAGEMENT STRATEGY

A. Estimates of Nutrient Loads

The commitment to achieve at least a 40% reduction in the amount of nitrogen and phosphorus entering the mainstem of the Chesapeake Bay by the year 2000 is based on agreed upon 1985 point source loads and on nonpoint loads in an average year.

Tables 1 and 2 present the base loads for phosphorus and nitrogen that the Commonwealth proposes to use to measure progress towards the 40% target. These loads represent the best information presently available.

These tables also contain the 40% reduction target for the year 2000. In developing this strategy it was assumed that both the point and nonpoint sources would be reduced by 40%. This assumption may change in the future as a result of information from monitoring, modeling, and research programs.

The river basin point source data represents either 1985 measured values, or estimated values based on the type of discharge. For point sources above the fall line, the delivery ratios that were used in the 1983 EPA report, Framework For Action, were used to deliver the discharge loads to the fall line. These delivered fall line loads were added to the total load from point sources below the fall line to arrive at a total river basin point source load. When revisions to the Chesapeake Bay Watershed model are completed it is anticipated that the delivery ratios used in this analysis may be revised.

The year 2000 projected flows for the municipal wastewater plants assume they are operating at their projected plant design flow (except for the Upper James River estuary facilities where projected actual year 2000 flows have been used). Therefore, total actual flow in the year 2000 is expected to be less than the flow used in this analysis. Correspondingly, the projected year 2000 point source nitrogen and phosphorus loads are also anticipated to be less than the loads shown.

Total basin nonpoint loads were estimated using the following procedure. A total fall line load for each river basin was estimated from available monitoring data for periods without major storm events. Delivered loads from point sources above the fall line were subtracted from the total fall line load estimates to provide a nonpoint source fall line load. The nonpoint source load below the fall line was estimated by multiplying the fall line load by ratios calculated from river basin loads contained in the EPA report, Framework For Action.

Average year controllable nonpoint source loads were calculated by partitioning the total nonpoint source basin loads according to benchmark nutrient budget percentages determined by EPA. River basin NPS loads attributed to animal waste, cropland needing treatment and uncontrollable sources were calculated.

B. Background

Point Sources

In the past point source nutrient control programs in Virginia have been established to address localized nutrient enrichment problems. During the 1970s nutrient controls were imposed on discharges into several lakes and river basins, such as the Occoquan Reservoir in Fairfax and Prince William Counties; Smith Mountain Lake in Franklin, Bedford, and Pittsylvania Counties; the Potomac River embayments below Washington, D.C., and the Chickahominy river which is a tributary to the James River estuary. With the publication of EPA's Chesapeake Bay Program findings in 1983, the concern over nutrient enrichment has broadened to encompass the entire Bay and its tributaries, especially east of the fall line.

In 1986 the Virginia Water Control Board (VWCB) authorized the development of water quality standards to protect the Chesapeake Bay, its tributaries, and the remaining waters of the Commonwealth from nutrient enrichment problems. Water quality standards provide the legal basis for establishing permit requirements for point sources. The VWCB recently adopted water quality standards for nutrient enriched waters along with a point source policy. Details on these significant actions are described later in this strategy.

Nonpoint Sources

The U.S. Environmental Protection Agency has published a comprehensive list of "Major Nonpoint Source (NPS) Pollution Categories and Subcategories" in the 1988 State Water Quality Assessment Guidance (April 1, 1987, p. 19). This list has been evaluated in detail by the Nonpoint Source Subcommittee of the Implementation Committee in terms of potential impact and availability of water quality data. Although many of these sources could provide a significant nonpoint source pollution impact, an evaluation of both impact and required improvements is not presently possible for all sources. Limited evaluation data regarding nonpoint source impacts overall is summarized in the Virginia Nonpoint Source Assessment Report available as of April 1, 1988. This document is a useful reference to inventory the numerous nonpoint sources which impact water quality. To address nonpoint problems found in the assessment the Department of Conservation and Historic Resources, Division of Soil and Water Conservation is completing a nonpoint source management plan to identify statewide management programs designed to quantify, control and limit the effects of nonpoint source pollution on the state's waters. This report will be submitted to the Environmental Protection Agency by August 4, 1988. Activities in the Chesapeake Bay Program are consistent with statewide programs but are presently funded at an accelerated level. The Division intends to continue to work toward quantifying the impacts associated with those nonpoint sources and to improve our control strategies accordingly.

The Chesapeake Bay Research study published in 1983 determined that as much as 39% of the phosphorus and 67% of the nitrogen in an average rainfall year is contributed by agricultural sources, primarily cropland and animal manures. Urban sources contribute only 6-8% of the nutrient load. The Division of Soil and Water Conservation operates programs for pollution abatement in each of these source areas, but research shows that the most significant impacts will result from agricultural strategies. As a result, the calculation of the baseload attributable to nonpoint sources is based upon nutrient losses from cropland, pastureland and animal waste management. Sufficient data do not exist to calculate nutrient loads or reductions for other sources at this time.

EPA has previously provided estimates on nonpoint source fall line and estuary mouth loads for all jurisdictions within the Chesapeake basin through an approach that estimates a total load, subtracts a point source load and labels the "remaining load" as the nonpoint source load. The "remaining load" includes a "background load" and the impacts of other nonpoint sources. For the purpose of this report, pollutant baseload calculations have been developed similar to point source calculations. By the use of a variety of existing cropland and pastureland treatment data, a non-delivered baseload for detached sediment and its nutrient characteristics has been developed. The method utilized to calculate reductions from this load evaluates the result of BMP installations funded within the state-wide cost-share program, the USDA-ASCS ACP program and the conservation reserve program. The load is non-delivered because, other than the Virginia cost-share program, the geographical location, stream location and runoff slope length for other installed practices is not available. However, county-wide aggregation of results is possible and thus county-based reductions due to BMP installations have been developed.

Calculation of nutrient baseload was based upon an estimation of the annual sediment loss in the drainage basin and the nutrient load associated with that soil loss. By counting the 1984 USDA-SCS Workload Analysis figures for agricultural acres eroding at different rates with ranges of rates by Major Land Resource Areas (Virginia Natural Resources Index, 1982, p. 70), baseload sediment loss conditions were approximated for all counties in the Bay drainage.

Basin erosion rates were computed by summarizing the county estimates according to individual basin distributions for the five major drainage basins (Potomac, Rappahannock, York, James and Coastal). Sediment loads were derived from these erosion rates and segregated by counties. These calculations also recognized practice lives for all programs analyzed. The impact of overlapping programs under the Farm Bill is also accommodated. Nutrient calculations are derived from sediment loads by the use of an "enrichment factor" of 5.44 pounds of nitrogen and 0.68 to 1.88 pounds of phosphorous per ton of soil.

Nutrient reductions attributable to the nutrient management program have also been estimated. There is data for tons of waste treated and estimates of nitrogen and phosphorous value of that waste, but a baseload can not be developed further as has been done with cropland. For this report, progress in animal waste reductions is calculated based upon the number of systems needed by 1984 workload analysis figures versus the number of systems installed in each target year. Nutrients saved are deducted from the portion of the nonpoint load attributable to animal waste in Technical Appendix 2 of the 1985 Chesapeake Bay Watershed Benchmark Nutrient Budget.

Estimated reductions for all three categories of practices are reported in percent improvement rather than pounds. Data provided by the Virginia Water Control Board on fall line loads, full river basin loads and point source loads has been used to convert these figures to nonpoint source basin loads for the purpose of reporting state-wide progress. These load figures cannot be interpreted literally.

Significant efforts are underway to improve Virginia's fall line monitoring and nutrient load characterization. The EPA-HSPF watershed model is also being improved and will serve to better characterize delivered nonpoint loads. The Division of Soil and Water Conservation data collection and retrieval system continues to improve for both agricultural and other source data. For instance, site data from the intensively-monitored demonstration watersheds is only now becoming useful, but could not be included in this report. Extensive research is underway to better define nutrient composition/soluble or particulate, transport mechanisms and the long term efficiencies related to nutrient management. It is anticipated that by 1991 each of the jurisdictions involved in this program will be developing and reporting more uniform and accurate information.

With additional monitoring data and the use of the 3-D and watershed models, we will be able to better evaluate separate components of this program and their sub-basin impacts, and make management decisions to most effectively meet program goals. At present, this analysis serves only to indicate trends in program impact. These trends and associated programs need to be continuously evaluated and refined as we move toward 1991 and beyond.

C. **Nutrient Reduction Activities - Phase I (1985 Through June 1988)**

Point Sources

- The 1987 Virginia General Assembly adopted a phosphate detergent ban which became effective on January 1, 1988. Based upon experience in other states it is estimated that the phosphorus discharged from municipal facilities will be reduced by 25 to 30% due to the ban. Treatment plant data analyzed through February 1988 confirm a significant level of reduction in the phosphorus discharged due to the ban. A complete evaluation of the impact of the Virginia ban will be conducted in early 1989 when a year's worth of data will be available.

- As preparation for implementing a nutrient management strategy in Virginia $360,000 in funding was provided for nutrient removal demonstration projects at the following three wastewater treatment plants:

PLANT	TREATMENT TYPE	RESULTS
HRSD-YORK RIVER	BIOLOGICAL NUTRIENT REMOVAL (BNR)	Phosphorus removal of 50-70%; effluent concentration: 3 to 4 mg/l. Nitrogen removal of 60-80%; effluent concentration below 10 mg/l during warm weather.
TOWN OF KILMARNOCK	BIOLOGICAL PHOSPHORUS REMOVAL (BPR)	Phosphorus removal of 55 to 60%; effluent concentration of 3 mg/l. Incidental nitrogen removal of 50%
CITY OF FREDERICKSBURG	SIMULTANEOUS CHEMICAL PRECIPITATION FOR BOD REMOVAL	Phosphorus removal of 63%; effluent concentration of 2.5 mg/l.

In addition, the Hampton Roads Sanitation District has conducted a year long pilot study of a new version of biological nutrient removal, which has been named the VIP process. The existing Lamberts Point plant in Norfolk is currently being upgraded and expanded with federal grant funds provided through the VWCB to incorporate this new method of removing phosphorus and nitrogen. The projected cost to construct and operate this facility is essentially equivalent to the cost of secondary treatment.

Each of these technologies should provide municipal and industrial dischargers with cost effective alternatives for meeting nutrient removal requirements.

- o In order to obtain more complete data on the actual discharge of nutrients from Virginia's municipal and industrial facilities a Voluntary Nutrient Monitoring Program began in July 1987. At present 32 municipalities and 16 industries are participating by analyzing their wastewater discharges for phosphorus and nitrogen.

- o In order to address nutrient enrichment problems in the waters of the Commonwealth, the Virginia Water Control Board has developed new Water Quality Standards. These Standards, which designate certain waters as 'nutrient enriched waters' were approved by the VWCB in March 1988. Within the Bay watershed nine embayments or tributaries to the Potomac River are now designated as nutrient enriched waters. The new designation also includes the entire Chesapeake Bay and it tributaries to a point five miles above their respective fall lines with the exception of the tidal fresh portions of the Mattaponi and Pamunkey rivers.

  The VWCB also approved a Point Source Policy for Nutrient Enriched Waters which provides for the control of point source discharges of nutrients to the nutrient enriched waters. A summary of the Policy requirements are as follows:

  1. Existing discharges authorized to discharge 1 MGD or more (and new discharges greater than 0.05 MGD) must meet a monthly average total phosphorus effluent limitation of 2 mg/l. Existing facilities will have three years after their permits are amended to meet this requirement.

  2. Those dischargers who voluntarily accept a permit to meet a monthly average total nitrogen limit of 10 mg/l during the months of April through October will be allowed an additional year to meet the Policy requirements.

- The VWCB and the Department of Conservation and Historic Resources' Division of Soil and Water Conservation have developed a comprehensive nutrient management strategy to ensure that management programs for point and nonpoint sources are conducted in a coordinated fashion.

- Ten major wastewater treatment plants in the Potomac River basin incorporated various types of nutrient removal during the 1970s in order to meet state water quality standards. The cost to upgrade these facilities to advanced treatment levels exceeded $300 million. Since 1985 several of these facilities have improved their operations in order to comply with an effluent phosphorus permit limit of 0.18 mg/l for discharges to the Potomac Embayments. One facility, operated by the Upper Occoquan Sanitation Authority, must meet a weekly average effluent phosphorus concentration of 0.10 mg/l.

- The most important change included in the June 1988 amendments to the VWCB's Regulation No. 6 is the inclusion of the Virginia Pollutant Abatement (VPA) Permit. The new VPA permit will replace the state No-Discharge Certificate thereby clarifying procedures and requirements for the regulation of facilities and operations which have the potential to discharge to state waters. The regulation will also require application for VPA permits for "concentrated animal feeding operations" (maximum permit life of 5 years) and "intensified animal feeding operations" (maximum permit life of 10 years). This action will strengthen an ongoing program to prevent the discharge of nutrients and other pollutants from these animal feeding operations.

Nonpoint Sources

The basic nonpoint pollution control strategy includes the following components:

1. Pollutant source identification i.e. cropland, urban areas, forested area, etc.

2. Development of appropriate management strategies or best management practices (BMPs).

3. Targeted implementation of these practices.

4. Evaluation of the program including load reductions and cost/benefits and refinement as necessary.

Implementation of this voluntary program is achieved through the appropriate combination of education and research, technical assistance and financial incentives. This requires the cooperation of a number of public and private agencies at the federal, state and local level. Basic program information in these categories is summarized below and in further detail in the Conventional Pollutant Strategy for Agriculture.

Education

Education extends the direct benefit of financial incentives to landowners beyond the reach of the cost-share program. Unassisted voluntary installation of BMPs is the only way to substantially reduce water quality impacts within an annual cost-share budget of $1,200,000. In an effort to reach audiences in all age groups, education initiatives developed between 1985-88 include the categories of media exposure, special events/items and awards programs. Examples of each are:

New releases, articles, public service announcements, radio programs, and presentations

Slide shows

Brochures, bumper stickers, etc.

Virginia Natural Resources Conservation Week

Rotating tabletop display

Rainfall simulator

Conservation tours of farms

Youth Conservation Camp

Governor's Model Clean Water Farm Awards Program

Technical Assistance

Technical assistance refers to the human resources involved in the design, inspection and installation of both structural and management BMPs. To date 5 additional SCS personnel and 27 Division of Soil and Water Conservation funded personnel are in the 25 Soil and Water Conservation Districts within the Bay to assist in the implementation of this program. Additional support technical staff are in the headquarters office of SCS and the Division of Soil and Water Conservation.

Financial Incentives

Land-use programs traditionally offer financial incentives to encourage participation in a program at low or no cost. Thereafter, eligibility may be curtailed and the landowner installs and maintains that practice without assistance. It was estimated that in 1984 $170 million in BMPs was needed in Virginia's Chesapeake basin. The expenditure of $1.2 million per year doesn't "buy" soil conservation, but hopefully installs sufficient BMPs in a water quality targeted fashion to allow the technical assistance and education elements of our program to promote far wider acceptance of selected BMPs. The voluntary expansion of this program is presently impossible to track, but estimates are that as many as 60% of all BMPs are installed without financial assistance.

Research

Education, technical assistance and financial incentives are focused and implemented most efficiently through a dynamic and state of the art research program. Through the use of geographic information systems (VirGIS) and modeling techniques, geographical regions are being assessed and ranked according to the pollution potential. This capability provides the Division of Soil and Water Conservation with the ability to distinguish potentially high-priority farms from low-priority farms. Outreach resources such as education and active recruitment are then targeted to high-priority areas. Individual cost-share requests are ranked on the basis of cost and pollution reduction algorithms developed in the research program. This type of ranking promotes overall BMP efficiency with regard to limited cost-share resources.

Our calculations confirm that the major pollutant reduction impact during this phase is due to the 6 Conservation Reserve Program sign-ups between 1986 and 1988.

Installations as a result of these sign-ups will convert approximately 24,448 acres of highly erodible cropland in the Chesapeake drainage basin to grass or trees. This is the major measurable impact during this time period.

TABLES 1 AND 2 PRESENT THE ESTIMATED NUTRIENT LOADS FOR POINT AND NONPOINT SOURCES AT THE END OF PHASE I.

D. **Nutrient Reduction Activities - Phase II (July 1988 through December 1991)**

Point Sources

- o The major activity in the area of point source nutrient removal during this period will focus on implementing the Point Source Policy for Nutrient Enriched Waters. Under the Policy 19 municipalities and at least 5 industries will be impacted by the phosphorus removal requirements. Since the Policy allows up to 3 years for the dischargers to upgrade their facilities, most of these dischargers should be in compliance with their phosphorus requirements by 1991 or shortly thereafter.

- o The Point Source Policy contains the option of extending compliance with the requirements of the Policy for up to one year if an owner agrees to meet a seasonal total nitrogen limit of 10 mg/l. It is not known at this time how many dischargers may elect to include nitrogen removal as outlined in the Policy.

  A recent study sponsored by 12 owners of 22 major wastewater treatment facilities indicated the most cost effective approach to meeting the requirements of the Point Source Policy was biological phosphorus removal (BPR) followed by chemical polishing. For the 16 facilities in the study that need to upgrade to meet the Policy requirements, the estimated capital cost is approximately $21 million. Twelve of the facilities were identified as possible candidates for using the BPR approach. A significant finding of Virginia's Nutrient Removal Demonstration Program indicates that using BNR, even if just designed and operated primarily for phosphorus removal, may also result in significant nitrogen removal during warmer weather.

  Thus, whether a discharger volunteers to install biological nitrogen removal (BNR) to meet seasonal nitrogen limits or uses BPR for phosphorus removal a significant reduction in nitrogen from point sources is anticipated.

- o Effluent requirements for ammonia-nitrogen should become effective during this period for a number of point source dischargers within the Chesapeake Bay watershed based upon ammonia toxicity or nitrogenous oxygen demand considerations:

  1. The Upper James River Estuary Plan proposes that major municipal and industrial dischargers between

- Richmond and Hopewell provide varying degrees of nitrification.

2. The Rappahannock Water Quality Management Plan contains the requirement that any new discharge or expansion of an existing major discharge in the Fredericksburg area must provide nitrification.

3. The ongoing reevaluation of the Potomac Embayment Standards may require certain dischargers to provide nitrification.

Identification of treatment facilities upgrading for nitrification is an important consideration in planning to meet the 40% reduction target for nitrogen. In general, a facility that upgrades to provide for seasonal or year round <u>nitrification</u> will invest a major portion of the capital cost needed to achieve seasonal or year round nitrogen <u>removal</u> - if BNR technology is used. In addition, providing BNR for nitrogen removal may save on operating costs since aeration requirements are usually reduced with the BNR process when compared to operation of a standard nitrification process. Thus, treatment facilities that are planning upgrades to meet nitrification requirements will be encouraged to consider the possible need for nitrogen removal in the future.

- Construction of the Virginia Initiative Plant should be completed toward the end of the period. Operation of the VIP process will provide for the cost effective removal of phosphorus and nitrogen at this 40 MGD facility. In addition, the 15 MGD HRSD-York River plant demonstration project for BNR should continue operation during this period.

- The VWCB will amend NPDES permits to require monitoring for phosphorus and nitrogen in accordance with the <u>Point Source Policy for Nutrient Enriched Waters</u>. This data will improve the VWCB's ability to track progress toward the 40% reduction target, and aid in establishing future nutrient control measures.

- The VWCB administers the <u>Revolving Loan Fund</u> program in Virginia for wastewater treatment facilities. In order to assist municipalities in meeting nutrient removal requirements the rating system used to prioritize projects for funding can incorporate additional rating points for projects proposing to use either phosphorus or nitrogen removal.

- o Any nitrogen control program at Virginia's point sources will require a significant expenditure of capital funds. Cost estimates for some facilities range from $20 to 40 million to provide seasonal nitrogen removal. Providing nitrogen removal for the entire year would add significantly to these cost estimates. Given the impact such an expenditure of resources would have on local communities, the Commonwealth will evaluate the establishment of a cost share program to assist municipalities in financing these improvements.

- o The 1988-90 biennium budget includes funding for a number of programs that will directly benefit Virginia's nutrient management strategy:

    1. Virginia's program of full scale demonstration projects for biological nutrient removal (BNR) will continue. This program will evaluate the impact of the phosphate detergent ban on the operation of BNR technology. Also, the operational capability of BNR technology to provide for seasonal, and possibly year round, nitrogen removal will be demonstrated.

    2. Funding has also been provided for engineering studies to identify where cost effective nutrient removal can be implemented at Virginia wastewater plants.

    3. In order to improve upon estimates of nutrient loadings to the Bay an enhanced fall line monitoring program will be initiated to supplement ongoing monitoring activities. The program, which will focus on the James and Rappahannock river basins, is scheduled to begin early in FY89.

Nonpoint Sources

New initiatives to take place during this time period for nonpoint source control include:

1. The addition of 15 new personnel dedicated to nutrient management of animal wastes and commercial fertilizer. The additional personnel will complement and increase the coordination of existing programs with the Cooperative Extension Service and Soil Conservation Service. This will lead to reductions of nutrients to the Bay, through better utilization of animal manures and commercial fertilizer, during phase II and beyond.

2. Improved targeting of cost-share and ACP program funding by

3. Potential increase in Chesapeake Bay funding or separate funding under Section 319 of P.L. 100-1

4. A revised agreement with the Cooperative Extension Service which includes education and technical assistance to homeowners regarding lawn fertilizer and chemical use

5. The addition of 13 new personnel to better implement and enforce the Erosion and Sediment Control Law

6. Implementation of Section 405 of P.L. 100-1 which establishes a permit requirement for stormwater discharges from systems serving populations in excess of 100,000 (1991) and 250,000 (1990). This potentially impacts 10 cities or counties in excess of 100,000 and 3 cities or counties in excess of 250,000 population in the Bay drainage. The number of industrial discharges affected is presently unknown.

7. Implementation of the Chesapeake Bay Preservation Act (Sec. 10-313 et seq., Code of Virginia) through the Chesapeake Bay Local Assistance Department. This newly created agency must "promulgate regulations which establish criteria for use by local governments in Tidewater Virginia (as defined in the law) to determine the ecological and geographic extent of Chesapeake Bay Preservation Areas..." and "...in granting, denying or modifying requests to rezone, subdivide or to use and develop land in these areas." These criteria are to promote the following:

    1. Protection of existing high quality state waters and restoration of all other state waters to a condition or quality that will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them.

    2. Safeguarding the clean waters of the Commonwealth from pollution.

    3. Prevention of any increase in pollution.

    4. Reduction of existing pollution.

    5. Promotion of water resource conservation in order to provide for the health, safety and welfare of the present and future citizens of the Commonwealth.

These regulations must be promulgated by July 1, 1989, and localities must use them to designate Chesapeake Bay Preservation Areas within their jurisdictions not later than July 1, 1990. In addition, the act requires that the Board shall, upon request by a locality, review any application for the use or development of land in that locality for consistency with the provisions of the Act and regulations within 90 days of such a request.

8. A Flood Control Policies Study was requested by HJR 114 for preparation by joint legislative committee. This study will inventory and analyze existing flood control policies in the Commonwealth and make recommendations if necessary for improvements. It is expected that a large part of this report will relate to stormwater management controls for both quantity and quality. This report will be available in January 1989.

9. Due to recent efforts by the Commonwealth and others, the bid pool designations in Virginia have been changed to carve out the Chesapeake Bay drainage area. This area now has a bid cap approximately 20 dollars per acre higher than the remainder of the State. This is expected to increase CRP sign-ups in the future.

10. The Virginia Erosion and Sediment Control Law (Section 10.1-560, et. seq., Code of Virginia) was modified under two separate bills (S.B. 152 and S.B. 326) during the 1988 session of the General Assembly to improve the enforcement and administration of the overall E&S program.

11. The Division of Soil and Water Conservation will implement a program utilizing state funds to encourage the conversion of additional acres from cropland to trees or grass through the USDA Conservation Reserve Program. Incentive payments will be offered to landowners for the conversion of cropland identified as having high pollution potential. First priority will be given to those areas located in the coastal plain. A bonus payment will be offered for conversion to trees. A minimum of $40,000 per year will be diverted to this program through 1991.

It is not possible to project the direct water quality improvement impact of these new initiatives at this time. Data will be collected to assist in a look-back evaluation in 1991, at the end of this phase. Projections for this phase are based only upon level funding of existing programs and the results of the 6 CRP sign-ups from phase I. The continuation of Farm Bill planning activities during this time period is critical to the assumptions for improvements projected for Phase III of this program.

TABLES 1 AND 2 PRESENT THE PROJECTED NUTRIENT LOADS FOR POINT AND NONPOINT SOURCES AT THE END OF PHASE II. A review of these projected loads leads to the following findings:

1. The 40% reduction target for phosphorus from point sources is expected to be achieved based upon projected reductions in phosphorus due to the phosphate detergent ban and the Point Source Policy for Nutrient Enriched Waters.

2. A significant amount of the point source nitrogen load will be reduced by the activities described above. However, there are too many unknown factors to predict the extent of these nitrogen reductions with any degree of certainty at this time. It is anticipated that additional point source nitrogen reductions will be needed during Phase III.

3. The reduction in <u>total</u> controllable nonpoint source loads is projected to be approximately 7.6% for both phosphorus and nitrogen. However, the percent reductions in the portion of the nonpoint source load from agriculture (crop and pasture) and animal waste that are currently targeted by Virginia's nonpoint source management programs is much greater. Crop and pasture loads will be reduced by 15% to 20% in most river basins for both nutrients. Under the animal waste program the percent reductions exceed 30% in the Rappahannock basin and 13% to 15% in the York and Potomac.

E. Nutrient Reduction Activities - Phase III (1992 Through 2000)

Point Sources

- A nitrogen regulation necessary to meet the Virginia target will be adopted and implemented during this phase. The adoption of this regulation will follow the procedures of the Virginia Administrative Process Act.

- In order to achieve a 40% reduction of nitrogen from point sources all of Virginia's major municipal treatment plants below the fall line would have to install nitrogen removal facilities to be operated throughout the entire year. Effluent monitoring conducted during Phase II will indicate which industrial facilities would also need to remove nitrogen.

  Removing nitrogen throughout the entire year is much more costly than seasonal nitrogen removal during warmer weather. Such a large scale wastewater treatment program would require several hundred million dollars in capital investment.

  Given the impact such an expenditure of resources would have on local communities, the VWCB will support various means to assist dischargers through establishing appropriate standards, setting reasonable permit requirements, and providing financial aid for municipalities.

- As the VWCB continues to administer the Revolving Loan Fund program for wastewater treatment facilities, projects will be subject to a priority rating system for funding that can incorporate additional rating points for projects proposing to use either phosphorus or nitrogen removal.

- Under the Point Source Policy adopted in 1988 dischargers who voluntarily accept permit limits for seasonal nitrogen removal have up to four years from their permit amendment date to meet the phosphorus and nitrogen requirements ofthe Policy. Those dischargers accepting these limits would be expected to complete their upgrades during this period.

- Effluent requirements for nitrogen may become effective during this period at additional point source dischargers within the Chesapeake Bay watershed based upon results of Toxicity Reduction Evaluations for ammonia toxicity or because of nitrogenous oxygen demand considerations.

Nonpoint Sources

Following a re-evaluation of the overall program in 1991, new programs to address additional sources of nonpoint pollution as refinements of existing programs may occur. It is not possible to predict these conditions at the present time. One major initiative that is predictable is the impact of the 1985 Food Security Act (Farm Bill). Approximately 1,257,658 acres of Virginia's Chesapeake Bay cropland have been identified as highly erodible land and have been located by county by the SCS. Conservation plans must be developed and approved by local Soil and Water Conservation Districts for all highly erodible land by January 1, 1990. These plans must be implemented no later than January 1, 1995 in order to maintain eligibility for USDA benefits such as farm loans and commodity price supports. We have assumed that a major portion of the highly erodible cropland will be controlled as a result of farmer dependence on USDA program income. Beginning with the 1991 adjusted baseload, it was assumed that 25% of the needed practices would be installed on this land each year through 1995. County based load reductions incorporating soil erosion severity ("T" values) were calculated and carried forward through the year 2000. Data developed in the construction of Tables 1 and 2 show that implementation of the conservation compliance provisions of the Farm Bill will determine the overall success of the cropland program. Theoretically, nutrient reductions at the edge of the field in 1991 will range from 5 to 21%. By the year 2000, this range will be from 55 to 97%. Due to the adjustment of cropland as a component of the total nonpoint source controllable load, even this degree of control only results in reductions ranging from 7.7 to 33%. The total nonpoint source reduction in Virginia due to agricultural programs is predicted to be a minimum of 25.1% for nitrogen and 25.1% for phosphorous in the year 2000. Additional strategies needed to make the full 40% target are reviewed in the "Discussion of Results" section.

TABLES 1 AND 2 PRESENT THE PROJECTED NUTRIENT LOADS RESULTING FROM THE ADDITIONAL NUTRIENT REMOVAL ACTIVITIES FOR POINT AND NONPOINT SOURCES THAT WILL BE REQUIRED DURING THIS PHASE.

Discussion of Point Source Results

Table 3 presents the specific point source nutrient reduction plan for implementing this strategy.

Phase I lists the plants that have already implemented some form of nutrient removal.

Plants listed under Phase II are those impacted by the Point Source Nutrient Policy. Plants intending to use chemical addition will only provide phosphorus removal. Those plants where biological nutrient removal will be used have the option of providing both phosphorus and nitrogen removal.

Under Phase III all major treatment facilities will have to provide year round nitrogen removal to achieve the 40% reduction target for point sources in Virginia.

Discussion of Nonpoint Source Results

It is apparent that Virginia is making significant progress toward the 40% nutrient nonpoint source reduction target, and will even exceed the target for both nutrients in the Rappahannock basin. Several conclusions can be drawn from the total data analyzed to date regarding cropland, pastureland and animal waste controls. First, cropland/pastureland components of the nonpoint load in the 5 river basins range from 14% in the Potomac to 48% in the Rappahannock. Similarly, animal waste contributions range from 24% in the James to 47% in the Potomac. Present program targeting emphasizes cropland/pastureland practices in the Rappahannock, York and lower Potomac and animal wastes practices in the upper Potomac. Higher success rates in the Rappahannock results are due principally to projected installations of animal waste controls. The progress in the Potomac can only be evaluated by summing the results of all 4 jurisdictions, however this analysis reconfirms the existing targeting strategy for Virginia. For further success to be derived from installation of these practices, it appears that additional funds will have to be provided in the James and Coastal basins for all three practice categories.

With the high degree of nonpoint impact as a result of agriculture it is important to understand that the approximately 25% nutrient savings calculated does not account for impacts as a result of the majority of the Phase II activities or for unreported voluntary practice installations. Increasingly accurate accounting procedures for these activities will certainly increase this figure.

Beyond these traditional agricultural controls, it appears that new emphasis needs to be placed upon better identification and characterization of the full range of loads in the designated nonpoint source component of each river basin. Loads not subject to agricultural BMP controls (including urban and natural background) range from 12% in the Rappahannock to 53% in the Coastal basin. Future grant applications will identify a variety of work in non-agricultural sources.

Other programs already exist to reduce other nonpoint sources, but have not received credit in this analysis. The Erosion and Sediment Control Program and its stormwater management provision provide mitigation of nutrient inputs as a result of new construction as an example.

Significant programs are in place or will be implemented as detailed in the Virginia Nonpoint Source Pollution Management Plan, which will be available in August 1988. Some examples of these programs and commitments are:

1. Forestry

   a. 40% reduction of nutrients and sediment to the Bay by the year 2000 to include 10% by 1991 and 30% by 1995 or mandatory BMPs will be recommended by the Department of Forestry.

2. Urban and Construction

   a. Develop or expand education and certification programs.

   b. Establish a citizen complaint "hot line".

   c. Improve load estimation procedures.

   d. Review all 171 local programs on a minimum 3 year cycle.

3. Mining

   a. Include water quality goals in prioritization of areas for reclamation activities.

   b. Reclaim 25 abandoned sites each year.

4. Land Treatment and Disposal

   a. Issue new or revised regulations for application of sludge and disposal of solid waste by mid-1989.

5. <u>Hydrologic Modifications</u>

a. Goal to have permitted hydrologic modification work performed utilizing effective BMPs to reduce water quality impacts.

6. <u>Other Sources</u>

a. Program to identify and quantify other sources of nutrients will be initiated on an interagency basis.

As stated in the introductory material in Phase I, the strategy to approach nonpoint source pollution requires that source identification continue. This requires a better characterization of the impacts of urban runoff, forestal practices, land fill and septic tank drainfield siting and operation and shoreline erosion, as examples. Management strategies and improved BMPs need to be designed and the entire program implemented in a cost-effective, targeted fashion. Research and data collection are planned for each of these sources during Phase II.

Upgraded fall line and ambient monitoring is underway and will provide useful information for decision making in 1991. Targeting and tracking of all of these programs will be continuously improved by the use of our geographic information system, or VirGIS. By July 1988, 38 of the 62 counties in the Bay drainage will have been taken into the system with incremental addition in each year thereafter. This system will potentially be useful in combination with the revised watershed model to greatly improve our decision make capabilities in 1991 on a river basin basis.

<u>Conclusions</u>

Virginia is committed to the Chesapeake Bay Agreement and the goal of 40% reduction in nitrogen and phosphorous by the year 2000. Significant progress is being made toward reducing nonpoint source impacts by agricultural controls, but other nonpoint sources remain to be better characterized and evaluated for their potential impacts upon the Bay. Better evaluation of program success is expected to be possible in 1991 once the 3-D and watershed models are available in combination with on-going improvements in data as discussed previously.

The data presented herein are useful for developing program management and targeting strategies and for providing a relative indicator of progress achieved.

We will continue to diligently work toward the collection of more accurate and comprehensive data and to improve the estimates on a continuing basis.

TABLE 1
VIRGINIA PHOSPHORUS LOADINGS
(MILLION POUNDS/YEAR)

RIVER BASINS	BASE LOADS: 1985 PS LOADS	BASE LOADS: AVE. YR. CONTROLLABLE NPS LOADS	BASE LOADS: TOTAL LOADS	ESTIMATED LOADS – BASED ON NUTRIENT REDUCTION MEASURES DURING THESE PHASES — PHASE I: PS LOADS	PHASE I: NPS LOADS	PHASE I: TOTAL LOADS	PHASE II: PS LOADS	PHASE II: NPS LOADS	PHASE II: TOTAL LOADS	PHASE III: PS LOADS	PHASE III: NPS LOADS	PHASE III: TOTAL LOADS
POTOMAC	0.149	2.512	2.661	0.107	2.396	2.503	0.144	2.316	2.460	0.173	1.507	1.680
RAPPAHANNOCK	0.123	0.156	0.279	0.112	0.135	0.247	0.075	0.125	0.200	0.108	0.056	0.164
YORK	0.416	0.201	0.617	0.342	0.185	0.527	0.136	0.181	0.317	0.171	0.121	0.292
JAMES	3.491	1.024	4.515	2.904	0.965	3.869	1.638	0.950	2.588	1.903	0.614	2.517
COASTAL	0.300	0.084	0.384	0.297	0.081	0.378	0.129	0.081	0.210	0.159	0.051	0.210
TOTALS	4.479	3.977	8.456	3.762	3.762	7.524	2.122	3.653	5.775	2.514	2.349	4.863
LOADING TARGET FOR THE YEAR 2000:										2.687	2.386	5.073

NOTE: PHASE I IS 1985 - JUNE 1988

PHASE II IS JULY 1988 - DEC. 1991

PHASE III IS JAN. 1992 - 2000

TABLE 2
VIRGINIA NITROGEN LOADINGS
(MILLION POUNDS/YEAR)

RIVER BASINS	BASE LOADS			ESTIMATED LOADS - BASED ON NUTRIENT REDUCTION MEASURES DURING THESE PHASES								
				PHASE I			PHASE II			PHASE III		
	1985 PS LOADS	AVE. YR. CONTROLLABLE NPS LOADS	TOTAL LOADS	PS LOADS	NPS LOADS	TOTAL LOADS	PS LOADS	NPS LOADS	TOTAL LOADS	PS LOADS	NPS LOADS	TOTAL LOADS
POTOMAC	8.156	13.997	22.153	9.153	13.333	22.486	10.953	12.878	23.831	4.894	8.398	13.292
RAPPAHANNOCK	0.459	0.925	1.384	0.584	0.811	1.395	0.862	0.756	1.618	0.275	0.380	0.655
YORK	1.311	2.108	3.419	1.174	1.939	3.113	1.385	1.901	3.286	0.786	1.265	2.051
JAMES	22.391	8.390	30.781	23.866	7.915	31.781	25.750	7.780	33.530	13.135	5.034	18.469
COASTAL	1.335	0.569	1.904	1.763	0.557	2.320	2.042	0.556	2.598	0.801	0.342	1.143
TOTALS	33.652	25.989	59.641	36.540	24.555	61.095	40.992*	23.871	64.863	20.191	15.419	35.610
LOADING TARGET FOR THE YEAR 2000:										20.191	15.593	35.784

* A significant amount of additional point source nitrogen load reduction is anticipated during this period. See text for description of programs.

TABLE 3

IMPLEMENTING THE STRATEGY

VIRGINIA'S POINT SOURCE NUTRIENT REDUCTION PLAN

PHASE I IMPLEMENTATION	PHASE II IMPLEMENTATION	PHASE III IMPLEMENTATION
* Phosphate detergent ban (all STPs) * P removal at: Arlington Alexandria Fairfax- L Hnt. Cr. Fairfax- L. Pot. UOSA Pr. Wm.- Mooney Dale City #1 Dale City #2 Quantico Staff.- Aquia Kilmarnock (demo) Fredericksburg (demo) * P & N removal at: HRSD- York River (demo)	* All Phase I actions plus: - P & N removal with BNR at: HRSD- VIP HRSD- York River Staff.- Falls Run Staff.- Aquia Spots.- FMC Fredericksburg Massaponax Ches.- Proctors Cr. Petersburg HRSD- Williamsburg HRSD- James River HRSD- Boat Harbor HRSD- Nansemond HRSD- Army Base HRSD- Ches./Eliz. Ft. Eustis - P removal at: Richmond Henrico Ches.- Falling Cr. Phillip Morris American Tobacco Smithfield Foods Smithfield Packing Holly Farms Ches. Corp. - P removal possible at 15 additional industries depending upon monitoring results	* Phase I & II actions plus year round nitrogen removal with BNR at all remaining 19 plants below the fall line with flows greater than 1.0 MGD (identified sources of N). * N removal possible at 15 additional industries depending upon monitoring results.

District of Columbia

Nutrient Strategy

1985 Nutrient Loading*

	Nitrogen (pounds/year)	Phosphorus (pounds/years)
Point Sources Blue Plains	14,099,950	114,610
Combined Sewer Overflows	148,400	36,800
Urban Runoff	290,000	70,000

* Estimates based upon D.C.R.A. and DPW Calculations.

Base Year

Point Source Loadings

The Blue Plains Wastewater Treatment Plant has provided nitrification and phosphorus removal to a high degree since 1981. This has resulted in a total nitrogen removal of 44% and a total phosphorus removal of 98% prior to the 1985 base year. These levels of removal are only achieved at one other treatment plant in the Chesapeake Bay drainage basin.

The loadings for Blue Plains were calculated from the discharge monitoring reports for 1985. They represent a flow of 300.6 MGD at 15.4 mg/l nitrogen and 0.12 mg/l phosphorus. Blue Plains is a regional treatment facility serving the District and portions of Maryland and Virginia.

Combined Sewer Overflows

The District began in 1978 a study of the combined sewer system to determine remedial measures which could be implemented. Thus the base year, 1985, represents a period prior to Phase I construction but after enormous improvements had been already obtained.

The loadings for the CSO category were calculated from overflow volumes and average concentrations of the volumes. No attempt was made to account for the first flush concentrations in either the 1985 loadings or the removals achieved by the CSO abatement program. The abatement program will capture almost all of the first flush, therefore, the calculation likely under predicts removal percentages slightly.

Urban Runoff

Prior to 1985, the District had in place a program to control runoff during construction projects, with about 1,500 erosion control permits issued each year.

The urban runoff was calculated from the 1985 rainfall, estimated runoff coefficients for non CSO areas, and average concentrations previously measured in the District. Nitrogen loads are 10.6 pounds per acre per year and phosphorus loads are 2.2 pounds per acre per year. No attempt was made to subtract the uncontrollable load nor to break the load down into land uses. Additionally, the calculation on effectiveness of BMP's does not account for changes in land use.

Post 1985 to July 1988

Point Sources

The District enacted a Phosphate Detergent Ban which reduced influent concentrations to the Blue Plains Wastewater Treatment Plant by about 20%. This has resulted in reduced chemical addition and some operating cost savings.

Combined Sewer Overflow

Since 1985 construction has been initiated on Phase I of the Combined Sewer Overflow Abatement Project. Phase I will be completed during 1988 with the reductions projected to be 25% (35,600 pounds) for nitrogen and 55% (20,000 pounds) for phosphorus.

Total District costs for Phase I are $9.35 million.

Urban Runoff

In January 1988, the District promulgated regulations requiring BMP's for all new development and redevelopment. Between 1985 and January 1988, seven development projects voluntarily installed BMP's.

July 1988 to December 1991

Point Sources

The District of Columbia will conduct a feasibility study of alternative nitrogen removal systems. The proposed study will specifically examine the effectiveness of various nitrogen removal systems in achieving benefits in Chesapeake Bay water quality.

Combined Sewer Overflows

The District will determine by additional studies if the conventional pollutant loads warrant further reductions.

Non-point Sources

The stormwater regulations are projected to affect 1,400 projects resulting in 525 acres brought under BMP controls. The assumed removal efficiency of 40% will result in 2,220 pounds of nitrogen and 535 pounds of phosphorus removed from the annual loadings. Two demonstration BMPs will have been constructed: Watts Branch bank stabilization and River Terrace housing development stormwater treatment. Approximately 400 pounds of nitrogen and 100 pound of phosphorus may be removed from the annual loadings at a projected cost of $650,000.

Goal Achievement

Point Sources

With the Blue Plains Wastewater Treatment Plant having an average flow of 300 MGD in 1985, the before treatment nitrogen load was about 25 million pounds. The CSO and urban runoff loads of nitrogen were about 438 thousand pounds or about 2 percent of the total. After treatment at Blue Plains, 44% of the nitrogen was removed leaving a total load within the District of 14.1 million pounds. The District of Columbia will further study the economics and feasibility of implementing additional nitrogen removal at Blue Plains. The District is committed to implementation of a Basinwide Strategy to equitably achieve by the year 2000 at least a 40% reduction of nitrogen entering the mainstem of the Chesapeake Bay.

No further reduction of phosphorus is deemed feasible at Blue Plains beyond the 98% present removal. This half of the goal is unequivocally achieved.

Combined Sewer Overflows

The Phase I CSO program will result in achieving a 25% reduction in nitrogen loads and a 55% reduction in phosphorus load. These reductions are based on the degree of removal of flows rerouted to Blue Plains for treatment. Phase II, if it is needed for conventional pollutants, will result in about an additional 6% nitrogen and 14% phosphorus removal.

Urban Runoff

At the projected rate of 150 acres per year of land with BMP's applied and the assumed 40% reduction of nitrogen and phosphorus, it is apparent that by the year 2000 the regulatory program will at the most only achieve a 5% reduction in nitrogen and phosphorus loads from urban runoff in the District. The Anacostia Restoration Funds, implementation grants and Section 319 program funds may achieve an additional 5% reduction.

Summary of Goal Achievement Needs

Achieving the goal of 40% reduction of phosphorus from point sources has been met based upon the "equity" interpretation of the Bay Agreement. In regards to a 40% reduction of nitrogen from point sources in the District, a final decision will be made after the 1991 reevaluation based upon cost effectiveness and water quality benefits. The District is proceeding to investigate the different nitrogen removal technologies so that this information will be available for this evaluation. The time period between 1991 and the year 2000 is adequate for design and construction of nitrogen removal facilities. The District is committed to implementation of a Basinwide Strategy to equitably achieve by the year 2000 at least a 40% reduction of nitrogen entering the mainstem of the Chesapeake Bay.

For the CSO loadings, the meeting of the goal is basically dependent upon the degree of treatment provided at Blue Plains. This is because the program reroutes flows to Blue Plains. At the existing levels of treatment, the phosphorus reduction will be easily achieved; however, there will be about a 9 to 15% short fall of nitrogen. This short fall will be investigated during the evaluation of the need for Phase II of the CSO abatement program.

Achieving a 40% reduction in nitrogen and phosphorus from urban runoff in the District will require modifications or additions to the existing program. One modification being explored is to monitor the per acre loadings from different land uses such as residential and commercial and to concentrate discretionary funds from the implementation grants, D.C. Anacostia Restoration Funds and Section 319 funds on BMP's for those land uses with the highest per acre loading. A second option under evaluation is end of pipe treatment for major storm sewers. Several demonstration projects are presently being planned. A third option is to reestablish aquatic vegetation in the Anacostia and Potomac to provide instream assimilation and buffering of nutrient loads. Pilot projects are expected to be implemented by 1991. Based upon the results of the existing programs and the pilot projects, modifications will be made to the urban runoff nutrient control program in order to meet the 40% reduction goal.

Maryland's Chesapeake Bay
Nutrient Reduction Plan
1985 - 2000

Introduction

On December 14, 1987, Governor Schaefer, Governor Baliles of Virginia, Governor Casey of Pennsylvania and Mayor Barry of the District of Columbia signed the 1987 Chesapeake Bay Agreement, which committed their jurisdictions to the ambitious goal of reducing nutrient loads entering the Chesapeake Bay by 40% by the year 2000. Water quality investigations and resource assessments conducted by EPA and the states since 1970 have revealed that the "health" of the Chesapeake Bay is deteriorating and that one of the principal causes of this deterioration is the excessive contribution of nutrients (phosphorus and nitrogen) to the Bay from point sources and nonpoint sources.

A recently-completed water quality modeling analysis of the Bay conducted by the EPA Chesapeake Bay Program (CBP) indicates that a significant improvement in the Bay's water quality could be achieved if overall nutrient inputs could be reduced by 40%. According to the model results, a 40% reduction in the nitrogen and phosphorus load, from both point sources and nonpoint sources, would result in a reduction in the levels of algae in the Bay (one measure of the degree of nutrient enrichment) and in an increase in the concentration of dissolved oxygen in the Bay's bottom waters. Hence, the 40% load reduction goal set forth in the 1987 Bay Agreement is derived directly from the CBP's two-dimensional model of the mainstem Chesapeake Bay, a model which will be superseded by a more sophisticated three-dimensional model in the early 1990's.

The purpose of this report is to set forth a strategy toward point and nonpoint source control measures that Maryland will pursue (in cooperation with local governments and private landowners) to achieve these load reduction goals for both nitrogen and phosphorus by the year 2000.

Background: Dealing With Uncertainty

Maryland's efforts to protect the Chesapeake Bay from pollution go back literally for decades. However, only in recent times (since 1975) have the importance of nitrogen and phosphorus in the Bay's current deterioration been recognized and addressed through sewage discharge policies and permit actions. Even today, uncertainty remains among scientists and managers over the relative importance of nitrogen vs. phosphorus in causing the Bay's problems. Furthermore, the Bay's response (in terms of algae and D.O.) to specific nutrient load reductions can be estimated only with imprecision.

Because of the complexity of the physical, biological and chemical processes affecting the water quality of the Chesapeake Bay, mathematical models, such as the one recently developed by EPA, must be understood to be gross simplifications, subject to significant error. Modeling analysis of this type for estuaries is in its infancy. Recognizing this fact, EPA has already begun work on developing a "second generation" model of the Chesapeake Bay. Completion of this three-dimensional, time-variable model is scheduled for 1991. It is conceivable that projections made with that model could subsequently result in redirection of the State's nutrient control program.

Separate from the uncertainties about Bay nutrient processes, we also lack a strong data base about the relative cost-effectiveness and reliability of some of the alternative approaches to nutrient management and control, and we cannot be certain how some of the proposed new programs will be received by the public.

Despite the uncertainties involved in the modeling results and in proposed new techniques, there is a need to get on with the process of nitrogen and phosphorus reduction for the Bay. The 2-D model of the Bay does show the direction we need to go--and that some significant reductions in nutrients will be necessary to bring about the improvements in water quality needed to enhance the status of living resources populations.

A Phased Approach

In light of the uncertainties discussed above, Maryland proposes a "phased" approach to nutrient load reduction that involves progressively more comprehensive policies and actions as our understanding of these issues improves. As indicated in the 1987 Bay Agreement, the states and EPA will reconsider the load reduction goals at the end of 1991. Maryland plans to reevaluate this program in detail at that time. Therefore, Maryland and the other states have agreed on three "phases" that reflect both the scheduled 1991 reevaluation and the initiation of the agreement at the end of 1987: 1985 through 1987, 1988 through 1991, and 1992 through 1999.

Phase I includes all nutrient-reduction actions, both point and nonpoint, either completed or funded between 1985-1987. Phase I essentially consists of all of the nutrient reduction measures required and promoted by the State policies and regulatory actions already in place. On the point source side, this would include our longstanding Upper Bay Phosphorus Policy, the Patuxent River Nutrient Strategy, the statewide Phosphate Detergent Ban, the Potomac River Strategy, etc., as well as upgrades at sewage treatment plants (STPs) and industries not explicitly intended for nutrient load reduction. Load reductions are estimated based on actual measurements of discharged effluent or on reasonable estimates of effluent quality at plants where direct data are lacking. On the nonpoint source side, it includes the estimated reductions resulting from agricultural "best management practices" (BMPs), retirement of some highly-erodible cropland from production through the Federal Conservation Reserve Program, and urban BMPs installed under Maryland's modest urban stormwater "retrofit" grant program. Phase I also includes a variety of outreach and information dissemination activities in the agricultural arena, such as education, demonstration and technical assistance efforts, which take place independently of cost-share programs.

Phase II of Maryland's proposed strategy (1986-1991) incorporates four principal components:

1. The continuation of existing (pre-agreement) policies, controls and management activities for point and nonpoint sources. These are equivalent to Phase I activities, and are believed to be essential elements of our overall approach to controlling nutrients.

2. Implementation of an array of promising new control activities, specifically intended to work toward nutrient load reduction.

3. Continuation of research, and initiation of new investigations to provide information necessary for evaluating and effectively implementing management alternatives.

4. Evaluation of the cost-effectiveness and socio-economic viability of alternative control activities, in conjunction with the overall re-evaluation of the 40% goal and progress toward that goal, in 1991.

Not only will Phase II actions result in significant reductions in both nitrogen and phosphorus entering the Bay from Maryland sources, but they also will provide badly needed information to facilitate modifications in Baywide nutrient reduction strategies following the 1991 reevaluation. No attempt is made during Phase II to "trade off" point source controls vs. nonpoint source controls, because there now exists too little accurate information about the relative benefits, costs and feasibility of many prospective control mechanisms. Maryland is fully committed to working toward interstate consensus on these and other technical issues identified in Chapter 4 of the Baywide Nutrient Plan (see main report), and will participate in all of the aspects of this process, including the data compilation and analytical efforts required.

An early milestone established for Phase II is the production of a detailed implementation plan for Maryland's nutrient reduction strategy. The description of Phases II and III presented subsequently in this document provides information on the new initiatives and activities needed to achieve the nutrient goal. Implementation approaches are outlined in concept, but could not be developed in detail in time for inclusion in the present plan. Therefore, Maryland intends to complete a detailed nutrient reduction implementation plan by mid-1989. The implementation plan will specify in detail the actions needed, the agency responsibilities and the funding arrangements for each of the Phase II activities and initiatives outlined in the following pages.

Phase III will consist of actions and programs which Maryland expects to carry out between 1992-2000. In general, Phase III efforts will involve a mixture of the kinds of activities outlined for Phase I and II, as needed to achieve the balance of the reduction goal in a cost-effective manner. Phase

III will involve two components. Following the 1991 re-evaluation by the States and EPA, alternative strategies for Phase III will be assessed. This would include a more rigorous examination of alternative control mechanisms, both within and between the major source categories of point and nonpoint sources, and the subsequent development of more specific implementation plans for each major river basin. This assessment and planning period would then be followed by the implementation of selected control and management activities. Details of Phase III of Maryland's nutrient control strategy cannot be specified with certainty at this time, because they are highly dependent upon the insights and results of the 1991 reevaluation. What is presented here is one scenario which appears to be both feasible and technically promising, in view of our limited ability to predict the benefits, costs and socio-economic viability of prospective alternatives.

Estimation of 1985 Loadings

Precise estimation of nutrient loads, at the scale of the entire Bay, is not technically possible at the present time. While nutrient loads from some point sources can be estimated with reasonable accuracy, the necessary data do not exist for most dischargers. Confidence limits cannot be placed on estimates for nonpoint sources without intensive, site-specific monitoring. Consequently, estimates of nutrient loads to the Bay from the major "source categories" (i.e., STPs, industry, agriculture, development, and natural cover types) can only be made by summing numerous values which are of widely varying precision.

Because of these limitations in accuracy, it is important to clarify the purpose(s) for which loadings are estimated, and thus characterize the context in which they can be appropriately used. Maryland recognizes that nutrient loads to its aquatic systems, including the Bay, have increased through man's activity, and are adversely affecting desirable attributes of these systems. Maryland intends to meet its obligations under the 1987 Bay Agreement by setting load reduction goals for both point sources and nonpoint sources. The estimates presented in this document are intended to provide a numerical basis for setting these goals and for establishing a rational accounting procedure through which progress toward the goals may be measured. These estimates are based on limited data and represent only the relative loads and reductions calculable from those data. Their real value and purpose is in suggesting appropriate control strategies for the present, which can then be studied, evaluated and refined during Phases II and III. This intention is made explicit in components 3 and 4, listed in the general description of Phase II in the preceeding section, "A Phased Approach".

Point source nutrient loads for 1985 and 1987 are summations of observed average loads from individual dischargers. The best discharge monitoring data immediately available for these years were used. The quality and quantity of these data for each discharge ranged from "good" for some dischargers to essentially nonexistent for others. The data for some large sewage treatment plants were sufficient to adequately quantify their nutrient loads. However, loads from most small sewage treatment plants were characterized using assumed levels of nutrients in their effluent. Direct measurements of nutrient loads from most industries are generally unavailable; for some industries, estimates from discharge permit applications provided the only data. A

Technical Supplement (see below) describes in greater detail the load estimation process used for point sources.

Nonpoint source (NPS) loads were estimated for all Maryland areas draining to the Bay. Total loads delivered to estuarine waters in three monitored tributaries (the Potomac, the Patuxent and the Choptank) were calculated from Maryland's actual Chesapeake Bay Program monitoring data. Since 1985 was a relatively "dry" rainfall year for many Maryland tributaries, river inputs from 1984 (a wet year), 1986 (a dry year for the Potomac), and 1985 were used to estimate annual input rates more representative of an "average rainfall year" for the State's land area as a whole. These loads were "partitioned" among contributing source categories using land use data, associated nutrient load coefficients, data on animal waste production, and data on point source discharges within the monitored watersheds. The "river input" monitoring data were then used to adjust the loading coefficients for each contributing land use category, by watershed. The adjusted coefficients were subsequently used, in conjunction with 1985 land use data, to estimate NPS loads from watersheds for which in-stream monitoring data were not available. (See Technical Supplement for a more detailed description.)

The approach for estimating NPS nutrient loads used for this plan focuses on land use/land cover types which fall into the categories of forested, agricultural and developed land. NPS loads were partitioned among these land uses. On-site sewage disposal systems, streambank/shoreline erosion, and other source categories may contribute significant nutrient loads in some areas. Nutrient loads from on-site disposal systems may be particularly large in watersheds where they are used extensively, especially where local conditions result in a high frequency of poorly functioning or failed systems. Unfortunately, the magnitude of these contributions could not be estimated for this plan in a manner which is consistent with the estimates for other sources. During Phase II, Maryland will perform the necessary analyses to determine the relative importance of these sources. This plan will be reviewed and modified as new information becomes available that would allow a sharper focus for targeting nutrient control emphasis and expenditures.

Estimated total nutrient loads to the Chesapeake Bay from Maryland's point sources and nonpoint sources for the "baseline year" (1985) are presented in Figures 1 and 2, for nitrogen and phosphorus respectively. During the "average rainfall year" depicted by these data, point sources and nonpoint sources are equally significant contributors of nutrients, on the statewide level. (The point source:nonpoint source ratio varies greatly among dry, average and wet years.) In an "average" rainfall year with 1985 land cover, point sources contributed about 51% of the total N and 43% of total P loads. As the figures depict, agricultural areas in Maryland contribute about 66% of the total NPS nitrogen and about 76% of the total NPS phosphorus.

EPA's two-dimensional model of the Bay estimated that a 40% reduction in "controllable" nonpoint source inputs was sufficient, together with the point source reduction, to effect Bay improvements. Consistent with EPA's approach, the non-controllable fraction of nonpoint source loads was taken to be the estimated nutrient load exported from a Maryland landscape consisting entirely of "pristine" forest. Nonpoint source loads in excess of these pristine forest estimates represent the controllable (man-induced, or anthropogenic) portion of total NPS loads. Pristine forest loads, calculated for the acreage associated with each land use, were subtracted from the loads estimated through the procedure described above, with the difference being defined as the "controllable" fraction for each NPS category. Maryland interpreted "controllable" to mean all nonpoint source loads originating in the landscape due to man's activities, which includes contributions from all agricultural and developed land. Future enhancement of our NPS estimating procedures may facilitate inclusion of estimates for other categories (eg., managed forest).

Finally, Maryland's loading goals to be achieved by the year 2000 (to fulfill the commitment in the Bay Agreement) were calculated as being 60% of the 1985 N and P inputs estimated for point sources as described above, and 60% of the estimated "1985" N and P inputs from "controllable" nonpoint sources. (See Table 1; Figures 3 and 4.)

<u>NOTE</u>: Technical Supplement Available

As the discussion of nutrient load estimation suggests, many of the procedures and calculations that contribute to the nutrient reduction plan are complicated and technical. Though these details are important in gaining a thorough understanding of the plan, they could not be included here. Therefore, the Maryland Department of the Environment (MDE) has prepared a Technical Supplement which presents greater detail on the estimation and projection of loads and the considerations used in applying control programs to meet the 40% nutrient reduction goal. The Technical Supplement is available from the MDE Water Management Administration, 201 West Preston Street, Baltimore, Maryland 21201, or telephone (301) 225-6306.

Atmospheric Deposition of Nutrients

Nutrient inputs to the Chesapeake Bay from atmospheric deposition are an important consideration for purposes of this plan. These inputs occur both through deposition on the terrestrial/freshwater portions of the basin and through direct deposition onto the estuary. Both pathways must be considered to reasonably evaluate the significance of atmospheric deposition, relative to the other major sources of total nutrients to the Bay.

As discussed previously in the introduction, the nutrient load reduction goal for the Bay was derived from the results of EPA's water quality modeling efforts, which showed a significant improvement in the water quality of the Bay when point and nonpoint source nutrient loads were reduced by 40%. Direct deposition of nitrogen from the atmosphere to the estuary was estimated in the 2-D model, and load reductions from this "source" (pathway) were not identified by EPA as essential to the reduction strategy. Future increases in atmospheric loads were not addressed by the modeling.

The methodology used here to estimate NPS loads to the estuary from the Maryland landscape inherently accounts for atmospheric inputs of nitrogen to the terrestrial portion of the landscape and to freshwater surfaces. This is true because the fall line monitoring data used to "calibrate" the NPS loading estimates reflect <u>all</u> nutrient inputs to upstream portions of the watershed, including those nutrients deposited from the atmosphere.

The influence of atmospheric deposition on nutrient export from nonpoint sources, relative to the effects of other factors (eg., fertilizer and waste inputs, land use, associated export flow pathways and cover type distributions, and extent of management through BMPs), is extremely uncertain at present, and is probably quite small over much of the landscape. If direct atmospheric deposition of nitrogen oxides to the estuary increases significantly in the future, as is predicted in several recent studies, the improvements resulting from the 40% load reductions could be affected. However, the exact impact on the Bay cannot be determined with any certainty, given the existing data. Atmospheric nitrogen transmitted via the landscape pathway will be controlled by most of the planned nonpoint source control measures. Many of the practices used to reduce nonpoint source pollution involve the retention of water, soil and nutrients on the land surface, while other practices "filter" released surface and subsurface flows through various types of "buffer zones". As a result, planned nonpoint source controls will reduce the amount of all nutrients, including those of atmospheric origin, entering the Bay from the landscape. On the other hand, the atmospheric nitrogen falling directly on the Bay will not be controlled unless there are major air quality improvements in the Bay area.

Prior to the 1991 re-evaluation of the baywide nutrient control program, MDE intends to more rigorously assess the importance of atmospheric deposition as a nutrient source, relative to both other sources and factors which affect nutrient export from the landscape. This assessment will consider the sources of nutrients to the atmosphere, land and water treatment processes as a means of addressing atmospheric inputs moving through the landscape, and projected increases in atmospheric inputs to the estuary.

Estimated and Projected Reductions

This section outlines the specific nutrient management and control measures in use and proposed by Maryland in order to meet the 40% load reduction goal, and provides estimates of the load reductions achieved or projected for each. As described previously, Phase I (1985 through 1987) achievements consist of all the efforts in place or substantially committed to before the end of 1987 for both point and nonpoint sources. Because the comparative costs, benefits and socio-economic practicality of the potential controls for each source category are so uncertain at present, Maryland's reduction efforts will be distributed among all categories during Phase II, focusing on those measures which appear most likely to achieve significant load reductions. Knowledge and experience acquired during Phase II (in coordination with EPA and the other states) may reduce some of these uncertainties, permitting more selectivity during Phase III among control alternatives, both within and among source categories. At present, our Phase III projections simply present one scenario which, at this stage of analysis, appears to be an effective and viable course to follow toward achieving the balance of the desired reduction expected to remain at the end of Phase II.

A. Point Source Initiatives and Projected Load Reductions

In Phase I (including 1985 through 1987), total phosphorus and total nitrogen load reductions, as measured by effluent sampling, were achieved via three mechanisms:

-- upgrading specific point sources explicitly to control nutrient discharge, as required by State nutrient control policies predating the 1987 Chesapeake Bay Agreement;

-- implementation of Maryland's phosphate detergent ban, which has reduced total phosphorus loads from all sewage treatment plants that were not already controlling phosphorus in their effluent; and

-- upgrading point sources to meet discharge permit requirements (e.g., suspended solids) other than for nutrients, which coincidentally reduced nutrient loads.

As presented in Table 1, nutrient control projects carried out in Phase I have already achieved a 33% reduction for total phosphorus. This early progress is the result of Maryland's aggressive phosphorus control program, established well before the signing of the 1987 Agreement. On the other hand, total nitrogen loads show about a 5% change, because nitrogen control occurred at only two or three industrial dischargers, as shown (cumulatively) in Table 1. Point source nitrogen control projects at Western Branch and Dorsey Run sewage treatment plants were not yet in operation at the end of 1987. They are expected to be operational in 1990 and 1988, respectively.

In Phase II, which includes 1988 through 1991, the same policies and permits in operation during Phase I are expected to continue to provide load reductions. Maryland will also pursue nutrient controls at additional point sources beyond those committed to in Phase I. A principal focus of this effort will be on nitrogen control at the Back River Sewage Treatment Plant, which is expected to provide a substantial reduction in Maryland's overall point source nitrogen load. Figure 3 also lists other large sewage treatment plants that are slated to begin biological nutrient control (BNR) during Phase II. To allow this work to begin, $5.5 million was authorized during the 1988 Maryland legislative session for fiscal year 1989. It is anticipated that additional authorizations will follow to allow continued progress.

As projected in Figure 3, Maryland will first meet the 40% reduction goal for point source phosphorus sometime in 1990-91. Significant progress toward the nitrogen goal is also projected, as a result of the implementation of biological nutrient control (BNR) technology at selected sewage treatment plants.

Maryland will also explore further opportunities for Phase II and Phase III point source implementation in two other ways. First, the potential to integrate nutrient controls into upgrades that are already scheduled to meet other (non-nutrient) discharge permit requirements during Phase II will be explored.

Secondly, additional opportunities to custom-fit nutrient controls to the unique requirements of significant sewage treatment plants and industrial facilities will be explored. The Maryland Department of the Environment will work cooperatively with the owners and operators to ensure that the most beneficial approach to nutrient control is employed. In this plan, the retrofitting of BNR technology at existing sewage treatment plants is the most important component of Maryland's Phase II and Phase III efforts to reduce point source nutrient loads. However, other technologies may be employed at selected facilities. For example, land treatment of treated effluent or other technologies may be cost-effective alternatives, if local conditions and opportunities are favorable. In all cases, the State will work to facilitate the use of the most appropriate upgrades and technologies.

As these nutrient control upgrades are implemented, it will be important to track progress toward the 40% reduction goal. Therefore, the NPDES permits for all point sources contributing significant phosphorus or nitrogen loads to the Chesapeake Bay in Maryland will require effluent monitoring for these loads, beginning no later than July 1, 1989. This requirement applies to all sewage treatment plants with an average effluent volume of 0.5 million gallons per day or greater and to all industries discharging an average nutrient load equal to or greater than 25 pounds per day for total phosphorus or 75 pounds per day for total nitrogen. This monitoring will be of sufficient quality and frequency to allow confident characterization of total nutrient loads (and appropriate nutrient species) on an annual basis, using monthly averages.

During Phase III, starting in 1992, Maryland will carry out a series of additional point source upgrades in order to meet the year 2000 nutrient reduction goals. Following the improved understanding expected to arise from the Phase II monitoring and modeling to be completed in 1991, Maryland will be able to focus its Baywide nutrient control program where the greatest benefit can be expected. The exact nature and location of these improvements will be determined during the 1991 re-evaluation, which will integrate point and nonpoint source strategies into a unified plan designed to achieve the balance of the overall reduction goals in a cost-effective manner. One potential scenario for achieving a 40% nutrient reduction by the year 2000 for point sources is presented in Figure 3. The graphs indicate that the nutrient load reduction goals for point sources will be approximately met by the year 2000. (This projection is based on the assumption that biological nutrient removal technology can achieve an average effluent concentration of 8 mg/l for total nitrogen. However, sufficient operative experience to verify this assumption in the temperate climate of the Chesapeake Bay region has yet to be accumulated.)

B. Nonpoint Source Initiatives and Projected Load Reductions

The primary purpose of this section is to outline a set of implementation and control activities that will allow Maryland to achieve the NPS portion of the reduction goal. Analysis shows that Maryland programs are making some progress toward this goal. However, projections indicate that significant enhancements of existing programs, as well as the establishment of selected new approaches, are necessary to attain this goal.

The implementation scenario presented here is an assembly of activities that are collectively projected to meet the nonpoint source nutrient reduction goal by the year 2000. Though this scenario is one of many that might be devised to achieve this goal, it represents the most technically defensible and cost-effective approach available, based on currently compiled information. Because current understanding and analysis are limited, however, some portions of Maryland's NPS strategy remain uncertain. Consequently, this prospective long-term strategy will be adjusted over time, as new information becomes available. This revision process will ensure that the nutrient reduction goal for NPS is attained in the most effective way possible.

Five considerations were emphasized in developing this nonpoint source strategy:

1. the effectiveness of each management/control practice in reducing nitrogen and phosphorus export;

2. the ability of each practice to address deficiencies in existing management and control approaches;

3. the costs associated with implementation;

4. the potential for implementation of the various practices in Maryland's portion of the Bay watershed; and

5. the existing and proposed basis for implementing individual practices, i.e., voluntary or mandatory implementation.

Currently compiled information on the costs and effectiveness of various practices were used to estimate potential reductions attributable to each. For the scenario presented here, it was assumed that no new regulatory requirements would come into existence for agriculture. For development, it was assumed that a number of modifications to existing regulations for stormwater management, as well as new policies and guidelines for site design characteristics which affect nutrient export, would be realized during Phase II. Significant changes in Maryland's NPS strategy following the 1991 re-evaluation may include new management and control practices, a different distribution of emphasis among practices, and more or fewer regulatory requirements than are assumed for these projections. Maryland will work to ensure that the 40% nutrient reduction goal is met by the year 2000 by selecting the most effective program alternatives.

Information on proposed NPS management and control efforts for which reductions have been estimated is summarized in Table 2. The table projects reductions in controllable loads, and associated implementation costs, for each phase in Maryland's strategy. (The fact that nitrogen tends to move primarily in water-soluble form, while phosphorus is more associated with soil particles, is considered in projecting the effects of the various control practices.) The table addresses only the "controllable" portion of Maryland's nonpoint source nutrient loads, as defined in an earlier section.

<u>Phase I - Agriculture</u> (1985-87)

Historically, a variety of soil conservation and educational services, technical assistance, and financial assistance have been available to farmers in Maryland through the local Soil Conservation Districts. Maryland's Agricultural 208 Plan, first published in 1979, defined the roles and responsibilities of a number of federal, State and local organizations in carrying out the agenda for sediment and animal waste control outlined in that plan. When the importance of agriculture as a source of nutrients to the Chesapeake Bay became clearer in the early 1980's, the focus of those organizations expanded to place a greater emphasis on the management of nutrients. The Maryland Agricultural Water Quality Management Program, published in 1987 as the State's revised 208 plan for agriculture, explicitly identified agricultural nonpoint source pollution reduction as the State's overall goal for that program.

Elements of the Maryland agricultural water quality program of importance to this plan include outreach and technical assistance to farmers, information and education, provision of cost-share funding for BMPs, research, and enforcement of water pollution laws. These elements are administered by the 24 Soil Conservation Districts in the state; the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS), both of U.S.D.A.; the Maryland Departments of Agriculture (MDA) and the Environment (MDE); the State Soil Conservation Committee (SSCC); and the Cooperative Extension Service (CES) and Agricultural Experiment Station (AES) of the University of Maryland. The functions of these organizations in addressing the State's goal of reducing agricultural nonpoint source pollution is described in the State 208 plan. All of the program elements contribute to nutrient load reductions, but for a variety of reasons, numerical reductions can not be estimated in relation to each. The importance of these agencies and their roles are emphasized here, because the success of the strategy for agricultural nutrient load reduction outlined in the present plan depends on its integration into the ongoing work of these various agencies and organizations.

As can be seen in Table 2, reductions in agricultural loads during Phase I are attributed to the implementation of agricultural best management practices (BMPs) on cropland, particulary soil conservation practices, and at facilities which generate animal waste. The funds used to share (with the farmer or facility owner) the cost of implementation include State funds available through the Maryland Agricultural Cost Share (MACS) Program, as well as federal funds from the Chesapeake Bay Implementation Grants and the U.S.D.A. Agricultural Conservation Program (ACP).

Phase I reductions attributed to the Conservation Reserve Program (CRP), administered by the U.S. Department of Agriculture, are associated with the removal of highly erodible cropland from production. This results in reduced nutrient export from that acreage, particularly through erosion control and also because of the reduced use of fertilizers on the retired land.

Information which could be used to estimate reductions from practices implemented by farmers independently of cost-share programs since January 1985 could not be compiled in time for this plan, but should become available in the future, as tracking of implementation improves. In particular, various tillage and cropping practices are used independently by many Maryland farmers, and will probably represent significant reductions, when their contributions can be estimated with confidence. This may be true for a variety of other management practices, as well.

Phase I - Development (1985-87)

Management of stormwater runoff from development in Maryland began, from a water quality perspective, with the inception of State stormwater regulations in 1983. Counties and municipalities were required to enact ordinances which would require that post-development runoff rates and volumes meet specific criteria related to pre-development characteristics. Existing State regulations also require that the stormwater BMPs used in managing runoff are selected from a prioritized sequence of BMP options, with the first option representing the most effective pollutant-control alternative. Subsequent options are to be selected only if those higher on the list of prioritized BMPs are not suitable for the development site in question.

Control of loads from existing development was very limited during Phase I (Table 2). Reductions counted in this plan consider only the installation of stormwater BMPs for existing development (a process called "retrofitting"). As discussed under Phase II, loads from new development were projected for the period 1985 - 2000, assuming the implementation of several improvements in stormwater and development management. These improvements, while essential to the achievement of the load reduction goals, do not reduce existing loads, as retrofitting existing development does; consequently, they do not appear as a reduction mechanism in Table 2. Retrofitting currently takes place on a small scale through the State's Stormwater Cost-Share Program, intended primarily for demonstration purposes, which financially assists local jurisdictions with selected retrofit projects. In addition, a few jurisdictions have performed retrofits independently, to a limited degree.

Under existing State and local law, stormwater management structures have been installed at an unknown number of new development sites--probably several thousand. However, under present practices, designs with strong pollution control benefits are not usually selected, so MDE "credited" only 20% of new development acres with any load-reduction benefits. (See also Note 2 on Table 2.)

Phase II (1988-91)

Phase II nonpoint source projections consider all of the same control mechanisms listed for Phase I, supplemented by several new components or new programs. The planned initiation of these new controls is intended to address the deficiencies in the ability of the current NPS programs to reduce the export of nutrients from agricultural and developed land at rates sufficient to meet the 40% reduction goals by the year 2000.

In summary, the initiatives proposed for Phase II include the following:

Agriculture

-- Improve coordination among the agencies involved in the various aspects of water quality protection, as it relates to agricultural sources of nutrients;

-- Initiate a program for developing and implementing farm-specific management plans for all nutrient inputs to farmland, including fertilizers, animal wastes, sewage sludge, and other nutrient sources;

-- Develop a coordinated implementation strategy among involved agencies and a long-term funding strategy for the establishment of forested buffer strips along surface water channels in or adjacent to cropland;

-- Improve targeting and planning for BMP implementation, to result in the use of practices which can best manage nutrient export on a farm-specific or watershed basis;

-- Develop more effective mechanisms to encourage implementation and maintenance by farmers of the BMPs which are optimal for NPS pollution control, and formally evaluate the adequacy of existing incentives to achieve satisfactory participation; and

-- Enhance outreach, education and training mechanisms to facilitate understanding, cooperation and implementation.

Development

-- Expand activities to "retrofit" existing development with BMPs designed to provide nutrient control for storm runoff;

-- Establish and enforce universal requirements for maintenance of stormwater management BMPs;

-- Modify stormwater management regulations to minimize nutrient load increases from future development, and to work in concert with development guidelines toward this end;

-- Develop and adopt (by the State and local governments) complementary regulations and guidelines to ensure proper constraints upon and management of development site characteristics which determine the quantity and quality of discharge from each site;

-- Identify other deficiencies in existing mechanisms for stormwater management and sediment/erosion control, and implement effective solutions; and

-- Expand education and training efforts as needed to ensure effective implementation of control efforts.

The estimates of load reductions from existing sources and of projected load increases from future development, which were used to predict loads between now and the year 2000, were made under the assumption that all of the mechanisms proposed for Phase II will be realized, or that alternative approaches with equivalent technical capability will be identified and initiated. It is important to note that only those elements to which load reduction estimates can be directly attributed, on the basis of implementation data, are included in Table 2; the remaining mechanisms or elements either function to minimize load increases, or to facilitate realization of the accomplishments projected for reductions in existing and/or control of future loads.

For Phases II and III, the estimates of implementation costs, and their distribution among the "State/Federal" and "Private/Local" categories used in Table 2, reflect the "implementation scenario" discussed previously (in the introduction to Section B.). These estimates are not discussed here in any detail, and are provided only as a general index to the projected costs of reaching the 40% goal under the assumptions and constraints described earlier for this scenario. Considerable care was taken to ensure that reductions associated with a given level of activity were not overestimated; hence, the cost estimates in Table 2 are believed to be generous, rather than conservative, with respect to direct implementation cost.

Because the cost estimates in Table 2 apply only to mechanisms which function directly to implement reduction-oriented practices, it should be recognized that costs associated with the other "supporting" mechanisms are not portrayed here. These include, for example, improved targeting, tracking and evaluation of NPS management and effectiveness; costs associated with enhanced maintenance of stormwater BMPs; the realization of more effective enforcement of stormwater and sediment control regulations; and expanded educational efforts in nonpoint source nutrient control. These costs have not been estimated at present.

The magnitude of these expenses, and the means through which they are to be funded, will be addressed as a part of Maryland's implementation plan for the Bay nutrient reduction strategy. Maryland intends to develop this plan, which will address each component of the strategy, within one year. The plan will describe the organizational responsibilities and the programmatic mechanisms needed to fully implement the strategy for Phase II, and the associated costs of administering and executing each component. For each of the key elements in the nonpoint source control program, as outlined in the implementation plan, the State will develop and carry out procedures for tracking and evaluating local programs, in terms of their ability to effect the level of control projected in this plan. Existing mechanisms (such as the State's triennial review of stormwater management programs), or new mechanisms, where necessary, will be used to organize the process of evaluation, to identify changes needed in the local programs, and to pursue implementation of viable solutions.

One of the supporting mechanisms most critical to containing nonpoint source nutrient pollution is the involvement of the public and local governmental jurisdictions. This need is addressed in part through a set of objectives and commitments in the Bay Agreement which focus on education, understanding and participation. Perhaps the most relevant of these is the commitment to conduct coordinated education and information programs to characterize the roles and responsibilities of the general public, local governments, businesses, students, and community associations in the Bay restoration and protection effort. For the purpose of achieving the desired levels of nutrient control from nonpoint sources, this commitment has special significance.

In Maryland, substantial responsibility for the realization of effective nonpoint source nutrient control rests with local jurisdictions. County agencies, municipal governments and soil conservation districts have the primary responsibility to ensure nonpoint source control efforts through local ordinances and regulations, outreach efforts, and planning activities; and to oversee the process of implementation by other organizations, businesses, farmers, and participants in the development process. Consequently, it is important that Maryland provide local leaders and staff with a clear understanding of the following facts:

-- Individual local implementation efforts are essential elements for success of the overall Chesapeake bay nutrient control program.
-- State requirements and guidelines, as well as other sources of technical guidance, are important aspects of local programs.
-- The ability of local personnel to properly plan, design, install, manage, and maintain nutrient control practices, and to disseminate this knowledge as appropriate, is essential to the long-term success of the nutrient control effort for restoring the Chesapeake Bay.

The State, in turn, must provide the coordinated training and education needed for these purposes, and assist the local jurisdictions in providing guidance and understanding to the organizations and individuals whose activities affect nutrient loadings. Maryland has already performed some of this educational work for specific purposes, such as holding workshops for the Maryland Agricultural Cost-Share Program, sponsoring annual conferences on stormwater management, and preparing technical papers and documents. During Phase II, the State will assess the adequacy of its education and training efforts to support the realization of its nutrient reduction goals, and will enhance these educational processes where possible.

Phase II - Agriculture (1988-91)

For agriculture, the practices emphasized on cropland through the existing control programs are reasonably efficient mechanisms for controlling soil loss and most of the associated phosphorus load. Their continuation is essential for these purposes. However, the "soil conservation" approach is notably deficient in its ability to control nitrogen and soluble phosphorus. The practices promoted by Maryland to control animal waste nutrients originating from concentrated production facilities have emphasized management by proper containment of wastes during their generation and subsequent storage before their application to cropland. These are necessary elements for controlling manure nutrients, but they fall short in addressing losses following application to cropland, from which most waste nutrients enter waterways.

To address these limitations of the control techniques promoted by the existing Maryland agriculture programs, two new initiatives are scheduled for Phase II. These are programs to encourage the widespread use of farm specific "nutrient management plans" and the establishment of forested buffer strips along stream channels adjoining cropland. A nutrient management program will facilitate the control of inputs to cropland from both animal wastes and commercial fertilizers, as well as from other sources, such as sewage sludge, cover crops and legumes. These inputs of nutrients, which can be managed in many cases, will be considered in conjunction with uncontrollable inputs, such as atmospheric deposition, to determine appropriate rates and frequencies of application for manageable inputs.

If properly planned and executed, reduced nutrient inputs to croplands and pastures will result in reduced nutrient export, with minimal or even positive economic impact on the farmer, and at a relatively modest cost to the State. Startup funding for this initiative was approved by the Maryland legislature in the 1988 General Assembly. Seven newly created nutrient management specialist positions, to be assigned to targeted areas, will be filled during State fiscal year 1989. These specialists will be part of the University of Maryland's Cooperative Extension Service (CES), and will complement the broader soil conservation and water quality planning activities of the local Soil Conservation District planners. The University of Maryland operates both soil and manure testing programs, which will perform the analyses necessary for farm-specific nutrient plan development.

Establishment of forested buffer strips along freshwater streams adjacent to cropland will result in very cost-effective reductions to NPS nitrogen (relative to other prospective control mechanisms for cropland), provided the buffer strips are implemented and maintained according to the appropriate criteria. Farmers will be reimbursed for removing land from production and will receive financial assistance in establishing forested cover on the land. Both of these implementation costs (i.e., compensation or easement payments, and site preparation/tree planting) are projected collectively in Table 2. The funding required for most of Phase II will be available through USDA's CRP program, the State's MACS program, the State's Green Shores Program (see below) and the State's supplemental CRP program, enacted by the 1988 General Assembly.

The State's Green Shores Program, administered by the Department of Natural Resources, will complement State and federal CRPs and the State MACS Program in facilitating buffer strip establishment. This program focuses on public lands, while providing outreach and technical assistance to private landowners for buffer establishment. The implementation rates projected for buffers during Phase II of the present plan include the estimated contributions of all of these programs. For Phase III, it was assumed that the State will develop a long-term implementation and funding strategy, which will integrate all of these related programs to accomplish the relatively extensive establishment of forest buffers required to meet the year 2000 load reduction goal.

Following 1990, it is expected that the federal CRP program will end. If the rate of implementation realized during Phase II (prior to 1991) can be accelerated beyond that now projected, then federal CRP funds which would later be unavailable can be used to facilitate buffer establishment. Maryland will pursue this possibility, examining ways to encourage higher rates of participation in the short term than we now predict. Should the federal program end as anticipated, Maryland will have to assume the full funding responsibility for the remainder of Phase II and all of Phase III for forest buffer strip establishment. This was assumed in projecting the load savings and implementation costs for Phase III (as shown in Table 2), resulting in estimated lower total payments to the participating farmers, relative to those currently possible under the combined federal/State programs. (Under these assumptions, a potentially valuable tool is the use of tax credits to enhance the incentives for participation by farmers. This approach has been successfully used in other states to encourage participation in conservation activities, and may be useful in Maryland as part of an incentives package.)

In addition to these two new programs (i.e., farm nutrient management and forest buffer establishment), three actions to enhance existing agricultural programs are needed to ensure that our expectations about load reductions can be realized. These include more effective targeting of the various control techniques; provision of better incentives to comply with management plans; and improved coordination among the agencies through which the agricultural nutrient load reductions must be achieved.

Realization of these three enhancement efforts is assumed in estimating the nutrient load reductions achieved and sustained for agricultural sources. Hence, the load reductions projected for Phase II cost-shared activities on cropland result not only from greater expected expenditures (Table 2) and implementation, but also include an estimated increase in "effectiveness", as a consequence of improved targeting of BMPs to specific geographic areas and conditions. Targeting is already an ongoing activity in Maryland. Current efforts by SCS, MDA and the University of Maryland should lead to more effective targeting, and to the identification of the additional research and data required for this purpose.

It is assumed for all of the agricultural controls that a fairly high degree of maintenance and longevity is realized for the implemented practices. "Conservation Compliance," as currently embodied in USDA agricultural programs, provides an economic incentive to farmers to implement and maintain the practices prescribed by the Soil Conservation districts for highly erodible lands in farm management plans. To ensure a high probability of implementation for a wider range of recommended controls, Maryland must explore potential approaches to improving the Conservation Compliance mechanism, in relation to both an expanded array of control techniques, and in recognition of the fact that less erodible land is also a significant nutrient source. One promising approach which should be explored lies in changing the federal requirements for compliance to include implementation of practices recommended from a more comprehensive "resource management" perspective in the farm conservation plans. This approach, which would require U.S.D.A. cooperation, could complement any similar requirements instituted for receipt of benefits from State programs.

In addition to investigating enhanced Conservation Compliance requirements, Maryland will also examine during Phase II the potential long-term effectiveness of its present voluntary approach to controlling nutrients from agricultural sources. The levels of implementation for all of the agricultural management and control activities projected in this plan must, at present, be achieved entirely through voluntary participation. During Phase II, it is essential that the State carry out an assessment of the adequacy of existing incentives for participation. This assessment will include, at a minimum, a comparison of projected vs. realized levels of implementation for all management practices; estimation of the number and type of practices implemented by farmers independently of technical and financial assistance programs; a focus on increasing participation at facilities producing animal wastes; and exploration of alternative means of providing more effective incentives, including both increased financial assistance and mandatory requirements for selected agricultural activities. This assessment will contribute significantly to our ability to evaluate our NPS control efforts at the end of Phase II, and to modify our incentive mechanisms as needed to achieve the water quality goals of the Bay Agreement.

Functions which are part of the agricultural NPS management effort at a broad scale (i.e., targeting, tracking, evaluation and compliance) will take on a greater level of complexity, resulting from the need to better integrate these functions and to ensure that implementation efforts by the various agencies are coordinated, in terms of objectives and technical criteria. The State will establish an interagency mechanism to coordinate data requirements, compilation, and use; to establish enhanced guidelines for targeting, tracking and implementation; and to identify a common basis for evaluating progress in reducing nutrient pollution from nonpoint sources. This level of coordination is necessary to facilitate truly effective progress towards the nutrient load reduction goals from agriculture.

<u>Phase II - Development</u> (1988-91)

The Phase II accomplishments for developed areas include load reductions attributed to a modified State cost-share program, in addition to new stormwater management requirements for redevelopment projects (see Table 2); more effective maintenance of stormwater management BMPs, to prevent load increases over time; modified stormwater management regulations and adoption of guidelines for new development, to contain the load increases expected from that source; and enhanced education, training, and enforcement.

"Stormwater retrofitting", as used in this plan, represents an expansion and modification of the cost-share effort, intended to reduce loads from the extensive development (approximately 700,000 acres) which has occurred in Maryland prior to 1985 without stormwater quality management. As indicated in Table 2, Maryland intends to continue the practice of sharing the cost of retrofitting activities during Phase II at an accelerated rate compared to Phase I. To fund the level of activity necessary to achieve significant reductions from this source category, increased financial responsibility is also anticipated for local juridictions.

One means of funding the the increased local share needed to accomplish the expanded retrofitting activity projected in this plan is the establishment of stormwater utilities programs, or of mechanisms which will provide equivalent funds. Many approaches to funding these activities are possible, but the "utilities" approach would direct funding responsibility toward the most extensively developed areas of the state, and would also minimize or eliminate inequitable distribution of financial responsibility among "user categories" (i.e.,commercial,industrial and residential users), which is a potential problem under a dedicated property-tax-financed system. In addition, the utilities approach can also address several other deficiencies in the existing control program, specifically by providing the funds required to maintain the water quality performance of BMPs, for the effective enforcement of both stormwater and sediment control regulations (see the discussion at the end of this section) and for planning and administration of these activities at the local level.

Realization of enhanced retrofitting and maintenance activities during the latter half of Phase II is assumed in the estimation of load reduction accomplishments. The significance of this assumption is that actual loads from development will be significantly larger than those projected (for the purpose of measuring progress towards the reduction goals), if widespread retrofitting and new maintenance requirements do not take effect. Maryland will expand the scope of its existing triennial review of local stormwater management programs, as a means of ensuring that local programs are satisfying the new, more rigorous requirements for maintenance. These requirements will apply to all BMPs, including those implemented with State contributions, existing structural facilities, and BMPs installed for new development.

In addition to loads from existing development, loads from new development were factored into the estimates of total load reductions for Phase II. Land use changes, specifically those involving the conversion of forested and (to a lesser extent) agricultural land to developed land uses, were projected to increase NPS nutrient loads over the period 1985 through 1999. These loads were projected under the assumption that two specific improvements in the control of pollution from new development come into being during Phase II:

-- modification to the existing stormwater management regulations, and
-- the establishment and incorporation of new development guidelines for site design.

Existing State regulations and local programs for new development attempt to encourage water quality management in the course of providing quantity management for flood control purposes. However, they provide little assurance in most cases that the most effective nutrient control practices are implemented. Characteristics of developments, such as the extent of impervious cover and its distribution relative to naturally vegetated areas, have a large effect on the quantity and quality of discharge from a site. This, in turn, can strongly influence the ability of structural management practices to intercept the exported load. Nutrient export can be greatly reduced through site planning and design. However, guidelines and constraints for site design for this purpose are absent or very limited in local zoning and development regulations, and an education program concerning these considerations does not exist at the State level.

Modified State stormwater regulations are recognized as a means of significantly reducing loads from future development, while incorporating the full costs of stormwater quality control into the cost of development. The need for retrofitting, which is often impossible or very expensive following development, can be avoided for a large percentage of new development. Regulation changes are now being developed by MDE.

The establishment of development guidelines and policies to minimize future water quality impacts from new developments is an explicit "commitment" in the 1987 Bay Agreement, which is being addressed by a special interstate committee. MDE intends to develop guideline criteria specifically aimed at reducing nutrient export from developed sites, to function in unison with the State stormwater management regulations. These guidelines will be provided to the interstate committee for its consideration. They will be designed to complement the new stormwater management regulations, and will be incorporated into the State's education/training program for stormwater management. If broadly implemented, the new guidelines will significantly reduce increases in loadings from new development in conjunction with structural BMPs. The nutrient loads from new development, which were subtracted from the reduction accomplishments in Phases II and III (Table 2), were estimated under the assumption that these improved controls will be in place for most of that period of time. (i.e. 1990-2000).

Because large amounts of soil and associated nutrients can be mobilized by construction activities, loads from construction sites were estimated as one of the sources contributing to development loads. Loads from construction sites are significant, relative to those from other developed land uses. Current law and regulations in Maryland require that an approved Erosion and Sediment Control Plan be obtained and implemented for most construction sites. Inspection and enforcement of the plans is essential to prevention of unnecessarily large discharges of sediment and nutrients. Inspection programs at the local and State levels are continually challenged to meet the steady rise in development statewide. The number of active construction sites routinely exceeds the ability of inspection staffs to visit sites with the frequency needed to be truly effective. State records show that between 80 and 95 percent of sites inspected are not complying with the implementation or maintenance required by their approved Erosion and Sediment Control Plans.

During Phase II, Maryland will identify the deficiencies which exist in State and local mechanisms for ensuring effective sediment and erosion control, and will pursue the appropriate changes in relevant regulations and/or policies. One clear requirement for success is larger staffs at the State level, as well as for many local jurisdictions.

<u>Phase III</u> (1992-99)

The levels of implementation of the pre-agreement mechanisms and the new control mechanisms (introduced in Phase II) which are projected for Phase III of the strategy are based on current estimates of the costs and effectiveness of these various practices, while recognizing that the extent to which any practice can be implemented is limited by a variety of physical and socio-economic factors. New information gathered on these factors during Phase II will be reviewed as part of the 1991-92 re-evaluation of the 40% goal and of the states' progress towards successful nutrient control. The NPS control program outlined for Phase III (Table 2) is therefore open to considerable modification at that time. Basically, Phase III assumes that the agricultural and development initiatives begun under Phase II are expanded after 1991.

Figure 4 presents projected loads, through the year 1999, for NPS nitrogen and phosphorus. As indicated in the figure, the top line in each graph depicts the projected loads that would result if only the existing (pre-agreement) NPS controls are continued at current (1987) levels through Phase III. The middle line in each graph portrays expected results if the "new" agricultural initiatives (but no new development controls), described under the preceding discussion of Phase II, were pursued at high levels during Phase III. The bottom line on each graph depicts the estimated "controllable" NPS loads that would be achieved if all of the enhancements for both agriculture and development were carried out during Phases II and III at the levels shown in Table 2 and in this text.

It can be seen from Figure 4 that the 40% phosphorus reduction goal for NPS is reached under the "middle" scenario, but that the nitrogen reduction from that scenario still falls far short of this goal. The bottom line scenarios in Figure 4 depict accomplishment of both load reduction goals through the additional incorporation of enhanced controls for existing and future development (i.e., through those controls described previously). The implication of our calculations is that the full range of control efforts described under Phase II, for both agriculture and development, must be realized in order to reach the year 2000 goals for nutrient reduction.

A number of management concepts, which have not been adequately explored for inclusion as reduction mechanisms at this time, provide potentially valuable alternatives to supplement the practices which are the focus of this strategy. These include:

-- development and expanded use of both different crops (and crop varieties) which use and conserve soil nutrients more effectively than those currently emphasized in Maryland;
-- increased use of cover crops (which are currently emphasized for erosion control) for nutrient retention;
-- a variety of new approaches emphasizing better use of animal manures (including distribution to cropland based on need, rather than proximity to the source area), and attempts to market manure products for energy generation, lawn and garden fertilizers, and animal feeds;
-- exploration of alternative or regenerative agricultural systems, which rely less on chemical fertilizers and pesticides, and shift emphasis toward organic materials and more broadly integrated management/cropping systems;
-- a more coordinated approach to sewage sludge disposal, which will balance disposal needs with cropland nutrient requirements, within the context of the State's new nutrient management program;
-- enhanced efforts to control shoreline erosion, which expand upon those currently in place in Maryland; and
-- expanded use of land treatment programs (PL566) in small watersheds, to facilitate establishment of BMP's to control nutrients and sediment.

Maryland will explore these alternatives, with an eye toward incorporating them into our strategy for nonpoint sources by 1992.

Conclusion

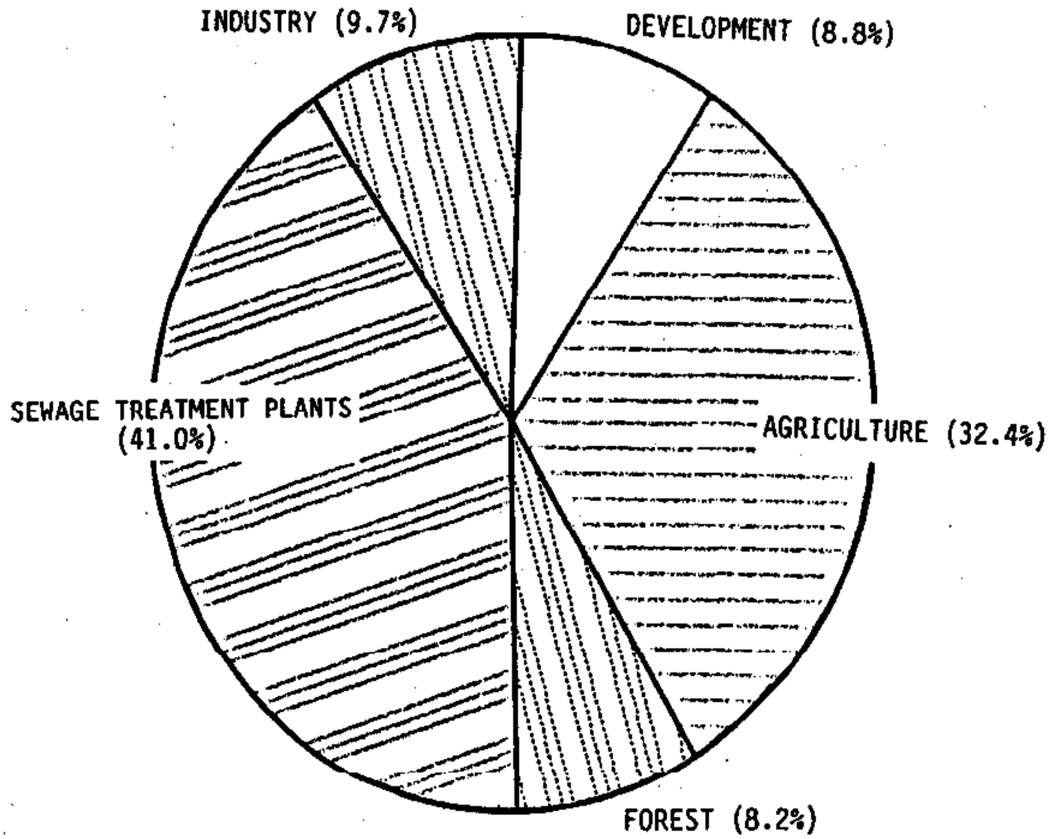
Maryland is committed to minimizing pollution loads entering the Bay and its tributaries in order to provide for their health and the protection of their living resources. At this time, it is certain that substantially improved controls for nutrients from point and nonpoint sources are essential to achieving that goal.

Education will play an important continuing role in almost all aspects of Maryland's efforts to meet the 40% nutrient reduction goals for the Chesapeake Bay. The State must continue to inform and involve the general public, sewage treatment plant operators, property owners, farmers, operators of industrial facilities, and many others. Without the necessary understanding which leads to informed action and full commitment, the new treatment technologies, best management practices, and nutrient management plans will not fulfill their potential to benefit the Chesapeake Bay, its tributaries and the living resources that depend on them. Maryland is committed to sustaining the educational process as a means of ensuring that our nutrient load reduction goals for the year 2000 can be met.

The strategy outlined in this plan represents Maryland's initial detailed response to the nutrient load reduction provisions of the 1987 Chesapeake Bay Agreement. Following the 1991 re-evaluation period, the State intends to follow through with the additional actions required to achieve its load reduction goals. At this time, the year 2000 loading goals, derived from the "40% reduction" of 1985 loads, provide an important gauge against which to measure our progress toward the greater goal of aquatic resource protection and restoration. In this light, we are committed to achieving the 40% load reduction goals by the kinds of efforts described in this plan.

FIGURE 1
TOTAL NITROGEN LOAD CONTRIBUTIONS TO THE CHESAPEAKE BAY
FOR MARYLAND IN 1985

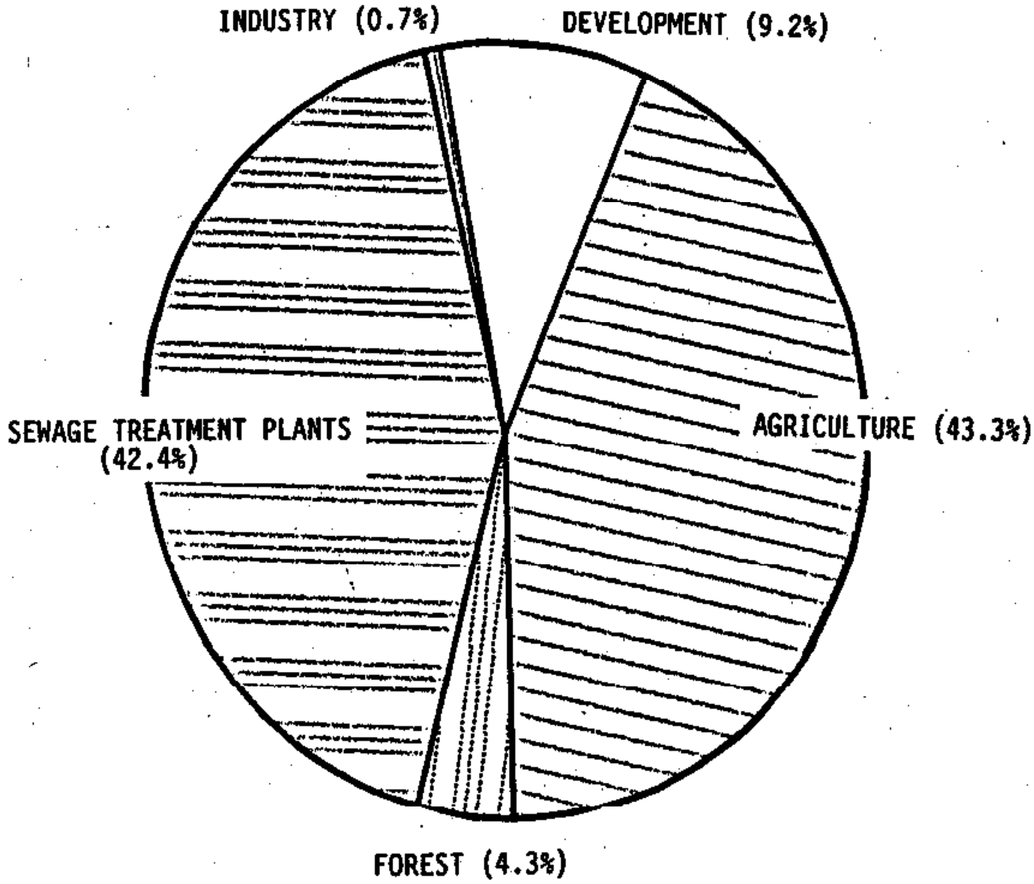
TOTAL LOAD = 64,800,000 POUNDS PER YEAR



Note: The relative nitrogen loads presented here reflect estimates of the total Maryland load to the Chesapeake Bay in 1985. For point sources, this means calendar year 1985. For nonpoint sources, this means an average rainfall/runoff year for 1985 land cover. Though point sources may be considered 100% controllable, only a large fraction of the total nonpoint source load can be controlled. Consequently, Maryland's nutrient reduction strategy addresses the controlable nonpoint source fraction only.

FIGURE 2
TOTAL PHOSPHORUS LOAD CONTRIBUTIONS TO THE CHESAPEAKE BAY
FOR MARYLAND IN 1985

TOTAL LOAD = 7,615,000 POUNDS PER YEAR



Note: The relative phosphorus loads presented here reflect estimates of the total Maryland load to the Chesapeake Bay in 1985. For point sources, this means calendar year 1985. For nonpoint sources, this means an average rainfall/runoff year for 1985 land cover. Though point sources may be considered 100% controllable, only a large fraction of the total nonpoint source load can be controlled. Consequently, Maryland's nutrient reduction strategy addresses the controllable nonpoint source fraction only.

TABLE 1
POINT SOURCE NUTRIENT LOADS AND ESTIMATED REDUCTIONS FOR THE CHESAPEAKE BAY IN MARYLAND SUMMARIZED BY IMPLEMENTATION PHASE IN POUNDS PER DAY

		1985		PHASE I (1987)		PHASE II (1991)		PHASE III (2000)	
		TP	TN	TP	TN	TP	TN	TP	TN
MAJOR STPs	EASTERN SHORE	500	1,850	360	2,300	400	2,700	400	1,900
	W. CHESAPEAKE	4,720	42,000	3,720	42,230	2,300	27,500	2,450	20,300
	PATUXENT	800	5,450	270	5,220	300	2,700	450	3,300
	POTOMAC	1,730	20,500	1,000	21,850	1,000	22,700	900	15,100
MINOR STPs		1,000	3,000	500	3,000	550	3,300	650	3,700
INDUSTRIES		150	17,200	150	10,400	150	10,400	150	10,400
TOTAL	POUNDS/DAY	9,000	90,000	6,000	85,000	4,700	59,300	5,000	54,700
TOTAL	POUNDS/YEAR	3,285,000	32,850,000	2,190,000	31,025,000	1,715,500	25,294,500	1,825,000	19,965,500
40% REDUCTION	POUNDS/DAY	3,600	36,000						
(TOTAL X 0.4)	POUNDS/YEAR	1,314,000	13,140,000						
YEAR 2000 GOAL	POUNDS/DAY	5,400	54,000						
(TOTAL X 0.6)	POUNDS/DAY	1,971,000	19,710,000						
ESTIMATED TOTAL CAPITAL COMMITMENT BY PHASE (TECHNICAL SUPPLIMENT PROVIDES DETAILS)				$77 MILLION		$42 MILLION		$89 MILLION	

Notes: This table projects the level of commitment necessary to acheive a 40% reduction in point source nutrients by the year 2000. The projected approach is retrofitting biological nutrient removal (BNR) technology at all Maryland sewage treatment plants larger than 0.5 MGD. (See the Technical Suppliment for important details.) 1985 and 1987 load estimates are based on the best effluent monitoring data immediately available for nutrients. Projected loads for 1991 and 2000 anticipate that BNR can generally meet 2 mg/l TP and 8 mg/l TN levels (assuming year-round capabilities at this level or seasonal control requirements.)

TABLE 2
ESTIMATED REDUCTIONS IN CONTROLLABLE NONPOINT SOURCE NUTRIENT LOADS AND ASSOCIATED IMPLEMENTATION COSTS BY PHASE

1985 LOADS	NITROGEN (lbs/yr)	PHOSPHORUS (lbs/yr)
Agriculture	15,790,000	3,000,000
Development	4,270,000	610,000
Total NPS	20,060,000	3,610,000

	Control Mechanism	Nitrogen Reduction (lbs/yr)	Phosphorus Reduction (lbs/yr)	Implementation Costs, By Phase (1985-1987 Dollars) State/Federal	Private/Local
PHASE I	Soil Conservation BMPs	158,000	121,000	$3,624,000	$906,000
	Animal Waste BMPs	518,000	34,000	$3,624,000	$906,000
	Federal Conservation Reserve	9,000	3,000	$241,000	N.A.
	Stormwater BMPs (Retrofits)	20,000	4,000	$3,200,000	$500,000
	Total PHASE I	440,000	103,000		
PHASE II	Soil Conservation BMPs	348,000	268,000	$11,644,000	$2,900,000
	Animal Waste BMPs	1,039,000	69,000	$11,644,000	$2,900,000
	Nutrient Management	130,000	73,000	$1,200,000	undetermined
	Forest Buffer Strips	149,000	26,000	$1,600,000	$64,000
	Federal Conservation Reserve	14,000	5,000	$390,000	N.A.
	Stormwater BMPs (Retrofits)	101,000	19,000	$8,000,000	$8,000,000
	Redevelopment BMPs	5,000	1,000	—	$1,120,000
	Totals PHASE II	1,495,000	374,000		

NOTES:

1. This table projects the load reductions needed to realize the 40% goal, and the estimated costs associated with implementation. The cost estimates provide an index to the distribution of effort among contributing control mechanisms for the scenario presented in the text. The table does not include information on several essential elements of the strategy outlined in the plan, specifically those for which reductions in existing loads, and in some cases associated costs, cannot be calculated at this time. Please see the text ("Nonpoint Source Initiatives and Projected Load Reductions") for more information on these points.

2. Total load reductions for each phase reflect the sums of the individual control mechanisms, adjusted for the impermanence of some management practices and additional loads from new development. A 25% loss of all soil conservation and nutrient management controls implemented is assumed, and losses are subtracted from total accomplishments in each phase. Similarly, additional loads from anticipated new development were also subtracted from total accomplishments in each phase. It is important to note that the loads estimated for this purpose assume that the range of new development controls (i.e., regulation changes, universal adoption of BMP maintenance, and widespread use of sound development guidelines), as discussed in the plan become standard practice. Without realization of these controls, anticipated loads would be significantly larger.

TABLE 2
ESTIMATED REDUCTIONS IN CONTROLLABLE NONPOINT SOURCE NUTRIENT LOADS AND ASSOCIATED IMPLEMENTATION COSTS BY PHASE

1985 LOADS	NITROGEN (lbs/yr)	PHOSPHORUS (lbs/yr)
Agriculture	15,790,000	3,000,000
Development	4,270,000	610,000
Total NPS	20,060,000	3,610,000

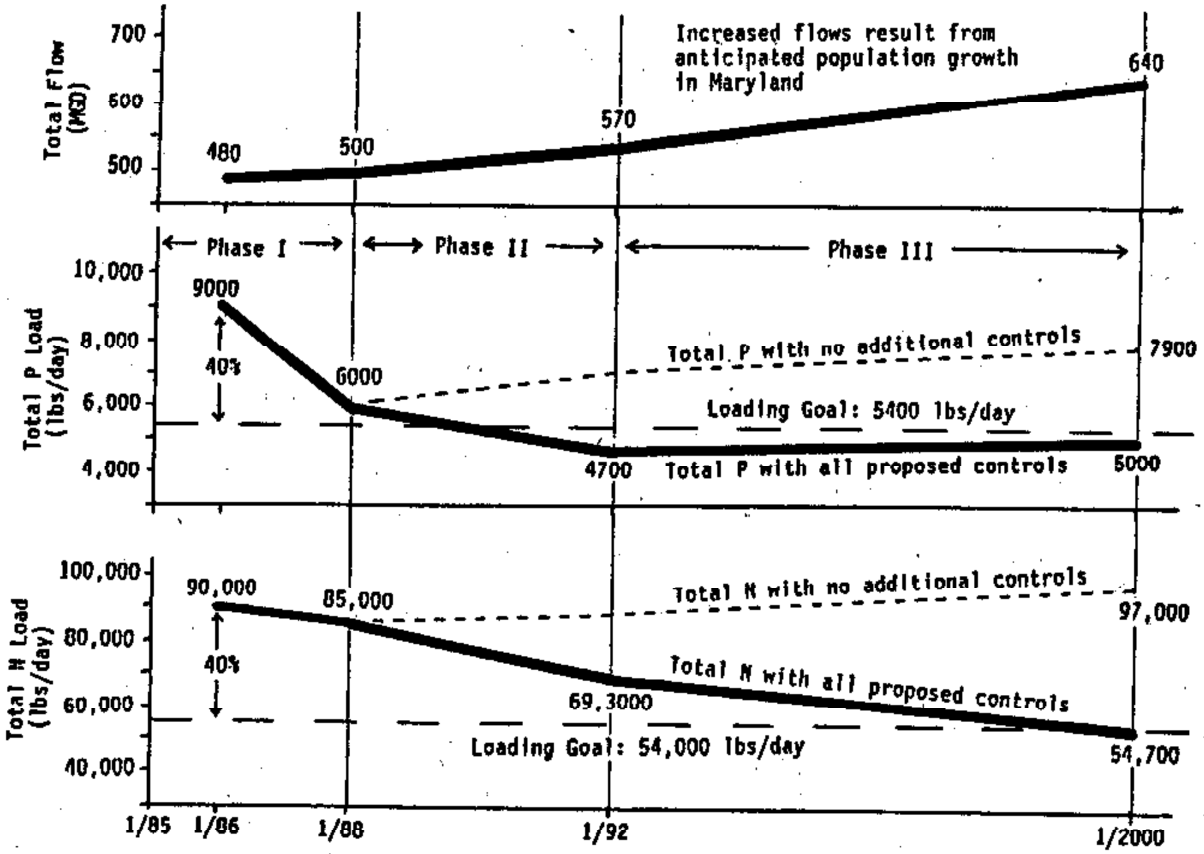
	Control Mechanism	Nitrogen Reduction (lbs/yr)	Phosphorus Reduction (lbs/yr)	Implementation Costs, By Phase (1985-1987 Dollars) State/Federal	Private/Loca
PHASE III	Soil Conservation BMPs	515,000	396,000	$16,340,000	$4,090,000
	Animal Waste BMPs	1,754,000	116,000	$19,160,000	$4,790,000
	Nutrient Management	1,652,000	919,000	$19,000,000	undetermined
	Forest Buffer Strips	2,491,000	428,000	$36,000,000	$1,736,000
	Federal Conservation Reserve	—	—	—	—
	Stormwater BMPs (Retrofits)	1,212,000	234,000	$23,000,000	$23,000,000
	Redevelopment	19,000	4,000	—	$4,480,000
	Totals PHASE III	6,955,000	1,792,000		

NOTES:

1. This table projects the load reductions needed to realize the 40% goal, and the estimated cost associated with implementation. The cost estimates provide an index to the distribution of ef among contributing control mechanisms for the scenario presented in the text. The table does include information on several essential elements of the strategy outlined in the plan, specif those for which reductions in existing loads, and in some cases associated costs, cannot be ca ed at this time. Please see the text ("Nonpoint Source Initiatives and Projected Load Reducti for more information on these points.

2. Total load reductions for each phase reflect the sums of the individual control mechanisms, adjusted for the impermanence of some management practices and additional loads from new development. A 25% loss of all soil conservation and nutrient management controls implemented is assumed, and losses are subtracted from total accomplishments in each phase. Similarly, additional loads from anticipated new development were also subtracted from total accomplishments in each phase. It is important to note that the loads estimated for this purpose assume that the range of new development controls (i.e., regulation changes, universal adoption of BMP maintenance, and widespread use of sound development guidelines), as discussed in the plan become standard practice. Without realization of these controls, anticipated loads would be significantly larger.

FIGURE 3
CHESAPEAKE BAY NUTRIENT LOAD REDUCTION PLAN:
MARYLAND POINT SOURCES



Phase I Implementation

- Phosphorus detergent ban (all STPs)
- P removal at:
  Back River
  Patapsco
  Western Branch
  Havre de Grace
  Elkton
  Bowie
  Dorsey Run
- N removal at three industries

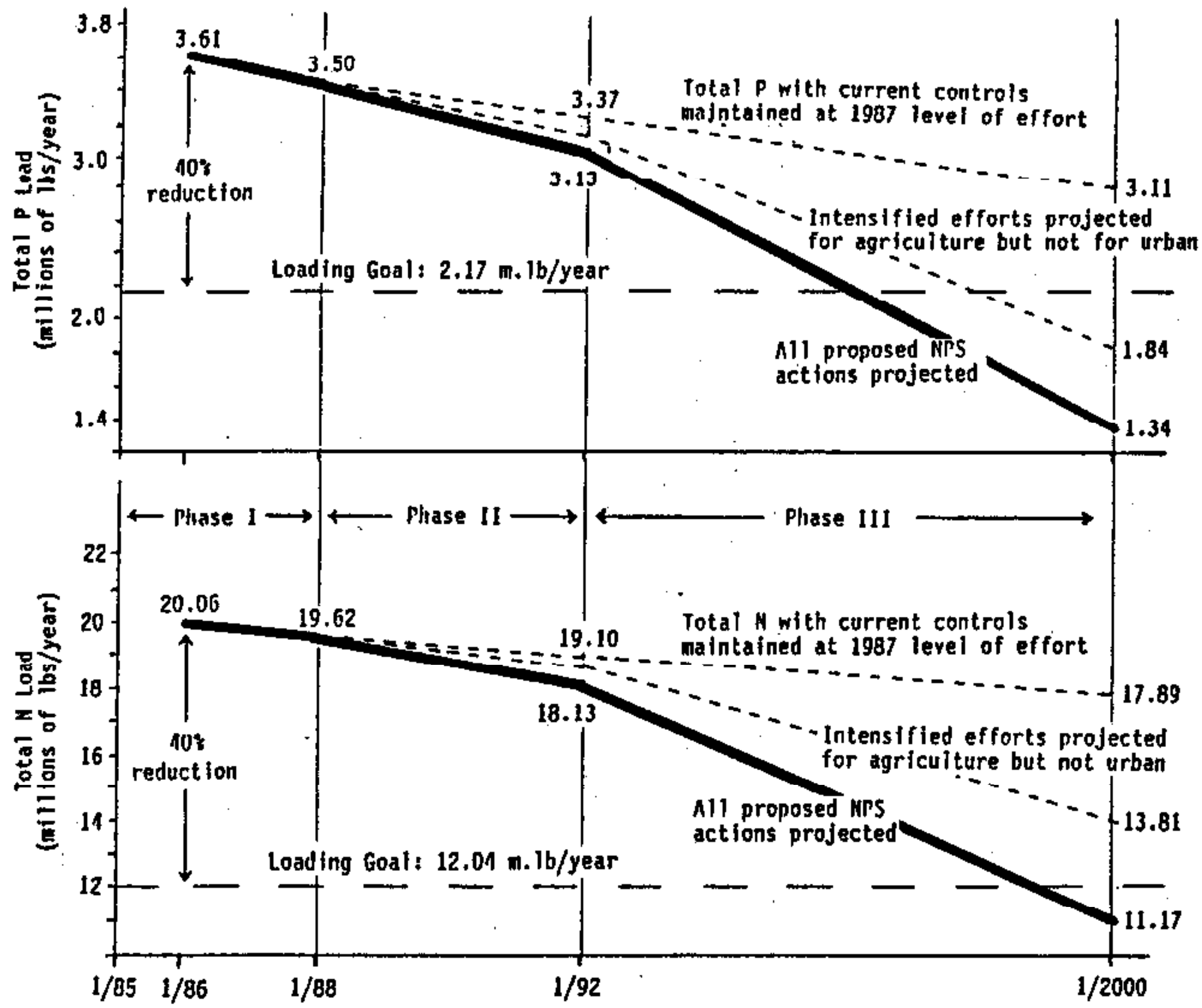
Phase II Implementation

- All Phase I actions plus BNR at:
  Back River
  Little Patuxent
  Piscataway
  Annapolis
  Sod Run
  Parkway
  Patuxent
  Maryland City
- N removal for Dorsey Run and Western Branch

Phase III Implementation

- Phase I & II actions plus BNR added at all remaining Maryland STPs with 1985 flows greater than 0.5 MGD.
- Cumulative effect of depicted program is to reduce both N and P loads by 40%, even with expected growth.

FIGURE 4
CHESAPEAKE BAY NUTRIENT LOAD REDUCTION PLAN:
"CONTROLLABLE" MARYLAND NONPOINT SOURCES



Phase I Implementation

Agriculture:
- Emphasis on Soil Conservation (SC) and Manure Handling/ Storage (MH/S)
- Removing highly erodible land from production (CRP)

Development:
- Existing Stormwater Management (SWM) Regs for new development
- Retrofit Cost-Share for existing development
- Existing sediment control programs

Phase II and Phase III Implementation

Agriculture:
- Continue/enhance SL and MH/S
- Fed CRP signup ends 1991, benefits continue through most Phase III
- Begin nutrient management and forest buffer programs
- Better coordination and targeting
- Enhance outreach and education

Development:
- Enhance SWM regulations
- Expand retrofit activities
- Establish site guidelines
- Improve effectiveness of sediment control programs
- Expand education and training