A MODEL FOR SUCCESS? MONITORING, MEASURING AND MANAGING THE HEALTH OF THE CHESAPEAKE BAY

HEARING

BEFORE THE

COMMITTEE ON GOVERNMENT REFORM

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A MODEL FOR SUCCESS? MONITORING, MEASURING AND MANAGING THE HEALTH OF THE CHESAPEAKE BAY

FRIDAY, AUGUST 20, 2004

HOUSE OF REPRESENTATIVES,
COMMITTEE ON GOVERNMENT REFORM,
Fort Monroe, VA.

The committee met, pursuant to notice, at 9:58 a.m., in the Breeze Community Center, 409 Fenwick Road, Fort Monroe, VA, Hon. Tom Davis (chairman of the committee) presiding.

Present: Representative Davis and Schrock.

Staff present: Brien Beattie, professional staff member; Robert White, press secretary; Teresa Austin, chief clerk; Allyson Blandford, office manager; and Amy Westmoreland, legislative assistant.

Chairman TOM DAVIS. Good morning, the committee will come to order. We welcome everybody to today's hearing on the Chesapeake Bay clean up effort.

The Chesapeake Bay is an ecosystem in crisis. All the witnesses we will hear from today will agree on this point. Large dead zones, areas of low dissolved oxygen that suffocate and kill native aquatic life, plague the bay every summer. These dead zones are caused by massive nutrient pollution from numerous man-made sources, exacerbated by natural weather processes. Nitrogen and phosphorous from sewage treatment plants, agricultural industry and urban sprawl are washed down the major rivers that feed the bay, fueling the uncontrolled growth of algae blooms that consume great quantities of dissolved oxygen, leaving precious little for oysters, crabs and fish. This algae also blocks out sunlight, killing grasses and other submerged aquatic vegetation.

This environmental crisis threatens to destroy a bay that is enjoyed by recreational admirers and upon which industrial fishermen and their families depend. Indeed, this is a vital economic interest for the States involved. For example, the Virginia Seafood Council has estimated that commercial fishing contributes $450 million annually to the economy of Virginia alone. Yet seafood harvest from the bay continue to shrink. In 1985, only 18 years ago, Virginia oyster men were able to pull 1 million bushels of oysters from the bay; in 2003 they harvested less than 15,000. In short, it is a crisis that concerns all of us, not only in this region—Virginia, Maryland, Pennsylvania—but across the country as well.

Since its creation in 1983, the Chesapeake Bay Program has been the coordinating agency for the effort to clean up the bay. The program is a regional partnership that includes the States of Virginia, Maryland, Pennsylvania, and the District of Columbia, a tri-State legislative body called the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency. The program has been hailed as a model for both estuarine research and for regional coordination of local, State and Federal stakeholders in meeting environmental challenges that span multiple jurisdictions.

In 1987, the Chesapeake Bay Program set the water quality goal of reducing the levels of nitrogen and phosphorous in the bay by 40 percent by 2000. However, over the years, the program has been forced to repeatedly lower expectations in the face of the great challenges it faces in accomplishing this mission. Using an advance computer model that has been described by one program spokesman as the Cadillac of watershed models around the world, the program has reported reductions of 28 percent for phosphorous and 18 percent for nitrogen since 1985. The program, also, has many water quality monitoring stations spread throughout the regions. However, according to recent media reports using just such water sample data from the U.S. Geological Survey, there has been little or no improvement in phosphorous or nitrogen levels.

The recent media attention on apparent inconsistencies between progress reported and progress made has prompted many in the scientific and environmental communities to question not only the effectiveness of the program's computer modeling by even its fundamental commitment to cleaning up the bay. Some claim the program's over-reliance on computer modeling and inadequate use of actual water sample data has created a false sense of security among policymakers and the public. However, program officials have strongly denied that they neglect water sampling in favor of total reliance on a computer model. They say the program utilizes 100 different indicators to develop an accurate picture of the bay's health and that only 11 of these are based entirely on computer models.

The committee hopes to clear the air today, or perhaps the water, over the Chesapeake Bay Program's modeling and monitoring procedures. We also want to get a status update from those on the front lines of the battle to save the bay and learn what, if anything, Congress can do to help.

I might add that first of all, I was a member of the Fairfax County Board of Supervisors during the years that we down zoned the watershed which feeds into the bay as a part of this program, and had it upheld in court, it has moved its way through.

I am going to now recognize Mr. Schrock, who is really responsible for putting this hearing together, for his opening statements and then move to our first panel. Mr. Schrock.

[The prepared statement of Chairman Tom Davis follows:]

Opening Statement
Chairman Tom Davis
Committee on Government Reform
"A Model for Success? Monitoring, Measuring and Managing
The Health of the Chesapeake Bay"
August 20, 2004
Fort Monroe
Hampton, Va.

I want to welcome everyone to today's hearing on the Chesapeake Bay cleanup effort. The Chesapeake Bay is an ecosystem in crisis. All the witnesses we will hear from today will agree on this point. Large "dead zones," areas of low dissolved oxygen that suffocate and kill native aquatic life, plague the Bay every summer. These dead zones are caused by massive nutrient pollution from numerous man-made sources, exacerbated by natural weather processes. Nitrogen and phosphorous from sewage treatment plants, agricultural industry and urban sprawl are washed down the major rivers that feed into the Bay, fueling the uncontrolled growth of algae blooms that consume great quantities of dissolved oxygen, leaving precious little for oysters, crabs and fish. This algae also blocks out sunlight, killing grasses and other submerged aquatic vegetation.

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Mr. SCHROCK. Well, thank you, and good morning everyone. Let me begin Mr. Chairman, by expressing my sincere gratitude to you for allowing the committee to hold this important hearing not in Washington, DC, but within view of the very body of water we are here to discuss and have much to be concerned about.

I want to express my appreciation to Colonel Perry Allmendinger who was the commanding officer of Fort Monroe, and these soldiers and civilians here at Fort Monroe, whose support and hospitality has made today's hearing a reality. Thank you very much, Perry, we appreciate it.

Welcome, all of you to the Second Congressional District of Virginia, especially our panel of witnesses who have taken their time to help us understand how we can effectively monitor and measure the health of this treasure that we call the Chesapeake Bay. To many the Chesapeake Bay is a body, whose water and watershed are a back yard of a business, a beloved home, a playground. A visit to the eastern shore, or to the island of Tangier, an observation of the time and energy invested in the watermen's way of life are true life examples of communities and people that depend on the bay for their very livelihood.

That our bay is impaired is of particular concern to me not only as the representative for the Hampton Roads area, but as a resident of this area as well. The Chesapeake Bay is the largest estuary ecosystem in the world and I have no doubt it is the primary model for ecosystem restoration and regional partnerships.

The Chesapeake Bay Program serves as an example for dozens of other estuary restoration efforts nationally, including Long Island Sound, San Francisco Bay, Tampa Bay, Puget Sound, among others. I firmly believe that much expectation is placed on our task and our efforts will be a model for success nationwide.

Without question, we all agree that there is still much work to be done. Recently, it was called to my attention in news reports in the Washington Post and in other local papers exactly how much the Chesapeake Bay cleanup has progressed—is disputed. And lying at the heart of the debate are the tools and methods used to measure the bay's health. This is a concern in that as we have sought to improve the health of the bay, we have called on States, localities, businesses, and farmers to change their practices so that they are more environmentally friendly. These requirements and regulations have cost taxpayers, business owners, and farmers millions of dollars in compliance.

As such, it is important for us to know that their investments are paying off. If they are not, we must understand why and change course, if necessary. In attempts to deal with the bay, the Federal and State governments passed laws and regulations that impact these stakeholders. Policymakers, before passing such laws and regulations, must know exactly where we are now and precisely the means necessary to achieve our goals of healing the bay.

So, in light of the conflicting reports about the health of the Chesapeake Bay, the purpose of today's hearing is to learn more about what the actual state of the bay really is, how the bay has helped to fix our region and how to best reevaluate it. I firmly believe that before we can legitimately tackle the huge task of saving the bay, we must establish the necessary framework before we can implement the right solutions.

Again, thank you all for coming today, I know that I have a lot to learn and I look forward to our witnesses' testimony. And again, Mr. Chairman, thank you for holding this hearing.

Chairman TOM DAVIS. Well, thank you very much Mr. Schrock, and now we turn to our first panel. It is the policy of our committee that all witnesses be sworn before they testify. Let me just introduce our panel.

First we have Rebecca Hanmer, who is the director of the Chesapeake Bay Program; we have Tayloe Murphy, Jr., former member of the Virginia House of Delegates and now the Secretary of Natural Resources of the Commonwealth of Virginia, and Tayloe Murphy goes with water quality and environment in this State for more than a generation. Lowell Bahner who is the Director of the Chesapeake Bay Office, National Oceanic and Atmospheric Administration. Scott Phillips, the Chesapeake Bay Coordinator for the U.S. Geological Survey; and Ann Swanson, the Executive Director of the Chesapeake Bay Commission.

Will you rise with me and raise your right hands.

[Witnesses sworn.]

Chairman TOM DAVIS. Thank you very much. Your entire statements are in the record. We will base our questions on reading that last night and, and we will ask you on that. So, what we would like you to do is keep it to 5 minutes as we go through. We do have a light up there, when it is working, it will be green for the first 4 minutes and then it will turn orange, and when it turns red your 5 are up and you can move to summary about that time. We will not gavel you or shout at you. Ms. Hanmer, we will start with you and then we will work straight on down the row. Thank you.

STATEMENT OF REBECCA HANMER, DIRECTOR, CHESAPEAKE BAY PROGRAM

Ms. HANMER. Thank you, Mr. Chairman.

Chairman Davis, and Congressman Schrock, thank you for inviting me to testify today. My name is Rebecca Hanmer and I am the Director of the EPA Chesapeake Bay Program Office.

I am sorry to be the unwitting cause of a controversy over how progress in implementing the bay cleanup is measured. I am especially sorry that the controversy has led respected newspapers and members of the public to conclude that the Chesapeake Bay Program does not monitor the water quality conditions of the bay and its tidal tributaries or care what the monitoring data tell us. We care very much. Curing the problems of the bay is our profession and our passion, therefore I welcome the opportunity to take a moment to discuss both our modeling and our monitoring programs. But, most importantly I'd like to talk about the additional actions we need to take to restore the bay.

Annually, we spend about $1 million on modeling. Having read other witnesses prepared testimony I think you will hear others say that our watershed model is, for example, one of the most advanced ecosystem models in the world, as from Ms. Pierno's testimony. The most comprehensive and powerful models of the watershed and estuary of their kind, as from Dr. Boesch.

Let me say from my own experience, the Chesapeake Bay Watershed Model is world class and we are proud of it. Like all water pollution control programs, we must rely on modeling to help us to determine what actions we should take to reduce pollutants and ultimately to achieve water quality improvement. We use modeling to help us determine what we can control and what we cannot—like the rainfall, or tidal resuspension. The model helps us set goals and develop management strategies.

Last year we concluded a 3-year effort to set new ecosystem-based water quality criteria for the bay. We then set basin-wide pollution reduction targets that would be needed to achieve this new scientific description of restored bay water quality. We concluded, for example, we should allow no more then 175 million pounds of nitrogen to enter the bay during an average hydrologic year. I do not think you will hear a single witness today dispute that number. It is a consensus goal and it was based on the use of the bay program's watershed model. It only makes sense then that we should use the same tool as we conduct annual progress runs to determine if we are making the right management decisions to reach those targets.

But that is not the only way we measure the health of the bay or evaluate the management decisions designed to restore the bay. While we spent about $1 million in fiscal year 2003 on modeling, we spent about $3 million on monitoring, with our partners investing much more than that in our monitoring program. I think most of the data that will be discussed today from dissolved oxygen levels to nutrients to bay grasses comes from the Chesapeake Bay Monitoring System.

So, it is simply not true to say that we do not monitor, we do and we pay close attention to the results. If you look at the bay program's Web site you will see a large number of indicators of the bay including information from both our tidal and non-tidal water monitoring networks. As you pointed out, Mr. Chairman, of the 100 indicators we use, about 11 are based on the watershed model output.

In 2003, as I said, we published new criteria for measuring the water quality of the bay. Attainment with these criteria will be measured through water quality monitoring data. That is the ultimate test of the success of our bay water quality restoration efforts. So, we clearly need both monitoring and modeling to be successful. But neither a world class model, nor robust water quality monitoring alone will restore the bay. What we need is action, implementation.

Over the past 20 years the bay program has helped bring about important actions that are making a positive difference in the health of the bay. For example, 97 wastewater treatment plants have already installed nutrient removal technology, and that is about 56 percent of the total flow. Over 3 million acres of crop land are operated under nutrient management plans designed to reduce excess nutrients. Over 1,300 stream miles have or will be open to migratory fish. Over 2,800 miles of stream side forest buffers have been restored. As important as these accomplishments have been, they are just the beginning. We estimate we have only removed a small percentage of the nitrogen pollution and about half of the phosphorous and sediment pollution that we need to remove in order to meet our water quality goals.

So, we have made modest gains in reducing the number of pollutants flowing to the bay, especially when we are faced with a 20 percent increase in population growth. But the amount of work ahead of us is truly daunting. To restore the bay will take unprecedented of levels of effort meaning that government at all levels, farmers, food processors, developers, homeowners, apartment dwellers, everyone alike will be affected by our tributary strategies and will need to help us clean up the bay. With their help and with your leadership I think we can succeed.

Thank you very much.

Chairman TOM DAVIS. Thank you, very much. Secretary Murphy.

[The prepared statement of Ms. Hanmer follows:]

Written Testimony of
Rebecca W. Hanmer
Director
Chesapeake Bay Program Office
before the
Committee on Government Reform
U.S. House of Representatives
Field Hearing, Fort Monroe, Hampton, VA
August 20, 2004

Mr. Chairman and Members of the Committee, my name is Rebecca Hanmer and I am the Director of the Chesapeake Bay Program Office. Thank you for the opportunity to testify today.

The Chesapeake Bay is North America's largest and most biologically diverse estuary, home to more than 3,600 species of plants, fish and animals. For nearly 400 years, the Bay and its tributaries have sustained the region's economy and defined its traditions and culture. It is a resource of extraordinary productivity, worthy of the highest levels of protection and restoration.

Accordingly, in 1983 and 1987, the states of Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the U.S. Environmental Protection Agency, representing the federal government, signed historic agreements that established the Chesapeake Bay Program partnership to protect and restore the Chesapeake Bay's ecosystem.

For two decades, the Chesapeake Bay Program partners have worked together as stewards to ensure the public's right to clean water and a healthy and productive resource. We have sought to protect the health of the public that uses the Bay and consumes its bounty. The initiatives we have pursued have been deliberate and have produced gains in the health and productivity of the Bay's main stem, the tributaries, and the natural land and water ecosystems that compose the Chesapeake Bay watershed.

While the individual and collective accomplishments of our efforts have been significant, even greater effort will be required to address the enormous challenges that lie ahead. Increased population and development within the watershed have created ever-greater challenges for us in the Bay's restoration. These challenges are further complicated by the dynamic nature of the Bay and the ever-changing global ecosystem with which it interacts. Let me stress this point: the progress that we have made has been real, but the amount of work ahead of us is enormous. By most of the key measures that we use to evaluate the health of the Bay, we are less than half-way to where we need to be to have a truly restored Chesapeake Bay.

The health of the Chesapeake Bay

The Committee has asked us to provide an assessment of the health of the Bay. But the Chesapeake Bay is a complex ecosystem, and the Chesapeake Bay Watershed, of which it is the defining element, is even more complicated. Trying to assess the health of the system is, necessarily, a difficult task.

Nevertheless, there are a number of ways to measure the Bay's health. Let me review some of them with you.

The simplest assessment of Bay health can be found on EPA's Clean Water Act 303(d) list, which is the list of the nation's impaired water bodies. Most of the Bay's waters do not attain their designated uses and fail to meet the states' water quality standards. They are currently on the 303(d) list.

But to say that the Bay is "impaired" fails to define the scope of the challenges we face.

For more specific assessment of the Bay's health, the Chesapeake Bay Program has a national, indeed an international, reputation for having developed an extraordinary suite of environmental measurements. The Program has literally one hundred "indicators" that we use to assess the health of the Bay and the restoration effort. The majority of these are based on monitored data. Only eleven are based almost exclusively on our computer models, but even these are calibrated with data gathered from monitoring stations.

The Bay Program's Watershed Model is perhaps the finest of its kind in the world. It has received recognition from outside experts as diverse as the Smithsonian Institution and the supercomputer makers, Cray, Inc. The model itself is developed by a collection of some of the top people in the field, including scientists and engineers from the EPA, United States Geological Survey, the University of Maryland, and a host of private sector contractors. All of their work is done in public and all the documentation of their work is available on the chesapeakebay.net website. Hundreds of people have provided input. I will let my colleague from USGS speak for that leading science organization. Let me point out, however, that in correspondence following the recent Washington Post articles, USGS notes that their monitored data, adjusted for annual flow variations, also show a downward trend in nutrients as does the Bay Program's model. That is not to say that the model always mirrors monitored data. Neither method can claim 100% accuracy; both are based on different approaches, and they serve different functions. Having said all of that, we also know that we must constantly evaluate our assessment methods and strive for further improvements. That's why for several years now we have been developing the next generation of the computer model that we use to analyze the Chesapeake Bay Watershed. Simultaneously, we've been working with USGS and the Bay states on improving both our tidal and non-tidal monitoring networks. We have already asked the Program's independent Scientific and Technical Advisory Committee (STAC) to "establish an expert group to review the model and provide advice as the Chesapeake Bay Program makes its Phase 5 model revisions." In addition, we have asked STAC to provide us with "advice broadly on the Program's data gathering and our use of data and modeling information in our decision-making and indicators for Program evaluation and reporting."

These indicators allow us to assess the health of the Bay.

- **Dissolved oxygen (DO)** levels in the mainstem of the Bay become dangerously low every summer. While lower dissolved oxygen levels in the deep waters of the Bay are a natural phenomenon during the warmer months, the dramatic extent of the low oxygen levels that we have documented for years are largely due to the vast amount of nutrient pollution that still finds its way into Bay waters annually.

- Last year high rainfall contributed to areas of low oxygen waters in the Bay reaching record levels in terms of range. In the summer of 2003 low oxygen levels stretched over 150 miles from Baltimore to the York River and covering an area of about 250 square miles. This year, with less rainfall washing non-point source pollution into the Bay, the size of the low oxygen zone has decreased, although the total volume of low oxygen waters is still enormous. Scientists inside and outside the Program differ on whether we are beginning to see small, but statistically significant improvements in DO levels. But there is no disagreement, however, that solving the dissolved oxygen problem is one of the central challenges in restoring the health of the Bay.

- **Bay grasses**, or submerged aquatic vegetation, are another key indicator of Bay health. Bay grasses are important because they produce oxygen, are food for a variety of animals (especially waterfowl), provide shelter and nursery areas for a variety of fish and shellfish, reduce wave action and shoreline erosion, absorb nutrients such as phosphorus and nitrogen, and trap sediments. Bay grasses had been on a sustained upward trend for several years. Then in 2003 we saw a record decline of 30% in a single year, down to 64,709 acres, at least partly due to high rainfall and runoff volumes. Even with that dramatic drop, we still had more than a 50% increase in Bay grasses last year than we did back in 1984. The data on grasses for this summer are still being collected. We have some encouraging reports in several areas that the grasses are rebounding, but we also have reports that Hurricane Isabel last fall scoured out some areas and they have not recovered. Overall, we are making some progress. To have a restored Bay, however, we need to get that number up to 185,000 acres, so we are only about 35% of the way toward our goal.

- **Water clarity** is another key measure of Bay health. And here, the news is mostly bad, although there have been some recent extraordinary improvements in some tributaries in the Upper Bay. Plants require light and, therefore, water clarity is particularly critical to Bay grasses. Water clarity as measured by Secchi depth is degrading in many parts of the basin. While most of the mainstem Bay, larger embayments and lower regions of large tributaries meet the minimum light requirement for Bay grasses, upper regions of the large tributaries and many minor tributaries fail.

- This summer we have seen some extraordinary and rapid improvements in water clarity in some Maryland waters, with some rivers showing water clarity improvements of 100% and even 200%. Watermen, local boaters and scientists alike are reporting water clarity of five and six feet in some of these areas. These are the kind of clarity depths that we think we should be seeing in the shallow waters throughout a restored Bay ecosystem. I wish I could tell you why we are seeing these remarkable developments. Initial theories include the role of macroalgae and the appearance of large numbers of dark false mussels, but Bay scientists are still sorting through the data and the theories. We need to be careful not to extrapolate this short-term phenomenon into a Bay-wide trend, but we will continue to keep a keen eye on this development.

- There are literally scores of other assessments that can be brought to bear in analyzing the health of the Bay. The number of nesting pairs of Bald eagles in the watershed has grown more than ten-fold, from 72 active nests in 1977 to 760 in 2003. Similarly, striped bass were officially designated as "restored" in 1995 by the Atlantic States Marine Fisheries Commission. Crabs and especially oysters, on the other hand, are at critically low levels. My colleagues from the National Oceanic and Atmospheric Administration (NOAA), our academic partners from the Virginia Institute of Marine Sciences (VIMS), Old Dominion University (ODU) and the University of Maryland Center for Environmental Science (UMCES), and some professional watermen will discuss some of the key living resources of the Bay such as oysters, crabs and finfish.

- As I noted earlier, there are 100 different indicators on the chesapeakebay.net website, and we encourage you and your staff to review them all. They are the result of a remarkable collaborative effort of scientists from the federal and state government, academic and nonprofit organizations, and even private citizens. One of the great strengths of the Bay restoration effort is the extraordinary watershed wide collaboration and these indicators are a good example of the ways we are all working together with a common purpose.

- So what can we say about the condition of the Chesapeake, beyond the fact that the Bay is "impaired"? Overall, I think it is a fair assessment to say that we have made modest progress. As I will be outlining later in my testimony, the key pollutants of nutrients and sediments are down, although not nearly far enough. Some important living resource indicators like Bay grasses show improving trends. In the face of a population that has grown by 20% since 1985 and all the attendant pollution that means, these gains are not inconsequential. But we need to be measuring ourselves against what the Bay needs, not how much effort we have made. And using that method, we have a substantial amount of work ahead of us, as outlined below.

What do we need for a healthy Chesapeake Bay

In a healthy Chesapeake Bay the waters will be clear and well-oxygenated. Vast beds of Bay grasses will provide essential habitat to thriving populations of shellfish and finfish. Essential plant food will be in abundance, and harmful algae will be limited. The Bay Program has always recognized that the health of the living resources of the Bay is the final measure of our success. But in the past we had been limited in defining exactly what that meant, so we have relied heavily on measures of our progress in reducing the pollutants into the Bay. That has been an enormously useful approach, helping us to define the management strategies that will work and to measure the effectiveness of different pollution control methods.

The landmark *Chesapeake 2000 Agreement*, however, has set us on a different course. We have completed a three year review of how best to measure the health of Bay waters. The new criteria that we have developed:

- dissolved oxygen concentrations in different habitats;
- water clarity, especially in shallow water areas;
- the extent of Bay grasses, and
- the amount of chlorophyl *a* in the water column

give us specific environmental endpoints rather than pollution reduction targets.

This change is extremely important. These new criteria for measuring water quality have been developed in a collaborative fashion with our state partners as well as leading academic and nonprofit scientists. They are very ambitious and represent perhaps the best scientific work of its kind done anywhere in America. All of the states with tidal waters of the Chesapeake are in the process of adopting new designated uses and water quality standards. As they complete this process over the next several months, we will have four specific yardsticks to use as we assess the water quality of the Bay.

In *Chesapeake 2000* we committed ourselves to removing the nutrient and sediment impairments to the Bay by 2010. When we assess the health of the Bay then to determine if it can be removed from EPA's impaired waters list, we will be using specific monitored results of these environmental criteria. Arguments about computer models vs. monitored data will, no doubt, still be raging in the scientific community. But the ultimate measure of our success will be actual field measurements of these crucial parameters.

Accounting for pollution reductions

Since 1987, the Chesapeake Bay Program's top priority has been controlling and reducing the Bay's number one problem - the overabundance of the nutrient pollutants nitrogen and phosphorus. Excess nutrients are a problem because they nourish algae blooms which cloud the water, deprive underwater Bay grasses of sunlight, and rob the water of oxygen needed by Bay creatures.

In the 1987 Chesapeake Bay Agreement, the Bay Program partners committed to reducing controllable nutrient loads 40% by the year 2000. This is the frequently cited 40% reduction goal that the Program promoted. In the *Chesapeake 2000* agreement, however, the Bay Program committed to reduce nutrient loads further and reduce sediment loads in order to correct all nutrient and sediment-related problems in the Bay by 2010.

When we set the goal in 1987 of a 40% reduction, there wasn't consensus on what the 40% should be measured against. We had little scientific understanding of the role of air pollution and how large a role it played in polluting the Bay. And the Bay partners said that they could only take responsibility for pollution originating in their states. Both of these were reasonable assumptions, especially nearly 20 years ago. But by 2000, we knew that we needed to more accurately account for the pollution coming from our headwater states of West Virginia, New York and Delaware as well as the atmospheric pollution, including substantial sources of nitrogen, that was coming into our airshed and contaminating our waters. In effect, we said that we needed to be playing on a bigger field.

We also realized that a 40% reduction of the controllable nutrient pollution originating from the Bay states would simply be inadequate to restore the Bay. In effect, we were saying that not only did we need to play on a bigger field but also that the goal line needed to be further away.

In 2003, the Bay Program partners agreed to reduce nutrient loads so that by 2010 (and every year thereafter) no more than 175 million pounds of nitrogen from all sources and 12.8 million pounds of phosphorus from all sources will be delivered to the Bay in an average hydrology year. We also agreed to reduce land-based sediment loads so that no more than 4.15 million tons will be delivered to the Bay in 2010 (and every year after). The estimated loads for these pollutants in our base year of 1985 were 338 million pounds of nitrogen, 27.1 million pounds of phosphorus, and 5.8 million tons of land-based sediments. These reductions in nutrients and sediment are expected to result in improved water quality conditions necessary to support the living resources of the Bay. All of these goals were established using the Bay Watershed Model, and this is an excellent example of the indispensable role this tool plays in the Program.

Using this more encompassing geographic scope and the even more stringent pollution reduction target, we now estimate that between 1985 and 2002, annual phosphorus loads delivered to the Bay from the entire watershed are projected to be reduced by 7.6 million lbs.

Annual nitrogen loads are projected to be reduced by 60 million lbs and sediment loads by 0.8 million tons. In order to achieve the new goals, an additional 6.7 million lbs of phosphorus, 103 million lbs of nitrogen and 0.9 million tons of sediment will need to be reduced by 2010. All of these numbers are based on monitored data from things like wastewater treatment plants in the tidal reaches of the Bay and projections from the Watershed Model based on management changes on the land and other variables. Using these various assessment methods, we can project that we have taken the necessary management actions to achieve one-third of the nitrogen and about one-half of the phosphorus and sediment reductions that are needed to restore the Bay.

Good science tells us that the new Program goals are the right ones for the Bay. But we are using a new set of parameters rather than ones that the public had grown accustomed to over the years, and that change has resulted in some confusion about assessing the progress we have made in reducing pollution over the last twenty years. Five years ago we were telling people that some jurisdictions were nearing their 40% reduction targets. When we reassessed what would be required to achieve a healthy Bay, we said our new targets would have to be much more ambitious, closer to 50% of ALL the nutrients, regardless of where they originated and whether we thought they were "controllable." The earlier accounts of pollution reduction projections were based on our best estimates of the time, but the benchmarks had changed so considerably that the percentage comparisons became skewed. That's one of the reasons that we have changed our reporting so that we now simply use actual annual load targets expressed in pounds or tons rather than percentages. These measurements will be based on outputs from the Watershed Model, and together with our extensive monitoring data, they will continue to provide us with excellent management tools to help us gauge whether we are on track for recovery. But the actual measure of recovery will be the monitored data of Bay water quality criteria and assessment of living resource stocks.

Where do we go from here

If reductions of nutrients and sediments are the keys to improving water quality, and improved water quality is a key component in the restoration of the living resources of the Bay, then what can and should be done to reduce the pollution loads coming into the Bay?

All of the Bay watershed states, including the headwater states, have embarked upon an ambitious tributary strategy exercise. Secretary Murphy will be able to give you a more detailed look at the Virginia strategies. This watershed-wide effort, though, is designed to take the overall pollution reduction goals for the Bay and have each of the 30+ subwatersheds design plans to reduce their inputs to the system. These "trib strategies" are all based on the new, more aggressive pollution reduction goals. And the pollution reduction efforts they are planning are impressive in their scope and depth.

Agriculture is a vital part of the economy and cultural makeup of the Chesapeake Bay Watershed. It is also the largest single sector source of nutrient and sediment pollution flowing into the Bay. A plurality of the nitrogen and phosphorus loads coming into the Bay originate on agricultural lands, and a majority of the land-based sediment run-off does as well.

- All watershed states have made significant commitments to working with farmers in reducing nutrient loads. In the tributary strategies, the jurisdictions have committed to accelerate implementation of conservation tillage, nutrient management, and cover crops on close to 100% of available lands. In many cases, we have a good start on these agricultural best management practices, but overall our level of effort will need to increase.

- We must employ new approaches. Jurisdictions have made a strong commitment to employ new approaches that hold great promise for the Bay, such as enhanced nutrient management which provide incentives to farmers to apply less fertilizer. There is a watershed-wide commitment to employ some level of nutrient management on close to 92% of all available land -- 16% of which will have enhanced nutrient management.

- The President's FY05 budget request included an additional $10 million for Chesapeake Bay nutrient reduction using trading and innovative approaches to non-point source runoff.

- USDA recently provided $5 million in additional funds for Delmarva peninsula nutrient reduction actions under the Farm Bill conservation programs.

Our point source commitments are just as strong.

- Before the tributary strategies were written, 97 out of the 360 significant municipal facilities in the Chesapeake Bay watershed were using advanced nutrient reduction technologies. New technologies are capable of reducing nutrients by more than 80% compared to traditional secondary treatment. The Chesapeake Bay region is a leader in new technology upgrades of wastewater treatment plants. The State of Maryland recently enacted legislation that was proposed by Governor Ehrlich that will finance new technolgy upgrades for Maryland's significant municipal facilities.

- With the tributary strategies, at least 330 out of the 360 significant municipal facilities will implement nutrient reduction technologies. To make sure that these tributary strategy promises become reality, EPA Region III recently announced a draft permitting strategy that will require nutrient pollution limits in the NPDES permits for virtually all the major waste water treatment plants in the watershed. Construction of needed upgrades would have to be complete by 2010.

- When the tributary strategies are fully implemented, they will result in an additional 23 million lb/yr reduction of nitrogen from the facilities and an additional 2.04 million lb/yr of phosphorus from the facilities.

On urban and suburban lands, we will need unprecedented pollution control efforts as well.

- Currently these lands contribute 17% of the nitrogen, 27% of the phosphorus and 18% of the sediment going into the Bay.

- The Maryland tributary strategy plan calls for every homeowner in the state to stop over-fertilizing their lawns. In Washington, the District envisions a major increase in the use of Low Impact Development techniques to slow the flow of pollution from city streets. Every one of the trib strategies will have to include similar levels of effort.

The President's Clear Skies Proposal would provide dramatic reduction in NOx emissions in the Chesapeake Bay watershed both improving air quality and reducing nitrogen entering the Bay.

- Oxidized nitrogen deposition to the Chesapeake Bay watershed would be reduced by up to 20%. We estimated in 2001, using 2000 land use patterns, that this would have resulted in an annual eight million pound reduction in the nitrogen load to the Bay by 2010. This is equivalent to more than half of the reductions it took 15 years to achieve through improvements to publicly owned treatment works.

- Chesapeake Bay States, including NY, VA, MD, PA, DE, WV and DC, recently agreed to incorporate the nitrogen reductions resulting from Clear Skies legislation as part of their overall plan to reduce nutrient loadings to the Bay.

- Congress has yet to enact Clear Skies thus EPA has proposed regulations that are similar to Clear Skies – the Clean Air Interstate rule – which will cut nitrogen emissions from coal-fired power plants by about 65 percent from today's levels.

- Under CAIR and other Clean Air Act programs - most notably the NOx SIP call - 50 counties in the six-state (plus District of Columbia) watershed will be brought into attainment with the new 8 hour ozone standard by 2015.

Conclusion

The Chesapeake Bay and its watershed are incredibly complex and dynamic. The resource is under tremendous stress. We have made modest gains in reducing the number of pollutants flowing into the Bay, especially in the face of rapid population growth. But the amount of work still ahead of us is truly daunting. To restore the Bay we will need unprecedented levels of effort. That means that governments at all levels, federal, state and local, will need to do more. The entire watershed will need to change their practices, sometimes dramatically. Homeowners and apartment dwellers alike will need to reduce their impacts on their local environment. We'll need help from academia to make sure that we get the science right, and from the nonprofit community to hold our collective feet to the fire.

While the task ahead of us is challenging, I truly believe that the Chesapeake Bay Program has developed the expertise and the partnerships that will enable us to succeed. But it won't be cheap, easy or fast. With your leadership and that of those in other key positions throughout the 64,000 square mile watershed, we can succeed.

Thank you for the opportunity to testify. I am happy to answer any of your questions.

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STATEMENT OF W. TAYLOE MURPHY, JR., SECRETARY OF NATURAL RESOURCES, COMMONWEALTH OF VIRGINIA

Mr. MURPHY. Mr. Chairman, and Congressman Schrock, thank you very much for the opportunity to be with you today. My message to you is a simple one. Restoration of the Chesapeake Bay is both possible, and critical to the future environmental and economic health of the Commonwealth. However, a clean and healthy bay will not come without substantial public and private investment, and the unwavering support of all levels of government as well as private stakeholders.

There will always be disagreements about water quality data and its interpretation. On the other hand, I do not doubt for a moment that the bay program office has been absolutely forthright with the public about the magnitude of the challenges involved in restoring the bay, and the difficulties we face in meeting them.

Our current efforts to improve dissolved oxygen and chlorophyll, A concentrations and water clarity through nutrient reduction strategies are fraught with political and fiscal complications. Simple solutions that make for good press do not necessarily constitute wise public policy. I want to take this opportunity to assure you that we are moving inexorably toward the goals established for a restored bay, but these are difficult, expensive and complex issues that take time to resolve.

As chairman of the Chesapeake Executive Council, Governor Warner and his counterparts in the other participating States and jurisdictions cannot do this alone. The success of the efforts in which we are now engaged will require the strong support of conservationists, industry, local government, members of the State legislatures, and the U.S. Congress, as well as the President himself. All of us who are charged with the responsibility of meeting the commitments contained in the Chesapeake 2000 agreement value the scientific work that is being done by the Chesapeake Bay Program, under the leadership of Rebecca Hanmer and her capable staff.

The program has always employed the best available science and state-of-the-art measures to assess progress. I have been personally involved in the Chesapeake Bay Program for over 20 years, and I know from my own experience that professionalism and the use of the best available science have always been the hallmark of this program. I know that Ms. Hanmer will continue to administer the program and according to these high standards so that the public will not be misled as to the state of the bay.

Regardless of what we may have heard in the press, we have always based our measures of success on actual water quality conditions, this will not change. Only monitoring will tell us whether our waters meet established water quality standards. Although, we used the bay model as a management tool in-stream conditions as determined through our monitoring programs will continue to constitute the basis on which progress and improving water quality is measured.

On the basis of recent press reports and other sources, the public may have the impression that they are being misinformed by the bay program of both the progress that has been made and the magnitude of the task at hand. The development of new water quality standards in accordance with the 2003 criteria promulgated by the bay program office and the strategies now being drafted to achieve the nutrient reductions necessary to achieve the new standards is a clear indication that progress to date in improving water quality in the bay and its tributaries is insufficient to restore the bay to a truly healthy condition.

Since becoming Secretary of Natural Resources for Virginia, I have consistently repeated myself and I will do so again today. Meeting the water quality objectives set forth in the Chesapeake 2000 agreement and the subsequent nutrient reduction commitments agreed to by the bay partners in 2003 constitute the single most important initiative to restore the bay to a healthy and productive estuary.

In all candor I must also state that we have no hope of meeting these ambitious water quality goals without significant additional financial support from both the public and private sectors and without significant changes in how we farm, manage stormwater, convert land, use septic tanks and treat industrial and municipal waste.

Now, I would like to take a moment to report to you on the actions we have undertaken in Virginia to meet our commitments to achieve these goals. Under Governor Warner's leadership and with strong support from the General Assembly, $37 million has been appropriated for the water quality improvement fund for this biennium. That fund is the principal source of State support for both point and non-point nutrient reduction programs. As a result of the fact that we ended the last fiscal year with a surplus we hope to receive another $30 million in appropriations to the fund at the next session of the General Assembly. It is certainly not all that we need, however, it represents the first contribution to this fund in 3 years and it is an important step in the right direction.

In April, I released for public comment draft tributary strategies for each of the major river basin in Virginia's portion of the Chesapeake Bay Watershed. These strategies contain a series of proposed management practices to control non-point source nutrient pollution and higher levels of treatment for point source discharges. On the basis of the public comment that has been received, we are currently revising these documents and preparing implementation plans. We will then use the bay program model to determine whether our final strategies if fully implemented will enable us to achieve our reduction goals.

However, only consistent widespread monitoring will tell us whether we have actually met those goals. On the regulatory front, in June the Virginia Water Control Board released for public comment draft water quality standards for dissolved oxygen, chlorophyll A and water clarity. These proposed standards prepared by the Department of Environmental Quality will apply to all of Virginia's tidal waters.

In its August 31 meeting, the Board will also consider a regulation to require technology based nutrient limits in wastewater discharge permits as well as nutrient loading allocations for point source facilities in the bay Watershed, the purpose of which is to reduce and cap point source loadings. On the non-point source side, we are working to target more effectively our cost share programs for non-point sources through the Department of Conservation and Recreation in partnership with local governments and soil and water conservation districts.

This department is working closely with the General Assembly's Joint Legislative Audit and Review Commission that is conducting a study of nutrient management planning in Virginia. We will review JLARC's findings later this year to determine what additional initiatives we should pursue in the use of this important nutrient reduction tool for agriculture.

In addition, the Department of Conservation and Recreation, in cooperation with the Department of Environmental Quality, is now in the process of implementing the legislation proposed by the Governor and passed by the 2004 General Assembly that reorganizes the Commonwealth stormwater management programs and expands the coverage of those programs Statewide.

With regard to non-point source controls, some practices can be implemented either through regulation or incentives or a combination of both. On the other hand, some non-point source practices can only be achieved through incentive based programs. Accordingly, our biggest challenge is quite clearly to find the additional revenue sources necessary to put in place both our point and non-point source initiatives. If we are unsuccessful in obtaining additional financial support from the State and Federal levels, the cost of success will fall entirely on the localities and their ratepayers and on the private property owner.

The water quality improvements that we seek benefit all Virginians and indeed all who live, work, and visit within the bay watershed. Therefore, the cost of success should be borne in my judgment by all taxpayers and not just by some of them.

In closing, I would like to share with you my personal perspective on what the achievement of our present water quality goals means to Virginia. As some of you know I am a native of the Northern Neck of Virginia. The peninsula bounded by the Potomac, and Rappahannock Rivers in the Chesapeake Bay. I was born there and I have lived nearly all of my life on the banks of the lower Potomac. During my rather long life I have witnessed dramatic declines in the living resources of the bay. And in the last 20 years which coincides with the years of my public service, these declines have continued unabated. In 1984, oyster harvests in Virginia were over 4.5 million pounds. In 2003 the harvest of oysters yielded just over 77,000 pounds. In 1984, there were 200 oyster shucking houses in Virginia; in 2003, there were 20. In 1984, blue crab harvest in Virginia produced over 50 million pounds; in 2003, the harvest was down 58 percent to just over 21 million pounds. In 1984, there were 75 crab picking houses in the Commonwealth; in 2003, there were 10. When one considers these statistics, there is small wonder that those engaged in the fishing industry feel that they have paid the cost of our neglect of their interest in water quality and habitat protection.

Now, let me say as I began, restoration of the bay is both possible and critical to the future environmental and economic health the Commonwealth. Your help is important to the success of the water quality initiative now underway. I thank you for providing me with the opportunity to make this plea to you today, and I hope that this hearing will have the effect of strengthening your commitment to be an advocate for the bay. Thank you very much.

Chairman TOM DAVIS. Thank you very much. Mr. Bahner.

[The prepared statement of Mr. Murphy follows:]

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TESTIMONY
To the House Committee on Government Reform
Secretary of Natural Resources W. Tayloe Murphy, Jr.
August 20, 2004
Fort Monroe
Hampton, Virginia

Mr. Chairman and members of the Committee:

On behalf of Governor Warner, I thank you for scheduling this meeting, and for taking such a keen interest in the Chesapeake Bay Program. My message to you today is a simple one. Restoration of the Chesapeake Bay is both possible, and critical to the future environmental and economic health of the Commonwealth. However, a clean and healthy Bay will not come without substantial public and private investment, and the unwavering support of all levels of government as well as private stakeholders.

I suspect that there will always be disagreements about water quality data and its interpretation. On the other hand, I do not doubt for a moment that the Bay Program office has been absolutely forthright with the public about the magnitude of the challenges involved in restoring the Bay, and the difficulties we face in meeting them.

I would suggest that it is much easier to write critical newspaper articles and press releases than it is to govern effectively and fairly. The work we have before us is fraught with political and fiscal complications and simple solutions that make for good press do not necessarily constitute wise public policy. I want to take this opportunity to assure you that we are moving inexorably towards the goals established for a restored bay, but these are difficult, expensive and complex issues that take time to resolve.

Governor Warner and his counterparts in our sister states cannot do it alone. We need the strong support of conservationists, industry, local governments, members of the General Assemblies of the states, the United States Congress and the President to achieve success.

I value greatly the scientific work that is being done by the Chesapeake Bay Program under Rebecca Hanmer's leadership. This program has always brought forward the best available science and state of the art measures of progress. I expect the professionalism and commitment to science that has been the hallmark of this program will continue. I know Rebecca will address these issues in her testimony, but let me say this: Regardless of the issues raised in the press, we have always and will continue to base our measure of success on actual water quality conditions. Only monitoring tells us that our waters meet water quality standards. We use the Chesapeake Bay model as a management tool, but what happens in the water is of paramount importance.

Based on recent press reports and other sources, the public may have the impression that we are somehow attempting to mislead them about the magnitude of the task at hand and the progress we have made. Nothing could be further from the truth.

I have said since becoming Secretary and I will say it again today: meeting our Chesapeake Bay restoration goals is the single most important water quality initiative facing Virginia. I will also say today, as I have said repeatedly in the past, these goals are monumental and without significant financial support from public and private sectors and without significant changes to how we farm, manage stormwater, convert land, use septic tanks and treat industrial and municipal waste, we have no hope in meeting them.

I would like to take a moment to report to you on the actions we are taking in Virginia.

With Governor Warner's leadership, the General Assembly appropriated $37 million over this biennium to the Water Quality Improvement Fund, the principal vehicle for funding nutrient reduction programs from point and nonpoint sources. We expect another $30 million will be appropriated to the fund in the next session of the General Assembly. If is certainly not all we need, but it represents the first contribution to the fund in 3 years and an important step forward.

In April, we released for public comment draft tributary strategies for all of Virginia's Chesapeake Bay tributaries. The strategies propose a suite of management practices for nonpoint sources and levels of treatment for point sources that achieve our reduction goals. We are currently revising those documents based on public comment and preparing implementation plans.

In June, the Virginia State Water Control Board released for public comment, draft water quality standards for Virginia's tidal waters for dissolved oxygen, chlorophyll "a" and water clarity prepared by the Department of Environmental Quality.

The board will consider, at its meeting on August 31, a regulation for technology-based nutrient limits in wastewater discharge permits as well as nutrient loading allocations for point source facilities in the Chesapeake Bay watershed that will reduce and cap point source loads.

On the nonpoint source side, we are working to better target our cost share programs for non point sources through our Department of Conservation and Recreation in partnership with local governments and soil and water conservation districts.

Agencies in my secretariat are working closely with the General Assembly's Joint Legislative Audit and Review Commission on its study of Nutrient Management Planning in Virginia. We will review the JLARC's findings later this year to help determine what additional initiatives we should pursue to better use this important nutrient reduction tool for agriculture.

In addition, DCR, in cooperation with the Department of Environmental Quality, is implementing the legislation proposed by the Governor and passed by the 2004 General Assembly that reorganizes our stormwater management programs and expands the coverage of those programs statewide.

With regard to nonpoint sources, some practices can be implemented either through regulation or incentives. However, some can only be achieved through incentive based programs. Therefore, money is clearly our biggest challenge. We must continue the search for new sources of revenue as well as increased amounts to support the achievement of our objectives. Without additional support from state or federal sources, the cost of compliance with new regulations and programs will fall entirely the property owner. Accordingly, we will continue to pursue initiatives to fund these ambitious strategies from other sources so that the entire burden will not be borne at the local level.

In closing, let me give you a final perspective on what these programs mean to me personally and to Virginia. As some of you know, I am from the Northern Neck of Virginia; a peninsula bounded by the Potomac, the Rappahannock and the Chesapeake Bay. I was born there and have lived nearly all of my life on the banks of the Potomac River. Since I began my career in public service as a member of the House of Delegates, I have seen changes in the resources of the bay. In 1984 oyster harvests in Virginia were over 4 million pounds; in 2003, the harvest of oysters yielded just over 77,000 pounds. In 1984 there were 200 oyster-shucking houses in Virginia; in 2003 there were 20. In 1984 blue crab harvests in Virginia were over 50 million pounds; in 2003 the harvest was down 58% to just over 21 million pounds. In 1984 there were 75 crab picking houses in the Commonwealth; in 2003 there were 10. When one considers these statistics there is small wonder that those engaged in the fishing industry feel that they have paid the cost of our neglect of their interest in water quality and habitat protection.

We are not talking simply about water quality improvements for water quality's sake; improved water quality will contribute mightily to Virginia's economy whether is be commercial or recreational fishing or tourism.

Once again, thank you for the opportunity to speak to you today and I look forward to your continued interest but more importantly your support in reaching our ambitious, but necessary, goals.

STATEMENT OF LOWELL BAHNER, DIRECTOR, CHESAPEAKE BAY OFFICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Mr. BAHNER. Mr. Chairman, and Mr. Schrock, I am Lowell Bahner, director of the NOAA Chesapeake Bay Office. Thank you for inviting me to testify regarding NOAA's role in supporting the Chesapeake Bay Program and the issue of modeling versus monitoring to evaluate progress in the restoration effort.

NOAA's role in the Chesapeake Bay Program derives from the agency's mission, the statutory mandate of the NOAA Chesapeake Bay Program and the Chesapeake 2000 agreement. As a partner in the Chesapeake Bay Program, NOAA works toward several specific commitments of the Chesapeake 2000 agreement. The Chesapeake Bay Program recently established a set of keystone commitments for bay restoration. I will discuss NOAA's lead role for four of those keystones.

First, by 2010, achieve a 10-fold increase in native oysters. NOAA is the lead Federal agency for Chesapeake Bay oyster restoration providing funding and technical assistance to large scale restoration and community efforts, hatchery infrastructure and applied disease research. The strategy for native oyster restoration continues to be refined based on evaluation of projects implemented to date.

In addition to restoration support, oyster disease research funding from NOAA Sea Grant continues to address disease management strategies, development of potentially disease resistant strains of native oysters, and evaluation of the possible introduction of alternative oyster species.

Second, by 2005, develop multi-species fishery management plans. Fisheries in Chesapeake Bay contribute significantly to U.S. catches at national and regional levels. Recent statistics indicate that an average of 600 million pounds of fish and shellfish with an estimated value of $156 million are commercially harvested from Chesapeake Bay each year. NOAA recently released a guidance document entitled Fishery Ecosystem Planning for Chesapeake Bay and is also developing an ecosystem-based fisheries model to support State and regional fishery managers in the development of new fishery management plans.

Third, for submerged aquatic vegetation, accelerate protection and restoration. The NOAA Chesapeake Bay Office began large scale submerged aquatic vegetation planting and research in 2003. NOAA awarded grants in fiscal year 2003 and fiscal year 2004 to establish pilot and large scale planting and restoration techniques for underwater grasses native to the various salinity regimes of Chesapeake Bay and its tidal tributaries.

Fourth, provide a meaningful bay or stream experience for all students in the watershed, beginning with the class of 2005. As the lead Federal agency for education in the Chesapeake Bay Program, NOAA coordinated the activities of the Chesapeake Bay Program education work group. The NOAA Bay Watershed Education and Training Program [B-WET] established in 2002, provides hands-on watershed education to students and teachers to foster stewardship of Chesapeake Bay. NOAA recognizes that environmentally aware citizens with the skills and knowledge to make well informed environmental choices are key to sustaining the Nation's ocean and coastal environments.

NOAA-wide investments: In addition to the programs of the NOAA Chesapeake Bay Program Office, NOAA provides a number of valuable products and services to address a broad range of bay user needs, including ensuring safe navigation and marine commerce, restoring habitats, improving the management of coastal resources, providing citizens with forecasts of wind, weather and water events, and protecting and restoring the bay's fisheries. NOAA has also afforded benefits to the Chesapeake Bay through strong partnerships with State and local government, academia, and private organizations.

Modeling versus monitoring in reporting progress: NOAA provides the EPA and Chesapeake Bay Program Office with data used to run the bay watershed pollutant loading model, including rainfall and precipitation data, meteorological data such as wind, temperature, humidity and solar radiation, remotely sensed chlorophyll information and an air deposition model. NOAA believes that both modeling and monitoring are important in reporting progress on bay restoration. Modeling provides a valuable tool for examining the potential impact of a given management scheme and looks back to understand what happened. Monitoring provides an ongoing means of accessing the net result of management actions, taking into account the natural variability in the environment and providing real world data for input back into modeling efforts.

This concludes my testimony Mr. Chairman, I will be happy to respond to any questions that you or members of the committee may have.

Chairman TOM DAVIS. Thank you very much. Mr. Phillips.

[The prepared statement of Mr. Bahner follows:]

TESTIMONY OF
LOWELL H. BAHNER
DIRECTOR
NOAA CHESAPEAKE BAY OFFICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE
COMMITTEE ON GOVERNMENT REFORM
U.S. HOUSE OF REPRESENTATIVES

Field Hearing on Progress Made in Safeguarding Chesapeake Bay

August 20, 2004

Mr. Chairman and Members of the Committee, I am Lowell Bahner, Director of the National Oceanic and Atmospheric Administration (NOAA) Chesapeake Bay Office. Thank you for inviting me to testify on NOAA's role in supporting the Chesapeake Bay Program and the issue of modeling versus monitoring to evaluate progress in the restoration effort.

NOAA has been a partner in the Chesapeake Bay Program since 1984, when the Northeast Regional Office of the National Marine Fisheries Service (NOAA Fisheries) first entered into a Memorandum of Understanding with the Environmental Protection Agency (EPA), establishing the participation of NOAA in the Chesapeake Bay Program. Between 1984 and 1991, NOAA Fisheries administered fisheries research and assessment grants, serving as chair of the Chesapeake Bay Stock Assessment Committee. The NOAA Chesapeake Bay Office was established through congressional authorization in 1992, beginning a new era of strengthened NOAA Bay Program involvement, including co-location of the new office and staff with the EPA-led Chesapeake Bay Program in Annapolis, Maryland. The NOAA Chesapeake Bay Office was reauthorized in 2002.

I am particularly pleased to be here representing NOAA. We in the NOAA Chesapeake Bay Office are proud not only of the programs we administer, but also of the broad range of science, service and stewardship activities represented by our agency at large. NOAA's missions in ecosystem management, weather and water, commerce and transportation, and climate all have applications in the context of Chesapeake Bay. We are continually looking for ways to improve our capabilities to meet the needs of the Bay and the region.

My testimony today will focus on the issues you requested in the letter of invitation: (1) NOAA's role in support of the Chesapeake Bay Program in its mission to clean up the Bay (particularly as it pertains to the Chesapeake 2000 Agreement) and (2) the issue of modeling versus monitoring as it relates to accurately reporting on progress. I will conclude with some remarks on emerging NOAA capabilities and programs that could further assist in restoring Chesapeake Bay.

NOAA's Role in the Chesapeake Bay Program

NOAA's role in the Chesapeake Bay Program derives from NOAA's mission as an agency, the statutory mandate for the NOAA Chesapeake Bay Program, and the Chesapeake 2000 (C2K) Agreement, whereby EPA is the signatory on behalf of the Federal partnership that includes NOAA. I will describe the specific programs and activities of the NOAA Chesapeake Bay Office as they relate to the C2K Agreement and briefly mention NOAA-wide programs that support overall Chesapeake Bay protection, restoration, and management.

As a partner in the Chesapeake Bay Program, NOAA works towards specific commitments of the C2K Agreement:

- By 2010, achieve, at a minimum, a 10-fold increase in native oysters
- Address exotic and invasive species, ballast water
- By 2003, revise fishery management plans for migratory fish
- By 2004, assess menhaden, oysters and clams
- By 2005, develop multi-species management plans
- By 2007, implement multi-species management plans
- For blue crabs, establish targets and manage species
- For submerged aquatic vegetation (SAV), accelerate protection and restoration
- For toxics, understand effects and impacts
- By 2003, assess effects of airborne nitrogen compounds
- For education, provide a meaningful Bay or stream experience for all students in the watershed, beginning with the class of 2005
- For community engagement, provide small watershed grants

The Chesapeake Bay Program recently established a set of "keystone commitments" for Bay restoration. NOAA is the lead for four of these keystones:

- By 2010, achieve, at a minimum, a 10-fold increase in native oysters
- By 2005, develop multi-species management plans
- For SAV, accelerate protection and restoration
- Provide a meaningful Bay or stream experience for all students in the watershed, beginning with the class of 2005

I will focus on these "keystone commitments" in describing the programs of the NOAA Chesapeake Bay Office.

Oyster Restoration/Non-native Oyster Research (By 2010, achieve, at a minimum, a 10-fold increase in native oysters)

NOAA is the lead federal agency for Chesapeake Bay oyster restoration, providing funding and technical assistance to large-scale restoration and community efforts, hatchery infrastructure, and applied disease research. Oyster restoration activities supported by the NOAA Chesapeake Bay Office are Bay-wide. The strategy for native oyster restoration continues to be refined based on evaluation of projects implemented to date. NOAA-sponsored oyster restoration in Virginia began in 1999, with approximately 350 acres of oyster grounds restored as of July 2004 in the Yeocomico, Coan River, Great Wicomico, Rappahannock, Corrotoman and Piankatank Rivers, and Tangier Sound. NOAA divers provide monitoring and assessment expertise to validate project results, and NOAA ship-based charting technology is being used to determine appropriate planting areas, bottom substrate types, and areas for reclaiming buried shell.

In addition to restoration support, oyster disease research funding from NOAA Sea Grant continues to address disease vector and management strategies, including development of disease diagnostic tools, development of potentially disease-resistant strains of native oysters, and evaluation of the possible introduction of alternative oyster species. Since 2002, the NOAA Chesapeake Bay Office has funded research on the non-native Asian oyster, *Crassostrea ariakensis*, proposed for introduction into Chesapeake Bay by the states of Maryland and Virginia. NOAA is a cooperating agency on the Environmental Impact Statement, led by the U.S. Army Corps of Engineers, to evaluate risks associated with potential *ariakensis* introduction. The NOAA Chesapeake Bay Office is also providing data management and geographic information system (GIS) support to provide comprehensive tracking and mapping of state and federal oyster restoration sites in the Bay.

Fisheries/Multi-species Management (By 2005, develop multi-species management plans)

Fisheries in Chesapeake Bay contribute significantly to U.S. catches at the national and regional levels. Recent statistics indicate that an average of about 670 million pounds of fish and shellfish are commercially harvested annually from Chesapeake Bay waters (1993-2003 average), with an average dockside value of more than $165 million per year. Maintaining the health of these fisheries is an important but difficult task given the inter-annual variability of each species, changes in ecosystem health, predator-prey interactions, and the multiple authorities responsible for fisheries management in the Chesapeake Bay region. Both federal and state agencies have responsibility for managing fisheries within the Bay. Maryland, Virginia, and the Potomac River Fisheries Commission are responsible for regulation of fisheries within their respective waters. However, a majority of stocks of individual species span all of these jurisdictions. Furthermore, migratory species that spend a portion of their life in coastal or oceanic waters are subject to Federal jurisdiction through either the Atlantic States Marine Fisheries Commission (within 3 miles of the coast) or the Mid-Atlantic Fishery Management Council (3 – 200 miles offshore).

The NOAA Chesapeake Bay Office chairs a Fisheries Steering Committee for Chesapeake Bay, composed of members from each of the Bay fishery management agencies in Maryland, Virginia, and Pennsylvania, the District of Columbia, the Potomac River Fisheries Commission, the Atlantic States Marine Fisheries Commission, the U.S. Fish and Wildlife Service, and the Chesapeake Bay Program. To meet the 2005 and 2007 goals for establishing multi-species fishery management plans, NOAA recently released a guidance document entitled "Fishery Ecosystem Planning for Chesapeake Bay" to provide state and regional managers with improved tools and technical advice for ecosystem approaches to fishery management. The NOAA Chesapeake Bay Office is also developing an ecosystem-based fisheries model to support fishery management decision making in the development of these new plans.

Submerged Aquatic Vegetation (SAV) Protection and Restoration (For SAV, accelerate protection and restoration)

In accordance with Congressional appropriations language, the NOAA Chesapeake Bay Office began large-scale SAV planting and research in 2003. NOAA awarded grants totaling $550,000 in fiscal year (FY) 2003 and $800,000 in FY 2004 to establish pilot and large-scale planting and restoration techniques for underwater seeds, shoots, and roots of grasses native to the various salinity regimes of Chesapeake Bay and tidal tributaries in Virginia and Maryland. Submerged aquatic vegetation is particularly sensitive to light conditions, with improved grass growth following periods when water clarity is greatest. Therefore, success of restoration efforts is contingent upon water quality in the Bay. As a result of being one of the wettest years on record, 2003 was a relatively poor year for water clarity, leading to a reported loss of nearly 30,000 acres of SAV bay-wide.

NOAA-funded research has identified techniques for large-scale seed harvest and successful storage, with the goal that SAV seeds for some species can be handled much like standard agricultural processes, with the difference that SAV seeds must be kept moist. Broadcasting of seeds has provided the best recent success for large-scale planting. Alternative planting techniques, such as mechanized planting from boats, have been less successful. Small-scale commercial operations are testing woven mats with SAV seeds in the weave. SAV restoration is a key component of successful shoreline restoration, providing a barrier to reduce wave action and trap sediment. SAV provide critical habitat for fish and shellfish, particularly for blue crabs during mating and molting.

Education (Provide a meaningful Bay or stream experience for all students in the watershed, beginning with the class of 2005)

As the lead federal agency for education in the Chesapeake Bay Program, NOAA coordinates the activities of the Education Workgroup. Much of the effort to meet the C2K commitment is supported through the NOAA Bay Watershed Education and Training (B-WET) Program, established in 2002. The B-WET Program provides hands-on watershed education to students and teachers to foster stewardship of Chesapeake Bay. NOAA recognizes that environmentally aware citizens with the skills and knowledge to make well-informed environmental choices are key to sustaining the Nation's ocean and coastal environments.

Using the environment to help advance student learning and problem-solving abilities has been shown to increase academic performance, enthusiasm for learning, and environmental stewardship. The main component of B-WET is a financial assistance program. The program provides competitive grants and technical support, facilitating meaningful watershed experiences for students and related professional development for teachers. Funding for the program grew from $1.2 million in 2002 to $2.5 million in 2004. In 2004, B-WET will reach an estimated 14,500 students and 3,300 teachers through 34 grants ranging from $10,000 to $200,000.

NOAA-Wide Investments

In addition to the programs of the NOAA Chesapeake Bay Office, NOAA has several other investments in the Chesapeake Bay region:

- The NOAA Restoration Center, within NOAA Fisheries, provides funding for community-based restoration. Habitat restoration projects typically include oyster reefs, SAV, tidal wetlands, riparian habitat buffers, fish blockage removals, "soft" erosion control measures, and beneficial use of dredged materials. Since 1997, 35 projects have been awarded and completed in Virginia, with NOAA support totaling over $750K. Thus far in FY 2004, 5 new projects totaling an additional $150K have been awarded. Projects include a ½ acre 3-dimensional oyster sanctuary reef in the Elizabeth River (1997), the Alexandria Seaport Wetland Restoration (2000-02), rebuilding the Paradise Creek Wetland of the Elizabeth River (2002), Back Creek Eelgrass Restoration offshore of Langley Air Force Base (2000), and the Lynnhaven River Oyster Restoration and Plan (2001).
- NOAA's Ocean Service, including the Center for Operational Oceanographic Products and Services, National Geodetic Survey, National Centers for Coastal Ocean Science, Coastal Services Center, Office of Coast Survey, Office of Ocean and Coastal Resource Management, and Office of Response and Restoration invested over $11.8 million in FY 2003 towards provided funding for research, restoration, environmental monitoring, nautical charting, and coastal management activities.
- NOAA Research provides funding for air research, habitat and fisheries interactions, and ballast water and invasive species research, and supports the Maryland and Virginia Sea Grant programs.
- NOAA's National Weather Service provides weather forecasts, flood watches/warnings, and low-flow predictions.
- NOAA Satellites provides satellite remote sensing services, including information on sea surface temperatures.
- NOAA's Ships and Aircraft provide support for research, coastal mapping, and hydrographic surveys of Chesapeake Bay.

As illustrated by this investment portfolio, NOAA provides a number of valuable products and services to address a broad range of Bay user needs, ensuring safe navigation and marine commerce, restoring habitats, improving the management of coastal resources, providing citizens with forecasts of wind, weather, and water events, and protecting and restoring the Bay's fisheries. NOAA has also afforded benefits to Chesapeake Bay through strong partnerships with state and local government, academia, and private organizations.

Modeling vs. Monitoring in Reporting Progress

Regarding the issue of modeling versus monitoring in reporting on progress in the Bay restoration, NOAA believes that both are important. Modeling provides a valuable tool for examining the potential impact of a given management scheme (forecasting) and looking back (or hindcasting) to understand what happened. Monitoring provides an ongoing means of assessing the net result of management actions, taking into account the natural variability in the environment, and providing real-world data for input back into modeling efforts.

The individual measurements from monitoring give us a snapshot of the environment experienced by the living resources, a "point in time" basis for evaluating water quality at a given location. When these snapshots are combined spatially and temporally, we are able to identify trends and interpret the data, drawing inferences between management actions and water quality results. However, there are many factors to be taken into account in our analyses of the observed data to explain such results, and models provide a means to quantify these factors and then hind- and forecast observed conditions.

Modeling in the Bay is also important because the response to nutrient inputs observed in deep water (anoxia) is actually caused by phytoplankton production taking place in the shallows, which is transported to the deep water by various mechanisms. Research is adding a lot to our understanding of and modeling of these mechanisms, so that we can better interpret our observed data in terms of cause and effect and in terms of progress. We depend on models to translate current conditions and management actions into future conditions. But models are only as good as the information used to develop them – we are still short of understanding many processes and are lacking data on many of the current inputs. Therefore, it is important that we rely on both monitoring and modeling as we evaluate progress in the clean-up of Chesapeake Bay.

NOAA provides the EPA Chesapeake Bay Program Office with data used to run the Bay watershed (pollutant loading) model. Specifically, NOAA provides:

- Rainfall/precipitation data from NOAA's National Weather Service
- Winds and other meteorological products (temperature, humidity, solar radiation, etc) from National Weather Service stations
- Remotely sensed chlorophyll information from NOAA Satellites (NESDIS)
- Living resource data (quantities and locations)
- An air deposition model (developed by NOAA's Air Resources Laboratory at Research Triangle Park)

Over the last decade, the NOAA Air Resources Laboratory has led a multi-organizational effort to assess the role of atmospheric deposition on the water quality of Chesapeake Bay and its tributaries. The work has brought together studies by NOAA and EPA, with an emphasis on nitrogen and mercury. Atmospheric deposition of compounds of nitrogen, resulting from power production, automobiles, and a variety of other activities (including farming), amounts to more than 25 percent of the input of nitrogen nutrients into the Bay water body. Most of the mercury that affects the Bay is derived from atmospheric deposition. There are significant potential implications for human health as a result of the bioaccumulation of mercury in the flesh of edible fish. For this reason, NOAA scientists from several of the agency's line offices have joined forces to coordinate a NOAA-wide mercury program.

NOAA meteorology, rainfall, water level information, and living resources data (quantities and locations) are used in the Chesapeake Bay hydrodynamic and water quality model developed partly run by the U.S. Army Corps of Engineers and also run by a scientist from the University of Maryland, Center for Environmental Science, at the Chesapeake Bay Program Office.

The NOAA Chesapeake Bay Office is funding the Chesapeake Research Consortium (comprised of Bay academic institutions) to develop the next generation of a "community model" for Chesapeake Bay, engaging the expertise of the academic research community. A product under development from this effort is a hydrodynamic model that simulates the dispersion of oyster larvae to predict where the larvae might set as oysters. The tool is being designed to meet the oyster larvae tracking needs of stakeholders making oyster management decisions for Chesapeake Bay. It should also prove useful in support of the Environmental Impact Statement for potential introduction of *ariakensis*. The model may also provide improved prediction for movement of oil or contaminant spills.

As I previously stated, the NOAA Chesapeake Bay Office is developing and testing a food web model for the Chesapeake Bay ecosystem to help state resource managers evaluate proposed management alternatives. While not directly linked to the U.S. Corps of Engineers water quality model, this model provides capability to link nutrients to phytoplankton growth as a driver of fish populations. This model is also being developed to examine spatial considerations of fisheries management, including the feasibility and efficacy of spatially oriented management schemes, for example, reserves and sanctuaries. It can also be used to examine different fishery management scenarios and their associated economic, social, and ecological consequences.

Emerging NOAA Capabilities to Further Support Chesapeake Bay Restoration

In my introductory remarks, I indicated I would conclude with some remarks on emerging NOAA capabilities and programs that could further assist in restoring Chesapeake Bay. As you are likely aware, the Preliminary Report of the U.S. Commission on Ocean Policy outlines a number of recommendations for improving the stewardship of the Nation's coastal and ocean resources. The Preliminary Report concludes that implementation of an Integrated Ocean Observing System (IOOS) must be a priority, stating that *"High quality, accessible information* *is critical to making wise decisions about ocean and coastal resources and their uses to guarantee sustainable social, economic, and environmental benefits from the sea."* [page xiii]

The tools and capabilities provided by IOOS will help us to address many needs, including the ability to:

1. Improve prediction of weather as well as climate change and variability and their impact on coastal communities and the nation;
2. Improve the safety and efficiency of marine operations;
3. More effectively mitigate the damaging effects of natural hazards;
4. Improve national and homeland security;
5. Reduce public health risks;
6. More effectively protect and restore healthy coastal marine ecosystems; and
7. Sustain use of marine resources.

The NOAA Chesapeake Bay Office began funding the deployment of remote sensing buoys and fixed sensor packages in Maryland and Virginia in 2003 for real-time monitoring of water quality and physical parameters as part of the development of the Chesapeake Bay Observing System (CBOS). One of NOAA's interests in monitoring is to install sensors in close proximity to restoration areas for submerged aquatic vegetation and oysters, to provide environmental data for evaluating the restoration program. Real-time sensors installed by NOAA's Ocean Service and National Weather Service provide data on tides, currents, winds, and waves that are widely used by recreational and commercial boaters. Predicted (model generated) winds and currents are used for gaining competitive advantage in sailboat races and for setting the starting times for the Great Bay Swim.

A second area of potential is improved application of NOAA's Coastal Zone Management Program and Estuarine Research Reserves System. In particular, these programs have developed communication tools that provide local decision makers with a better understanding of how their actions fit into the larger Bay watershed. An example is the Nonpoint Education for Municipal Officials (or NEMO) program, developed initially at the University of Connecticut as a collaboration between the Cooperative Extension System, the Natural Resources Management and Engineering Department, and the Connecticut Sea Grant College Program. NEMO is an educational program that links land use to water quality. It is built around GIS images of natural resources and remote sensing-derived images of land cover. Because the local land use decision-making process is complex, political, and widely varying, NEMO provides research-based, non-advocacy, outreach as a means to foster better land use decisions.

This concludes my testimony, Mr. Chairman. I will be happy to respond to any questions that you or members of the Subcommittee may have.

STATEMENT OF SCOTT PHILLIPS, CHESAPEAKE BAY COORDINATOR, U.S. GEOLOGICAL SURVEY

Mr. PHILLIPS. Mr. Chairman and Congressman Schrock, thank you for the opportunity to testify about the progress in safeguarding the Chesapeake Bay. My name is Scott Phillips, I am the Chesapeake Bay coordinator for the U.S. Geological Survey. This morning my testimony will focus on the role of the USGS in providing science to the bay program, and how the USGS science is used to report water quality progress.

Since the formation of the Chesapeake Bay Program in 1983, the USGS has performed a critical role of providing unbiased scientific information that is used by our bay program partners to help understand and restore the bay and its watershed. More recently, findings from the USGS have been used by the bay program partners to help formulate approaches to meet and evaluate the restoration goals in the Chesapeake 2000 agreement.

Over 40 USGS scientists located in offices throughout the bay watershed are involved in conducting studies. These scientists directly interact with our partners to present and explain the results of these investigations.

Now, let me talk more specifically about the use of USGS science in the issue of modeling and monitoring to assess water quality progress. One of the primary goals of the Chesapeake 2000 agreement is to reduce the pollution that enters the bay to improve conditions by 2010. Each year the bay program partners monitor the major pollutants—nitrogen, phosphorus and sediment—that are in the rivers and tidal waters. The monitoring data are used with modeling results to help the bay program partners assess progress in meeting the water quality goals of Chesapeake 2000.

USGS, in cooperation with our partners, monitors water quality at nine principal rivers that enter the tidal portion of the bay watershed. At each of these nine river input sites which are shown here on this map, the USGS has monitored the levels of river flow and nutrient and sediment concentrations in each of these rivers. This information is used to determine the amount or loads of nutrients and sediment that enter the tidal waters. Results show that in 2003, the nutrient loads were the second highest since monitoring began in 1980's, that can be seen on this bottom graph. The loads of nutrients at these sites have been affected by yearly changes in river flows and changes in nutrient concentrations.

In just the last few years, the river flow and nutrient loads have varied from near record lows due to drought conditions in 1999 through 2002 to near record highs in 2003. The higher nutrient loads in 2003 are related to increased rainfall and higher nutrient concentrations due to runoff in this very wet year. The changes in load have a very real impact on the bay, these increased loads on 2003 contribute to large areas of low dissolved oxygen levels and a decline in underwater grasses in the bay. These changes in yearly loads, which are driven partially by weather conditions, suggest a lack of progress in reducing pollutants to the bay.

The USGS has developed statistical techniques to compensate for these natural changes in river flow, so we can better understand progress related to management actions. Using these techniques results from the nine river input sites show improvements in nitrogen and phosphorus concentrations at about half of these sites. There were declines in total nitrogen concentrations at four rivers including the Susquehanna, Potomac and James, which comprise almost 90 percent of the river flow that enters the bay. Total phosphorus concentrations also declined at two sites, including the Susquehanna and James.

There has been some question about the use of the Chesapeake Bay Program Watershed Model to evaluate progress in reducing loads to the bay. The model progress runs were not intended to reflect these annual changes in nutrients and sediment loads. They focus more on the average river flow conditions to predict load reductions. When the results of the model progress runs are compared to the flow adjusted trends in the rivers, there is general agreement about the progress in pollution reduction.

In conclusion, the watershed model is a critical tool to predict load reductions to the bay. The bay program has utilized new scientific findings on the effectiveness of management actions to improve these predictions. Further the bay program partners, including the USGS, are making enhancements to current models to produce an improved version that incorporates additional data on river flow, water quality, and other watershed processes. Ultimately, evaluating progress will be based primarily on monitoring data. The USGS and the bay program partners are working to increase the amount of monitoring and interpretation of water quality conditions in the bay and its watershed.

Additionally, USGS is working to better document the human activities and natural factors that impact water quality, fisheries and migratory birds that depend on the bay. We face a huge challenge in restoring the Chesapeake Bay. There will be a critical need for increased monitoring and research to understand the progress from restoring the Nation's largest estuary.

Mr. Chairman, the USGS appreciates your continued interest in the Chesapeake Bay Program. I will be pleased to answer any questions.

Chairman TOM DAVIS. Thank you very much. Ms. Swanson.

[The prepared statement of Mr. Phillips follows:]

STATEMENT OF
SCOTT W. PHILLIPS
CHESAPEAKE BAY COORDINATOR
U.S. GEOLOGICAL SURVEY
U.S. DEPARTMENT OF THE INTERIOR
BEFORE THE
COMMITTEE ON GOVERNMENT REFORM
HEARING ON "SAFEGUARDING THE CHESAPEAKE BAY"

Mr. Chairman and Members of the Committee, thank you for the opportunity to participate in this hearing about progress in safeguarding the Chesapeake Bay. My name is Scott Phillips and I am the Chesapeake Bay Coordinator for the U.S. Geological Survey (USGS). This morning my testimony will focus on the role of USGS in providing data and analysis to the Chesapeake Bay Program (CBP), how USGS science supports water quality goals of the Chesapeake 2000 agreement, and the use of USGS science in the issue of modeling versus monitoring as it relates to accurately reporting water quality progress.

USGS role in providing data and analysis to the Chesapeake Bay Program
Since the CBP started in 1983, the USGS has performed the critical role of providing unbiased scientific information that resource managers use to help understand and restore the Bay and its watershed. The USGS provides a combination of research, monitoring, modeling, and coordination with the partners in the CBP and the Department of the Interior (DOI). Findings from the USGS have been used by the CBP partners to help formulate approaches to meet and evaluate progress towards the restoration goals established in the Chesapeake 2000 agreement. To support the technical needs of the Chesapeake 2000 agreement, USGS scientists work:
(1) To improve watershed and land-use data and analysis.
(2) To understand the sources and impact of sediment on water clarity and biota.
(3) To enhance the prediction, monitoring, and understanding of nutrient and contaminant delivery to the Bay.
(4) To assess the factors affecting the health of fish, wildlife, and their habitats.
(5) To synthesize information and enhance decision-support tools to communicate results.

Over forty USGS scientists located in offices throughout the Bay watershed and at the CBP office in Annapolis, Maryland, are involved in studies and information dissemination to support the technical needs of the CBP partners. USGS interacts directly with CBP partners through active participation in the monthly meetings of all technical subcommittees of the CBP. Additionally, USGS results are disseminated through published reports and journal articles, as well as through Internet GIS-based data delivery and decision-support models and tools that are integrated with the CBP Chesapeake Information Management System (CIMS). The USGS Chesapeake Bay Studies depend on the coordination of multiple USGS programs that have a scientific interest in the Bay.

How USGS science supports water quality goals of the Chesapeake 2000 agreement
One of the primary goals of the Chesapeake 2000 agreement is to reduce the amount of nutrients and sediment that enter the Bay to improve dissolved oxygen, water clarity, and chlorophyll-*a*

conditions to help restore the Bay ecosystem by 2010. The USGS has worked closely with the CBP partners: (1) to help develop water quality criteria for the Bay; (2) to analyze management strategies to reduce nutrients and sediment; (3) to monitor water quality in the Bay watershed and the principal rivers entering the Bay; (4) to compute annual changes in water quality; (5) to understand the factors affecting water quality changes; (6) to develop approaches to document water quality and living-resource conditions in the Bay and (7) to assess progress in restoring water quality. The water quality information from the watershed is used in conjunction with tidal monitoring data and CBP model results to help assess progress towards meeting the water quality criteria by 2010. The information provided by the USGS and many other CBP partners and universities has allowed for an adaptive management approach to restoration by setting and revising goals as scientific information improves the understanding of the ecosystem and the effectiveness of management strategies. The USGS has worked with the CBP partners to utilize both monitoring information and model results to address these issues.

The USGS was involved in several of the technical workgroups that developed water quality criteria to protect living resources in the Chesapeake Bay. The workgroups were organized by the CBP to review and utilize monitoring data, modeling results, and other data to develop the dissolved oxygen, water-clarity, and chlorophyll-*a* criteria. The water quality criteria guidance was published in April 2003 and is available on the following website: http://www.chesapeakebay.net/baycriteria.htm. The guidance is intended to assist the multiple jurisdictions in the Bay watershed (Maryland, Virginia, Delaware, and the District of Columbia) in adopting revised water quality standards to address nutrient- and sediment-based pollution in the Chesapeake Bay and its tidal tributaries.

In 2003 and 2004, the CBP used a Watershed Model to help set nutrient- and sediment-reduction allocations that were needed to help meet the water quality criteria. The model provided predictions of the amount of nutrient and sediment reductions that could be accomplished by different management strategies in States throughout the watershed. The States worked closely through the CBP to formulate management strategies to achieve their respective nutrient- and sediment-load reduction allocations. The USGS developed complimentary watershed models to help further identify high nutrient source and delivery areas to the Bay. The USGS has worked to provide information to help State and local jurisdictions target areas where the nutrient- and sediment- reduction actions could be implemented.

The USGS, in cooperation with State agencies, has the important role of monitoring the nine principal rivers that enter the tidal portion of the Bay watershed. Through the River-Input Monitoring project, the USGS has established nine monitoring sites that collectively represent 78 percent of the area of the Bay watershed. The remaining portion of the watershed is difficult to monitor due to the influence of tides in these rivers, which prevent accurate measures of river flow. The monitoring sites are located at the head of tide on the Susquehanna, Potomac, James, Rappahannock, Appomattox, Pamunkey, Mattaponi, Patuxent, and Choptank Rivers (see map below). Sampling of some of the rivers began in 1979, with sampling for all rivers implemented by 1990. At each site, the USGS measures the amount of river flow and collects between 15 and 30 samples each year that are analyzed for the concentrations of nutrients and sediment. The information is used to compute the amounts of nutrient and sediment (known as loads) that enter the tidal portion of the bay watershed and also document water quality changes over time to help assess the effectiveness of management actions in the nontidal portion of the watershed.

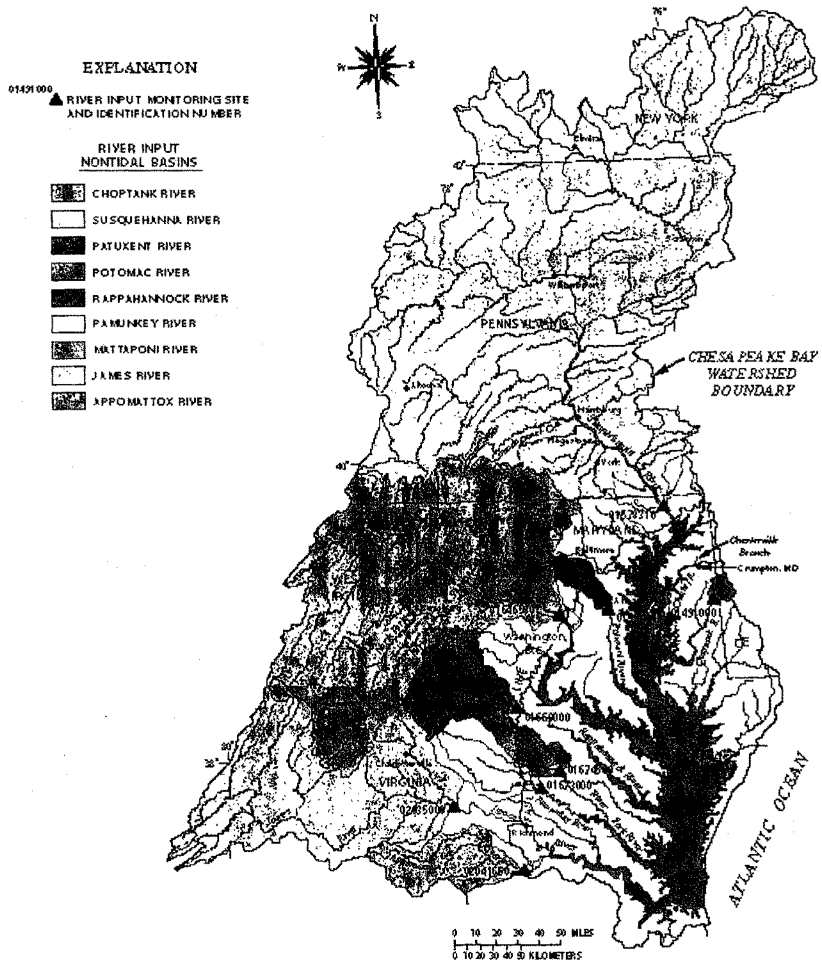


Figure 1. Map of Chesapeake Bay watershed and Chesapeake Bay River-Input Monitoring Program site basins.

In addition to the River-Input sites, the USGS compiled and analyzed data from another 1,000 sites in the Bay watershed. In the mid-1990s, the USGS worked in partnership with the CBP to develop a database of all the nutrient and sediment data collected by various agencies in the Bay watershed. Evaluation and analysis of data from 25 key sites that were selected by the States and the River-Input sites are conducted each year and shared with the CBP partners through several technical meetings and workshops.

Another important role for the USGS is identifying the factors affecting changes in water quality in the Bay watershed. From 1997 to 2000, the USGS conducted a joint project with the CBP to use the Watershed Model to help interpret water quality changes at River-Input Monitoring project sites. The Watershed Model results, USGS trend tests results, and additional data sets showing changes in nutrient sources proved to be valuable tools to help understand the changes in water quality. The study revealed that a combination of natural factors and human activities affected water quality conditions at the River-Input sites. Natural factors included variability of rainfall and streamflow, seasonal temperature changes, and watershed characteristics such as soils and the influence of ground water. Factors related to human activities included the amount of nutrients and sediment discharged into the watershed from both point sources, usually municipal and industrial treatment plants, and nonpoint sources, generally related to air deposition and urban, suburban, and agricultural activities. Another important human factor was the effectiveness and implementation of management practices to reduce contributions from these sources. This study and additional USGS studies on groundwater suggest that some of these factors result in a "lag time" between implementation of management practices to reduce nutrient and sediment sources and improvements in water quality. For these reasons, the USGS reported in 2003 that achieving the new water quality criteria for dissolved oxygen, water clarity, and chlorophyll-*a* criteria in the Bay by 2010 would be very difficult. Resource managers are using this information to consider increasing the rate of implementation of practices to reduce nutrients from all sources, particularly point sources from municipal treatment plants, as well as agricultural and urban sources.

Use of USGS Science in the Issue of Modeling and Monitoring to Assess Water quality Conditions and Progress

Each year, results from monitoring of rivers in the Bay watershed are used with other data from the monitoring of tidal waters and living resources and modeling results to help the CBP partners assess progress in meeting the water quality goals of Chesapeake 2000. Information is analyzed to assess the factors affecting changes in both the water quality criteria (dissolved oxygen, water clarity, and chlorophyll-*a*) and the amount of nutrient and sediment entering the Bay. The information is synthesized by the CBP and presented in annual updates and in the "State of the Bay" report that is published every two years.

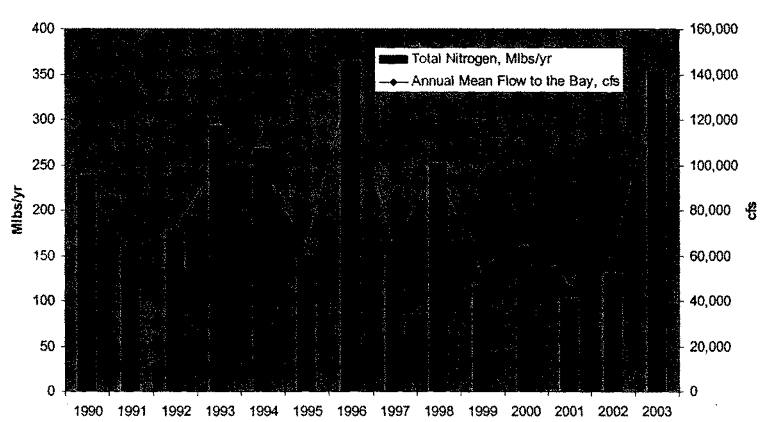
Prior to the Chesapeake 2000 agreement, CBP had adopted the goal of reducing the loads of nutrients entering the Bay by 40 percent by the year 2000. At that time, actual water quality criteria for the Bay had not yet been developed. The two primary tools that were used to evaluate the reduction of nutrients entering the Bay were the Watershed Model "progress" runs, and monitoring of nutrients at the USGS River-Input sites. Both of these tools used approaches to compensate for the large yearly changes in river flow that affect nutrient concentrations and loads to the Bay in order to make a more direct evaluation of the effectiveness of management actions.

Results from both the Watershed Model progress runs and the USGS River-Input sites indicated that management actions have resulted in progress in reducing the flow of nutrients to the Bay. Analysis of concentration data from nine River-Input sites, using statistical techniques that compensate for the influence of river flow, show improvements in nitrogen and phosphorus at about half of the sites. Between the late 1980s and 2003, a decline in nitrogen concentrations occurred at four sites, statistically significant trends could not be detected at four sites, and one site had an increasing trend. Declines in total phosphorus concentration occurred at four sites, statistically significant trends could not be detected at two sites, and three sites had an increasing trend. Notably, the nine rivers vary greatly in size and the concentration reductions for nitrogen were seen in three of the largest rivers (Susquehanna, Potomac, and James) that comprise the majority (about 90 percent) of the river flow from the River-Input model Stations. Declines in phosphorus concentrations were detected in two of these large rivers (the Susquehanna and James). Results for estimates of load reductions from the Watershed Model are not available for 2003; however, analysis of data from years when results of both the Watershed Model progress runs and the USGS River-Input Sites are available and show general agreement of the results at the majority of the sites.

Since the Chesapeake 2000 agreement, there has been more focus on assessing progress in meeting the water quality criteria in the tidal areas of watershed and not just addressing progress in reducing nutrients in the Bay. Therefore, additional approaches are being developed to evaluate the annual changes in river flow, load, and concentration of nutrients in the Bay and relate them to changes in tidal waters. Evaluating and synthesizing the information to report progress in restoring the Bay and its watershed is a challenging task because there are multiple natural and human-induced factors that need to be assessed. In some cases, there is not a clear scientific understanding of how the interrelation of multiple factors affects water quality and living resources in the Bay and its watershed. For example, there are multiple factors in addition to water clarity that affect the amount of submerged aquatic vegetation in the bay.

Additional results from the USGS River-Input sites that are now emphasized to support assessment of progress in meeting the water quality goals of Chesapeake 2000 include the amount of river flow and the loads and observed concentrations of nutrients that enter the tidal waters of the Bay watershed each year. Results from the USGS River-Input sites showed that in 2003 the nutrient loads were the second highest since 1990 (see graph below for nitrogen loads and river flow). Analysis of the load of nutrients to the Bay from the major rivers is complicated by recent variations in river flows, which reflect year-to-year variations of weather in the Chesapeake Bay watershed. In just the last few years, the river flow into the Bay has gone from near-record lows due to the drought conditions from 1999-2002, to near-record highs in 2003. As a result of these natural variations, nutrient loads and concentrations have fluctuated, and after four years of very low amounts of nutrient inputs in 1999-2002, 2003 saw much higher nutrient loads. The high input rate of nutrients in 2003 is related to the high rates of runoff in this very wet year. These increased nutrient loads resulted in near-record, low dissolved oxygen levels in the Bay during the summer of 2003, and poorer water clarity that contributed to a decline of submerged aquatic vegetation (SAV).

Load Estimates for Total Nitrogen at the River Input Stations



The Watershed Model progress runs were not intended to reflect these annual changes in nutrient loads. They focus more on the long-term average river flow conditions to predict future load reductions. When large fluctuations in the nutrient load and water quality conditions occur from year to year, such as between 2002 and 2003, the amount of "progress" being made to restore water quality in the Bay appears to falter. These water quality variations, driven by weather variations, suggest a lack of progress. However, when the data are adjusted to account for these year-to-year weather-driven variations, the monitoring results are generally in agreement with the Watershed Model. They both point towards some improvement over time. However, very wet years such as 2003, and potentially 2004, can result in real problems for the Bay.

Conclusion

Because variable weather and other natural factors cause significant swings in sediment and nutrient loads from year to year, statistical adjustments based on models are necessary to identify trends in water quality in the Chesapeake Bay. We continue to believe that the river input monitoring data, coupled with statistical methods aimed at compensating for flow variations, indicate overall progress in improving the Bay's water quality. Wet years such as 2003 and possibly 2004 cause apparent reversals of the general trend, however. The Watershed Model is a critical tool to relate nutrient sources, effectiveness of implementation practices, rainfall, river flow, and watershed characteristics to simulate and predict nutrient- and sediment-load reductions to the Bay. The CBP has utilized new scientific findings on the effectiveness of management actions to improve these simulations. Further, the CBP partners, including the

USGS, are making enhancements to the current model to produce an improved model (Phase V) that incorporates additional data on river flow, water quality, and other watershed processes.

The Watershed Model progress runs are one of the tools that provide estimates of the amount of progress in reducing nutrient loads in the Bay. Ultimately, the evaluation of success of efforts to restore water quality in the Bay and its watershed will be based primarily on monitoring data. The CBP partners, including USGS, are working to increase the amount of monitoring and associated data analysis to improve the assessment of progress in restoring water quality and living resources in the Bay and its watershed.

Thank you, Mr. Chairman, for the opportunity to present this testimony. I will be pleased to answer questions you and other Members of the committee might have.

STATEMENT OF ANN PESIRI SWANSON, EXECUTIVE DIRECTOR, CHESAPEAKE BAY COMMISSION

Ms. SWANSON. Chairman Davis, Congressman Schrock, thank you very much for the honor to be here. My name is Ann Pesiri Swanson, and I have worked for more than two decades on Chesapeake Bay, having served for the last 16 years as executive director of the Chesapeake Bay Commission. I would like to first thank you for recognizing the Commission as a very different entity than my colleagues.

Your committee has asked us to provide a summary of current legislation and regional cooperation and the role of the Chesapeake Bay Commission in bringing those constituent legislators together. On that note, let me say that we do serve to represent the legislative branch of the Chesapeake Bay Program, with the colleagues of course representing the executive branch.

It is within that rubric of legislation that we have done most of our work, and I have submitted to you for the record a summary of the past 20 years of legislative accomplishments. I hope that you will take as a compendium of our efforts which have in fact been very substantial. Of course, the question here is have they been enough. And that is what I would like to address today. Because at the end of the day despite these two decades of legislative effort, the restoration does indeed continue to stall.

Reductions in nutrient loads both above and below the fall line have yet to translate into measurable increases in the concentration of dissolved oxygen in the main stem of Chesapeake Bay. This is not due to lack of effort, it really is testimony to how much more needs to be done, because of some very unique characteristics of the Chesapeake itself.

I do not think that it is responsible if I do not began by recognizing a very significant physical feature of the bay which makes it worldwide, very unique. And that is its vulnerability, the land to water ratio in the Chesapeake Bay region is actually the highest of any water body on Earth. What that means is that the bay itself is extremely shallow. That is both its greatest flaw and its greatest attribute. The attribute because if you are shallow you can allow light to penetrate and where there is light there is productivity. The vulnerability lies in the fact that an enormous watershed, 64,000 square miles drains into that extremely shallow body of water with a mere 18 trillion gallons of water. The result is that what you do on land is inextricably linked to the water. The result is when there is high rainfall, lots of non-point source pollution, lots of nutrients, lots of sediment, come off that land and are expected to be diluted by a very shallow body of water, which in fact is impossible.

So, despite the fact that we have enacted just a plethora of laws at the State and the Federal level they do not seem to be able to keep pace with the shallowness. Does that say we give up, no. What it says is we need more laws more regulations and we need more money coming into the bay to essentially counter this unique physical feature that makes the bay the most productive body of water, estuarine water, on Earth.

The second thing I would like to make a point about has to do with the modeling versus the monitoring. Monitoring has always been the Chesapeake Bay Commission's determinant of success and it will continue to be so. But, the models allows us to predict the potential impact of some of the policies that we consider. And in fact, the model tells us the good news which may lie ahead if we take certain strident actions. But the monitoring essentially tempers us and tells us you better keep trying.

And so, I just want to make the point that we do in fact use the predictive capabilities of the model in a very valuable way. In fact, right now we are using the model combined with a very serious data bank of cost to look at cost effectiveness, to determine not only where are the best investments in State policy but also, where are the best investments and the largest bang for your buck at the Federal level.

Let me then speak to the Federal level opportunity. Essentially we know what to do in the Chesapeake Bay Region. We are unique in that regard, we have already planned the course and the course is an outstanding one. Complex? Yes. Difficult to achieve? Yes. Doable? Yes, but only with the proper policies and dollars. At the Federal level there are some extremely significant things that you can do to help. And let me say right here that while I believe we can protect Chesapeake Bay and while I believe it is possible I must say that I do not believe it is possible at simply the State and local level. I believe that leadership has to come from all three.

So, in closing let me point out just four areas where I think the Congress deeply can help. One, is through your appropriation process. We have outlined through the Chesapeake Bay agreements some very real opportunities in water quality, land conservation, living resources and environmental education. And the dollars that you provide to the bay region have indeed really provided for much of its success. They are catalysts for State action, and without them I do not believe we would have made the progress.

The second thing really has to do with point sources. The point sources are the more sure fire bet of reducing pollution. What you get out of the pipe is out the pipe and out of the pollutant load. And anything that you can do to pump dollars into those sewage treatment plants to achieve nitrogen removal. We are one of the few places in the United States, ways to do that along the Tampa Bay and Long Island Sound, would be most helpful and I call your attention to Blue Plains. Blue Plains is the largest sewage treatment plant in the world, and if we do not pull that up to state-of-the-art, we are missing an opportunity. The district cannot do it alone.

The third, is the farm bill, please sit down with us on the 2007 farm bill and really analyze those areas of the farm bill where we can really make a difference in terms of water quality improvement. They are there, they are profound and with the agriculture committing a full third of the pollutant load to the Chesapeake Bay, it is an opportunity that is hanging out there and if we miss it, we miss the opportunity to protect the bay.

And finally, it is really you that sit on the Surface Transportation Act, it is you that then sit on the integration and the final recognition that stormwater is a component part of impervious surface. There are opportunities to change the way we grow in terms of transportation and I deeply encourage you to look at that.

So, in closing let me say you began by saying let us clear the air and clear the water. The Clean Air Act and the Clean Water Act are two pieces of law that really do affect the Chesapeake Bay Region. They present very real congressional opportunities to make a difference, and I offer the Commission and the Commission's staff to you and to your staff to try and make improvements to those bodies of law. Thank you very much for this opportunity to testify.

Chairman TOM DAVIS. Thank you all for your testimony.

[The prepared statement of Ms. Swanson follows:]

Testimony of
Ann Pesiri Swanson
Executive Director
Chesapeake Bay Commission
before the
Committee on Government Reform
U.S. House of Representatives
Field Hearing on "Safeguarding the Chesapeake Bay"
Hampton, Virginia

August 20, 2004

Chairman Davis, Congressman Schrock, members of the Committee, thank you for this opportunity to testify before you today. My name is Ann Pesiri Swanson. I have worked on Chesapeake Bay restoration for more than two decades and have served for the last 16 years as Executive Director of the Chesapeake Bay Commission. It is in this capacity that I share the Commission's perspective on the status of the Chesapeake Bay restoration and offer some ideas as to how best the U.S. Congress can contribute to the campaign's ultimate success.

Let me say right upfront that without enhanced state and federal support, in both dollars and policy, we do not believe that the Bay's health can be restored. Federal interest and funding has served a catalytic role for action in the region. Thus, garnering increased financial support (at both the state and federal levels) has been and remains a principal focus of the Commission's work.

In order for you to place my comments in a context, allow me to provide for the record a description of the Chesapeake Bay Commission, its composition and its work:

Like my colleagues on the panel, the Commission is a partner in the Chesapeake Bay Program – one of six signatories to the agreements that make up its leadership. What makes the Commission unique is the simple fact that it is not an Executive Branch agency and not of a single state, but instead provides a regional voice for the legislature within the Program.

The Chesapeake Bay Commission is a tri-state legislative commission, established in 1980 prior to the creation of the Chesapeake Bay Program, to advise the members of the general assemblies of Maryland, Virginia and Pennsylvania on matters of Baywide concern. The catalyst for our creation was the Environmental Protection Agency's (EPA) landmark seven-year study (1976-1983) on the decline of the Chesapeake Bay. Congressional concern prompted our beginnings and has since contributed handsomely to our success.

Twenty-one members from three states define the Commission's identity and its workload. Fifteen are legislators, five from each member state. Completing their ranks are the governors of each state, represented by cabinet members who are directly responsible for managing their states' natural resources, as well as three citizen representatives who bring with them a unique perspective and expertise. Hardly a piece of Bay-related policy or legislation -- delving into matters of air, land, water, living resources and the integrated management of all of them -- has come to pass in the past two decades without the Commission's involvement.

Your subcommittee has asked me to provide a "summary on the current state of the Bay, particularly regional cooperation and the role of CBC in bringing together its constituent legislatures to address Bay issues." I have attached to my testimony a list of legislative accomplishments spanning the last 20 years of our work. I ask you to accept this compendium of legislation as testimony to our efforts. Yet, on the same note, I must also emphasize that this body of law only partially addresses the Bay's problems. To complete the list we fully realize that we will have to conquer even tougher legislative and financial challenges, ranging from agriculture to stormwater, point sources to forests, air to sprawl.

The efforts to date have been substantial. Yet, despite two decades of exemplary effort, restoration continues to stall. Reductions in the nutrient load, both above and below the fall line, have yet to translate into measurable increases in the concentration of dissolved oxygen in the mainstem of Chesapeake Bay. Whether from Congressmen like you, state legislators like my bosses or the press corps, the question remains the same: *Why so little improvement?*

Many of the preceding speakers have addressed this point quite thoroughly. Groundwater lag time, weather variability, lack of funding and enforcement power and the sheer size of the watershed all factor in to the equation. Still, there are a few points that I would like to add that do not seem redundant.

My first point deals with the Bay's vulnerability.

Chesapeake Bay is a truly unique ecosystem with two defining characteristics. First, it is a remarkably shallow body of water, averaging 21 feet in depth; it is this shallowness and the ability of the light to penetrate to the bottom that gives the Bay its immense productivity. The second is the massive size of the watershed draining into this shallow tidal system -- 64,000 square miles flowing through 110,000 miles of streams and rivers, some of which are themselves enormous tidal estuaries. Together these characteristics give the Bay a ratio of land area to water volume that is an order of magnitude greater than the next closest body of water on earth.

Quite simply, the Bay's land to water ratio is its Achilles heal. What happens on the land will always define the quality of the water. While 60 percent of the watershed remains forested, the remaining land is characterized by both extensive and intensive farming and a highly urbanized population of 16 million people living and working in the basin. These characteristics make pollution control strategies extremely difficult and complex, and provide some insight into the difficulties inherent in forecasting their effectiveness.

This provides segue to my second point: the relationship between and importance of *both* modeling and monitoring.

Monitoring has always been the Commission's final determinant of success. In countless publications, we have reported conditions of the Bay based on monitoring results and the potential for success based on modeling. The model often tells us that good news is ahead if the nutrient control strategies input are properly implemented, fully funded and appropriately enforced. Tempering the news, monitoring results usually caution us that the Bay is not yet responding.

Clearly, there is a distinct use for each of these tools. Monitoring provides us with the most surefire measure of condition. Modeling, by contrast, allows us to test future conditions based upon a hypothetical scenario. In fact, this predictive capability has proved quite valuable to us, particularly in recent years. The Commission is constantly working to identify and analyze emerging policy issues at the state and federal level. Currently, the Commission is using the model, combined with cost information generated by the Commission, the states and the EPA, to identify those nutrient control strategies that will result in the most cost-effective reductions. This information can be very helpful as our members identify state or federal programs that deserve additional money or attention.

Having said that, let me make it clear that the Commission is fully cognizant that there is a serious water quality problem in the Chesapeake. We know that during the summer of 2003, monitoring data revealed that a "dead zone" inhospitable to most species living in the Bay extended 100 miles south from the Patapsco River near Baltimore to the mouth of the York River, near Hampton Roads. Heavy rains and snowmelt had flushed more than two years of nutrients and sediments into the Bay, nutrients that had been accumulating on the land during the past two years of drought. By early July, scientists reported that the volume of oxygen-depleted—or hypoxic—waters had reached the highest levels seen in the last 20 years. Data from July 7 to 9, 2003, indicated that oxygen levels less than 5 mg/l were prevalent in 40 percent of the water in the main stem. In fact, since the 1950's the volume of Bay water devoid of adequate oxygen has been steadily rising.

In November 2003, the impact of the summer's oxygen-depleted waters was fully reviewed at the Commission's quarterly meeting in Solomons, Maryland. Scientists and watermen provided Commission members with first-hand accounts of murky, sewage-laden waters devoid of fish and crabs. They reported that the prevalence of dead crabs, and the belief that many crabs retreated to hibernation mode due to these stressful conditions, may have contributed to as much as a 40 percent reduction in fishing effort during the 2003 crabbing season.

But discouragement over the summer's poor water quality was tempered by scientists' counsel and my third point: that "nutrients have a short memory."

Unlike some toxic pollutants, whose impacts last for years or even decades, reductions of excess nutrients can trigger a rapid response from the ecosystem. Scientists reported that meaningful reductions in nutrients, particularly those that are delivered directly to the Bay from pipes and hard surfaces, would result in discernable improvement in water quality in just a year or two. My point here is that investments in nutrient reductions provide a short turnaround to results. They are investments that make ecological, economic and, importantly, political sense since changes *can* occur within your tenure.

My fourth observation is that our dependence on modeling versus monitoring is presently shifting. First, a bit of history:

In 1983, the Chesapeake Bay states, the District of Columbia, the Chesapeake Bay Commission and the EPA, on behalf of the federal government, signed the first Bay agreement, a short document setting out a set of broad objectives for the restoration of the waters and living resources of the Bay. This was followed by another agreement in 1987 which established more far-reaching objectives, including the goal to reduce nutrient loadings by 40 percent by 2000.

By the end of the 90's, it was felt that more specific efforts needed to be defined. The result was Chesapeake 2000, containing many new or revised goals for restoration and a multi-tiered, semi-regulatory approach to achieving the necessary water quality improvements. This blended approach of cooperative and regulatory action was primarily the result of a July 1998 law suit brought by the American Canoe Association and the American Littoral Society against the U. S. Environmental Protection Agency (EPA). The suit stated in part that EPA and the Commonwealth of Virginia had failed to (1) identify Virginia waters that did not meet water quality standards and (2) establish total maximum daily loads (TMDL) for the pollutants which caused the impaired water quality. The decree sets out a schedule by which Virginia must develop TMDLs. The Chesapeake Bay is included in Category 1. All of the Category 1 TMDLs must be completed by May 1, 2010. If Virginia fails to complete the work, then EPA must establish the TMDLs by May 1, 2011 at the latest.

In light of this decree, the Bay Program partners, in *Chesapeake 2000,* reaffirmed their intent to resolve the Bay's water quality problems through their voluntary, cooperative restoration program. The partners agreed to correct, by 2010, the nutrient and sediment problems of the Bay sufficiently to remove the Bay and its tidal tributaries from the federal list of impaired waters. The choice of 2010 as the completion date deliberately correlates to the deadline imposed under the consent decree. Through the development of the tributary strategies, the Bay states will achieve the nutrient and sediment reductions necessary to meet the Bay's water quality standards.

At the same time the states are developing tributary strategies, Maryland and Virginia have initiated rulemakings to adopt nutrient water quality standards for the Bay and its tidal rivers. EPA is providing the technical support for this effort and both states are proposing new water quality criteria and use designations that better reflect what we know is the science of the estuary. Once these new standards are adopted, they will become the measure of success for our nutrient reductions. And what is most important to understand is that achieving water quality standards will be measured by monitoring data, not modeling predictions. Additionally, in order to avoid the imposition of a federal TMDL for the Bay, the states must empirically demonstrate that water quality standards have been met, based on instream, water quality data measuring dissolved oxygen, algae abundance and water clarity. In fact, the states will need to provide three years of monitoring data to remove the Bay from the impaired waters list. Monitoring, then, will provide the ultimate measure of progress in the Bay's restoration.

My final and fifth point is to clearly recognize the Bay Program for what it is: a world class leader.

I truly believe that the Chesapeake Bay Program offers us the best chance in the nation to address watershed degradation that is multi-state in nature and largely non-point source in origin. Our program is advanced, our skill level is high, our constituency's commitment runs deep and our data, in relative terms, is rich. If we cannot do it here, I don't think we can be successful anywhere. Yet if we can be successful, as I believe we must, then the Bay region can provide a model for the entire world to learn from.

Of course, whenever I make this point, I never know whether to be proud or sad. I am proud because our accomplishments are unmatched nationwide. Yet I am sad, as I am sure Ms. Pierno from the Bay Foundation will attest that we have not come far enough. In fact, the sad truth is that the best program of our country is simply not good enough. Must the states and local governments of the region do more? *Yes*. Must the citizens be more engaged? *Yes*. Can we do it without enhanced federal support? *I have to say no*.

Clean water will continue to be elusive with anything but the most stringent nutrient and sediment controls. Our success will be built on installing state-of-the-art nutrient controls for most municipal wastewater treatment plants, aggressive best management practices on most farms, many miles of stream buffers, more rigorous controls on sources of air emissions, cooperation by all states in the watershed, and significant amounts of money.

Just last May, the Commission traveled to Washington to meet with our Congressional colleagues that represent the Chesapeake Bay watershed to make the case that finding resources within existing federal programs is one of the best investments we can make to benefit the Bay. We also urged President Bush to designate the Bay as a "national treasure" and provide one billion dollars of federal funding in FY2005. We reiterate today these requests and we hope that you can help us reach these goals.

No one disputes the significance of the Chesapeake Bay as an economic engine, driving property values, supporting resource-based industries and attracting tourism and recreational dollars. Taking into account all of the benefits and values we recognize today, its worth is vast, reaching well beyond the trillion dollar mark.

It should be no surprise then, that its restoration will require big dollars. Large projects with important benefits require large investments. After all, fifteen billion dollars is the price attached to the restoration of South Florida's Everglades. Nearly $7 billion will cover the upgrades at Chicago's O'Hare International Airport. For the Chesapeake, successful restoration carries a sticker price of roughly $19 billion, $6 billion of which is projected to be forthcoming from existing sources. Clearly, three things will make or break this program: sound policy, a committed constituency and money, to be precise. The U.S. Congress can help with at least two of these.

To help, we ask that you:

1. Promote existing and new federal programs targeted to our region. Build support among your colleagues for authorizations and appropriations bills to support water quality, land conservation, living resource and environmental education goals of the Chesapeake Bay agreements.

2. Provide federal cost-share grants to localities in the six-state basin to pay for the installation of advanced nutrient removal technology for the region's largest wastewater treatment plants. The Blue Plains Sewage Treatment Plant, whose discharges into the jurisdictionally-shared waters of the Potomac River make it the largest sewage treatment plant in the world, must be central to this effort. (Legislative Vehicle: The Chesapeake Bay Watershed Nutrient Removal Assistance Act S827; HR568 and appropriations bills)

3. Improve the federal 2007 Farm Bill's provisions for farmland preservation and water quality improvement. Include programs to support nutrient management, cover crops, conservation tillage, diet and feed formulations and carbon sequestration. In the meantime, strongly support a special USDA-funded program to demonstrate a number of these innovative management practices on agricultural lands in the Bay watershed. (USDA proposal entitled "The Chesapeake Bay Working Lands Nutrient Reduction Pilot Program." Status: Yet to be acted on.

4. Include funding to mitigate the impacts of stormwater runoff from roads and highways which is estimated to contribute 22 percent of the urban nitrogen and 32 percent of the urban phosphorus. (Legislative Vehicle:

Reauthorization of the Surface Transportation Equity Act, SAFETEA)

Certainly, this hearing is not the place or the time to discuss the details. But let me assure you that the Commission staff is well versed and would welcome the opportunity to work with you and your staff on any of these proposals. I have attached as Appendix B a summary of pending federal legislation, prepared by the Commission in May 2004 that would assist our restoration efforts.

I cannot conclude without reiterating that we still have enormous amounts of work to do. Be clear on this. We know what needs to be done. The dispute has been over measuring success to date and clearly the rosier side of the story has been told. I urge you to continue to watch dog the program to ensure that you are always getting the biggest bang for the federal buck along with honest, comprehensive reporting. But I also urge you to continue your support and make every effort to enhance it. The Bay cannot be restored without you.

I encourage you to recognize the Bay for what it is – a National Treasure – and to make sure that this hearing marks the beginning of your *enhanced* commitment to making strong federal policy and ferreting out the federal dollars to ensure the Program's success. The next Virginia Field hearing could then focus on monitoring with grand results.

Thank you for the opportunity to testify. I am happy to answer any questions you may have.

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CHESAPEAKE BAY COMMISSION · LEGISLATIVE RECAP

DECEMBER 2003

Reflecting on 20 Years Of Legislative Achievements

THE RESTORATION OF THE Chesapeake Bay began twenty years ago, with the signing of the *1983 Chesapeake Bay Agreement.* The Chesapeake Bay Commission and its partners in the Chesapeake Bay Program – the Governors of Maryland, Pennsylvania and Virginia, the Mayor of the District of Columbia and the Administrator of the U.S. Environmental Protection Agency – believed that through cooperation and partnership, using regulation and incentive, they could reverse decades of man-made decline in our nation's most abundant estuary.

Perhaps no other activity better defines the work of the Chesapeake Bay Commission and its role as a Bay Program partner than its efforts to advance legislation at the state and federal levels. Since its inception in 1980, the Commission has recognized that each Bay state must devise its own approach to the problems facing the Chesapeake in order to address the cultural, financial and ecological conditions of its jurisdiction. It also recognizes that to do so, the legislative branches of each jurisdiction must be fully engaged in devising that approach.

The list on the following page reflects both the breadth of subject and the diversity of approaches that have been used. In many cases, a watershed-wide approach has been achieved, as with the passage of phosphate detergent bans throughout the region. In other instances, such as the management of fisheries whose habitats extend beyond the waters of the Bay, Federal legislation has been the appropriate vehicle.

Regardless, the list stands as testimony to the dedication of the state General Assemblies and the U.S. Congress in the protection of the Bay. Together, they have laid a strong foundation of environmental law in the region that has contributed sizably to the restoration of the Bay. The Commission has played an instrumental part in this effort.

The legislators who have been a part of the Commission are proud of the laws that they have passed in defense of the Chesapeake Bay. Clearly, the work of the Commission, the General Assemblies and the partners in the Bay Program is far from complete. The rate of nutrient reduction must be doubled. More habitats must be protected and restored. And land management approaches must be fine-tuned. This list, then, serves as testimony to the accomplishments to date and as an inspiration for what more needs to be done.

What Is the Chesapeake Bay Commission?

The Commission is a tri-state legislative authority created in 1980 to advise the General Assemblies of Maryland, Virginia and Pennsylvania on matters of Baywide concern.

Twenty-one members define the Commission's identity and its workload. Drawn equally from the states, 15 are legislators, three are Cabinet members, and three are prominent citizens.

Legislation and Major Policy Initiatives

Nutrient/Sediment Pollution

Virginia Water and Sewer Assistance Authority [VA 1984]
Virginia Water Facilities Revolving Fund [VA 1986]
Phosphate Detergent Bans in the watershed [MD 1985, VA 1987, PA 1989]
Erosion and Sediment Control [PA, MD, VA – mid to late 1980s]
Sewage Treatment Plant Compliance [MD 1990]
Stormwater Control Legislation [VA 1991; MD 1982, 1985]
Nutrient Management Act [PA 1993]
Forestry Bad Actor Law [VA 1993]
Nutrient Management Certification Program [VA 1994; MD 1993]
Ag-Linked Investment Program [PA 1994]
Agricultural Bad Actor Law [VA 1996]
Virginia Water Quality Improvement Act of 1997
Tributary Strategies Act [VA 1997]
Maryland Water Quality Improvement Act of 1988
Poultry Waste Legislation [VA 1999]
Animal Waste Technology Fund [MD 1999]
Sewer Overflow and Treatment Plant Bypass Reporting [MD 2001]

Living Resources

Striped Bass Management Act [Fed 1988]
Clean Vessel Act [Federal 1991]
Susquehanna River Fish Passage Resolutions [MD, VA, PA 1992]
National Invasive Species Act of 1996, US, October 1996 [Federal 1996]
Fisheries Management Plan legislation [MD 1997; VA 1996, 1995, 1992]
Prohibition on Hydraulic Clam Dredging [MD 1998]
Bi-State Blue Crab Strategy Development [MD, VA 1999]
Recreational Crab License [MD 2001]
SAV Protection Zones [MD 2002]

Land Stewardship

Critical Area Protection Law [MD 1984-85]
Chesapeake Bay Preservation Act [VA 1988]
Growth Management Commission [VA 1989]
Farmland Conservation Program–Agricultural Area Security Law [PA 1989]
The Consolidated Lands Preservation Act [MD 1990]
Wetlands Act enforcement legislation [VA 1990]
Land Conservation Fund [VA 1991]
Income Tax Credit Legislation [VA 1991]
Forest Conservation Act [MD 1991]
Economic Growth, Resource Protection and Planning Act [MD 1992]
Land Recycling & Environmental Remediation Standards Act [PA 1995]
Phragmites Control Legislation [MD 1996]
Smart Growth Legislation (series of three bills — Brownfields, Rural Legacy, Smart Growth) [MD 1997]
Open Space Lands Preservation Act [VA 1997]
National Forest Buffer Initiative [NRCS 1997]
Supplemental Agricultural Conservation Easement Purchase Program [PA 1999]
Municipalities Planning Code Omnibus Amendments (Sustainable Growth) [PA 2000]

Others

Clean Water Act of 1987 [Federal]
Oil Spill Prevention, Liability and Compensation legislation [MD 1990, VA 1991]
Conservation and Recreational Foundation [VA 1992]
Environmental Education Legislation [PA 1993]
Vehicle Emissions Control Legislation [PA 1992, VA and MD 1993]
Recreational Boat Pollution [MD 1992, 1994, 1999]
Farm Bill [Federal, 1996 and 2002]
VA Chesapeake Bay Partnership Council [VA 1996]
Water Quality Toxics Legislation [VA 1997]
Small Watershed Grants Program [Federal 1997]
Clean Water Action Plan [Federal 1998]
Chesapeake Bay Gateways Act [Federal 1998]
Environmental Stewardship & Watershed Protection Act (Growing Greener) [PA 1999]
Marine Habitat and Waterways Improvement Fund [VA 2000]
Water Resources Planning Act [PA 2002]

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Appendix B

UPDATED MAY 2003

Chesapeake Bay Legislation for the 109th Congress
Summary of Priority Bay Legislation

INTRODUCTION

This summary provides a brief overview of major pieces of legislation that are the focus of the Chesapeake Bay Commission's efforts to enhance federal support for Chesapeake Bay related activities. Included in this summary is TEA-3, implementation of the Farm Bill and the package of five Bay-related bills sponsored by members of the Senate delegation.

SURFACE TRANSPORTATION ACT, SAFETEA

Congress reauthorizes the surface transportation programs every six years. The last two surface transportation bills contained significant structural changes in the highway programs to ensure a focus on the environment. Both the Intermodal Surface Transportation Efficiency Act (ISTEA) and TEA-21 recognized vehicle emissions as a significant cause of air pollution and provided a funding source ($8.1 billion over 5 years) for states to mitigate the impacts of this pollution. No funds are specifically provided to mitigate the harmful impacts of stormwater and stream degradation.

SAFETEA could do more to help make up for past mistakes. Approximately half of the land area in and around cities consists of roads and motor vehicle infrastructure. Yet, when most of the roads and other impervious surfaces in this country were constructed, virtually no storm water controls were in place to protect water quality. As a result, polluted storm water is the leading cause of impairments for nearly 50 percent of the nation's waterways.

The Chesapeake Bay Commission has asked members of the Congress to make 2004 the year for water in SAFETEA by providing funding to address both water quality and stream corridor impairments resulting from *existing* highway stormwater discharge.

C2K STATE FUNDING NEEDS: Addressing the nutrient and sediment loads attributed to urban stormwater is a primary cost driver for C2K attainment in each of the states. While stormwater pollution control costs related to transportation have not been estimated to date, the CBC fiscal analysis looked at the cost of urban stormwater retrofits on 20 percent of existing residential and commercial development (a Tier 3 level of control). For the period 2003-2010, this results in costs of $150 million/year in Maryland, $112 million/year in Pennsylvania, and $212 million/year in Virginia. Income streams for stormwater pollution control and prevention were not identified by the states.

STATUS: On February 12, the Senate approved a $318 billion measure known as SAFETEA reauthorizing surface transportation programs and funding for another 6 years. Included in this measure is a provision which sets aside 2% of a State's Surface Transportation Program – or approximately $1 billion -- for stormwater runoff mitigation. The stormwater provision would provide more than $73 million for the Bay states and local governments for stormwater abatement. On April 2, 2004, the House approved a $286 billion measure reauthorizing the surface transportation programs and funding known as TEA-LU. The House measure did not include a stormwater mitigation program, so the matter must now be addressed by the joint Senate-House Conference Committee.

FARM BILL

The governors of Maryland, Pennsylvania and Virginia, the Mayor of the District of Columbia and the Chesapeake Bay Commission submitted "*The Chesapeake Bay Working Lands Nutrient Reduction Pilot Program*" to U.S. Secretary of Agriculture Ann Veneman in August 2002. The program proposes to use $20 million per year for five years of Farm Bill funds to test four innovative practices to reduce nutrient losses from agricultural lands. Funding would be supplemental to monies allocated through the state formulas for EQIP, CRP, CREP and other USDA programs.

About half of the requested funding will be used to support the Yield Reserve Program (YRP) that has tremendous potential to reduce nitrogen losses while improving profitability. The pilot program would also test the use of this new practice to generate marketable nitrogen credits for possible use in future trading programs.

The proposal, which was originally contained in the Farm Bill, was removed in conference. However, a colloquy between Senators Daschle and Sarbanes acknowledged the appropriateness of funding the proposal under the Partnerships and Cooperation section. However, the funding guidance and RFP for that section of the Farm Bill is not expected out until 2004. Thus, no action has been taken on the proposal.

We must keep the proposal on the Secretary's radar screen in order to compete for the limited dollars, once they become available. In order to avoid further delay, Senator Sarbanes has requested an earmarked appropriation for FY 2005.

STATE FUNDING IMPLICATIONS: The states have just adopted their new nutrient reduction allocations, which call for more than double the reductions achieved in the past. Funding of this proposal will provide funds to test innovative new approaches to agricultural pollution control that are otherwise unavailable.

C2K STATE FUNDING NEEDS: With 38 percent of the nitrogen, and 41 percent of the phosphorus and 63 percent of the sediment loads coming from agriculture, funding for agricultural best management practices is among our highest priorities. In order to meet our nutrient reduction goals we will have to do far more than what we have done to date, searching out new and innovative approaches that will amplify our reductions. Funding to pilot the four innovative practices contained in the proposal is not available elsewhere.

SENATE LEGISLATIVE PACKAGE

1. CHESAPEAKE BAY WATERSHED NUTRIENT REMOVAL ASSISTANCE ACT (S. 827; HR 568)

This Act would establish a federal nutrient removal technology (NRT) grants program in the 6-state Chesapeake Bay watershed. The program would provide grants for 55 percent of the capital cost of upgrading publicly owned wastewater treatment plants (WWTP) of at least 0.5 million gallons per day with nutrient removal technologies to remove nitrogen down to an average annual concentration of 3 mg/liter. The total authorization is $660 M over a 5-year period, divided equally at $132 M a year. There are approximately 300 major wastewater treatment plants in the Chesapeake Bay watershed, which contribute about 56 million pounds of nitrogen per year – one fifth – of the total load of nitrogen to the Bay. Upgrading these plants with nutrient removal technologies to achieve state-of-the-art reduction would remove 41 million pounds of nitrogen, or 40 percent of the total nitrogen reduction needed.

STATE FUNDING IMPLICATIONS: While there is no state-by-state breakdown of the funding, Pennsylvania has the largest number of sewage treatment plants under the NRT bill and presumably would be the largest beneficiary. Each jurisdiction's share of the funding will be determined by how many requests for NRT are received and at what cost. Cost share is provided at 55:45 federal/state.

Funding of this proposal is directly tied to an increase in the State Revolving Loan Fund (SRF). For FY 2004, SRF is appropriated at $ 2.2 B, with $1.3 B targeted to waste treatment plants. In place of the $2.2 B, the Administration has asked for $1.7 B. Senators Sarbanes and Mike Crapo (R-ID) successfully introduced an amendment that would take the total Clean Water package (including both drinking water and wastewater funding) to $5.2 B, including $3.2 B for wastewater treatment plants, nationwide. The House Budget Committee does not contain a similar amendment and funds the SRF at the $2.2 billion level, so the matter must be addressed by a House-Senate Conference Committee. Following is a breakdown of what the Bay region states stand to gain under the allotments for Clean Water SRF at $3.2 B using the current formula:

STATE	at $1.3B	at $3.2B	DIFFERENCE
MD	$32,357,492	$ 76,853,866	$44,496,374
PA	$52,994,802	$125,870,552	$72,875,750
VA	$27,379,721	$ 65,030,918	$37,651,197

C2K STATE FUNDING NEEDS: The application of NRT is targeted to WWTP with a flow of at least 0.5 million gallons per day. In Maryland there are 65 plants, in Pennsylvania there are123 and Virginia has 86. The CBC fiscal analysis estimated capital costs required to bring all significant municipal plants down to 5 mg/l (Tier 3 level) at: $778 M in Maryland; $675 M in Pennsylvania; and $1.0 B in Virginia. If these plants were taken down to 3mg/l, the cost estimates rise to: $1.4 B in Maryland, $911 M in Pennsylvania, and $1.5 B in Virginia. The funding sources for WWTP upgrades vary considerably among the states, with all states reporting significant gaps in funding associated with this level of control.

These grants will substantially augment the funding needed to remove nitrogen at all significant plants throughout the watershed, while providing an additional incentive for the plants to take nitrogen reduction down to the limit of technology. Reductions from point sources are the most dependable and immediate of any source of nutrients in the Bay watershed.

STATUS: The bill has been introduced in both the House and the Senate. HR 568 was referred to the Committee on Transportation and Infrastructure. There are 22 bi-partisan co-sponsors with Representatives Tom Davis (R-VA), Wayne Gilchrest (R-MD) and Tim Holden (D-PA) providing the lead. S. 827 was referred to the Committee on Environment and Public Works and is sponsored by all six Bay state senators.

2. CHESAPEAKE BAY ENVIRONMENTAL EDUCATION PILOT PROGRAM ACT (S. 828)

This legislation amends the Elementary and Secondary Education Act of 1965 to establish a pilot program to make grants to elementary and secondary schools, school districts and not-for-profit environmental education organizations in the six-state watershed to support teacher training, curriculum development, classroom education and meaningful Bay or stream outdoor experiences. It authorizes $6 M a year over the next three years and would require a 50 percent non-federal match, thus leveraging $12 M in assistance. The program complements the new NOAA B-WET initiative was established last year and would formally authorize it in the next measure. An assessment of the funding needs to meet the education commitments of Chesapeake 2000 estimates a gap of more than $125 M in the three main Bay states alone. This measure and the B-WET program are intended to help meet the federal responsibilities in closing that gap.

STATE FUNDING IMPLICATIONS: Since the grants would be awarded competitively, funding under the measure would entirely depend upon how many schools/districts or non-profits apply from each state. There is a maximum funding level set at $50,000 per grant and all six states' K-12 schools are eligible for funding.

C2K STATE FUNDING NEEDS: CBC has estimated a funding gap of $125 M for C2K education goals. This includes an estimated $8 M per year in Maryland, $7 M per year in Pennsylvania, and $5 M per year in Virginia over the period 2003-2010.

STATUS: S. 828 was referred to the Committee on Health, Education, Labor and Pensions and is sponsored by Senators Sarbanes, Mikulski, Allen, and Warner. In order to jump start the legislation, Senator Sarbanes succeeded in getting an appropriation of $350,000 in the Fiscal 2004 Omnibus Appropriations bill for the Chesapeake Bay Foundation and Living Classrooms

Foundation for standards-based curricula, teacher professional development, student field experiences, and community service opportunities in schools and on school properties. Senator Specter provided an additional $50,000 to the Chesapeake Bay Foundation for Pennsylvania students.

3. REAUTHORIZE AND IMPROVE THE CHESAPEAKE BAY ENVIRONMENTAL RESTORATION AND PROTECTION PROGRAM (S. 829)

This program, which was first established in Section 510 of the Water Resources Development Act (WRDA) of 1996, PL 104-303, authorizes the U.S. Army Corps of Engineers to provide design and construction assistance to state and local authorities in the environmental restoration of the Chesapeake Bay. To date, the Corps of Engineers has constructed or approved $9.3 M in projects under the 510 program, including oyster restoration projects in Virginia, shoreline protection and wetland/sewage treatment projects at Smith Island in Maryland, and the upgrade of the Scranton Wastewater Treatment Plant in Pennsylvania. These projects have nearly exhausted the current $10 M authorization.

This legislation increases the authorization for this program from $10 M to $30 M. Consistent with all other environmental restoration authorities of the Corps of Engineers, it enables states and local governments to provide all or any portion of the 25 percent non-federal share required in the form of in-kind services. The law specifically requires that projects be undertaken in each of the Bay states. It also establishes a new small-grants program for local governments and nonprofit organizations to carry out small-scale restoration and protection projects in the Chesapeake Bay watershed. The National Fish and Wildlife Foundation would administer the program. Ten percent of the funds appropriated each year under this program would be set-aside for these grants.

STATE FUNDING IMPLICATIONS: Since the grants would be awarded competitively, funding under the measure would entirely depend upon the state projects submitted and on Congressional appropriations. Cost share is provided at 75:25 federal/state.

C2K STATE FUNDING NEEDS: Section 510 of WRDA provides the authorization to the Corps to work with the Bay states on projects relating to streams, shoreline stabilization, wastewater treatment and fish habitat. Using oysters and wetlands to illustrate the funding opportunity, the total states' cost for oyster restoration is estimated at $111 M over the period 2003-2010, while wetlands restoration is estimated at $245 M over the same period. The cost breakdown by state for oysters is: $9 M per year in Maryland and $5 M per year in Virginia. For wetlands, the costs are higher and apply to all three jurisdictions: $20 M per year in Maryland, $5 M per year in Pennsylvania, and $6 M per year in Virginia. The total estimated federal funding gap is $4 M for oyster restoration and $30.4 M for wetlands.

STATUS: S. 829 was referred to the Committee on Environment and Public Works and is sponsored by Senators Sarbanes, Mikulski, Allen, Warner, Specter and Santorum. Senators Sarbanes, Mikulski, Allen and Warner have since written to the Committee requesting that the funding for the Section 510 program be boosted to $1 billion.

4. THE CHESAPEAKE BAY WATERSHED FORESTRY ACT (S. 830)

This legislation is nearly identical to a provision that was included in the Senate-passed Farm bill, but dropped by the House in Conference. It codifies the roles and responsibilities of the USDA Forest Service to the Bay restoration effort. It strengthens existing coordination, technical assistance, forest resource assessment and planning efforts. It authorizes a small grants program to support local agencies, watershed associations and citizen groups in conducting on-the-ground conservation projects. It also establishes a regional applied forestry research and training program to enhance urban, suburban and rural forests in the watershed. Finally, it authorizes $3.5 M for each of fiscal years 2004 through 2010, a modest increase in view of the six-state, 64,000 square mile watershed.

STATE FUNDING IMPLICATIONS: Funding would go directly to the Bay Program Forest Service office and would benefit all states in the watershed.

C2K STATE FUNDING NEEDS: The C2K commitments related to forest buffer restoration and conservation are estimated by the states to cost $109 M over the 2003-2010 time frame. A funding gap of $6 M in both Maryland and Virginia was identified for meeting these commitments by 2010. Pennsylvania has no funding gap.

STATUS: S. 830 was referred to the Committee on Agriculture, Nutrition and Forestry and is sponsored by Senators Sarbanes, Mikulski, Allen, and Warner.

5. NOAA CHESAPEAKE BAY WATERSHED EDUCATION, TRAINING, AND RESTORATION ACT (S. 831)

This measure would enhance the National Oceanic and Atmospheric (NOAA) Chesapeake Bay Office's authorities to address the living resource restoration and education commitments of C2K. It would codify the Bay Watershed Education and Training (B-WET) Program that we initiated in the Fiscal 2002 Commerce, Justice, State Appropriations bill and establish an aquaculture education program to assist with oyster and blue crab hatchery production. It would establish an internet-based Coastal Predictions Center for the Chesapeake Bay to better coordinate and organize the substantial amounts of data collected and compiled by federal, state and local government agencies and academic institutions – data such as information on weather, tides, currents circulation, climate, land use, coastal environmental quality, aquatic living resources and habitat conditions – and make this information more useful to resource managers, scientists and the public. It codifies the ongoing oyster restoration program and authorizes a submerged aquatic vegetation restoration program. It authorizes a shallow water-monitoring program to address critical gaps in information on near shore and river area water quality conditions needed for restoration of living resources. The legislation authorizes a $2 M increase in NOAA's base program and $17 M for the various initiatives.

STATE FUNDING IMPLICATIONS: Use of money is for monitoring, multi-species programs and other NOAA activities that benefit all of the states.

C2K STATE FUNDING NEEDS: The multi-functional aspect of this legislation makes it difficult to associate it with specific C2K commitments and funding estimates.

STATUS: S. 831 was referred to the Committee on Commerce, Science and Transportation and is sponsored by Senators Sarbanes, Mikulski, Allen and Warner.

Prepared by Chesapeake Bay Commission: May 2003

Chairman TOM DAVIS. Thank you all for your testimony.

Mr. SCHROCK. Mr. Chairman, would you yield?

Before we go with questioning, I want to recognize two members of the legislature, the Virginia Legislature, who are with us today. From northern Virginia, is Virginia State Senator Jean Marie Debalites, who I believe who on June 26th became Senator Jean Marie Debalites Davis, the wife of the chairman, she is here with us today.

Chairman TOM DAVIS. I was afraid of the primaries.

Mr. SCHROCK. His words not mine. And from Chesapeake is House delegate John Cosgrove and both of their districts impact the tributaries of the Chesapeake and I am delighted that they are here today. So, Jean Marie and John welcome. Thank you very much for being with us.

Chairman TOM DAVIS. Ms. Swanson, let me start with you. Yours was stimulating testimony. Dollars fill a huge component of this. Do you feel right now—and I will ask everybody—that the amount of money coming in to here from the Federal, State and local is adequate or does it need to be stepped up significantly or how you characterize it?

Ms. SWANSON. I think it needs to be stepped up and the reason is because in our analysis, basically right now the Federal Government contributes just shy of 20 percent, 18 percent of the amount of money coming into the bay region for restoration. However, if we are going to step up the total dollars invested to implement the bay agreement, then that proportion of money, just to keep pace with your current level of partnership, would need to grow. And according to our calculations, that means that your investment would have to about triple on par with the tripling with State and local dollars as well. So, the answer is clearly, yes. And in truth if you wanted a $500,000 house and you were only going to invest $90,000, your realtor would say let us readjust, lets have a different dream house. If the dream is a Chesapeake Bay that is truly clean, then we need to put the cash in that will make that a reality.

Chairman TOM DAVIS. We are uniquely situated to do something about some of the other issues. We have three appropriators in the House on the Virginia side. We have—the Blue Plains sewage treatment plant lies directly under our committee jurisdiction. We have done some things to try to help it. We have had a lot of management issues up there as you can imagine.

Ms. SWANSON. Right.

Chairman TOM DAVIS. But we can come back and look at that and we would be happy to have further discussions with you on what we really need to do to reduce the nitrogen levels coming out of there.

The farm bill, Representative Goodlatte now chairs that committee and I hope that we can open that dialog, because what happens to the bay really affects the whole Commonwealth.

I am concerned of the fishing numbers, Mr. Murphy. You talked about that, and the fishing numbers have depleted rapidly and I do not know that you need to define success just by the number of fish, I think it is a larger issue than that. But, long term strategy, how do you get those numbers back up? You put more claims in, do you introduce new species? Mr. Bahner, had something to say about that as well. What is the long term strategy for getting the number of oysters and crabs up?

Mr. MURPHY. Well let me say that I believe that the measure of success is partly measured by the living resources of the bay. How healthy are our fisheries, we have the food fish, we have the thin fish species, we have menhaden as opposed to food fish, we have crabs, oysters. And the health of those populations is I think a significant criteria of determining success in restoring the bay. But I do not think that is the only measure of success.

Chairman TOM DAVIS. You are saying first they have to be healthy.

Mr. MURPHY. I think in order for those fisheries to be healthy and to be able to restore the populations in those various species, we need to make sure that we have both fishery management tools in place to regulate the harvest of those species. But we also need to improve the quality of the water of the habitat in which they survive. You cannot have a healthy fish or crab population, for example, without having healthy sea grass beds. And that is one of the major problems we face in the bay today, that is the restoration of sea grasses. That was one of the three problems that the EPA report back in 1982 identified—nutrient, toxics and the loss of submerging vegetation. Our water clarity, our new water quality standard for water clarity will be measured by the increases in submerged aquatic vegetation acreage. That is vitally important to our fishery resources.

So, I think that the measure of success in restoring the bay is partly based on the improvements in our living resources and also in water quality. There are other uses of the bay—swimming, boating. We are seeing areas that were formally off limit to water contact. The Potomac, for example, in Washington, 30 years ago you could not have water contact because of the pollution that existed there. Today, the river at Washington is being used by boaters and in Richmond the James River is being used to a far greater extent than it was in the past years, for recreational use.

So, I think we measure success by different factors but I think that fisheries are one of the main ones. And that's been one of the great commercial benefits. The Virginia Marine Resources Commission is the oldest agency in the State of Virginia. It was created back in the 19th century, and it was originally known as the Oyster Commission, because that industry was so vitally important to Virginia's economy that a commission was necessary to regulate the oyster industry.

Today, we face problems with oysters that perhaps are not necessarily related to pollution. Diseases have been a major factor in the reduced population of the native oysters.

Again, I think one of the program issues that we face today is the use of non-native species. That is a controversial issue but it is one that we are going to have to look at and address, both from the standpoint of water quality and from the standpoint of restoring that particular fishery.

Chairman TOM DAVIS. Mr. Bahner, speaking on the non-native, I know one of the controversies is the Asian oysters coming into the bay. Could you bring me up to date? I have read different accounts on what this will do.

Mr. BAHNER. Certainly. The States of Maryland and Virginia petitioned to bring in a non-native oyster to Chesapeake Bay. That began a process called an environmental impact statement. There is a process that EPA, NOAA, and Fish and Wildlife are cooperating agencies with the Corps of Engineers and the States to examine this request to introduce this non-native species. NOAA's role in this process is to provide money for research to understand the potential impact and benefits of this introduction. We have funded through the Virginia Institute of Marine Science a program to examine and provide data for this introduction. The data will be generated over some period of time, 1 to 3 years as is necessary. Those data then will become part of the public process to make a determination whether or not it is an intelligent decision to bring in that Asian oyster or not to introduce that organism.

So, our role is to make sure that the science is there so that a good public decision can be made at the appropriate point in time.

Chairman TOM DAVIS. When is that time going to come, do you know?

Mr. BAHNER. That is somewhat difficult to decide, but at this point based on recommendations from the National Research Council and through the Scientific and Technical Advisory Committee of the Chesapeake Bay Program, both of those have recommended the need for studying this issue for about a 5-year period. I would say at this point the States are more aggressive in their schedule, wishing to have a decision in the 1½ to 2 year timeframe. But, I believe everyone is agreed that we need to make sure we have adequate data, so that the public can make the right decision. So, probably in the order of 2 to 5 years is the best projection I can give you today.

Chairman TOM DAVIS. What about the role of over-fishing, do you have any comments on that?

Mr. BAHNER. On the native oyster?

Chairman TOM DAVIS. I would expand that to other areas too, because we have seen that the volume that is harvested each year has declined sharply. I think that is partly of because the population has declined.

Mr. BAHNER. Absolutely. I think the general consensus is that the stock of native oysters over the last 200 years was pretty seriously over-fished. In the 1960's, there was still a population, I am estimating at probably 20 percent of the historical highs when the diseases set in. Since then we have seen an increase in disease and we are struggling against that disease. As Mr. Murphy pointed out, if we can get the stock of native oyster back to a healthy state then we have some opportunity to bring that native population back, which is certainly a position that we hold along with other Federal agencies and State agencies. At this point I cannot tell you whether that strategy will be successful.

Chairman TOM DAVIS. Mr. Phillips, in your testimony you referred to this study by the Geological Survey conducted joining with the CBP between 1997 and 2000 using the water quality model to assist in interpreting water quality changes at your river input monitoring site. As expected the manmade factors played a role in these changes. But the study also acknowledges the role natural factors, such as weather variations, have. In your conclusions, you reported the existence of a so-called lag time between the implementation of management practices that were designed to reduce nutrient and sediments sources and the verifiable results of your actions. How much of a lag time are we talking about and what kind of negative impact will this have on your ability to make both actual management decisions and a reliable report of concrete progress made? It seems to me that a sufficiently severe lag time could jeopardize the CBP's ability to meet the 2010 deadline.

Mr. PHILLIPS. Yes, that study we looked principally at nitrogen which is major pollutant going in the bay, and we saw that about half the nitrogen once it is on the land surface actually slowly infiltrates down into the shallow ground water and then seeps back into the streams. When it is in this ground water, it can take 1 to 50 years to move, but on average about a decade. So, you can have a delay of up to about 10 years in some of these river basins between when you implement practices to reduce non-point sources of nitrogen, and when you finally see an improvement in the rivers to the bay.

Chairman TOM DAVIS. Ms. Hanmer, the Chesapeake Bay Foundation testified that its projection for nitrogen flows into the bay between 1998 and 2002 are 16 percent higher than your projections. Then you also testified that the EPA has not done enough to institute permitting for sewage treatment plants in the region. How do you respond to these criticisms? What is your assessment of improvements that need to be made to point sources of pollution like sewage treatment plants to decrease pollution in the bay?

Ms. HANMER. If I could start with the first question of the different methods, I believe the CBF used a different time period than that used in our model, and because of that, got some different results. But both of the methods I think show a slight improving trend, they do show the reduction of nitrogen and phosphorus. I studied the method but I am not a scientist and so I am not able to tell you exactly what the differences are. But it has to do, I believe, with the years chosen and the method that was used.

As far as sewage treatment plants are concerned, as I pointed out, about 50 percent of the reductions that have been made so far in nitrogen and more then 50 percent of the reductions that have been made in phosphorous are attributable to wastewater treatment plant improvements. About 56 percent of the flow from wastewater treatment plants in the basin is receiving some advanced nutrient removal technology. That is using a different method.

We are basing our statement on the total amount of flow whereas I think the CBF statement talks about the number of individual plants. So, there is a difference there in how we report it. But we look at flow because we are interested in total flow.

Most of that advance to date has occurred because of the voluntary cooperative program with the Chesapeake Bay, and especially when there was incentive funding available from the States. We recognize that we need to use our regulatory authorities under the Clean Water Act, the NPDES program. In the Chesapeake 2000 agreement specifically the executive council said that we were to marry the two programs, the cooperative approach of the Chesapeake Bay Program and the more regulatory approaches of the Clean Water Act. The regulatory basis in the Clean Water Act for regulating sewage treatment plants is to have good water quality standards. It is extremely difficult, it is almost impossible to enforce water quality standards that are not scientifically based.

So, what we had to with great urgency was to change the water quality criteria to adopt a scientific basis for both the designated uses and also the criteria themselves—chlorophyll A, dissolved oxygen and clarity—so that we could provide the basis for the States to change their water quality standards. That is our base regulatory mechanism.

We spent a while doing that with a collaborative process in order to get the States to all buy into the same numbers we were buying into. This speeds the standards adoption process, which can frequently take 5 to 8 years from the time the EPA issues a criteria document until the time it is adopted by the States. In this case we published the criteria document in April 2003. Delaware has already completed the process of changing its standards. The District of Columbia is near completion. Maryland is going out for the prepublication review of its standards today, and Virginia has gone before its Water Control Board. So we are moving as quickly as we can to establish the water quality standards, proper regulatory base that is both scientifically sound and extremely useful for the regulatory process, and we will move quickly.

The EPA published a permitting strategy for comment that also represents not just EPA's point of view, but is a document covering 64,000 square miles in six States and the District of Columbia. So, we have a pretty good consensus on where we go with permitting.

The final thing I would say is that we are promoting watershed permitting, which is a much faster method of permitting than reopening individual sewage treatment plant by sewage treatment plant permits. I think in a couple of years we will have solved the problem that we have of having the right water quality standards and that we will be in the permitting mode. The Maryland water quality standards, because of the way we operate our allocations, will actually drive permit limits in virtually the entire bay region. From New York and West Virginia through Pennsylvania through Maryland through the District of Columbia, and northern Virginia, it will be the Maryland water quality standards that will be the regulatory basis for our allocations and our permitting.

Chairman TOM DAVIS. From a congressional point of view, what is the most important thing we can do. Ms. Swanson, talked about we have an opportunity in the transportation bill to review pieces of that on the impervious surfaces. On the agriculture bill obviously we can look at things like Blue Plains sewage treatment plant, specifically noted, sending dollars, from your perspective how would you rank the priorities in terms of what we do at the national level?

Ms. HANMER. Well, I would have to agree. A lot of the cost numbers came from the study that the EPA did to support the new water quality criteria. And it is a prodigious total of many billions of dollars. Based on our economic analysis, there are going to be areas where financial support will be absolutely necessary or the people who have to take the actions will not be able to take them. I think that the issue of stormwater controls, both in terms of public policy and public funding is also important in this rapidly growing region. This is our growing problem. We had an 8-percent increase in population in the decade of 1990 to 2000, but we had a 41 percent increase in impervious surface. Which means we are changing the hydrology, making it much more difficult; so the steps that Virginia has taken to strengthen its stormwater program are important. But stormwater enforcement and the stormwater program in general need attention throughout the basin, so that is a priority.

The funding support I think for the agriculture sector is extremely important for a lot of reasons. The farming community is an essential part of the Chesapeake Bay region, but ours is a farming community of small farms and generally lacking in the financial capability to meet all the bay cleanup requirements with their private incomes.

Chairman TOM DAVIS. I guess my question was a lot of this is State and local governments, zoning laws and the like. At the Federal level, we have our role too. And I think I will ask you and also Mr. Murphy, when we sat down to build a new road out to Dulles, put rail out to Dulles, the Governor sat down everybody and said here is what we think the State can do, here is what we need the locals to do, here is what we need the feds to do, we kind of all agreed. Do we really have an agreed partnership about this is a Federal, we need to do a, b, c, d. This is what the States need to do, this is what the locals, is it that well defined at this point, or are we still sitting around with general goals and guidelines?

Mr. MURPHY. I do not think it is well defined as to the share that each level of government should bear. In response to the question that you addressed to Ms. Hanmer, you get the quickest reduction for nitrogen and phosphorous through the point source side. Our limits of technology will allow sewage treatment plants to reduce their discharges to 3 milligrams per liter. And if you place the money that is necessary to achieve those retro fittings that would enable these sewage treatment plants to reach the limits of technology, you would make a quicker reduction in nutrients. Virginia, for example, over 32 percent of the nitrogen entering Virginia's portion of the bay comes from point sources.

Chairman TOM DAVIS. Does the Blue Plains study meet that criteria?

Mr. MURPHY. It does not, it has not reached that level of treatment at this point. And so, you could—if you put the money in this effort, it seems to me that you can get a larger bang for your buck initially. That does not mean that you do not continue to try to fund the non-point sources as well. But, if you place a greater burden on the point sources, for example, then you have the political problem of asking the sewage treatment plants to do more than they are contributing. And unless you give them the financial support to upgrade, it becomes a political and legislative problem.

So, I would say that the funding is absolutely critical and we do need to try to refine the agreement between the Federal Government and the participating States and the District of Columbia. The Chesapeake Bay Program, through an executive council directive that was issued last December, created a blue ribbon financing panel that is being staffed by Ms. Hanmer's office. Former Governor Bliley of Virginia chairs that panel and it will make a report in October with regard to the funding that is required to achieve the goals that we have set for ourselves and the objectives that we hope to achieve. And I would suspect that report is going to outline and I think recommend some type of sharing responsibility and that perhaps will fall on the basis for a more specific agreement as to each level of government's responsibility.

Chairman TOM DAVIS. And this falls across all different jurisdictional lines in the Congress? I mean although our committee can referee them. Do you want to add anything?

Ms. HANMER. I was going to make the point that in order to clarify what the funding responsibilities should be and any innovative methods anyone can find, we are staffing the blue ribbon panel and they should make their report by the end of October.

Chairman TOM DAVIS. Thank you. Mr. Schrock.

Mr. SCHROCK. Thank you, Mr. Chairman.

If I have my figures right, I believe when John Smith came into the Chesapeake Bay in 1607, he could see down to 70 feet and they said that there were so many fish and oysters in the bay that it was a hazard to navigation. A lot has happened in 400 years, has not it—it has. Let me follow along with what the chairman was talking about, about what Congress could do and this is for all of you. In your opinions, what are the three most important things that would accelerate the rate of progress in cleaning up the bay, money we know that, Ms. Swanson, you said more laws, is it more laws or is it just enforcing the laws we already have on the books?

Ms. SWANSON. Well, if I were to answer the question I would say certainly enforce the laws that we have on the books. We have an extraordinary set of laws on the books. In terms of new laws, they need to be very targeted laws that fill the gaps in the areas that we have not addressed. When I look at the difference between the Federal and the State and the local I think to some degree we have defined different responsibilities. We have not written a paper on it per se but some of it ends up aligning with tradition. For example, at the Federal level certainly in the past you have been a catalyst in many of the point source upgrades. And so we look to you for that continued assistance.

Let me also, say that the scientists who came before our commission specifically told us that, for example, nitrogen is an excellent thing to work on from an ecological point of view, but also from a political point of view because if you get the nitrogen out of the water there is fairly quick response. Now, for non-point, you are dealing with lag time, but for point sources you can get it out of the water and within a year or two, according to the scientists, you can see a response in the water. So, I would say point sources at the Federal levels is an excellent example and it gets some of the political heat off the State legislators as well.

The second thing is agriculture, its tradition at the Federal level nationwide and many of the practices that we are seeing as the biggest investment for your dollar are not right now cost shared at the Federal level, are not on the research agenda, and if they win in the Chesapeake Bay region, they win nationwide. So, I would say that is an area of Federal concentration.

And the third is air. Whenever we try to address air issues, we are often told no, no, no, the Federal Government is dealing with that. And of course in the bay region about a third of the nitrogen is coming in through atmospheric deposition, a piece of which comes from of course within the region. But another significant piece comes from outside, so in a way I counsel the—and then of course stormwater which is the forgotten stepchild of everyone. And so, to me, it would be fortuitous at this point to put our blinders on and say we are going for these sources, and we are going for enhancement over what we do now.

Mr. SCHROCK. Mr. Phillips.

Mr. PHILLIPS. The Congress has appropriated money to the Chesapeake Bay Program and other partner agencies to help monitor the improvements of water quality within the bay and its watershed. And at this time we have been working with all the States in the bay watershed to enhance the amount of monitoring throughout the bay watershed. We are about to sign a memorandum of understanding between the six States, District of Columbia, the EPA and the USGS to enhance that monitoring. Right now, we will be able to implement about 100 sites using various sources of funding. It is felt that at least 200 sites in the bay watershed are needed to help local governments understand their water quality improvements, as they put in point source and non-point source actions.

So, more Federal support for monitoring within the watershed will be very beneficial and also, within the bay itself. The time schedule for monitoring does not allow for all the monitoring to assess the water quality criteria for the bay by 2010 at this time. So, Federal support for monitoring within the bay especially the shallow waters of the bay would be a huge help.

Mr. SCHROCK. Mr. Bahner.

Mr. BAHNER. Yes, sir. The living resources that NOAA works with the States to protect and restore are highly dependent upon the water quality. So, as has been discussed here, water quality is absolutely the highest priority. In conjunction with that the restoration programs can contribute to that improving water quality. At one point, the discussion was that when all the oysters were there in the early 1600's the entire bay water was filtered somewhere in 1 to 3 days. Today the estimate is on the order of 1½ years. Any engineer that could filter the bay in 1 to 3 days would probably be able to take most of the pollutants out of the water in addition to the sediments.

So, the restoration of oysters who are natural filters, biological filters, could go a tremendously long way to improving water quality. One of the issues with that is that probably 90 percent of the natural oyster habitat has been covered over by sediment from our clearing land and erosion upstream as well as shoreline erosion.

Sediments have never really been addressed very strongly in this region, yet they have been talked about for 25 years. And it is my belief that a stronger sediment protection/restoration program is needed. Part of that is based on our public policy that we grew up protecting the land from being eroded by the water. But, if you take the other perspective that we are trying to protect the water of Chesapeake Bay we should be protecting the water from the land. If we change that policy, then we could use public money to do soft shoreline restoration/protection programs that would limit the shoreline erosion within the bay which contributes to the sediment load that ultimately smothers oyster beds.

Mr. SCHROCK. Soft shorelines, rip-rap put down.

Mr. BAHNER. We would prefer not to use rip-rap right up against the shore. It would be better to have the breakwater offshore—well, the difficulty is that we have this continual erosion offshore by waves. If we had a breakwater off shore—this is just one example of a technique—the waves would hit that, behind that we could use restoration techniques such as dredged material from a port. A small amount could be placed behind the breakwater as a beneficial use of that dredged material. So, it is not just waste material, you are actually using it for restoration. That site, the part that is under water could then be used to also rebuild submerged aquatic vegetation beds.

The SAV restoration is also a critical part of this for a number of reasons. One that the grasses slow down the action of the water allowing sediment to deposit out, improving water quality, which strengthens the SAV. So, it is a cycle. You can also put emergent plants on land so that when you have a larger event, such as a hurricane, those grasses protect the higher shoreline from erosion. And from the hurricane last fall, where we had soft shoreline protected areas, those areas survived very well in the hurricane, whereas you had hardened shoreline, the water came over and washed out from behind it, and there was a lot of damage.

So, I think there is a big opportunity for us to look at large scale shoreline restoration/protection programs. From NOAA's perspective, we collectively are at the point where we can go from small scale pilot studies that we have been doing, we have the knowledge and confidence to move to the large scale that is needed for this size of water body.

Mr. SCHROCK. Mr. Phillips, do you have anything to add to that?

Mr. PHILLIPS. Well, it is a very interesting comment, because I have at my own residence in West Moreland County, about 3/4 mile of shoreline, and we have done some shoreline erosion control using the off water—the break waters. And I will have to say it has worked. Before we did our own shoreline management plan, I had a straight shoreline, it ran in a straight line. Now, it is a crescent shaped shoreline because we have these chevron shaped off water break waters, and the sand has built up behind them and we have planted grasses on that sandy area. And I will have to agree that during Hurricane Hazel that plan worked very, very well for us—Isabel, excuse me.

Mr. SCHROCK. Isabel—I thought you said Hazel, I say whoa. [Laughter.]

Mr. PHILLIPS. I remember it though. I was in the U.S. Navy, stationed in Norfolk.

Mr. SCHROCK. You said you have been here a long time I believe it.

Mr. PHILLIPS. That is true I was an officer in the U.S. Navy at the time of Hurricane Hazel stationed here in Norfolk.

Mr. SCHROCK. It destroyed this place.

Mr. PHILLIPS. That is right.

Mr. SCHROCK. Ms. Hanmer.

Ms. HANMER. To make a point, a really quick point about trees, trees are our best BMP. You have heard about sewage treatment plants, you have heard about farms, but the riparian forest buffer program was pioneered in the Chesapeake Bay Program by the Forest Service, that one of our most cost effective ways to meet the challenges is a vigorous program for riparian forest restoration. The tributary strategies contain a number of specifics like this. All the States have taken our allocations and our water quality criteria and they have developed a very specific plan for what needs to be done.

So, the first thing we need is the funding to achieve the goals that the States have put in those tributaries strategies, and we need political will and public support. Visibility, like this is important. Even though we think we are doing a lot and we are writing tributaries strategies and we are doing standards, I do not think we have been able successfully to penetrate the minds of all the people in the watershed that this is not a problem that some big industry will solve. This is a problem that needs us all, and so political will and support. We have to enforce Federal, State and local laws especially for stormwater and sewage treatment plants with great vigor. And I think at the end of the day we really need this understanding and visibility that the bay is in trouble, and the bay needs to be cleaned up. It can be cleaned up and in fact if we do not act now it will only get worse.

Mr. SCHROCK. This may be cruel and unusual punishment, but maybe every person who faces the bay needs to be forced to read your testimony.

Ms. HANMER. Sorry.

Mr. SCHROCK. Now, I did, and it is amazing what I learned from that, that I did not know anything about. I assumed a lot and by reading your testimony you would be amazed how I am coming at this from a different perspective, I really am.

The Chesapeake Bay Program has been around for what a couple of decades. Why all of a sudden the recent surge in criticism, any of you? Yes, ma'am.

Ms. HANMER. I would say it is exactly what you said that is what people will ask. They expect the government or the Chesapeake Bay Program to clean up the bay and it has been 20 years. And especially the rainy weather in 2003, the unusual wetness led to dissolved oxygen problems in the bay that people had not seen for awhile and they were very shocked about it. Certainly, through our Web site you can follow those water quality monitoring results every 2 weeks, and so you ask yourself why is something not being done. I think that is the criticism.

In our case, we can answer from a standpoint of the program activities what we are doing, but as you see it is not nearly enough. I do not believe that the Chesapeake Bay Program, those of us who are the bureaucrats and the State agencies can do this job by ourselves. I think we have the right plan and the right standards, and the right allocations, but we need help in mobilizing the actions on the ground.

Mr. SCHROCK. That is a good segue to ask the Secretary the other question I was going to ask him. Overall do you believe that there is a constituency across State agencies regarding programs that deal with the Chesapeake Bay, and is there a fluid coordination among agencies as well as a coordination with other Chesapeake Bay States?

Mr. MURPHY. That is a difficult question, Congressman Schrock, because I think there is good news and bad. There is cross agency cooperation at the State level, but it is not perhaps as effective as it should be. The natural resources secretariat do not include all of the agencies that have an impact on water quality.

Mr. SCHROCK. The DEQ for instance.

Mr. MURPHY. Well, DEQ is within the secretariat, but outside of the secretariat.

Mr. SCHROCK. Outside, OK.

Mr. MURPHY. Under the Secretary of Commerce and Trade for example, there is the Department of Agriculture, and the Department of Forestry. These areas have a direct impact and yet there are in a different secretariat, so that the coordination between the agencies within the secretariat of Natural Resources and the agencies outside of the secretariat are not as strong as they should be. The Virginia Highway Transportation Commission, for example, the Department of Transportation, has a tremendous impact on water quality through its construction projects, and while there is coordination and cooperation between the agencies I think it could stand to be strengthened.

Across inter-jurisdiction lines, yes, and Ms. Swanson as the executive director of the Chesapeake Bay Commission, can speak to that as well. There has been over the 20 years that I have been involved strong dialog and cooperation between the jurisdictions. On the other hand, there is a perception that some have acted more quickly and more effectively than others. And we need I think to continue to promote the cooperation, rather then pointing fingers and blame, we really need to try to—

Mr. SCHROCK. Let me ask you and Ms. Swanson, how do our efforts compare with the efforts of other Chesapeake Bay States, somebody gave some figures a few minutes ago, I think it was you.

Ms. SWANSON. You mean Virginia's efforts.

Mr. SCHROCK. Virginia's efforts compare with the other States we were talking about here.

Ms. SWANSON. Well, right off the bat, one of the things—even before I answer that question, I think, you know in my time with the Commission if I have learned one thing it is never expect sameness.

Mr. SCHROCK. Right.

Ms. SWANSON. And never believe that all the States are the same culturally, ecologically, socially, economically, by any measure. And never forget that the Chesapeake Bay region spans the Mason Dixon line. And as a result, there are entirely different forms of government. It is north meeting the south with town rule, meeting this broad swath, and so, the No. 1, is to immediately compare is an immediate error.

Mr. SCHROCK. Good point.

Ms. SWANSON. Instead what I would say is that there are certain things that each State has led on. Virginia, clearly is in the lead on native oyster restoration efforts, for example. Virginia when it comes to point source changes. Maryland took an entirely incentive-based approach with this recent surcharge, you know, to essentially with money, incentivize the installation of nitrogen removal. Virginia is taking an entirely different tack. Obviously it will take considerably longer, but it is a regulatory approach. And so, if it works, you know, it stands to endure because it is not based on the availability of money.

So, I could go on and on depending on the subject, whether it is crabs, oysters, and I would say that Virginia has indeed done a great deal to protect the Chesapeake Bay. Is it enough? No. That is why we are here.

Mr. SCHROCK. Are you ready to go back to 1607.

Ms. SWANSON. No, I do not think question ultimately is monitoring versus monitoring or who is telling the truth or why did it all just now come to fruition, you know, this question of how far we have gone. I think the issue at the end of the day is by any measure modeling, monitoring, body of law, money availability, you measure it, and basically we are not far enough. And so, we need to address that. When you look nationwide, at other programs with multiple States, we are farther along than that.

Mr. MURPHY. May I Congressman?

Mr. SCHROCK. Sure.

Mr. MURPHY. In response to Ann's comments regarding the different approaches that Virginia and Maryland have taken with regard to nitrogen and phosphorous reduction. The fact that we do have these regulatory programs underway, that does not mean that I feel or that I would not recommend that the State appropriate funds to assist the localities in meeting those regulatory funds. I do not mean by instituting the regulatory programs to indicate that I feel that the cost of implementing those regulations should be borne solely by the ratepayer and the private land owner. I think that there is an appropriate role for the Federal and State governments to make in assisting the localities in achieving compliance with those regulations.

Mr. SCHROCK. Thank you, Mr. Chairman.

Chairman TOM DAVIS. Well, thank you very much. I think that is all the questions we have for this panel, it has been great testimony. We appreciate it, hopefully we can take some action.

So, I will dismiss this panel we will do a 5-minute recess and then convene the next panel.

[Recess.]

Chairman TOM DAVIS. We are going to move to our second panel. Theresa Pierno, who is the vice president for Environmental Protection and Restoration, Chesapeake Bay Foundation. Donald Boesch, who is the president, Center for Environmental Science, University of Maryland. Linda Schaffner, associate professor, Virginia Institute of Marine Science. We have Eileen Hofmann, the professor of ocean, Earth and atmospheric sciences, Old Dominion University. Frances Porter, executive director, Virginia Seafood Council, and Mark Wallace, Eastern Shore Watermen's Association.

It is our policy that we swear you in before you testify. So if you rise and raise your right hands.

[Witnesses sworn.]

Chairman TOM DAVIS. Your entire statements are in the record you do not need to use your full 5 minutes, but we have a light here in the middle that has green for your first 4 minutes and then it turns orange after 4, and when you see it turn red, if you try to move to summary, we can move through this crisply. We have everybodys testimony read and digested here that is in writing so, you can emphasize the main points in your oral testimony. We will not gavel should you go over though.

Thank you very much for being with us.

STATEMENT OF THERESA PIERNO, VICE PRESIDENT FOR ENVIRONMENTAL PROTECTION & RESTORATION, CHESAPEAKE BAY FOUNDATION

Ms. PIERNO. Thank you, Chairman Davis, and thank you Representative Schrock for having me here today. It is a pleasure to speak on behalf of the Chesapeake Bay Foundation.

It is really our hope that the additional attention that the news and certainly unfortunately, a lot of the effects of water quality have brought on this issue will really help to guide additional resources and efforts and leadership so that we can really see the changes and the progress that we need to see in order to really have a restored bay. My fear is that in my lifetime if we continue at the same rate of progress that we have been going the last 20 years, then I will not live to see a restored bay. And in fact, with the additional growth as projected and the changes in land use it is very possible that it might even be a further deteriorated Chesapeake Bay and tributaries.

So, I really do appreciate the attention and certainly your leadership to this issue. I think that one of the things I want to talk about right away and get out of the way is really the modeling and monitoring issue. You know, in our opinion the model is an excellent tool and we say that in our testimony. But, we think it really has been used in a way that has not been as beneficial and has been used really as an expectation far more then it is capable of. And so, therefore, I think the public in general and even our leadership and our legislators are really under a false premise that the Chesapeake Bay is really improving, and a lot of the attention and communication over the last several years has been very positive. In fact, recently I had a reporter say to me that it was not until the Washington Post article recently that they were given the approval to cover this story because their editor said, why should we talk about the Chesapeake Bay, it is doing well. And so, I think it is really critical if we are going to be calling for the kinds of resources that are going to be necessary to turn and the tide on this and really see the improvements we need, it is going to take a little bit public understanding and education as well as our leadership to really understand the critical need here.

Certainly, the debate is not about whether we have seen progress or not. Certainly there has been some progress, but part of the problem is due unfortunately to the increase in population that and an ever-increasing loss of forest and wetlands that continue to make it more difficult. And that is just going to require more and more effort. In fact, what we have found and we have given you a copy of our manure report as well as our sewage report along with the state of the bay that the Chesapeake Bay Foundation does.

And what we found is there are some things that we can be doing and that we need to do very quickly. We cannot afford to continue to take an approach that allows for a lengthy time period to take place before we see action. We know with sewage treatment plants there is technology today. Ms. Hanmer basically suggested that about 96 wastewater treatment plants were using BNR and have been upgraded and that is correct. But, unfortunately that is not the latest and best technology that has been out for many years now, and the reality is about 98 percent of the wastewater treatment plants in the watershed are not using the best technology and have not upgraded to what is considered 3 milligrams per liter.

So, I think the reality is we need resources and we need attention to this and quite frankly we need EPA to enforce the Clean Water Act and to require permit limits that do address nitrogen and phosphorous limits in wastewater treatment plants. And in fact, more recently in December of last year, we petitioned EPA requesting that they do just that and we have still not gotten a formal response from EPA. So, you know what we are saying is certainly nothing new and nothing you have not heard. Agriculture is a major impact, we need further support and there are things that you can do. I concur with Ms. Swanson, when she went through her list related to the farm bill, that is also in our testimony, as well as the action for the sewage treatment plants. Stormwater, through the Federal transportation bill, and safety. There is an opportunity to add additional support for urban stormwater reductions. As well as air and if we do not take action and I mean action we talked about tripling the needed resources. It is very difficult for our agencies, our Federal agencies, to stand up here and say that sorry we are not getting the resources we need. And if we continue to get a lack of resources, we are not going to be able to do the job that we have all committed to.

That is the reality at the State and Federal level, and I am here to say please understand the critical need and that we certainly support the efforts and the work that has been done and we have been part of a lot of that work. And we are not here to criticize that. But, we are here to ask you and I think from what I have heard, your really very thoughtful questions, that you do understand the critical need. And that we would ask you to do whatever you can to get those resources flowing to the Chesapeake Bay watershed so that we can really see the kinds of recovery and improvement that we all hope for.

Thank you.

Chairman TOM DAVIS. Thank you very much. Dr. Boesch.

[The prepared statement of Ms. Pierno follows:]

August 20, 2004

STATEMENT OF
THERESA PIERNO
VICE PRESIDENT FOR ENVIRONMENTAL PROTECTION AND RESTORATION
CHESAPEAKE BAY FOUNDATION
BEFORE THE
COMMITTEE ON GOVERNMENT REFORM
HEARING ON "SAFEGUARDING THE CHESAPEAKE BAY"

Summary

The Chesapeake Bay is dying as a result of pollution, and progress in reducing pollution has been insignificant in terms of improving the Bay's health. For more than 20 years, Bay scientists have known that nitrogen and phosphorus pollution are the largest obstacles to the restoration of local rivers, streams, and the Bay, and today science has developed a road map for restoration.

That road map was developed through the use of a computer model, one of the most advanced ecosystem models in the world, which allows scientists to assess pollution sources from across the watershed, test hypotheses, and evaluate the potential impact of management options.

The Chesapeake Bay Foundation (CBF) applauds the science behind the modeling effort but believes that to evaluate the health of the Bay, it is essential to judge progress with monitoring data. In fact, in most of the Bay and its tributaries the data show no improvement or declining trends.

The lack of progress stems directly from a lack of sufficient funding and adequate accountability. Commitments made are routinely broken. For example Tributary Strategies, which map actions necessary to reduce pollution, are years late and remain incomplete. To date, the strategies don't outline how they will be monitored, who is responsible, milestones to measure progress, or funding sources. The Bay states and EPA have also been delinquent in implementing or enforcing the Clean Water Act by not requiring permit discharge limits for nitrogen and phosphorus pollution.

Finally, to reduce pollution and restore the Chesapeake Bay, substantially greater investments will be needed from federal, state, and local governments as well as the private sector.

CHESAPEAKE BAY FOUNDATION
Save the Bay

State of the Bay

One of the most common questions CBF receives from the public is "How is the Bay doing?" In order to answer this seemingly easy but complex question, CBF developed an annual State of the Bay Report, which examines 13 of the most critical indicators to the Bay's health. To create the State of the Bay Report, CBF scientists examine the best available current and historical information for indicators in three categories: pollution, habitat, and fisheries. Although we seek advice from other Bay scientists, ultimately the best professional judgment of CBF scientists determines the value assigned each factor. While no single number can fully convey everything that is occurring in the Bay, CBF's State of the Bay Report does present an overall representation and some historical context.

The current state of the Bay is measured against the healthiest Chesapeake we can describe--the rich and balanced Bay that Captain John Smith described in his exploration narratives of the early 1600s, supplemented by accounts of other early seventeenth-century visitors and some sophisticated scientific detective work. Smith explored the Chesapeake when clear water revealed meadows of underwater grasses, oyster reefs so prodigious they posed threats to navigation, and abundant fish. The Bay that John Smith saw rates 100 and is our benchmark. While CBF recognizes that a Bay of 100, is impossible in this modern age, a Bay at 40 could be achieved in the short term if current commitments are kept, and a Bay of 70 could be possible in the long term.

In 2003, the CBF State of the Bay index was 27, which represented the first decline in the index since CBF first released the report in 1998. CBF estimates that the State of the Bay reached its lowest point in the early 1980s, and improved slightly since that time, but that the Bay is still existing only at approximately one-quarter of its full potential. Many scientists outside CBF have supported this overall conclusion of the Bay's health.

The single most important commitment made in the Chesapeake 2000 Agreement by all of the Bay jurisdictions and the federal government was to reduce nutrient and sediment pollution sufficiently "to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act." To guide this effort, Bay scientists have developed a very innovative and scientifically based approach to define conditions specific to each tributary and habitat of the Bay for three key water quality factors: dissolved oxygen, algae abundance, and water clarity. These three factors will be the most crucial in meeting the Bay's water quality goals and are the ultimate measure of progress for Bay restoration.

Like animals on land, nearly all of the Chesapeake Bay's aquatic life, from worms and crabs on the bottom, to perch and striped bass above and underwater grasses in between, depend on oxygen to survive. Low dissolved oxygen (DO) levels, called hypoxia, can impair growth and reproduction and stress living resources, making them vulnerable to disease. Water with no oxygen, called anoxic, will kill most aquatic animals.

Over the last four decades, the volume of hypoxic and anoxic water in the Chesapeake Bay has more than tripled. Last year, dissolved oxygen was too low to support a healthy ecosystem in more than 40 percent of the mainstem of the Bay, stretching from south of Baltimore to the York River. This July, it was more than 35 percent of the Bay's mainstem.

Frighteningly, on average, dissolved oxygen levels in bottom areas of the Bay begin to decline in March, becoming hypoxic in May and not returning to healthy levels until October or November. This means that bottom areas of the Bay suffer from decreasing or low levels of dissolved oxygen for roughly ten months a year. In addition, data from both Maryland and Virginia show unhealthy levels of oxygen affecting many local rivers as well.

Bay Program monitoring and analysis show very little progress on dissolved oxygen and that in many places conditions have worsened. Ninety percent of the monitoring stations in the Bay and the tidal tributaries show no improvement or worsening of summer bottom dissolved oxygen levels or water clarity from 1985 to 2003. In addition, 82 percent of the monitoring stations showed no improvement or worsening of *chlorophyll a* (algae abundance) from 1985 to 2003. Nitrogen and Phosphorus pollution are the largest controllable factors influencing dissolved oxygen, algae abundance, and water clarity.

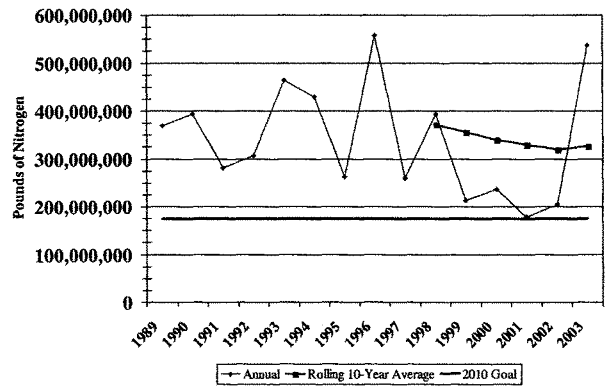
In 2003, CBF calculated total nitrogen and phosphorus loads to the Bay based to the maximum extent on monitoring data. Using the reported loads from USGS monitoring from above the fall line and EPA monitoring data for point sources below the fall line, CBF was able to account for 74 percent and 67 percent of the nitrogen and phosphorus loads, respectively, directly from monitoring data. CBF extrapolated the monitoring data to the total nutrient load using relationships documented in the Bay Program model.

CBF's calculations show that the amount of nitrogen and phosphorus pollution entering the Bay each year varies considerably. Consequently, the Bay's health varies greatly from year to year as well. In years of low pollution, the Bay's levels of dissolved oxygen, water clarity, and algae improve and in years of high pollution those levels decline.

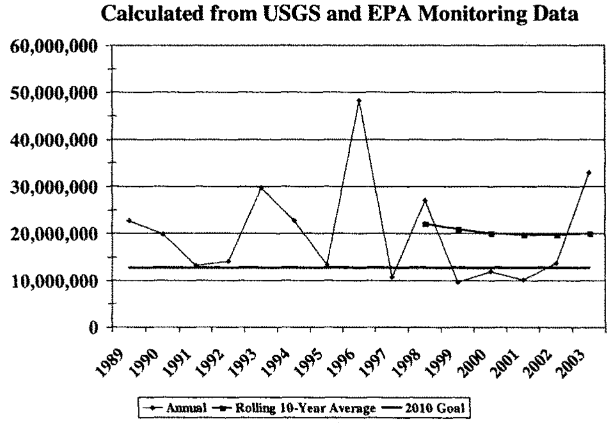
An example of the impact of that variability is the astounding 535 million pounds of nitrogen pollution flowing into the Chesapeake Bay in 2003, and 33 million pounds of phosphorus pollution. The model, looking at long-term averages, does not account for the variability and therefore does not reflect the damage caused by high amounts of pollution.

The most common way to examine the effects of management practices is to adjust for natural variability. When this is done using a rolling 10-year average, CBF's calculations show a decrease in average nitrogen and phosphorus load to the Bay between 1998 and 2002, with a slight increase in 2003. These trends are similar to the Bay Program model results and the USGS adjusted flow concentrations. The average total nitrogen load, however, is 16 percent higher than that projected by the Bay Program model, an indication that more pollution reduction will be necessary.

Chesapeake Bay Nitrogen Pollution
Calculated from USGS and EPA Monitoring Data



Chesapeake Bay Phosphorus Pollution
Calculated from USGS and EPA Monitoring Data



Overall, the progress in reducing pollution has been insignificant in terms of improving the Bay's health. While averaged, flow-adjusted, or model results have shown that management actions are having an effect, they have not been implemented to the scale necessary to see substantial improvement in the Bay's health. All measures of Bay health and nutrient pollution reduction show that we have far to go to remove the Bay from the impaired waters list.

Limits to Progress

Two key factors have limited the progress in restoring the Bay's health: resources and accountability. Increases in both of these elements are critical in order to achieve the 2010 commitments in the Chesapeake 2000 Agreement.

Both the Chesapeake Bay Commission and EPA have analyzed the costs of achieving the water quality commitments of the Chesapeake 2000 Agreement. The EPA looked specifically at the cost of achieving the nutrient and sediment pollution reductions across each jurisdiction in the watershed and determined both capital costs and annual operating costs. Their analysis estimated that the total annual cost including both capital and operating costs would be $1.1 billion annually in order to achieve the water quality standards over a ten-year period (2001-2010).

The Chesapeake Bay Commission examined the cost of meeting all of the Chesapeake 2000 commitments for Virginia, Maryland, and Pennsylvania. It based its analysis on many of the same practice cost estimates and practice implementation levels as the EPA analysis. However the CBC also determined the 2003 level of funding already devoted to achieving the goals, thereby identifying a funding gap. The results showed that achieving the water quality commitments accounted for 63 percent of the total costs of Chesapeake 2000 and would require $11.5 billion over eight years (2003-2010). Current funding levels for nutrient and sediment reductions efforts would provide $2.1 billion, therefore an additional $9.4 billion, or four times the current funding levels, will be required to achieve the 2010 commitments.

There is no question that significantly greater resources will be required to restore the Bay's health. Maryland has already taken a substantial step through the establishment and funding of the Chesapeake Bay Restoration Fund that will provide approximately $1 billion for sewage plant upgrades, septic system improvements, and key agricultural practices. The Chesapeake Bay Watershed Blue Ribbon Finance Panel is examining strategies to close the remaining funding gap. When viewed in the broader context of the overall impact that the Chesapeake Bay has on the region and the nation, the required funding is quite small. The estimated cost of achieving the water quality commitments for the Bay amount to only 0.4 percent of median household income of the Bay watershed. Furthermore, the estimated cost is only 1.7 percent of the 1989 economic value of the Bay.

To be successful, increased funding must be accompanied by increased accountability. Past performance relative to commitments to restore the Chesapeake Bay demonstrate that without strong leadership, those commitments will go unmet.

In the 1987 Chesapeake Bay Agreement the Executive Council (EC) committed to reverse the decline in the Bay's health and outlined goals and timelines. Specifically, the EC set a goal of reducing nitrogen and phosphorus pollution in the Chesapeake Bay by 40 percent by 2000. To achieve that pollution reduction and improve water quality, the 1987 Agreement outlined specific strategies, many which still have not been fully implemented:

Commitment	**Outcome**
➢ "Evaluate and institute, where appropriate, alternative technologies for point source pollution control, such as biological nutrient removal and land application of effluent to reduce pollution loads in a cost effective manner;	➢ Fifteen years later, two-thirds of the sewage treatment plants in the watershed did not use biological nutrient removal or any other technology to reduce nutrient pollution.
➢ "Establish and enforce pollutant limitations to ensure compliance with water quality laws;" and	➢ In 1998, the Bay and the tidal portions of its tributaries were formally designated as impaired by nutrient pollution under the federal Clean Water Act. EPA and the states have yet to implement, let alone enforce, nutrient pollution limitations as required by the Clean Water Act to reduce nitrogen pollution.
➢ "...develop, adopt and begin implementation of a basin-wide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorous entering the mainstem of the Bay."	➢ As of today, the 40 percent goal is unmet Bay-wide.

CBF remains concerned over the lack of implementation of the new Chesapeake 2000 Agreement (C2K) and its commitments and timeframes. Concerning water quality, the agreement committed to:

Commitment	**Outcome**
➢ "By 2001, define the water quality conditions necessary to protect the Bay's aquatic living resources and then assign load reductions for nitrogen and phosphorus to each major tributary;"	➢ Not accomplished until 2003, two years behind schedule.
➢ "Using a process parallel to that established for nutrients, determine the sediment load reductions necessary to achieve water quality conditions and assign load reductions for sediment to each major tributary by 2001;"	➢ Not accomplished until 2003, two years behind schedule.
➢ "By 2002, complete a public process to develop and begin implementation of revised Tributary Strategies to achieve and maintain the assigned loading goals;" and	➢ Not completed; implementation won't begin until after December 2004, assuming the revised tributary strategies are completed according to the revised Bay Program goals.
➢ "By 2003, the jurisdictions would use their best efforts to adopt new or revised water quality standards consistent with the defined water quality conditions."	➢ Adoption of new or revised water quality standards have just begun and will not be complete until at least 2005.

The EPA and the Bay jurisdictions have also been delinquent in implementing and enforcing the Clean Water Act. The Clean Water Act requires that all sewage treatment plants and industrial discharges operate with permits that are sufficiently stringent to protect water quality. These permits, called National Pollution Discharge Elimination System (NPDES) permits, are to include specific, quantitative limitations for individual parameters such as toxic pollutants. NPDES permits are generally issued by state governments, with oversight and approval responsibilities retained by the U.S. Environmental Protection Agency.

CBF has concluded that the Clean Water Act requires that NPDES permits include specific limits for nitrogen and phosphorus pollution in Chesapeake Bay. However, only a handful of the hundreds of sewage treatment and industrial permits include such limits. The EPA Assistant Administrator for Water affirmed in a recent letter that NPDES permits must contain nitrogen and phosphorus limits sufficient to protect water quality.

The Clean Water Act also requires the states to identify waters that fail to meet established water quality parameters. This "impaired waters" list includes the Chesapeake Bay and the tidal portions of its tributaries as a result of excessive levels of nitrogen and phosphorus pollution. For impaired waters, the Act requires the development of a Total Maximum Daily Load (TMDL). A TMDL is a regulatory tool that identifies specific sources of pollution and sets forth a plan to remove the impairment caused by that pollution.

In 2000, the EPA agreed to let Bay watershed states work together voluntarily to remove the Bay from the "impaired waters" list by 2010, rather than imposing Clean Water Act mandates for the development of a TMDL. Three and a half years later, not one state in the watershed is on track to reduce nitrogen and phosphorus pollution to the levels necessary to remove the impairments.

As a result of the EPA and the Bay jurisdiction's failure to implement and enforce the Clean Water Act, CBF filed a petition to compel EPA to comply with the requirements of the Clean Water Act (copy attached). CBF's petition outlines a far-reaching series of remedies for the EPA to assure compliance with the Clean Water Act's requirements, including:

- New, enforceable permit limitations for nitrogen and phosphorus at sewage treatment plants and industrial discharges, consistent with the goals of C2K;
- New, technology-based standards for sewage treatment plants and industrial discharges that reflect modern, affordable techniques for controlling pollution (EPA has not revised its sewage technology standards since 1984);
- Development of a regulatory TMDL for the Chesapeake and impaired tributaries before allowing the states to issue permits for new or expanded sources of nitrogen and phosphorus pollution; and,
- Assuring that at least 25 percent of federal grant money be directed toward reducing nitrogen and phosphorus pollution from sewage treatment plants.

In response to many of the issues raised in CBF's petition, EPA recently announced a draft proposed permitting strategy for sewage and industrial treatment plants in the Bay watershed that purports to require nutrient pollution limits in the permits. However, this "new" approach in fact fails to specify any new measures or commitments that the states must implement now to address their nutrient reduction obligations under the Clean Water Act. In fact, it actually allows them to backslide from current requirements of the Act until finalization of new state standards for the Bay and its tributaries, even though those standards are already two years late.

Needed Actions

In order to achieve the 2010 commitments for the Chesapeake Bay, actions to increase resources and accountability must be taken immediately for each of the major sources of nutrient pollution: point sources, agriculture, stormwater, and air pollution.

Point sources – EPA and the Bay jurisdictions must enforce the Clean Water Act and immediately require that permit limits for nitrogen and phosphorus discharges be included in permits for sewage treatment plants and industrial facilities. Maryland has already established a mechanism to increase funding for sewage treatment upgrades. Virginia and Pennsylvania must now follow suit and the federal government must increase its share of the needed funding.

Agriculture – Both federal and state funding for agricultural practices must increase to provide $250 million annually to assist farmers in the Bay watershed. The next federal Farm Bill provides an opportunity to create a funding structure that will continue to support America's farmers but also comply with new global trade rules by rewarding good environmental performance. Public subsidies of agricultural operations should ensure that water quality goals are met.

Stormwater – A portion of public funds supporting new development and roads should be dedicated to addressing the nutrient and sediment pollution associated with those sources, and the development community should internalize initial stormwater management costs as well, across the watershed. The new federal transportation bill (TEA-LU in the House of Representatives and SAFETEA in the Senate) should dedicate 2 percent of the surface transportation program funds to addressing stormwater pollution from highways.

Air Pollution – EPA and the Bay jurisdictions must fully utilize and implement the Clean Air Act to achieve reductions in nitrogen deposition in the Bay watershed. Specifically, the EPA and the Bay jurisdiction should stop delaying compliance with previous one-hour standards under State Implementation Plans. EPA must also enforce new source reviews consistent with the Clean Air Act to curb the amount of nitrogen pollution deposited in the Bay from mid-west power plants, and should promulgate new requirements for year-round Nox controls for those facilities.

Conclusions

The Bay's living resources and the people who depend on them for a living continue to suffer as a result of the lack of significant progress in restoring the Bay's health. The Chesapeake Bay restoration effort has the best science of any major aquatic ecosystem in the world identifying what the problems are, what solutions are needed, and mapping out a strategy for attainment. However, the resources and accountability have been insufficient to produce any significant progress in restoring the Bay. EPA and the Bay jurisdictions must enforce and implement the already existing laws that are intended to clean up our waters. Substantially greater investments must also be made to protect and enhance the value of the Chesapeake to local communities, the region, and the nation.

STATEMENT OF DONALD F. BOESCH, PRESIDENT, CENTER FOR ENVIRONMENTAL SCIENCE, UNIVERSITY OF MARYLAND

Mr. BOESCH. Yes, Chairman Davis and Mr. Schrock, it is really a pleasure to be here. I thank you for your invitation.

That this opportunity comes at historic Fort Monroe is particularly meaningful for me. In 1968, I undertook, as an extremely young scientist I would indicate, my first scientific research right here in Hampton Roads, just on the other side of the Spit. And the publication of that research really launched my career, so this area, Hampton Roads in particular, has a very strong meaning for me. And I, like Ms. Pierno, hope that I can see the restoration of the bay on my watch, as a scientist first and living in this region.

As you know by now, the principal cause of the rapid degradation of the Chesapeake Bay ecosystem that was observed during the 1970's and 1980's after I really started my research actually, was the multifold increase in loading up the estuary with nutrients, particularly nitrogen. And you have heard many different perspectives on how we are making progress in reducing nutrient loads to the bay. We know that nitrogen inputs from municipal wastewaters for example, have in fact, been reduced by 23 percent since 1985, this is no mean feat given the fact that we have had an increase in population and wastewater volumes to handle, increasing by 45 percent. So, we should recognize that we have made significant progress in a number of areas.

Where we seem to have some confusion is with regard to the non-point source run off which dominates the inputs of nitrogen and phosphorous. And this is where we have to get the modeling and monitoring right to understand exactly what we are doing and the effect that we are having.

For a large part of the watershed drained by rivers monitored by the USGS, concentrations of nitrogen and phosphorous discharges have generally been declining, at least when adjusted, as Mr. Phillips indicated, for river flow. While the watershed model obviously also estimates a downward trend in nutrient concentrations, the actual amount of the decrease differs. And it is important to know what it really is and why they are different and how we can improve these estimates as we move along. And to improve our basis of estimates of progress in the real world.

An important point made in greater detail in my written testimony and in the testimony of Ms. Pierno, gets lost in the use of model estimates to track progress. That is, despite our efforts, the total amount of nutrients actually reaching the bay over the past 10 years or so is more or less the same as during the early benchmark of the years of the Chesapeake Bay Program. This was as many witnesses earlier indicated because of the fact that we had this period of extremely high climatic variability with river inflow on the average higher than in the benchmark years or over the long run.

As an analogy let me see if I can help you understand this. It is as if you were trying to cut back on your sugar intake and you succeeded in using say 15 percent less sugar in your cup of coffee.

Mr. SCHROCK. Bite your tongue.

Mr. BOESCH. But somehow you were forced to drink 15 percent more coffee so your total sugar intake would not change, even though you have been successful in reducing your sugar per cup of coffee. So it is important to understand that, because that is what the bay actually has been seeing, rather than what we have been projecting on the basis of average-year models. And this explains to a great degree why we have not seen more success from our efforts in the bay in terms of improved signs of recovery.

As it was discussed in more detail in my written testimony for two important indicators of the health of the bay, the extent of serious oxygen depletion or hypoxia during the summer months and the abundance of submerged grasses, I have not seen convincing evidence of changes or trends for the bay as a whole that cannot be clearly explained by variations in fresh water inflow rather then the results of management actions to reduce nutrient inputs. Hypoxia shrinks and grasses spread in dry years or as a result of dry years. When this and other ephemeral phenomena such as population explosions in mussels as we have in some tributaries of the upper bay occur, we should avoid irrational exuberance, and the temptation to claim success. On the other hand, when hypoxia expands and grasses contract during very wet years we should resist inconsolable depression and placing blame. This is the reality of what we have to deal with.

Bay program models have been designed to answer, "what if," or more appropriately, "what will it take" questions important in setting program goals. The recent application of watershed and estuary models to determine the new Chesapeake Bay 2000 nutrient reduction goals has been the focus of government agencies, Ms. Pierno and I both agree, are exemplary in the inclusion of strong scientific expertise and peer review.

There is scientific consensus that achieving these nutrient reduction goals will achieve the desired restoration outcome. The current controversy, therefore, regarding estimates of progress to date should in no way undermine public confidence in the use of these models for setting these goals as we move forward.

However, the public is misled by statements that nutrient loading has actually been reduced by certain amount based on watershed model estimates and accomplishments. There are obviously uncertainties about the efficiencies and levels of implementation and management practices. Furthermore, there are lag times as was talked about earlier and inter-annual variations that are not represented in the models and these need to be addressed.

The Chesapeake Bay region endowed by the largest and most accomplished community of estuarine scientists in the world. This is in no small measure the reason we have gotten this far in getting the understanding of the nature of the problems and the challenges that we need to address. From both the government and university sides, intellectual and material resources are fully engaged in advancing knowledge and critical assessment to advance bay restoration goals. And specifically we need to work with the agencies in improving these models and the models of the monitoring results.

All of the witnesses before you agree on two things, the Chesapeake 2000 goals are worthy and we are seriously behind the schedule in meeting water quality restorations by 2010. Let me close with an analogy, another analogy, that maybe helps you understand the nature of the problem. We are at a football game, and this is based on—an analogy based on nitrogen, our progress with nitrogen. We are behind 42 to 14, it is the beginning of the fourth quarter and we are still trying to run the ball up the middle. We need to not only play strong defense to keep the other side from scoring, that is for example, really kind of control and stop sprawl which will make the challenge even more difficult. But we need to throw long, we need to go long, in Maryland we recently did that. Governor Ehrlich and the General Assembly with strong popular support, public support, passed a restoration fund that basically ratepayers pay for the sewage treatment improvements. So, we should be going, once we get the ball in the end zone to 3 milligrams per liter limits, the limits of practical technology as a result of that.

The other area where the Federal Government can assist us just to underscore, agriculture. Agricultural policy and what farmers have to deal with is largely set by Federal policies with respect to subsidiaries and rules and regulations and the like. And also, air quality, please pursue rigorously the air quality objectives under the Clean Air Act amendments and we will gain a significant reduction to the nitrogen input as a result.

Thank you, very much for the opportunity.

Mr. SCHROCK. Mr. Chairman, may I make one quick comment? One of the nicest things you have in your testimony that you did not share with people, I am going to. You said in March 1970 I stood with my young wife in front of the Chamberlain Hotel right down the street. As we watched a total eclipse of the sun over Willoughby Bay, an experience that overwhelmed us with awe for the natural world. That is really neat. I agree with you.

Mr. BOESCH. I also said that we will not see another one of those in our lifetime. Maybe, we will see the bay restoration.

Mr. SCHROCK. I was trying to be upbeat about this.

Chairman TOM DAVIS. Are we still in the fourth quarter, or are we just in the second half?

Mr. BOESCH. Pardon.

Chairman TOM DAVIS. Are we in the fourth quarter, or are just in the second half?

Mr. BOESCH. If we start the beginning of the game in 1987, when the bay States said we are going to reduce nutrients to the Chesapeake Bay, and the end of the game is 2010 we are just about at the end of the third quarter.

Chairman TOM DAVIS. Dr. Schaffner.

[The prepared statement of Mr. Boesch follows:]

Committee on Government Reform
U.S. House of Representatives

Hearing on Progress in Safeguarding Chesapeake Bay
August 20, 2004

Testimony of
Dr. Donald F. Boesch
President, University of Maryland Center for Environmental Science
Cambridge, Maryland

Chairman Davis and members of the Committee, I am pleased to have this opportunity to offer my perspectives on progress made in restoring the Chesapeake Bay.

That this opportunity comes at historic Fort Monroe is particularly meaningful for me. In 1968 I undertook my first independent scientific research with a study of the animals that live on the bottom of Hampton Roads. The publication of that research truly launched my career. In March 1970 I stood with my young wife in front of the Chamberlin Hotel as we watched a total eclipse of the sun over Willoughby Spit, an experience that overwhelmed us with awe for the natural world. Although a magnificent body of research has now demonstrated that human impacts on the Chesapeake Bay began well before I began studying it, regrettably its lapse into seriously poor health, with widespread oxygen depletion and disappearance of extensive seagrass meadows, mainly occurred since the 1960s—on my watch, so to speak. While none of us here today will live long enough to observe another solar eclipse from Fort Monroe, I certainly hope I can chronicle, and maybe even assist, the Bay's recovery to good health during my remaining tenure as a scientist.

I will do my best to address the charge of your invitation to assess the state of the Bay, progress that has been made in restoring it, and the appropriate use of modeling and monitoring in reporting progress. More importantly, I will offer some suggestions about what we can do to accomplish this mission while I am still standing watch.

Have Nutrient Loads Been Reduced?

As you know by now, a principal cause of the rapid degradation of the Chesapeake Bay ecosystem observed during the 1970s and 1980s was the multifold increase in loading the estuary with nutrients, particularly nitrogen. A substantial body of evidence indicates that the Chesapeake Bay Program has been successful in turning this trend around for the Bay as a whole since the 1980s. Nitrogen inputs from municipal wastewater discharges (point sources) have, in fact, been reduced by 23% since 1985—no mean feat because wastewater volumes have increased by 45%. Because of the phosphate detergent ban coupled with improved waste treatment, phosphorus discharges from wastewaters have declined by 80% since 1970. We have high confidence in these point-source reductions because they are directly measured and reported. In addition, for the large part of the watershed drained by rivers that are monitored by the USGS, concentrations of nitrogen and phosphorus in the river discharges have generally been declining. However, this is not uniformly the case; there is evidence that some rivers and Bay tributaries influenced mainly by coastal plain drainage may actually have experienced increasing nutrient inputs. While the watershed model obviously also estimates a downward trend in nutrient concentrations, the actual amount of decrease differs greatly between model and monitoring estimates. In my opinion, more detailed analysis is required before progress in reducing nonpoint source inputs can be confidently estimated based on observations consistent with model estimates.

Declining nutrient concentrations do not necessarily mean that the Bay has been receiving lower nutrient inputs. Even if nutrient concentrations decrease, high river inflow can mean that the amount of nutrients delivered to the Bay (what we call loading) actually increases. For example, the nutrient loads delivered by the major rivers in 2003 were the second highest since 1990 because of very high freshwater inflows last year. River inflows into the Bay have been unusually variable and, on average, higher than normal during the period we have been attempting nutrient reductions. Of the 11 years of record since 1992 only two fell within the normal range of annual river inflow to the Bay, while inflow was higher than the normal range for five years and below the normal range for four years. Despite the general decline in nutrient concentrations, the average annual total nitrogen loading from the four rivers with a suitably long monitoring record to allow comparison (Susquehanna, Potomac, Patuxent, and Choptank) was slightly greater (5%) since 1992 than it was for the period 1985-1992. With the reductions in point-source contributions factored in, the average annual loading of total nitrogen was essentially the same for the years before and after 1992. The same is true for phosphorus.

I would summarize, then, by saying that the average loadings of nutrients actually delivered to the Bay over the past decade or so were not less than during the beginning the Chesapeake Bay Program, largely because of the higher than normal freshwater inflows experienced over that period. It should not be surprising, therefore, that we have not seen much improvement in the symptoms of nutrient overenrichment in the Bay. Unqualified statements that nutrient inputs have been reduced by a certain stated amount based on a watershed model that assumes unvarying, normal flow conditions do not comport to the reality of a highly variable Chesapeake Bay. Nonetheless, generally declining nutrient concentrations at the fall lines, together with documented point-source reductions, indicate we are making progress in reducing nutrient sources, although the amount of progress remains difficult to quantify for nonpoint sources.

Is Hypoxia Getting Better?

The short answer to this question is that there is no convincing evidence that the extent of serious oxygen depletion of Bay bottom waters during the summer has been reduced since 1985. Again, we have to keep in mind the highly variable freshwater inflows in recent years. Higher flows not only deliver more nutrients, but also intensify the density stratification of Bay waters that is also an important contributing factor to hypoxia. On the other hand, drought years such as 2001 and 2002, are characterized by much less severe hypoxia. So, deducing trends over this highly variable period is tricky business at best. Moreover, strong wind events can mix Bay waters, causing a shrinking of the volume of hypoxia during any part of the summer.

EPA analysts have found no significant trends in the summertime (June-September) volume of moderate hypoxia (dissolved oxygen <2 mg/l) and anoxia (<0.2 mg/l or virtually no dissolved oxygen) between 1985 and 2002.[1] In many areas around the world, including the famous Gulf of Mexico Dead Zone, the 2 mg/l concentration of dissolved oxygen is used to delimit harmful hypoxia because, in general, mobile animals such as fish and crustaceans are seldom found when the concentrations dip below this level. The EPA analysts did report a significant decreasing trend in the volume of water with dissolved oxygen levels less than 5 mg/l (a concentration reflecting some oxygen depletion but that is generally not lethal) during this same period, but remember the unusually dry years of 1999, 2001 and 2002, with predictably lower extent of hypoxia, occurred at the tail end of that record. The inclusion of 2003 in this analysis produced a problematic outcome because it was a high flow year with extremely extensive, moderate-to-severe hypoxia during the first half of the summer, which was alleviated somewhat by mixing from storms during the later part of summer. In conclusion, I would have to say that the claim of "recent indications of improving trends since 1985" on the Bay Program website was premature and failed to consider the confounding effects of flow variability and weather.

Another analysis of trends in hypoxia was recently published by my colleagues James Hagy and Walter Boynton[2]. It covers a longer period, from 1950 through 2001. Their study showed convincingly that little or no anoxia occurred prior to our solar eclipse in 1970, except in unusually high river flow years, but has since become a regular feature of the Bay, even during drought years. An analysis of the long-term statistical trend showed that the volume of moderate hypoxia has increased almost three-fold for an average flow year. The complex multiple linear regression technique used suggests that hypoxia continued to grow through the 1990s, however if just the period after 1985 was examined, there was no significant trend up or down. Therefore there is no inconsistency in the findings of the University of Maryland scientists and the EPA: there is no statistical evidence that the volume of anoxia or moderate hypoxia (2 mg/l) has decreased or increased since 1985.

In their work, my colleagues uncovered an intriguing and very troubling relationship between nutrient loading and the volume of hypoxia in the Bay, namely that the extent of hypoxia for a given level of nitrogen loading seems to have increased. That is to say, the Bay appears to have lost some of its ability to assimilate nutrients without becoming seriously hypoxic. While we do not understand the reasons for this—it could be related to longer-term effects on the benthic community—this diminished resilience probably means that we simply have to accomplish much more reduction in nutrient loading before we see greatly reduced hypoxia.

What About Other Indicators?

As Director Hanmer has pointed out to you, the Chesapeake Bay Program employs many other indicators to track progress in Bay restoration in addition to estimating nutrient

[1] Communication from Marcia Olson, August 12, 2004.
[2] Hagy, J.D., W.R. Boynton, C.W. Keefe, and K.R. Wood. 2004. Hypoxia in Chesapeake Bay, 1950-2001: Long-term change in relation to nutrient loading and river flow. *Estuaries* 27:634-658.

concentrations and loadings and the extent of hypoxia. Some of these indicators, for example populations of striped bass, shad and waterfowl and riparian forest buffers, have been on the upswing. Some of the needles on the gauges have barely moved at all, while some, such as oyster populations and nontidal wetlands, have been moving in the wrong direction. An important biological indicator of water quality, the areal extent of submerged grasses (commonly referred to as SAVs) that provide such a critical habitat, has increased slightly from the start of the Bay Program in the early 1980s, but has leveled off during the 1990s, far below our restoration goals. The annual surveys provide encouragement during dry years as we find more grasses and discouragement during high flow years, when the grasses retreat. I don't know if we should claim much credit for the expansion in acreage that did occur. This took place between 1984 and 1989, when our efforts to control nitrogen from wastewaters and agriculture were just beginning had not yielded any appreciable results, and may have just represented longer term recovery after the devastation of Tropical Storm Agnes in the 1970s. However, we have seen some encouraging signs of SAV recovery in localized areas that are likely the result of reduction of nutrient pollution.

What Are the Appropriate Uses of Modeling and Monitoring?

The Chesapeake Bay Program has the benefit of the most comprehensive and powerful models of the watershed and estuary of their kind and a very extensive and competent environmental monitoring program. Scientists in my institution and their colleagues in Virginia and Pennsylvania have contributed extensively to both the modeling and monitoring programs and agency managers have every right to be proud of them.

Bay Program models have been designed to answer "what if" or, more appropriately, "what will it take" questions important in setting Program goals. They are strategic, not tactical. The recent application of the watershed and estuary models to determine the new Chesapeake 2000 nutrient reduction goals was exemplary in the inclusion of scientific expertise and peer review. Because of the openness and rigor of the process, there is a strong scientific consensus that achieving those nutrient reduction goals will achieve the desired outcomes. The current controversy regarding estimating progress to date should in no way undermine public confidence in the use of these models for setting achievable goals.

However, it is clearly misleading to state that nutrient loading has actually been reduced by a certain amount based on watershed model estimates of accomplishments, even if various elements of the model have been calibrated with field measurements. There are obviously uncertainties about the efficiencies and levels of implementation of management practices as well as inescapable imperfections in how well the model itself mirrors nature. Furthermore, lag times, which delay the effect of pollution reduction actions for several years, and interannual variation in river flow, which can result in atypically large or small inputs of nutrients, are not represented in the present watershed model. They will be incorporated in the next generation of the model currently under development.

I suspect that the Program espoused model-based estimates of progress that are over-simplified because of the natural human tendency of managers to look on the bright side, promote optimism and encourage future progress. That said, I would hope that the current controversy would: (1) make managers and policy makers more aware of the uses and limitations of both modeling and monitoring; (2) prompt them to promote a scientific culture of organized skepticism; (3) strengthen its efforts in environmental monitoring and interpretation of monitoring results; (4) develop and employ models that are appropriate for addressing interannual variability and event-scale processes (e.g. storms); and, most importantly, (5) advance the thorough integration of modeling and monitoring in order to better achieve the requirements of adaptive management[3]. The Chesapeake Bay region is endowed with the largest and most accomplished community of estuarine scientists in the world. From both the governmental and university sides, we need to work to ensure that their extraordinary intellectual and material resources are fully engaged in advancing knowledge and critical assessment to advance Bay restoration goals.

What It Will Take To Restore The Bay?

All of the witnesses here today agree on at least two things: (1) the Chesapeake 2000 goals are worthy and (2) we are seriously behind schedule in meeting the water quality restoration goals by 2010 and need to accelerate our efforts. There is close agreement between the nutrient reduction targets developed through the strategic use of Bay Program models and the more empirical estimates by Drs. Hagy and Boynton of what it would take to eliminate anoxia as a recurring problem. The attainability analyses performed by the Bay Program and the Scientific and Technical Advisory Committee's *Chesapeake Futures* report[4] both demonstrate that we have the ability to meet these targets. Yet, we are nearly three-quarters into the game begun in 1987 with the first commitment for reductions in nutrient loading and, even if one accepts the model estimates of progress, we are only about one-third of the way toward the nitrogen reduction goal. More aggressive public policies and investments are clearly required.

In Maryland, our General Assembly recently passed, and even expanded, Governor Ehrlich's bold proposal for levying statewide user fees (the so-called "flush tax") to fund sewage treatment improvements that would reduce nitrogen concentrations in wastewater to 3 mg/l. If other states took similar steps, perhaps assisted by some strategic federal assistance, we would greatly reduce point-source nutrient inputs and have capacity of handling growing wastewater streams without degrading the Bay.

Significant reductions in nitrogen loading can also be achieved if we aggressively implement the existing Clean Air Act. That would significantly reduce atmospheric deposition that accounts for at least 25% of nitrogen loading to the Bay.

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[3] Please see the report of a National Research Council panel I recently chaired on adaptive management: National Research Council. 2004. *Adaptive Management for Water Resources Project Planning*. National Academy Press, Washington, DC.

[4] Boesch, D.F. and J. Greer (eds.). 2003. *Chesapeake Futures: Choices for the 21st Century*. STAC Publication 03-001. Chesapeake Research Consortium, Edgewater, MD.

Reductions of urban nonpoint sources of nutrients will require expensive retrofitting of stormwater management systems. However, these sources are still a small slice of the nutrient pie and can be dealt with incrementally. The biggest challenge regarding urban nonpoint sources is, of course, continued urban, suburban and exurban sprawl, which threatens to undo gains made in reducing nutrients from other sources. Our *Chesapeake Futures* report depicts three scenarios representing present development trends, smart growth and smarter growth to show the importance of our future growth decisions on whether a healthy Bay can be achieved and sustained.

The most daunting obstacle to reducing nutrient loading to the point where the Bay can be "delisted" as an impaired water body remains agriculture. The tipping point for the health of the Bay, and in many other coastal ecosystems around the world, was clearly associated with the dramatic increase in the use of manufactured fertilizers in the 1960s and 1970s. Agriculture remains the largest source of both nitrogen and phosphorus for the Bay. Reductions in agricultural nonpoint sources have been difficult because of limitations in the effectiveness of management practices and economic constraints. However, *Chesapeake Futures* identified existing and emerging technologies and policies that could accomplish nutrient source reduction objectives. We need to fully and vigorously implement practices we can apply today (nutrient and animal waste management, cover crops, etc.), bring to implementation emerging practices and approaches (diet modification, precision agriculture, manure treatment, etc.), and adapt future agricultural production systems that have less impact on water quality (alternative crops, bio-energy/carbon sequestration, etc.).

These will require alignment of national agricultural and environmental policies and this is where you as Members of Congress can help. The 2002 Farm Bill provided many of the tools needed to reduce nutrient impacts from current crop and animal production systems as well as offering opportunities for long-term adaptation. Funding for the Environmental Quality Incentive Program (EQIP) increased five fold but needs greater targeting to nutrients and water quality issues in regions like the Chesapeake and Mississippi River basins. The Conservation Security Program (CSP) would pay incentives to farmers for increasing levels of conservation. The CSP was authorized at $7.7 billion but the Administration's FY 2005 budget request is only $205 million, with only one small watershed in Pennsylvania eligible. The CSP could replace production subsidies with conservation subsidies in the long term and thereby be the answer to World Trade Organization objections to current production subsidies while providing a major tool in water quality improvement. A regional CSP pilot program for the Bay watershed could provide a tool we need in the short term and help the Department of Agriculture refine the program for broad national implementation. Finally, two years ago the Governors of the Bay states submitted a five year, $100 million dollar proposal to the Secretary of Agriculture for funding through the Partnership and Cooperation Program in which conservation programs can be bundled to support innovative regional partnerships. However, the USDA has not acted on this proposal. This is an immediate step that could be taken to reduce agricultural impacts on the Bay and the regional Congressional delegation should urge the Secretary to support implementation of this already authorized program.

Mr. Chairman, thank you again for the opportunity to speak with you. I know that the restoration of the Chesapeake Bay can be achieved on my watch. I hope that we have the will to seize the opportunities before us to make that happen.

STATEMENT OF LINDA SCHAFFNER, ASSOCIATE PROFESSOR, VIRGINIA INSTITUTE OF MARINE SCIENCE

Ms. SCHAFFNER. Chairman Davis and Mr. Schrock, thank you for inviting me to speak to you today. I am associate professor of the School of Marine Science, at the College of William and Mary and the Virginia Institute of Marine Science. I also serve as the president of the Estuarine Research Federation, which is an international scientific society that has a membership of over 2,000 scientists, educators, and managers who are committed to the acquisition and application of sound scientific knowledge to sustain the integrity of estuarine and coastal systems.

I am going to take a slightly different tack in my testimony and I am not going to focus too much on things that other people have said a lot about already. I want to bring up some other things that I think are important as well.

Just 4 months ago, the U.S. Commission on Ocean Policy released its draft findings and recommendations that we need a coordinated and comprehensive national ocean and coastal policy. The Commission found abundant evidence of degraded water quality depleted fisheries and vanishing wetlands throughout the Nation's coastal and estuarine areas and they determined that the problems require urgent attention. So, I can assure you that we are not alone in our concerns about the state of our estuary.

As a scientist who has been working in the bay community for over 20 years, the multiple indicators of bay health lead me to conclude that the Chesapeake Bay is a significantly degraded ecosystem and I made a medical analogy, the bay has cancer, not a common cold. But, the bay is resilient, and I believe it can be restored. I am not going to touch on modeling and monitoring, I do agree with the comments that have been made by Dr. Boesch.

I do want to say that the U.S. Commission on Ocean Policy calls for ecosystem-based management of ocean and coastal resources. And this is always been a major goal of the Chesapeake Bay Program, which really since its inception has been admired and emulated throughout the United States and worldwide.

Just last year I was up in Maryland when a group from Thailand came over to learn how to run a watershed management program. The program has successfully brought scientists, managers, industry, and citizens to the table to discuss complex environmental issues, and develop strategies for dealing with these issues. I also want to emphasize to you that academic scientists have significantly contributed to the success of the bay programming objectives. They provide the program with unbiased credible and up to date scientific information and a point that I did not state clearly enough in my written testimony is that they provide essential peer review. Much of the focus today has been on the funding, we need to support nutrient reductions.

I also want to use this opportunity to stress the importance of strength in funding for science research efforts. Much of the research conducted by the bay's scientists has been supported by funding coming from outside the bay program via other mission oriented agencies, for example, NOAA, and USGS, other parts of EPA, and the National Science Foundation which plays a key role in supporting basic research. These agencies could see budget declines of

5 to 10 percent or more annually over the coming years. The U.S. Commission on Ocean Policy expressed concern that the Federal agencies supporting ocean and estuary research are in fact chronically under-funded.

We in the bay community cannot afford these declines in research support at a time when we face increasingly complex scientific questions and management issues. We have been focusing on nutrients today, but looming on the horizon are problem issues such as harmful algae blooms, non-native species, the sediment loading we talked about, and fisheries collapse. So, you our Members of Congress can help by voting for increased appropriations for science funding in these agencies.

There is no question that achieving the ambitious goal of restoring the Chesapeake Bay to a healthy sustainable ecosystem will require increased scientific capacity in this Nation. Recognizing the challenges that we face in managing our ocean and coastal resources, the Ocean Commission calls for the creation of a new national ocean policy framework, better coordination among Federal agencies, a doubling of Federal research investments in ocean science, and improved environmental education. All of these recommendations have relevance in our discussion about how to accelerate the restoration and protection of the Chesapeake Bay.

Others have spoken in a more informed way on the specific policies and levels of funding we need to obtain Chesapeake Bay 2000 goals. But it is clear to me that we need both political will and strength in financial commitment. There is no time like the present for action particularly for those of us that are concerned with the Chesapeake Bay.

Thank you.

Chairman TOM DAVIS. Thank you very much. Ms. Hofmann.

[The prepared statement of Ms. Schaffner follows:]

Written Testimony of
Linda C. Schaffner, Ph.D.
Associate Professor, Virginia Institute of Marine Science

"Progress in Safeguarding the Chesapeake Bay"
Committee on Government Reform
U.S. House of Representatives
Field Hearing, Hampton, Virginia
August 20, 2004

Chairman Davis, Congressman Schrock, and Members of the Committee, my name is Linda Schaffner. I am an Associate Professor of the School of Marine Science, College of William and Mary and the Virginia Institute of Marine Science (VIMS). I also serve as the President of the Estuarine Research Federation (ERF), an international scientific society with a membership of over 2000 scientists, educators, and managers who are committed to the acquisition and application of sound scientific knowledge to sustain the integrity of estuarine and coastal systems. Thank you for inviting me to speak to you today.

I will begin by diagnosing the current health of the Chesapeake Bay estuarine ecosystem based on the many indicators available. I also want to comment on the importance of monitoring and modeling as tools in the scientific toolbox and the importance of science-informed management in the Chesapeake Bay restoration efforts. Finally, I will reflect on what is needed to move us forward towards our goal of a healthy, sustainable Chesapeake Bay.

An Estuary Under Stress

The Chesapeake Bay is one of the world's largest, most diverse and productive estuarine systems. Its watershed is home to a significant percentage of the U.S. population. We all understand the key role the Bay has played in supporting bountiful harvests of commercial and ecologically valuable species, such as crabs, oysters and fish. We also recognize the Bay's importance in support of transportation and industry and the need for it's ports and harbors. Tourists and recreational fishermen enjoy the Bay and contribute to local economies. Many of us value the Bay for its natural beauty. In addition, scientific research has highlighted the important ecological services provided by the Chesapeake Bay and other estuaries. Unfortunately, the very features that promote high productivity and facilitate its use, make the estuary highly vulnerable to human effects, which in turn jeopardizes these goods and services.

Just four months ago the U.S. Commission on Ocean Policy[1] (USCOP) released its draft findings and recommendations for a coordinated and comprehensive national ocean and coastal policy. The USCOP found abundant evidence of degraded water quality, depleted fishery resources, and vanishing wetlands throughout the Nation's coastal and

[1] http://www.oceancommission.gov/

estuarine areas and determined that these problems require urgent attention. In a study released in 2003, the Pew Oceans Commission[2] independently reached a very similar conclusion that our oceans and coastal systems are in severe distress. I can assure you that we are not alone in our concerns about the state of our estuary.

Human alteration of the Chesapeake and its watershed began hundreds of years ago, but the most significant activities have been during our lifetime. When I first arrived to the Bay community as a graduate student in 1976, a favorite late fall activity was roasting oysters over an open fire with a group of friends on a Saturday night. Over-harvest, disease, and habitat alteration have now resulted in the near demise of the native oyster. The oysters I buy in my local grocery store come from the Gulf of Mexico or the west coast. The once clear, shallow waters of the Bay are now turbid, and the submerged grasses that once flourished there, providing critical habitat for juvenile fishes and crabs, are 60% less abundant than they were 40 to 50 years ago[3]. Each summer, a blanket of water that is devoid of essential oxygen smothers communities of small bottom dwelling (benthic) invertebrates throughout the deeper waters of the Bay. This is important because these benthic communities support the Bay's food web and also play a role in helping to cleanse the Bay of excess nitrogen, a key nutrient fueling eutrophication. For 2002, scientists estimated that about 50% of the Chesapeake Bay and 65% of the Maryland tidal waters failed to meet the restoration goals set for these communities[4].

For most of the indicators we use to gauge the health of the Bay, the available monitoring data allow us to examine trends over only the last few decades, not the last 100 years or more. When we look back even further – for example, using markers preserved in the accumulated muds of the deep floor of the Bay- we find evidence of the longer history of human alteration of the Bay's structure and function. This record tells us that sediment loading to the Bay increased when farmers began extensive clearing of the watershed, that the composition of pollutants entering the estuary has changed over time and that a record of increasing hypoxia and anoxia in bottom waters parallels a trend of increasing nutrient fertilization. Just as we expect a doctor to diagnose our health using multiple indicators, these indicators of Bay health lead me to conclude that the Chesapeake Bay is a significantly degraded ecosystem. To continue with the medical analogy, the Bay has cancer, not a common cold.

But, there is always room for more positive thinking. Like many of my colleagues, I have seen evidence of the Chesapeake Bay's resilience – its natural capacity to recover from disturbances. Each year scientists working in and around the Bay's meadows of submerged aquatic vegetation (SAV) report the presence of grass seedlings in the deeper waters outside of the existing beds[5]. The production of seeds and subsequent growth of seedlings are examples of the natural processes that help to make populations resilient

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[2] http://www.pewoceans.org/

[3] Robert Orth and Ken Moore, Virginia Institute of Marine Science, communication on August 16, 2004

[4] Llansó, R. J., L. C. Scott and F. S. Kelley. 2003. Chesapeake Bay Water Quality Monitoring Program, Long-term Benthic Monitoring Component Level 1 Comprehensive Report, Prepared by Versar, Inc. for Maryland Department of Natural Resources, September 2003.

[5] Robert Orth and Ken Moore, Virginia Institute of Marine Science, communication on August 16, 2004

despite environmental variations. Under present Bay conditions, the grass seedlings generally don't survive the summer due to light limitation caused by eutrophication and suspended sediments. The expansion of SAV meadows in drought years, when reduced freshwater flow reduces the problematic nutrient loadings, and the declines of SAV in wet years, when nutrient loadings tend to increase, gives us insights into what might happen if we could turn off the "nutrient faucet."

Every year, and especially during the spring, benthic invertebrates -- clams, worms and small shrimp-like creatures called amphipods -- reproduce and send innumerable larvae into the waters of the Bay. If you dredge a channel in the lower Bay, where the water quality is still relatively good, you will see initial colonization of the bottom in only a few weeks, and most of the natural community will be completely restored in only a year or two. Many of these larvae also reach the deepest channels where they settle and grow until the summertime levels of dissolved oxygen in the overlying waters become limiting. While restoration of dissolved oxygen to the deepest bottom waters is considered to be one of the most difficult problems we face, it seems likely that these areas would rapidly recover their productivity if given a chance.

Modeling and Monitoring

Scientists in the estuarine science community, including those working as a part of the Chesapeake Bay Program, have repeatedly demonstrated that the combined use of powerful modeling approaches and good observational data can lead to rapid advances in scientific understanding. The ever-increasing power of today's computers allows us to model the complexities of natural systems in ways that were unthinkable only a decade ago. Models help us to understand how aquatic systems respond to various scenarios, such as variations in rainfall or changes in land use, independent of what is happening at any given time in the "real world." They can be used to forecast future changes in an ecosystem, and to test, for example, whether implementation of specific policies and management strategies will be successful. Conversely, monitoring data document trends in the "real world" and give us a needed reality check for our models. The data obtained via well-designed monitoring programs can be used to constrain the models and to verify model predictions.

Attempts to weigh the relative merits of modeling or monitoring are misguided – they are two sides of the same coin. We need both and they should be used in concert to understand and verify where we are in our efforts to restore the Bay. Good communication and exchange of information between monitoring and modeling efforts is essential. Although this needed level of communication may be relatively easily established and maintained when a program is small, it can be considerably more difficult to attain when a program is large or when different agencies are responsible for modeling versus monitoring programs. The current discussions should make everyone more sensitive to the need to maintain good communication and present a consistent overview of the findings of the monitoring and modeling efforts.

The Importance of Science-Informed Management

In its April 2004 draft report, the USCOP called for ecosystem-based management of ocean and coastal resources and recommended that management "... reflect the relationships among all ecosystem components, including human and nonhuman species and the environments in which they live." This has always been a major goal of the Chesapeake Bay Program (CBP), which since its inception has been admired and emulated throughout the U.S., and worldwide, as a model for ecosystem-based management. The CBP, working in partnership with the states and various agencies, has provided both a structural framework and leadership that helped to focus one of the world's strongest estuarine science communities, build well-designed and executed environmental monitoring and modeling programs, create an environmentally-informed public and spearhead new approaches to environmental policy development and governance. The program has successfully brought scientists, managers, industry and citizens to the table to discuss complex environmental issues and develop strategies for dealing with these issues.

When I met with colleagues at the Virginia Institute of Marine Science earlier this week in preparation for this testimony, they reflected positively on their interactions with the CBP. We agreed that program has done a good job of soliciting science input on the issues, asking scientists to review programs, recommendations and strategies, and practicing science-informed management. When a CBP manager wants something from you, he or she will find you. The CBP program helps to keep us focused. The holistic view that many of us working in the Bay's science community have of the Bay and its ecosystem can be attributed, in my opinion, to the structure and synthesis the CBP has promoted.

I also want to emphasize that academic scientists, many employed at the major state universities around the Bay, have significantly contributed to the success of the CBP objectives. They provide the CBP with unbiased, credible and up-to-date scientific information. The Bay's scientists have led the way in the development of state-of-the-art modeling approaches, experimental approaches in the lab and the field and well-designed monitoring programs to address both the basic and applied questions posed by managers. Many have been exemplary "scientist-citizens," working in service to the Chesapeake Bay Program for the greater good.

Much of the focus today will be on the funding need to support nutrient reduction in support of efforts to restore the Bay's water quality. I also want to use this opportunity to stress the importance of funding for science research efforts. Much of the research conducted by the Bay's scientists has been supported by funding coming from outside the CBP, via other mission-oriented agencies, such as NOAA, ONR, DoD and USGS, other parts of EPA, and the NSF, which plays a critical role in supporting basic research. A number of recent reports and analyses, including those by the American Association for the Advancement of Science (AAAS), indicate that these agencies could see budget declines of 5 to 10% or more annually over the coming years[6]. In their draft report, the USCOP expressed concern that the federal agencies supporting ocean and estuarine research are, in fact, chronically under-funded. We in the Bay community cannot afford these declines in research support at a time when we face increasingly complex scientific questions and management issues. You, our Members of Congress, can help by voting for increased appropriations for science funding in these agencies. I strongly encourage you to support the doubling of the budget for the National Science Foundation, an authorization that was passed by the 107th Congress and signed into law by the President.

There is no question that achieving the ambitious goal of restoring the Chesapeake Bay to a healthy, sustainable ecosystem will require increased scientific capacity, including:

- utilization of the latest technologies and approaches, such as real-time data collection and observing systems to increase monitoring capacity and ensure the collection of the highest quality data, while improving the cost efficiency
- expansion of monitoring programs to evaluate impacts and guide research, not just in the Bay's main stem, but in the tributaries and extensive shoal areas that remain understudied
- support of basic research that will lead to rapid improvement in the integration and synthesis of existing and new information using the most advanced techniques and the most powerful modeling approaches – this will allow scientists to turn data systems into knowledge systems
- improvement in our ability to integrate across the disciplines of natural science, economics, and social systems, and at larger spatial scales and greater temporal resolution
- improvement in our ability to rapidly and effectively share an ever growing body of knowledge, in order to facilitate wise decisions by all about use of the Bay's resources.

Moving Forward for a Healthy, Sustainable Chesapeake Bay

Recognizing the challenges we face in managing our ocean and coastal resources, the USCOP called for the creation of a new national ocean policy framework, better coordination among federal agencies, a doubling of federal research investments in ocean science, and improved environmental education. All of these recommendations have relevance in our discussion of how to accelerate the restoration and protection of the Chesapeake Bay. Others have or will speak in a more informed way on the specific policies and levels of funding needed to attain the Chesapeake 2000 goals. It is clear that both political will and strengthened financial commitments are necessary. We need the public and all of our elected representatives to recognize the true value of the Chesapeake Bay to the Nation. There is no time like the present for action, particularly for those of us concerned with the future of the Chesapeake Bay.

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[6] Schaffner, L.C. 2004. Science Advocacy: The 10% Solution. *Estuarine Research Federation Newsletter* 30: 1, 13-14. and additional articles by D.M. Allen, R. Magnien, and J. Bartholomew. Available on the web at: www.erf.org.

STATEMENT OF EILEEN HOFMANN, THE PROFESSOR OF OCEAN, EARTH AND ATMOSPHERIC SCIENCES, OLD DOMINION UNIVERSITY

Ms. HOFMANN. Chairman Davis, Congressman Schrock, thank you for the opportunity to appear before you today. I am a professor in the Ocean, Earth and Atmospheric Sciences Department at Old Dominion University.

My comments are in three parts and provide an academic perspective on modeling and monitoring. The first part addresses the importance of maintaining modeling and monitoring programs. The second part describes an ongoing effort to advance modeling of the Chesapeake Bay system. And the final part of my comments provides an example of a new direction for modeling in the Chesapeake Bay system.

Predictions of nutrient loadings and the extent of regions of low-oxygen water in an estuary such as Chesapeake Bay are difficult at best. The recent controversy suggests that the Chesapeake Bay modeling and monitoring program results are incompatible.

The reliance on models versus monitoring data for assessing the state of the system has long been debated within the marine science community. It is now recognized that both are needed. Combining data via models provides a powerful approach for understanding marine systems and for making predictions about future States. To suggest that the Chesapeake Bay Program abandon or lessen its reliance on models in favor of a data-only approach is not appropriate and is not in keeping with the current state of understanding and scientific abilities. So, what can be done to better integrate the bay program modeling and monitoring efforts? An effort now ongoing in the Chesapeake Bay academic and research communities provides an approach for how this might be done and that brings me to the second part of my comments.

In the 1990's, the scientific community of the region participated in a review, through the Chesapeake Bay Scientific and Technical Advisory Committee, of the Chesapeake Bay model. The committee report noted that the modeling and monitoring components of the Chesapeake Bay Program were not well integrated, that the Chesapeake Bay circulation water quality watershed models did not have the ability to include in simulations the effects of processes such as variations in freshwater inflow, which we have heard a lot about today. And I also think variability in winds which are known to influence nutrient loading and dissolved oxygen distributions, and that the reliance on a single model structure had slowed scientific advances and reduced estimates of confidence.

A positive result of this review was the development of a grassroots modeling effort within the Chesapeake Bay scientific community, which has now become the Chesapeake Community Modeling Project. The goal of the Chesapeake Community Modeling Project is to improve the ability to model and predict physical and biogeochemical processes in the Chesapeake Bay and its watershed. The foundation of this effort is the collaborative open source research oriented modeling framework designed to focus and coordinate the intellectual resources of the Chesapeake Bay research institutions and the broader scientific community. The approach is designed to foster scrutiny of all aspects of the models and simulations including assessments of projections derived from single models that would likely underlie Chesapeake Bay restoration. And this is something that the research and academic community felt like had been missing in the Chesapeake Bay modeling program.

The Chesapeake Bay Program is a partner in this new effort. There is much that the research community and the bay program can provide to one another and the last part of my comments highlights one example.

The Chesapeake Bay Program is in a unique position of having, through its monitoring program, a robust data set with space and time resolution that is adequate for developing and implementing what are called data assimilative models. These are models that incorporate observations into models to adjust the output toward observation. This is an approach used routinely in numerical weather forecasting and ocean circulation simulations. This approach helps to adjust the model and it includes information in it that allows things like freshwater flow variations to influence model simulations. The process of development of data assimilative models may potentially result in revisions to dynamics included in the circulation water quality and watershed models, thereby making comparisons with previous models difficult and perhaps calling into questions previous model-based conclusions. That latter is appropriate, enabling open discussion for science-based resolution, the most beneficial practices for bay restoration.

In summary, the development of data assimilative models is just one example of the change needed in infrastructure, philosophy, and approach for any modeling program. The need to provide accurate predications with far reaching policy and social implications make it imperative that any Chesapeake Bay modeling program be aware of and take full advantage of current practices and advances in marine resource modeling. This will require a long term sustained funding effort.

And in summary I would like to say thank you for the opportunity to address you today, and I will be happy to answer any questions that you may have.

Chairman TOM DAVIS. Thank you very much. Ms. Porter.

[The prepared statement of Ms. Hofmann follows:]

Testimony of Eileen E. Hofmann
Center for Coastal Physical Oceanography
Department of Ocean, Earth, and Atmospheric Sciences
Old Dominion University

U.S. House of Representatives
Committee on Government Reform

Field Hearing on Progress in Safeguarding Chesapeake Bay
20 August 2004
Hampton, VA

Chairman Davis, Congressman Schrock, members of the Committee, thank you for the opportunity to appear before you today. I am Eileen E. Hofmann, Professor in the Department of Ocean, Earth, and Atmospheric Sciences at Old Dominion University in Norfolk, VA. My comments today are based on my research and experience as a scientist and are my own and should not be attributed to Old Dominion University.

My comments are given in three parts. The first part addresses the importance of maintaining modeling and monitoring programs. The second part describes an ongoing effort to improve modeling of the Chesapeake Bay system and the final part of my comments provides an example of a new direction for modeling the Chesapeake Bay system.

I would like to begin my comments by saying that the combined circulation-water quality-watershed model structure and concurrent Bay-wide monitoring program initiated in the mid 1980s by the Chesapeake Bay Program defined a state-of-the-art approach to managing marine resources that has influenced other marine resource management programs. It is now inconceivable that a marine system would be managed without the combined input of modeling and data collection programs. The Chesapeake Bay Program deserves credit for taking such a monumental step at the start.

The Need for Modeling and Monitoring

Predictions of nutrient loadings and the extent of regions of low-oxygen waters in an estuary such as Chesapeake Bay are difficult at best. The recent articles in the public media suggest that implementation of the Chesapeake Bay modeling and monitoring program is problematic and possibly flawed. The apparent discrepancies between results obtained from model simulations and those obtained from data analyses in regard to nutrient loads and dissolved oxygen distributions in Chesapeake Bay have resulted in suggestions that the model does not represent real conditions, that the modeling effort has not made good use of available data, and that the modeling effort be abandoned and only observations be used to determine the state of the Bay.

The reliance on models versus monitoring data for assessing the state of a system has long been debated within the marine sciences community. It is now recognized that both are needed. Data collection systems are capable of providing continuous high-quality measurements. Mathematical modeling and computer technology have made tremendous advances in the past decade. Combining data via models provides a powerful approach for understanding marine systems and for making predictions about future states. So, to suggest that the Chesapeake Bay Program abandon or lessen its reliance on models in favor of a data-only approach is not appropriate and is not in keeping with the current state of understanding and scientific ability. So, what can be done to better integrate the Chesapeake Bay Program modeling and monitoring efforts? An effort now ongoing in the Chesapeake Bay academic and research communities provides an approach for how this might be done and brings me to the second part of my comments.

Chesapeake Community Modeling Project

In the late 1990s, the scientific community of the region participated in a review, through the Chesapeake Bay Scientific and Technical Advisory Committee, of the Chesapeake Bay model by an external committee that included Dr. Scott Nixon from the University of Rhode Island as Chairman and Dr. Hugh Ducklow from the Virginia Institute of Marine Science and me as members. The committee report (available at: http://www.chesapeake.org/stac/stacpubs.html) noted that the modeling and monitoring components of the Chesapeake Bay Program were not well integrated, that the Chesapeake Bay circulation-water quality-watershed models were lacking in ability to include in simulations the effects of processes such as variations in freshwater inflow and winds known to influence nutrient loading and dissolved oxygen distributions, and that the reliance on a single model structure had stifled scientific advances and reduced estimates of confidence in model output.

One result of this review was the development of a "grass roots" modeling effort within the Chesapeake Bay scientific community, which has become the Chesapeake Community Modeling Project (see http://ccmp.chesapeake.org/CCMP and the attached Chesapeake Community Modeling Project Implementation Plan). The goal of the Chesapeake Community Modeling Project is to improve the ability to model and predict physical and biogeochemical processes in Chesapeake Bay and its watershed. The foundation of the effort is a collaborative, open-source, research-oriented modeling framework designed to focus and coordinate the intellectual resources of the Chesapeake Bay research institutions and the broader scientific community, and promote free and open exchange of information, data, models, and results. Within this framework, the Chesapeake Community Modeling Project is developing a range of models and the availability of multiple models will greatly enhance the ability to evaluate model skill and predictions, providing some measure of confidence through multiple model predictions.

An explicit goal of the Chesapeake Community Modeling Project is to develop state-of-the-art, coupled watershed and estuarine models for the Chesapeake Bay region based upon the latest technologies and modeling approaches. This is intended to foster the development of a diversity of approaches and models, and to promote model inter-comparison efforts. This approach fosters scrutiny of all aspects of the models and simulations, including assessments of projections derived from single models that will likely drive Chesapeake Bay restoration. This is something that has been missing in the Chesapeake Bay modeling program.

The Chesapeake Bay Program is a partner in this new effort. There is much that the research community and Bay Program can provide to one another and the last part of my comments highlights one example.

Example of a Potential Change in Modeling Approach

The Chesapeake Bay Program is in a unique position of having, through its monitoring program, a robust data set with space and time resolution that is adequate for developing and implementing data assimilative models of the Bay system; these are models that incorporate observations into the model to 'adjust' model output towards observations, an approach used routinely in numerical weather forecast models and numerical ocean circulation models. Because real data include dynamics responsible for a particular process or distribution in the estuary, inclusion of the observed data will improve model simulations and predictions. Therefore, development of data assimilative circulation, ecosystem, water quality, and watershed models would ensure that the monitoring and modeling efforts are combined.

Combining modeling and monitoring efforts via data assimilation will improve model predictions, model structure, and the design of the monitoring program. The use of data assimilation allows event scale features, such as storms or variations in freshwater inflows, to be resolved and influence model predictions, something not possible with the present Chesapeake Bay model configuration or with the planned Phase 5 modifications to the model.

One note of caution: the process of development of data assimilative models may potentially result in revisions to the dynamics included in the circulation, water quality, and watershed models, thereby making comparisons with previous models difficult and perhaps calling into question previous model-based conclusions. The latter is appropriate, enabling open discussion for science-based resolution of the most beneficial practices for Bay restoration. Data assimilation can be used to determine optimal sampling designs and the frequencies at which data need to be collected, allowing more efficient use of monitoring resources.

In summary, the development of data assimilative models is just one example of the changes needed in infrastructure, philosophy, and approach in the Chesapeake Bay modeling program to bring it to a state-of-the-art system. The need to provide accurate predictions with far-reaching policy and social implications make it imperative that the Chesapeake Bay modeling and monitoring programs be aware of and take full advantage of current practices and advances in marine resource modeling.

Thank you for the opportunity to address you today. I will be happy to answer any questions you may have.

Attachments: 1) Chesapeake Community Modeling Project Implementation Plan, 2) Hofmann current and pending support forms

CRC Community Modeling Project Implementation Plan

Steering Committee:

Raleigh Hood (chair), UMCES
Hugh Ducklow, VIMS
Don Weller, SERC
Bob Wood, UMCES
Peter Wilcock, JHU
Eileen Hofmann, ODU/CCPO
Gary Shenk, CBP
Tom Gross, NOAA
Alexy Voinov/Tom Maxwell, U. Vermont

CRC Staff

Kevin Sellner, Executive Director
Benjamin Hilliard

CRC Member Institutions

The Johns Hopkins University
University System of Maryland
Smithsonian Institution
The College of William and Mary
Old Dominion University
Pennsylvania State University

I Mission Statement

The overarching goal of the proposed CRC member institution-supported Community Modeling Project is to significantly improve our ability to model and predict physical and biogeochemical processes in the Chesapeake Bay and its watershed. The foundation of the effort will be a collaborative, open-source, research-oriented modeling framework designed to focus and coordinate the intellectual resources of the CRC institutions and the broader scientific community, and promote free and open exchange of information, data, models, and results. Within this framework, the Community Modeling Project will develop a range of models serving the research and management communities. An explicit goal will be to develop a new, state-of-the-art, coupled watershed and estuarine model for the Chesapeake Bay region based upon the latest technologies and modeling approaches. However, this effort is also intended to foster the development of a diversity of approaches and models, and promote model inter-comparison efforts. Another major goal of this initiative will be to develop of a suite of models intended for a wide range of purposes, including management, research and operational applications. In so doing we hope to fundamentally change the way in which models are developed, tested and applied in Chesapeake Bay.

II Background and Motivation

In this document, we set forth the rationale, goals and operating plan for implementing a CRC-sponsored, Chesapeake Bay community modeling effort. This Implementation Plan represents the culmination of a series of meetings and workshops and discussion within the Chesapeake Bay modeling community in the past 3 years. Here we provide a brief summary of the key developments and CRC actions leading to the present state.

There is a wealth of expertise in circulation, ecological and watershed modeling at the many institutions in the Chesapeake Bay region. Until now, however, much of this modeling has been largely uncoordinated individual efforts. The reasons for the lack of integration are many, but may stem from a perception that the large-scale models developed by the EPA Chesapeake Bay Program (CBP) fill the need for modeling physical and ecological processes in the region. While the CBP 'Bay Model' has dominated the regional modeling scene for the past decade, many individual investigators have expressed concern that the CBP modeling efforts have become disconnected from the academic research community and that these models are not well-suited for their research and education needs. Moreover, the CBP models offer only one approach and one solution for modeling the watershed and the estuary even though there are alternative models and approaches that can and should be applied. This problem cuts both ways. While research and education would benefit from a more open modeling framework, the CBP effort would benefit from complementary activities and more interaction with the research community.

Acting in response to these concerns and a STAC-sponsored review that was critical of the CBP Water Quality Model (STAC 1999. Review of the water quality model. Edgewater, MD, Chesapeake Research Consortium: pp. 1-79), the CRC convened a small group of CRC member-institution scientists at Linden House, Champlain, VA on June 26, 2000 to discuss the need for a new Chesapeake Bay modeling initiative. The group crafted a short, formal report which stated in part:

"We believe there is urgent scientific need for a new, research-based, long-term program of integrated observations and modeling of estuarine circulation, nutrient dynamics, plankton ecology, benthic ecology, living resources, and sediment dynamics. Although the Bay research community represents a significant expertise in estuarine science, it has not yet availed itself of the modern, cooperative, community-shared style to advance the modeling art. A vigorous initiative is needed to provide the scientific foundation for the next generation of coupled estuarine circulation/ecology models, which in turn is needed to support water quality managers and decision makers in the public policy sphere, and a wide spectrum of research and educational activities. The Chesapeake Research Consortium is an ideal mechanism for coordinating and providing focus for this multi-state, multi-institutional effort." (Linden Group 2000).

The group also identified a list of key principles to guide the initiative they envisioned:
1) Models should be open source and supported by a substantial user community.
2) Models should have institutional homes.
3) Data integration, prediction and uncertainty quantification are essential aspects of the modeling process.
4) Modeling activity should be integrated into the educational mission of the CRC institutions.
5) Models should incorporate modern numerics as well as physical/biological parameterizations.

The Linden House document was presented to the CRC Retreat at Airlie House, VA on July 26, 2000. CRC member institutions accepted the proposal for a new Chesapeake Bay modeling initiative and commissioned a more comprehensive statement (CRC 2000), which was accepted and signed at the December 18, 2000 CRC Board meeting. This agreement committed the CRC institutions to supporting a new modeling effort and charged them with seeking and assigning the resources necessary to improve models and make them accessible, and to implement the observing systems which would provide new data for model assimilation and validation. Since that time, CRC and the modeling community have been engaged in identifying scientific, personnel, institutional and financial resources for the modeling effort.

This latter process finally culminated in a large workshop which was held June 5-7, 2002. The workshop attendees constituted a substantial fraction of the Chesapeake Bay research modeling community, along with field scientists and representatives from other regional community modeling efforts. This group expressed unanimous support for a CRC sponsored modeling initiative and, through 2.5 days of presentation, debate and discussion, provided a set of general guidelines on how to proceed. Following the workshop, a steering committee was formed and officially charged with drafting this implementation plan.

III Scope of the Effort

As articulated by the Linden Group, there is urgent scientific need for a new, research-based, long-term program of integrated observations and modeling of estuarine circulation, nutrient dynamics, plankton ecology, benthic ecology, living resources, and sediment dynamics. Here we expand this statement to explicitly include the Chesapeake Bay watershed and all of the relevant physical, biogeochemical, and ecological processes therein. We include these because the watershed sets the boundary conditions (flow, nutrient and sediment loads) for the Bay proper. Moreover, many of our most pressing environmental problems in Chesapeake Bay stem from the effects of human activities in the watershed (e.g., alteration of the landscape and increased loads due to agricultural activities and urban growth). Yet the resources available to us in terms of state-of-the-art watershed models are surprisingly limited. Clearly, development and refinement of watershed models and watershed modeling expertise needs to be actively promoted. With the watershed included, the need for a new, research-based, long-term program of integrated observations and modeling now includes watershed and estuarine processes and living resources:

1. Landscape and soil biogeochemistry and ecology
2. Stream and wetland ecology and biogeochemistry
3. Surface and groundwater hydraulics and flow
4. Estuarine hydrodynamics and circulation
5. Sediment transport and resuspension
6. Water column and benthic biogeochemistry and ecology
7. Shoreline and intertidal biogeochemistry and ecology
8. Atmospheric forcing and deposition

Clearly, the scope of any comprehensive Bay and watershed-wide modeling effort must be very broad, and must engage a wide range of scientific disciplines in the model development and validation process, including physics, geology, chemistry, biology, ecology and computer science. Moreover, it will require considerable observational and experimental expertise (data and conceptual knowledge) in addition to a computing and modeling research core.

IV Open Source and Collaborative Modeling

The problems identified by the STAC review and the Linden Group are not isolated to the CBP modeling efforts. Development of large-scale models in general has been limited by the ability of any single team of researchers to deal with the conceptual complexity of formulating, building, calibrating, debugging, and understanding complex models. Communicating the structure of the model to others can also become an insurmountable obstacle to collaboration and acceptance of models. The traditional closed team approach to model development often results in a model that is essentially a "black-box" as far as the rest of the research and management community is concerned. We believe that developing the next generation of complex computer models, capable of supporting research, management and operational applications in Chesapeake Bay, requires a new, collaborative approach to modeling based on established open-source modeling approaches.

Collaborative modeling environments are software tools designed to operate over a network to allow diverse, groups of researchers to work together on a project, sharing data and computer resources, and communicating ideas, data and results in real time. The need for such tools is a consequence of the increasing complexity and multidisciplinarity of the research, and of the increasing delocalization of research groups. Many approaches to collaborative research are possible, depending on which collaborative model is considered and which level of collaboration is required. Approaches vary from the simple, asynchronous sharing of data and code to the incorporation of conflict resolution algorithms within multi-agent models.

A well-recognized method for reducing conceptual and programming complexity involves structuring a model as a set of distinct modules with well-defined interfaces. Modular design facilitates collaborative model construction, since teams of specialists can work independently on different modules with minimal risk of interference. Modules can be archived in distributed libraries and serve as a set of templates to speed future development.

A second step toward reducing the complexity of the modeling process involves the utilization of graphical, icon-based module interfaces, wherein the structure of the module is represented diagramatically, so that new users can recognize the major interactions at a glance. One major advantage of this graphical approach to modeling is that the process of modeling can become a consensus building tool. The graphical representation of the model can serve as a blackboard for group brainstorming, allowing students, educators, environmental managers, policy makers, scientists, and stakeholders to all be involved in the modeling process.

Here we propose to develop an internet-based research platform for developing a suite of models that support modularity and take advantage of graphical module interfaces. This platform will provide a universal modeling language and an interactive hub to promote open collaborative development of a new suite of Chesapeake Bay models.

V The Chesapeake Bay Community Modeling Project

The overarching goal of the CRC Community Modeling Project is to significantly improve our ability to model and predict physical and biogeochemical processes in the Chesapeake Bay and its watershed. To achieve this goal we will construct a research-oriented modeling framework that will change the way in which research and management-oriented models are developed, tested and applied in Chesapeake Bay. This modeling framework will be designed to:

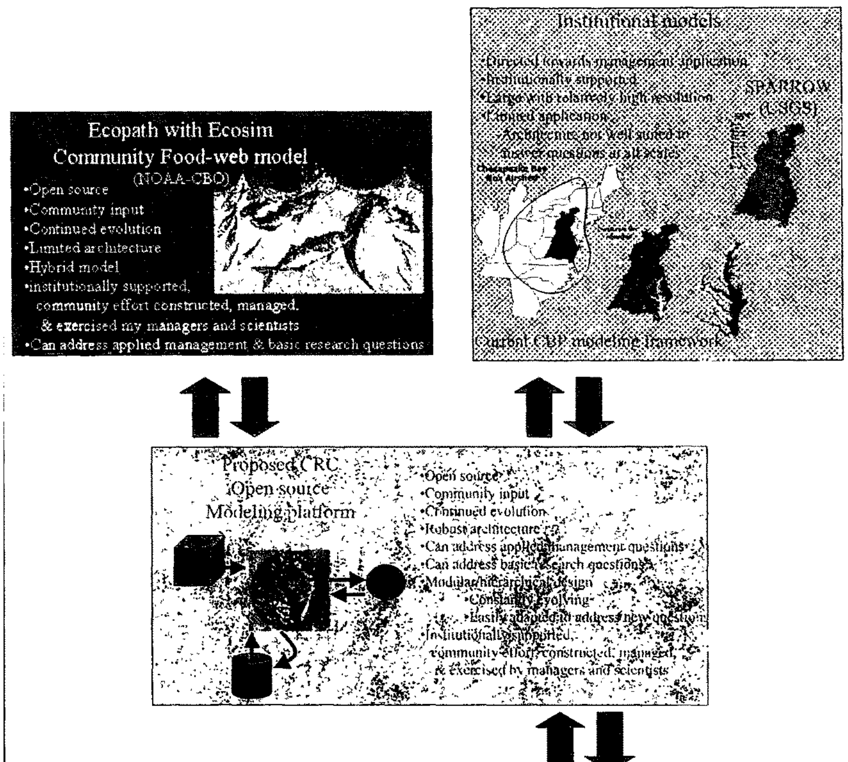
- Facilitate, focus and coordinate the intellectual resources of the CRC institutions;
- Promote free and open exchange of information, data, models, and results;
- Develop state-of-the-art models for research, management and operational applications;
- Integrate and facilitate combined modeling and observational efforts in Chesapeake Bay.

The core of this initiative will be aimed at developing a collaborative modeling framework and a set of standards to facilitate the development, testing and intercomparison of a wide variety of physical, ecological and biogeochemical models. *An explicit goal of this effort will be to develop a new, state-of-the-art watershed model and a new state-of-the-art estuarine model for the Chesapeake Bay region based upon the latest technologies and modeling approaches.* These models will be research-oriented and they will be designed to facilitate development and testing of a wide variety of submodel formulations and configurations. They will also incorporate advanced approaches for combining models and data (e.g., data assimilation), and methods for quantifying the error associated with model predictions.

However, we will not limit ourselves to focus on the development of a single modeling system. *A second major goal will be to encourage the development of a range of approaches and models, in large part by maintaining an open-source framework and by promoting model inter-comparison efforts to quantify the performance of different models.* Standards will be set for model I/O and subroutine formats so that data, output, and subroutines can be easily shared, compared and interchanged.

The third major goal of this initiative will be to use this framework to develop a suite of models intended for a wide range of management, research and operational applications. We envision that models intended for specific applications, such as TMDL specification for the EPA, or development of an operational model for determining real-time conditions in the Bay, will be developed as spinoffs of our core set of models. In this effort we will also promote research and development of submodels aimed at capturing the effects of important ecological and biogeochemical processes that are not currently represented in estuarine and watershed models (e.g. higher trophic level interactions and marsh nutrient sources and sinks in tributaries). This focus on specific processes will be particularly important for helping the management community respond to new pressures and changing emphasis in environmental management.

Relationships between the proposed CRC Community Modeling Project, EcoPath-EcoSim, CBP models, and Academic Research



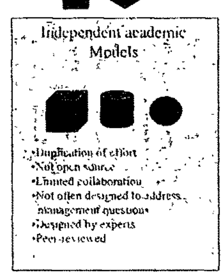


Figure 1. Schematic diagram showing the attributes of the current Chesapeake Bay modeling efforts, and their relationship to the proposed CRC Community Modeling Project. As depicted, the proposed effort would act as a hub for collaborative research that would provide access to research models and focus these efforts to address both basic research and management questions.

All of these model development efforts will be carried out in a free and open environment that facilitates rapid incorporation of state-of-the-art models and modeling approaches. Our efforts will be guided by three fundamental principles: 1) An "open source" policy will be mandated where all model and software code will be freely available to anyone who wishes to inspect or use it; 2) A collaborative modeling approach will be adopted to facilitate input and exchange with the wider scientific and management communities in all model development, testing and intercomparison; 3) Scientific peer-review will be used as the primary metric to judge the scientific validity of a model.

It is extremely important to emphasize that this platform will be open to all scientists, managers and stakeholders. Indeed, the Community Modeling Project *is* the community, communicating about how the Bay and its watershed work. The modeling will be conducted not only by Chesapeake scientists, but also by researchers working in other systems, within an infrastructure for collaboration and integration that is the foundation of the project. A crucial aspect and obvious starting point for establishing this interaction will be creating a worldwide web-based center of operations which allows full and free access to all models and resources that will be developed and promoted as part of this project. This website will act as a hub for focusing modeling-oriented research efforts in Chesapeake Bay and for linking them to estuarine and watershed research efforts elsewhere. In this way we will help the Chesapeake Bay research community maintain its leadership in regional modeling and decision making by providing tools and support for similar efforts worldwide. At that same time this system will provide opportunities for cross-pollination from other projects and modeling efforts.

We envision that funding for this effort will be derived from two primary sources. A "hard-money" core provided by the CRC institutions will support the staff and hardware needed to create the project infrastructure, which will include development of an interactive web site, and initiation of efforts to develop and maintain the collaborative modeling framework described above. This core of support will be augmented by "soft money" contributions derived through traditional funding sources, i.e., grant and contract proposals submitted to the various funding agencies (e.g., NSF, NOAA, EPA, NOPP, Sea Grant, etc.). The existence of the Community Modeling Project will also provide an important outlet for Chesapeake modelers and a basis for strengthening proposals for external funding.

It is also important to emphasize the central role of the CRC in this effort. External funding will be essential, but it cannot provide the long term, stable infrastructure that will be required for what will essentially be a volunteer-based effort. Moreover, too much reliance upon soft money promotes competition, which can inhibit open exchange of information, code and data. It will therefore be essential to create a CRC member institution-funded infrastructure to support voluntary efforts and contributions. This has always been the core of the open source paradigm and it has been tested and approved by existing practice.

Finally, we believe that the CRC is the logical home for this effort. Unlike the individual CRC institutions, where research programs generally operate on 2 – 3 year funding cycles, the CRC can potentially provide a stable, long-term infrastructure for this community wide effort. Moreover, the CRC represents "neutral territory" and therefore avoids potential conflicts over project ownership that might arise if the effort was centered at one of the CRC institutions. But most importantly, the goals of the Chesapeake Bay Community Modeling Project are essentially identical to the institutional goal of the CRC, which is to "…bring together scientists and scientific information in efforts that will facilitate progress towards understanding the biological, chemical, hydrological, and geological processes within Chesapeake Bay and to predict the response of the ecosystem to changes in these processes brought on by natural forcing and human activities".

VI Applications

Research

The CRC Community Modeling Project will provide a powerful platform for coordinating scientific research within the Chesapeake Bay community, for sharing research tools and results with the broader scientific community, and for more tightly integrating research with management. Many other open source projects have demonstrated that open sharing of codes and data creates strong positive feedbacks within the development community. As a result, the contributions of individuals are integrated to yield rapid improvements and efficient exploitation of shared products (e.g., Linux, SME, HSPF, POM, ROMS, USGS, ERSEM).

The main focus of this effort will be upon research aimed at significantly improving our ability to model and predict physical, biogeochemical and ecological processes in the Chesapeake Bay and its watershed. Specific research foci will include:

Watershed and Landscape processes:
- Spatially explicit watershed and landscape models
- Sediment production and routing over the full range of spatial scales
- Sediment and nutrient sequestration and transformation
- Groundwater flow
- Soil biogeochemistry
- Effects of land use change

Hydrodynamic modeling:
- Mixing parameterizations
- Impacts of different coordinate systems
- Sediment transport, burial and resuspension
- Surface forcing and air-sea exchange
- Open ocean boundary conditions

Water quality modeling:
- Higher trophic level interactions and effects
- Tributary processes and nutrient sources and sinks
- P, N and C-cycling and dynamics
- Multiple limiting nutrient interactions
- Low oxygen biogeochemistry

Error analysis:
- Methods for quantifying model uncertainties
- Sensitivity analysis

Data assimilation:
- Parameter optimization
- Optimal determination of boundary conditions

We envision a web-based platform that will provide several different services, all of which will be aimed at facilitating research in the areas outlined above. This platform will host a suite of open-source models. Some of these will be under active development while others will be provided more as final products for various research, management and operational applications. The core of this site will be focused on the development of a system-wide, research-oriented, state-of-the-art, watershed and estuary hydrodynamic/water quality model that will be freely available to anyone who wishes to download and use it. This model will be constructed as a set of distinct modules with well-defined interfaces that will allow researchers to develop and test the response of a wide variety of physical, biogeochemical and ecological sub-models in the context of a larger, coupled watershed and 3-dimensional estuary system.

Open-source candidates already exist for these core watershed and estuary models, and efforts have already begun to develop a ROMS-based estuary model for Chesapeake Bay, which will likely provide one of the first core models for this initiative. However, in developing this set of system-wide models, we will be mindful of the danger of focusing too much effort on a single coupled model system, and we will actively promote the development of alternative watershed and estuary model formulations and standardized I/O formats which facilitate model intercomparison activities. These models can also supply the broad-scale spatial and temporal context (i.e., boundary conditions) for more highly resolved efforts in specific areas (e.g., specific tributaries).

In addition to providing a 3-D context for model development and testing, our platform will provide a commons for assembling and distributing the data needed to force and validate a wide variety of watershed and estuary models. The shared data are themselves a key component of the community effort because obtaining the data required for forcing and validation is often a major hurdle in model implementation efforts. Our goal will be to provide easy access to data organized specifically for modeling purposes using standardized formats. The shared data will also facilitate the exploitation of emerging modeling methods, such as data assimilation.

This framework will also act as a clearinghouse for open exchange of documented source code and subroutines that can be shared, used and improved by the entire scientific community. This clearinghouse will provide an extremely important service because at present, although numerous models exist for a wide variety of purposes, there is no common catalogue of these models and no direct way to locate or access them. This code-sharing capability will also provide a general framework for integrating more focused research efforts. For example, a shared model can provide a quantitative context for a detailed investigation or modeling effort focused on a particular biological or biogeochemical process. Finally, we envision that this framework will provide a vehicle for sharing analysis tools, in particular those for quantifying model sensitivity and uncertainties in model predictions.

All the above efforts will help to integrate research and management efforts. Detailed research on particular processes or regions will inform management-oriented models, providing scientifically rigorous algorithms or results that can be incorporated to improve current management models. This will help to translate science into effective management and decision-making. Conversely, the community modeling efforts will help identify gaps in knowledge and direct limited research funding to answer critical questions.

Management

Since the *1987 Chesapeake Bay Agreement* (CBA), computational modeling has served as a primary tool in guiding management efforts of the Chesapeake Bay program and its partner institutions. Over this period, the Bay Program has relied heavily upon a linked modeling framework that today consists of an airshed model (RADM), a watershed model (HSPF), and an estuarine model (CE-QUAL-ICM), which itself is composed of water quality and hydrodynamic submodels. Over the course of this framework's evolution, modeling research and development has primarily focused on the relationships among estuarine nutrient concentrations, hydrographic conditions, phytoplankton abundance, and dissolved oxygen concentrations.

While water quality and habitat issues remain important management goals of the Program, concerns over the health and abundance of higher trophic level populations have become much more prominent. This shift is perhaps best exemplified by the approach to living resource management outlined in the *Chesapeake 2000* agreement:

> "To advance this ecosystem approach, we will broaden our management prospective from single-system to ecosystem functions and will expand our protection efforts by shifting from single-species to multi-species management. We will also undertake efforts to determine how future conditions and changes in the chemical, physical and biological attributes of the Bay will affect living resources over time."

This new approach represents a new level of complexity in the Bay Program management prospective; one that requires computational models that are capable of simulating these processes and their effect on higher trophic levels under various management scenarios and hydro-climatic conditions. In response to this challenge, NOAA's Chesapeake Bay program office has recently initiated a complementary effort using the EcoPath with EcoSim (EwE) modeling framework, which is focused primarily on characterizing linkages and interdependencies among higher trophic levels to inform multi-species management decisions. As such, the EwE modeling activity is primarily focused on food web dynamics and therefore these models will not specifically address many important ecosystem and biogeochemical processes.

In addition to these higher trophic level considerations, the CBP and the states have been tasked to set total maximum daily loads (TMDLs) for EPA designated "impaired" tributaries. The EPA has targeted oxygen, chlorophyll, and water clarity as the parameters to be controlled. The existing CBP modeling system is being put into service to help determine these tributary TMDLs, even though the model was not originally designed for this purpose. A major problem is that the current model does not account for many important nutrient sources and sinks in the tributaries and so does not reproduce the observed variability very well in these regions.

An important goal of the Chesapeake Bay Community Modeling Project will be to support and facilitate these EPA and NOAA sponsored modeling efforts to the highest degree possible. We envision that our modeling framework will be used as a platform for carrying out much of the research and model development that will be needed to meet these new management challenges. In this initiative we will specifically emphasize and promote modeling efforts aimed at higher trophic level processes and multi-species interactions, and better representation of the many complex processes that influence water quality in the watershed and tributaries of the Chesapeake Bay.

Operational Modeling

In addition to supporting management-oriented modeling activities, we envision that the CRC Community Modeling Project will also directly support and facilitate current and planned operational modeling in Chesapeake Bay. A nowcast and forecast system to provide oceanic information in real time, like the National Weather Service provides weather data, is a common vision of the Global Ocean Observing System (GOOS), Global Ocean Data Assimilation Experiment, (GODAE), the Ocean.US Integrated and Sustained Ocean Observing System (IOOS) and SURA's Southeastern Coastal Ocean Observing Program (SCOOP). The idea is to create an "observing system" which handles disparate data sources and assimilates the information into a single product. These data sources would include discrete and continuous (e.g., mooring or remotely sensed) observations of physical, chemical and biological parameters. The observing system would synthesize and increase the value of the data by placing it into a usable context. Central to this vision is an assimilative modeling system which provides data organization by acting as a data interpolator, display and forecast system.

The data assimilation system envisioned for the Chesapeake Bay would handle the physical processes of weather, runoff, evaporation, waves, tides and sea level forcing to provide a hydrodynamic image of the tides, currents, salinity, temperature and general circulation of the bay on time scales of minutes to days or for climate studies of decadal variation. Presently NOAA runs an operational model providing water levels and the EPA has a climatological hindcast model for salinity and temperature. NOAA also runs an experimental, operational model for predicting a biological quantity in Chesapeake Bay, namely jellyfish distributions. Though currently a prototype, this model is envisioned as a potential precurser to future efforts aimed at predicting a variety of biotic phenomena, such as harmful algal blooms.

The CRC Community Modeling Project can contribute significantly to these efforts by providing a platform for carrying out the basic research and model development that will be required to support these operational efforts. For example, at present only one 3-dimensional circulation model (CH3D) has been fully implemented and validated in Chesapeake Bay. Though this model performs well in many respects, the current version has not been released and it is not widely available to the research community. There is a pressing need to implement and validate alternative, state-of-the-art, open-source physical models in the Chesapeake Bay for these operational applications. A major goal of this effort will be to promote and facilitate the development of open source watershed and estuary models that can provide a foundation for the wide variety of operational/data assimilation efforts that are currently planned for Chesapeake Bay (e.g., GOOS, GODAE, IOOS, and SURA/SCOOP).

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Eileen E. Hofmann

Other agencies (including NSF) to which this proposal has been/will be

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Collab. Res.: WinDSSOcK: Winter Distribution and Success of Southern Ocean Krill (Hydrography and Modeling Studies)
Source of Support: National Science Foundation, Office of Polar Programs
Total Award Amount: $305,471 Total Award Period Covered: 09/15/00 to 08/31/04
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1 in Yr. 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Variability in Transport and Recruitment of Antarctic Krill Across the Scotia Sea
Source of Support: National Science Foundation, Office of Polar Programs
Total Award Amount: $348,576 Total Award Period Covered: 02/15/01 to 01/31/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Southern Ocean GLOBEC Planning Office
Source of Support: National Science Foundation, Office of Polar Programs
Total Award Amount: $314,348 Total Award Period Covered: 10/01/00 to 09/30/04
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Southern Ocean Global Ecosystems Dynamics (GLOBEC) Program
Source of Support: Scientific Committee on Oceanic Research/Johns Hopkins Univ.
Total Award Amount: $25,000 Total Award Period Covered: 03/17/00 to 03/16/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Physical-Biological Interactions and the Carbon Cycle of the Tropical Pacific and Atlantic Oceans
Source of Support: NASA
Total Award Amount: $92,899 Total Award Period Covered: 09/01/01 to 08/31/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1/year

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Eileen E. Hofmann | Other agencies (including NSF) to which this proposal has been/will be

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
PARADIGM: The Partnership for Advancing Interdisciplinary Global Modeling
Source of Support: University of Rhode Island
Total Award Amount: $438,121 Total Award Period Covered: 02/01/02 to 02/01/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Eastern U.S. Continental Shelf Carbon Budget: Modeling, Data Assimilation and Analysis
Source of Support: NASA
Total Award Amount: $251,572 Total Award Period Covered: 06/01/04 to 05/31/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Collaborative Research: Seasonal Biogeochemical Processes in the Ross Sea: A Modeling Approach
Source of Support: National Science Foundation, Office of Polar Programs
Total Award Amount: $397,293 Total Award Period Covered: 03/01/04 to 02/28/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1/year

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Genomic Approaches to Understanding Genetic and Physiological Causes of Variation in Survival, Dispersal & Recruitment of Larval Marine Organisms
Source of Support: National Science Foundation (subcontract through USC)
Total Award Amount: $114,897 Total Award Period Covered: 08/01/04 to 07/31/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1/year

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Field Measurement and Modeling Study on the ecology of Vibrio parahaemolyticus in Shellfish to Minimize Impacts on Human Health
Source of Support: National Science Foundation (subcontract from Rutgers Univ.)
Total Award Amount: $277,745 Total Award Period Covered: 09/01/04 to 08/31/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1/year

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

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Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Eileen E. Hofmann | Other agencies (including NSF) to which this proposal has been/will be

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
A Modeling Study of the Growth, Survival and Recruitment of Hard Clam (Mercenaria mercenaria) Larval and Post-Settlement Populations
Source of Support: New York Sea Grant
Total Award Amount: $30,465 Total Award Period Covered: 08/15/04 to 08/14/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: .95

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Modeling Oyster Larvae Transport in Chesapeake Bay
Source of Support: NOAA
Total Award Amount: $50,186 Total Award Period Covered: 10/01/04 to 09/30/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Habitat Utilization of Southern Ocean Seals: Foraging Behavior of Crabeater & Elephant Seals Using Novel Methods of Oceanographic Data Col.
Source of Support: NSF, Office of Polar Programs (subcontract through UCSC)
Total Award Amount: $160,957 Total Award Period Covered: 01/01/05 to 12/31/07
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1/year

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Continued Hydrographic Studies and Analyses in Support of the U.S. AMLR Program
Source of Support: NOAA, Southwest Fisheries Science Center
Total Award Amount: $24,997 Total Award Period Covered: 09/01/04 to 08/31/05
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Modeling Growth and Development of Crassostrea ariakensis
Source of Support: NOAA Chesapeake Bay Office
Total Award Amount: $98,047 Total Award Period Covered: 10/01/04 to 09/30/06
Location of Project: Old Dominion University
Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 1/yr

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY

STATEMENT OF FRANCES W. PORTER, EXECUTIVE DIRECTOR, VIRGINIA SEAFOOD COUNCIL

Ms. PORTER. I am Frances Porter, of the Virginia Seafood Council. The council is a trade association, non-profit and incorporated, which represents the interest of commercial fishing in Virginia. Membership includes packers, processors, shippers, harvesters, and aquaculturists of Virginia seafood, and it includes work in both the bay and on the ocean.

A member of the commercial fishing industry will speak next and will tell you that the health of the Chesapeake Bay is negatively impacting his livelihood. Pollution in the bay is believed to be a strong contributor to the decline in fish, crab, and oyster populations. Fish, crabs, and oysters are, of course, vital parts of the food chain in the bay. Oysters are vital to the filtration of the bay. If an oyster packer were here he would give you an impassioned speech on the critical situation in the oyster industry and document it with the facts which you have heard from someone else today that we harvested 15,000 bushels of oysters in Virginia in 2003, compared to 1 million bushels 18 years ago in 1985.

As a representative of the commercial fishing industry, I simply cannot separate economics and ecology. It is important for members of this committee to understand that the commercial fishing industry contributes $450 million to the economy of Virginia annually, that 30 counties and 8 cities are at some level economically dependent on the seafood industry and that about 17,000 persons are employed in the industry and industry-related jobs.

We have certainly all agreed already today that the development in the watershed is a major problem for the health of the bay. More cars, people, houses, lawns, and far less timberland. Are sewage plants sufficiently regulated and routinely monitored regarding their discharge? Has the rate of development along the shoreline been slowed? Is there measurable restoration of the watershed? Are farmers adhering to the best management practices in cultivating and fertilizing their crops? Those are questions to be answered by the scientists, regulators and environmentalists, but they are important issues for the fishing industry. Through the national press, local press, trade journals, and magazines I read weekly about the health of the bay, with conflicting reports about measurable progress versus reports of slow to no progress, scientifically, the Virginia Seafood Council is not qualified to judge the progress of the clean up of the bay. But practically, we see the steady decline in the living resource. Living resources are an excellent measure of the health of the bay.

It is best that I talk about the council's efforts to restore one living resource, the oyster, to the bay. The oyster has great economic value to the Commonwealth of Virginia. Far greater is its ecological value to the bay. And you have already heard that a healthy oyster resource is reported to have the capability to filter the entire bay in a day. Imagine a consistently heathy, constantly growing oyster resource pumping the nutrients through its gills, purging the bay day after day after day.

The council has been on a parallel track to restore the native oyster and introduce the non-native oyster. To renew the native oyster, we continue to plant shells, move seeds, and work existing beds. We have developed huge reefs and have supported moratoriums on harvest. Since 1990, private oyster growers and the State of Virginia have spent millions on millions of dollars in restoration efforts. There is some marginal progress in the native efforts, but for the most part, restoration is stalled and the oyster industry is dying.

Since 1995, the council has been engaged in a project to introduce a non-native oyster to the bay. You have heard Dr. Bahner and Secretary Murphy talk about that. In conjunction with the Virginian Institute of Marine Science and with the approval of the Virginia Marine Resources Commission, we have worked meticulously in conformance with State, Federal and international laws and protocols, to conduct in water testing of a non-native oyster. We have had tremendous success in finding an oyster that grows rapidly, resists disease, and tastes like the Virginia oyster. To date, we have no evidence that it will introduce any known pathogens to the bay and no evidence that it will damage the food chain in any way.

However, our project has been met with intense scrutiny by numerous Federal agencies including the Army Corps of Engineers, the EPA Chesapeake Bay Program, U.S. Fish and Wildlife Service, and NOAA, National Marine Fisheries Service. An extension of our existing permit was an intense 5 month negotiating process between Federal agencies, the council and our advisors at VIMS. The extension now requires new risk mitigation strategies and numerous additional conditions to the original permit. This is a clear indication that the agencies are striving to prevent any further damage to the bay by the introduction of a non-native oyster. The entire non-native oyster permitting process is about risks and benefits. The emphasis belongs on the ecological benefit that a renewed oyster population will bring to the bay. Let me reiterate that a healthy oyster population will filter the bay daily and contribute to clean water.

While we are moving steadily toward water renewed oyster resource with the Crassostrea ariakensis, we are not moving rapidly. We are waiting for the completion of the environmental impact statements that you have heard about. And economically, we feel that time is running out to restore this industry. Ecologically, the sooner we have a natural, filter feeder resource in the bay the better.

I believe the Federal agencies, who have worked with us on this project also understand the value of the oyster resource. And I hope they will expedite all the processes in order to allow the oyster in the bay next year.

Chairman TOM DAVIS. Thank you very much. Mr. Wallace.

[The prepared statement of Ms. Porter follows:]

Remarks Presented by

Frances W. Porter to

U. S. House of Representatives

Committee on Government Reform

Friday, August 20, 2004

I am Frances Porter, Executive Director, Virginia Seafood Council. VSC is a trade association, non-profit and incorporated, which represents the interests of the commercial fishing industry in Virginia. Membership includes packers, processors, shippers, harvesters, and aquaculturists of Virginia seafood; it includes both Bay and ocean fisheries.

A member of the commercial fishing industry in Virginiawill speak to you today and will tell you that the health of the Chesapeake Bay is negatively impacting his livelihood. Pollution in the Bay is believed to be a strong contributor to the decline in the fish, crab and oyster populations. Fish, crabs and oysters are, of course, vital parts of the food chain in the Bay. If an oyster packer were here he would give you an impassioned speech on the critical situation in the oyster industry and document with these facts: in Virginia we harvested less than 15,000 bushels of oysters in 2003, down from 1,000,000 bushels 18-years ago in 1985.

It is important for members of this committee to understand that commercial fishing contributes $450,000,000 annually to the economy of Virginia. Thirty counties and 8 cities have some level of economic dependence on the seafood industry and about 17,000 persons are employed in the
industry and industry related jobs.

I believe that we can all agree that development in the watershed is a major problem for the health of the Bay. There are more cars, people, houses, lawns and far less timberland. Are sewage treatment plants sufficiently regulated and routinely monitored regarding their discharge? Has the rate of development along the shoreline been slowed? Is there measurable restoration of watershed? Are farmers adhering to best management practices in cultivating and fertilizing their crops? Those are questions to be answered by scientists, regulators and environmentalists, but they are important issues for the fishing industry.

Through the national press, local press, trade journals and magazines, I read weekly about the health of the Bay,

with conflicting reports about measurable progress versus reports of slow to no progress. Scientifically, VSC is not qualified to judge the progress of the clean up efforts, but practically, we see the steady decline in resource. Living resources are an excellent measure of the health of the Bay.

In my limited time, it is best that I talk about the Council's efforts to restore one living resource, the oyster, to the Bay. The oyster has great economic value to the Commonwealth of Virginia. Far greater is its ecological value to the Bay. A healthy oyster resource is reported to have the capability to filter the entire Bay in a day! Imagine a consistently healthy, constantly growing oyster resource pumping the nutrients through its gills, purging the Bay day after day after day!

The Council has been on a parallel track to restore the native oyster and introduce a non-native oyster. To renew the native oyster, we continue to plant shells, move seeds and work existing beds; we have developed huge reefs and have supported moratoriums. Since 1990 private oyster growers and the State of Virginia have spent millions and millions of dollars in restoration efforts. There is some marginal progress in the native efforts, but for the most part, restoration is stalled and the oyster industry is dying.

Since 1995, the Council has been engaged in a project to introduce a non-native oyster to the Chesapeake Bay. In conjunction with Virginia Institute of Marine Science and with the approval of Virginia Marine Resources Commission, we have worked meticulously, in conformance with state, federal and international laws and protocols, to conduct in-water testing of a non-native oyster. We have had tremendous success in finding an oyster that grows rapidly, resists diseases, and tastes like the Virginia oyster. To date, we have no evidence that it will introduce any known pathogens to the Bay and no evidence that it will damage the food chain in any way.

However, our project has been met with intense scrutiny by numerous federal agencies including the Army

Corps of Engineers, the EPA Chesapeake Bay Program, U. S. Fish and Wildlife Service, and NOAA/National Marine Fisheries Service. An extension of our existing permit was an intense five-month negotiating process between federal agencies, the Council and our advisors at VIMS. The extension requires new risk mitigation strategies and numerous additional conditions to the original permit. This is a clear indication that these agencies are striving to prevent any further damage to the Bay by this introduction.

The entire non-native oyster permitting process is

about risks and benefits. The emphasis belongs on the ecological benefit that a renewed oyster population will bring to the Bay. Let me reiterate that a healthy oyster population will filter the Bay daily and contribute to cleaner water.

While we are moving steadily toward a renewed oyster resource with the *Crassostrea ariakensis,* we are not moving rapidly. We are waiting for the completion of an Environmental Impact Statement. Economically, we feel that time is running out to restore an industry. Ecologically, the sooner we have a natural, filtered feeder resource in the Bay, the better.

I believe the federal agencies, who have worked with us on this project, also understand the value of the oyster resource. I hope they will expedite all the processes in order to allow the oyster in the Bay next year.

STATEMENT OF MARK WALLACE, EASTERN SHORE WATERMEN'S ASSOCIATION

Mr. WALLACE. Chairman Davis and Congressman Schrock. I appreciate the opportunity to speak on behalf of the Eastern Shore Watermen's Association. I am Mark Wallace representing the Eastern Shore Watermen's Association that has an annual membership of around 80 individuals and represents 757 commercial fishermen who live on the Eastern Shore of Virginia.

In 2002, Virginia's commercial fishermen harvested $100 million in finfish and shellfish. In the last decade, the fishing industry has seen numerous regulations to reduce over-harvesting. These regulations have led to much hardship for individuals who rely upon fishing for their livelihood. While over-harvesting may negatively affect the industry, we feel this is a secondary problem aggravated by poor water quality.

The hard clam aquaculture industry is also dependent upon clean water. In 2000, this industry had a local economic impact of $40 million in the State of Virginia. Aquaculture offers an alternate way for commercial fisherman to make a living while alleviating pressure on native stocks. It is important to expand the aquaculture industry to other species. For instance the Ariakensis oyster is being studied to explore its feasibility as an aquaculture species. The Ariakensis has an economic potential for fisherman, and the ability to improve water quality through filtration.

The areas that we feel need the most attention are stormwater retention from agriculture operations and shoreline development. Both of these pose a significant threat to the fishing and aquaculture industries. In the agriculture industry we would like to see the use of stormwater retention sites, properly engineer these sites could prevent the direct accumulation of nutrients and toxins in the water ways. Development of agricultural land should be handled in a way that maximizes open space to absorb nutrients from concentrated areas of development.

Programs should be enacted that encourage individuals to leave open spaces undisturbed. Focus should also be directed at waterways that are not already imperiled. A good example of this is the Mattaponi River on the coastal side of Virginia. This river supports an aquaculture industry that produces 200 million hard clam seed in 2003. The Mattaponi River is currently clean enough to support the industry, the cleanliness is being jeopardized by shoreline development and installation of a mass drain field. To us it seems it would be much easier to maintain a clean Mattaponi River than to clean up a polluted waterway.

I have been involved in operations on this river for 8 years. I have seen the effects runoff can have on production. To me it makes no sense to destroy an industry because there is a lack of sound land management.

Finally, let me offer a couple examples of hardships affecting the fishing industry. I serve as the secretary on the harbor committee of my town. In 1989, there were 103 stalls available for lease; of these 103 stalls, commercial fishermen occupied 59. In 2004, this number is down to 17 individuals who are active in commercial fishing and aquaculture. The harbor has shifted from a commercial harbor that was put in place by local commercial fishermen to a recreational harbor. When the commercial fishery was very active, it supported a small store by the harbor. As the number of commercial fishermen declined the store opened seasonally, and now it is closed year round.

In my town, there is also a crab processor. The scale of this business has declined substantially in the last decade. In the early 1990's, this business employed at least 10 full-time employees. Today there are only four seasonal employees during the month of May. This illustrates the effects of a declining harvest from the Chesapeake Bay.

These examples demonstrate the necessity of clean water to the fishing industry. We cannot say if the Chesapeake Bay Program has helped our industry. We do know that we are at a critical state, and that it is imperative that we continue to work toward a cleaner Chesapeake Bay to maintain a strong fishing and aquaculture industry.

[The prepared statement of Mr. Wallace follows:]

Honorable Congress people and speakers and guest

I am Mark Wallace representing the Eastern Shore Waterman's Association that has an annual membership of around 80 individuals and represents 757 commercial fishermen who live on the Eastern Shore of Virginia.

In 2002 Virginia's commercial fisherman harvested 100 million dollars of finfish and shellfish. In the last decade the fishing industry has seen numerous regulations to reduce over harvesting. These regulations have led to much hardship for individuals who rely upon fishing for their livelihood. While over harvesting may negatively affect the industry, we feel this is a secondary problem aggravated by poor water quality.

The hard clam aquaculture industry is also dependent upon clean water. In 2000 this industry had a local economic impact of 40 million dollars. Aquaculture offers an alternate way for commercial fisherman to make a living while alleviating pressure on native stocks. It is important to expand the aquaculture industry to other species. For instance the Ariakensis oyster is being studied to explore its feasibility as an aquaculture species. The Ariakensis has an economic potential for fisherman, and the ability to improve water quality through filtration.

Let me offer a couple more examples of the hardships affecting the fishing industry. I serve as the secretary on the harbor committee of my town. In 1989 there were 103 stalls available to lease. Of these 103 stalls, commercial fisherman occupied 59. In 2004 this number is down to 17 individuals who are active in commercial fishing and aquaculture. This harbor has shifted from a commercial harbor that was put in place by the local commercial fisherman, to a recreational harbor. When the commercial fishery was very active it supported a small store by the harbor. As the number of commercial fisherman declined the store opened seasonally, and now it is closed year round.

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These examples demonstrate the necessity of clean water to the fishing industry. We cannot say if the Chesapeake Bay Program has helped our industry. We do know that we are at a critical state, and that it is imperative that we continue to work towards a cleaner Chesapeake Bay to maintain a strong fishing and aquaculture industry to support both the economic and cultural benefits of the industry.

Chairman TOM DAVIS. Thank you very much. We will start the questioning with Mr. Schrock.

Mr. SCHROCK. If I understand correctly I think most Federal agencies not just the Army Corp of Engineers including the Chesapeake Bay Program and NOAA are not in favor of the introduction of the non-native oyster, I believe that is the case. I know you have strong opinions about that, but I think that is one of the roadblocks we are going to have, because I do not believe those two organizations want that either.

Chairman TOM DAVIS. Who are the two?

Mr. SCHROCK. NOAA and the Chesapeake Bay Program. Am I correct on that?

Chairman TOM DAVIS. NOAA spoke in the last panel I thought that they were still evaluating it.

Mr. SCHROCK. Can anybody answer that?

Mr. BOESCH. I think I could maybe give it a shot. Correct me if I am wrong.

We tried when this issue was first raised I think the States, the Chesapeake Bay Program, the Federal agencies tried to take the first responsible step by asking the National Academy of Sciences for a review. There were eminent scientists from outside of this region, who sat, looked and listened to all the evidence and issues and its report basically says this: we do not feel that there is sufficient basis to go ahead with introduction now because of the uncertain risks. However, recognizing that there are severe problems with this industry, and with the oyster population ecologically, the recommendation was to undertake a 5-year aquaculture program that was based upon using a sterile non-reproducing oysters that could not escape cultivation and that would be coupled with a intense strategic research program.

So, now we just have for the first time in the NOAA program appropriations for the research program. So, I would think the agencies would say that it is inconsistent with the advice given to us by the National Academy to make that decision now, rather we should make that decision after all the evidence, pros and cons and risks can be thoroughly evaluated.

Mr. SCHROCK. What are the problems with introducing that foreign oyster here? Ms. Porter said that it tastes the same as the Chesapeake Bay oyster. You have to go some to do that but I believe you. What are the problems that are inherent in that?

Mr. BOESCH. Where there have been non-native oysters introduced for production purposes in other parts of the world, in some cases they have been successful. In other cases the oysters have not survived, so is not a given that the oysters will actually establish populations here. Second, there are some cases where oysters have caused—introduced oysters have caused some severe problems. Fouling of vessels, fouling of virtually everything out there. And then, of course we are concerned about with the populations of the non-native oysters might interfere or compete and interfere with the native oyster restoration. So, there are a number of others, but those are the kinds of questions just to give you a flavor, that the Academy listed, should be addressed.

Mr. SCHROCK. So, the 5-year program began?

Mr. BOESCH. I think you would have to say it is just beginning.

Mr. SCHROCK. Just beginning. For all of you, in your opinions, if Congress were to invest new dollars in the Chesapeake Bay restoration efforts, where do you think that they could best be spent?

Ms. PIERNO. Do you want me to start.

Mr. SCHROCK. Go ahead.

Mr. WALLACE. Go ahead.

Ms. PIERNO. Go ahead.

Mr. WALLACE. Well, I said it before and I will say it again. We need to explore other aquaculture options. I mean the ariakensis is one, it has a lot of potential I mean we know it works. It has been in the water. There are risk, but at the same time if we can follow through in a controlled manor or eventually there are going to be private individuals that are tired of waiting and they are going to introduce it in an uncontrolled manner. At that point we stand a greater risk.

The Federal money to followup on other species as well, I mean not only the ariakensis, but I am sure that there are other species we could work with. I know this year, NMS spawned some crabs and released them. So that is one important area, I think. It alleviates the pressure on the nature stocks. And the other is on the Eastern Shore, there is the agriculture industry and there is the fishing industry. And of course, the real estate end of business, but we need to focus on—[laughter.]

Mr. SCHROCK. You are not kidding. They are major player up there right.

Mr. WALLACE. Restoration of land and open spaces in that area to absorb the nutrients rather than what is happening now, in particular the past months where we have had so much rain. Everything that is on the land is in the water right now, and you see it, things are dying along the shoreline, we had a huge fish die off last week or about 2 weeks ago. So, to focus the money in both of those areas would be very important in my opinion.

Ms. PIERNO. I was just going to say, I think one area is the native oyster, unlike many other areas you have not spent enough resources to really meet the goal that was the 10-fold increase. And the reality is at our oyster farm here in Virginia, we are seeing some real progress, and I think we are learning an awful lot. And so, with some more resources dedicated to the new oyster restoration effort, I think that could be very productive. So, I do not think we want to give up on that.

I do want to say in the report we talk about agriculture needing an additional $250 million annually to this region, the watershed to be able to do the kind of agricultural practices that are going to be needed to get to those reductions as well as the upgrades on wastewater treatment plants. So, I think those two as well as of course urban stormwater are going to take substantial dollars. And there is an opportunity through the Federal transportation bill to get some of those dollars, but they would be the top priorities.

Mr. SCHROCK. We have to get the transportation bill out.

Ms. PIERNO. Yes.

Mr. BOESCH. I would just say that on the top of my list is agriculture. Agriculture is the largest source of both nitrogen and phosphorous to the bay. It is pretty clear that what really tipped this bay over in the 1960's as well as in many other coastal areas around the country, around the world is the expanded use of fertilizers in agriculture. It doubled and tripled within a couple of decades. And so, we need to learn to continue to have agriculture production but also minimize the downstream consequences.

I actually think it is not going to be as costly as you might think if we aligned our agriculture policies, our farm policies with the environmental policies. As you know, this country spends billions, tens of billions of dollars each year for agricultural subsidies. Those subsidies are going to be going away probably because of world trade considerations, because we have already had rulings against this country in terms of subsidized agriculture.

And one way that we can continue to keep that subsidization going—and other countries are moving this way rapidly—is toward environmental restoration, environmental improvement and conservation practices. So, if we could use some small part of that, that present Federal investment to get the outcomes and benefits, to do the kinds of things that we are already trying to do. For example, cover crops have proven to be enormously effective, but it costs the farmer money, they do not harvest the cover crop. If we can get some of that Federal investments to accomplish things like that, we can make this happen without a substantial increase in the total Federal expenditure.

Mr. SCHROCK. Anyone else want to comment?

Ms. SCHAFFNER. Yes, I would like to comment.

Mr. SCHROCK. Yes.

Ms. SCHAFFNER. Just quickly, I agree that probably the nutrient reduction strategies are something that is an easily identifiable target that we can work on. But I also want to continue to stress that what we need to maintain in this country is a process, a really effective process for linking science and policy development. We know what we have to do in the Chesapeake Bay, because this process has worked in the past, so we need to ensure that we maintain our leadership and ability to do that. So, maintaining a process of linking science and policy that helps us identify the best solutions is something that I will put at the top of my list.

Mr. SCHROCK. Ms. Hofmann.

Ms. HOFMANN. I agree with all the comments that have gone on. I think we need to control agriculture and the Clean Air Act and all that. But one thing I would like to make a point here is that, that all works well, but one of the things that has to happen is to have capacity building in the community through education. And I am not talking about education in universities or whatever, education at primary grades, K–12 type of approaches. And to implement a lot of the things that we have heard about this morning requires an informed public that understands why you need to do this. And my general impression from having worked with some education outreach activities is that is always one of the last things to be funded. And when it is funded, it is not typically funded at a level where you can do a whole lot of anything.

And I would encourage you to put that into legislation, to put money in for educational activities and to target those toward Chesapeake Bay. I know that the Chesapeake Bay Program has a large outreach program, there are a lot of groups doing it at the Chesapeake Bay Foundation. But right now, that is not getting translated very well into the primary grades, which is where you really need to put the educational efforts.

Mr. SCHROCK. Catch them in the cradle type thing.

Ms. HOFMANN. Exactly.

Mr. SCHROCK. Mark, what is your No. 1 main challenge that the watermen face in this industry?

Mr. WALLACE. Regulations, I would have to say. I am involved in aquaculture as well as the commercial harvest of native species. I do both, and in aquaculture we are not seeing the regulations, but in the fishing industry every year, and when I stated about there being around 80 individuals, that is based on how many regulations we are facing in a particular year. The more proposed, the more members we have. But just the regulation of the industry and I would think it would be a lot of the fishermen's complaint that a lot of these regulations that come through really are not based on sound data that comes in.

But that is the primary, the No. 1 thing that we face that is affecting our industry, is regulation, and declining harvest.

Mr. SCHROCK. Regulation that is enacted that is not based on sound science?

Mr. WALLACE. Yes.

Mr. SCHROCK. Do you agree with that? If you do not tell me.

Mr. BOESCH. Well, I cannot comment on the specifics of the regulations the gentleman is talking about. But I think we have in the Chesapeake Bay area evolved a fairly effective mechanism. Different in the different States, because of the structure; for example, Virginia has a marine resource commission. We do not have a commission we have a State agency in Maryland, where we are getting better and better scientific information into the decisionmaking. A good case in point is the blue crab problem. Blue crabs were declined substantially over the few years. Great alarm, the people who suffer mostly are the watermen, obviously. And we are all concerned about the state of the bay, and the role that plays. There is a direct relationship with the health of the bay and the blue crab population, and it has to do primarily through this linkage with the submerged aquatic vegetation. These are nursery areas for little blue crabs that come in. So, we need to restore those.

But it is also clear with present populations we have to deal with the evidence is pretty clear that we had over harvesting, that we were not going to allow enough females to survive the process to go down in the bay right off here, and spawn and reproduce. So, we had to reduce the harvest pressure in order to allow enough females to survive to rebuild the stock, and the jury is still out. There are some signs, at least in the upper bay we have a bumper year for crabs. We cannot claim credit necessarily until we look at it all. But we are optimistic that we are going to see some recovery as a result of the regulations.

To the folks that are regulated, I can understand that it is an onerous problem and it is something that they—it is a bottom line economic issue for them. But hopefully over the long run it will assure the vitality and sustainability of that resource in the future.

Mr. SCHROCK. There is a big delicate balancing act there, you have some magnificent watermen up there who do their trade and do it very well. It is really tough. In July—oh, I am sorry.

Ms. PORTER. I would like to respond to that.

Mr. SCHROCK. Sure.

Ms. PORTER. With due respect to Mark and the fact that working watermen feel that they are being regulated out of business, I think though Virginia Marine Resources Commission does an excellent job of studying the issues. They rely heavily on the scientific advice that comes from VIMS. And the regulators themselves do not want to keep regulating and regulating. But we are trying hard to preserve and restore the resource.

Chairman TOM DAVIS. Let me just ask on that, if you put a moratorium or you put some significant limits on here over a multi year period, would the population come back of the oysters and crabs. In your opinion, is the water clear enough that at a given time and not allowing them to be fished or controlling that will that bring it back by itself or will we still have environmental problems would prohibited it?

Ms. SCHAFFNER. We definitely have a combinations of factors that are affecting these populations. One of the things that we do know about these coastal ecosystem is that they often have reservoirs of individual places in the bay, for example, where populations are doing better. Some parts of the lower bay are more healthy than some parts of the tributaries or the upper bay. So, there is an enormous capacity for some resilience in there and if everything lines up, you know, the stars and the moon and the sun all line up the right like it did with striped bass, when we put a fishing moratorium on, we got just the right combination of factors and the population just took off. If you happen to have a number of really wet years and nutrient loadings were really high, you might not see those kinds of recoveries right away.

Mr. SCHROCK. You would have significant impact on the watermen and everybody and you would not necessarily get an impact if the weather was bad.

Ms. SCHAFFNER. Right, I think the systems are variable, so sometimes it takes a combination of everything lining up—the environmental conditions and the moratoriums—to work, but there is a lot of natural resilience in these populations and nothing has gone extinct in the bay. We do have residual populations that are there to provide seed material, if you will. So we still are positive about what we could see if we took the pressures off.

Mr. BOESCH. Could I just amend that, sorry.

Mr. SCHROCK. Sure.

Mr. BOESCH. Just to say that it varies with the resource species you are interested in. Striped bass, we had a very small number of spawners left in the population, so a moratorium was the right thing to do. We had to let those folks survive. For blue crabs, we catch 150 million blue crabs out of the bay, every year. There is no shortage of female blue crabs, enough that the population is going to disappear and crash. We have to let more of those survive so it is not a moratorium, it is worrying about how many crabs can we catch, issues such as sanctuaries for spawning crabs. For oysters, it is a more challenging issue because we have mined out the basic habitat that they once lived on so that is not going to rebuild overnight. But there are things we will do; for example, in Maryland, we are adapting the management strategy so we do not move, transplant, diseased oysters from one part of the bay to the area where the disease is not. So, it varies with the species.

Ms. PORTER. I would like to speak to that about the oysters, also and I am not a scientist. And I do not want to misrepresent anything, but you know for 20 years the scientists have been trying to determine what durmo and MSX really are and how to remove them from the bay. And I guess they know what they really are, but they do not know how to get them out of the bay. So, the oysters are plagued by the two diseases.

Mr. SCHROCK. Can you figure that out.

Mr. BOESCH. One of those diseases, I would submit and the one that is really devastating Virginia is MSX, is our own fault, it is an introduced species.

Mr. SCHROCK. I was in the Navy.

Mr. WALLACE. We are not scientists.

Mr. BOESCH. MSX, it has a scientific name but very briefly throughout all of our community, watermen and scientists, we refer to these two diseases as MSX, which was a code name developed a long time ago, and durmo, just keep in mind MSX and durmo are two different diseases. MSX is particularly virulent in the highest parts of the bay. We have only occasionally, in dry years, an MSX problem in Maryland; we have the durmo problem. MSX, the work of VIMS, that group has done excellent work demonstrated convincingly using molecular ecology, molecular biology, the genes analysis. That this disease was introduced by a previous failed attempt to introduce another alien non-native species. A West Coast Japanese oyster that was living on the west coast was introduced here, it did not take off or survive but it introduced MSX, which was devastating to the native populations which had no evolutionary history or tolerance to that pathogen.

Chairman TOM DAVIS. So, that gives appreciation for what we are trying to do now, this generation.

Mr. BOESCH. Absolutely.

Mr. SCHROCK. I have one final question. Ms. Pierno, last month in July, the EPA announced that sewage treatment plants in Virginia and six other States and Washington, DC, were going to be required to reduce discharges of nitrogen and phosphorous. What is your opinion of that plan? It has really been brought to our attention in the last few days, because the town of Onancock on the Eastern Shore is trying to get re-permitted for their sewage system and apparently they are going to be denied. And they are saying that they are going to have to pay $3.5 million for new treatment plants which is three times longer, three times more then their town budget every year. It is a real catch 22. What is your opinion of that plan that they have?

Ms. PIERNO. I think the plan that you are speaking of is the actual plan that goes beyond Virginia, it is for the entire border.

Mr. SCHROCK. That is right.

Ms. PIERNO. And the reality is unfortunately the plan allows for further delay. We know; in fact, we received a letter from the former administrator Tracy Mehen that currently EPA has the authority and the responsibility to issue permits that control nitrogen and phosphorous. And so, we have simply been asking them to do that and certainly we recognize that in some of these plants—but

I will say that most of the cost estimates that have come in for these upgrades have been as much as 50 percent higher then what the actual cost has been ultimately. And this is even seen with an upgrade that was done in Blue Plains.

So, I think that what we need to understand when we hear these large numbers is that they are estimates, they are cost estimates and they are not always accurate. But the reality is in Maryland, we recognize that there are going to be small jurisdictions and areas that we are not going to be able to afford. They just do not have enough ratepayers to be able to pay for the cost of that upgrade. So, that is when the State stepped in now, with flush fee, a bill that was passed this legislation session, to provide those kinds of resources for the very kind of situation that Onancock is facing. So, we think it is an entire, you know, responsibility for States to look at this issue and to help those jurisdictions that need help. As far as the new—it is really not regulations that the EPA is putting out, unfortunately, again they are not requirements. It is another kind of advice, in fact on page in the small print at the bottom, it specifically says this does not have any additional requirements or regulatory authorities.

So, the reality is it is more language saying we are going to gradually bring you along and we recognize that this is going to take years—and we do not have years. And the fact is, is that we recognize the it is very possible that there may be lawsuits and challenges once those permits are issued. So, we would say do it as soon as possible.

Mr. SCHROCK. So that $2.50 a month per household fee is going to solve the problem Onancock has right now. So, they do not have to bear the brunt of the whole thing.

Ms. PIERNO. That is in Maryland.

Mr. SCHROCK. Oh, I understand that. I only wish that the $2.50 Maryland fee could be applied to Onancock, VA.

Ms. PIERNO. I think it is a little bit more in Virginia. I think it is more like $4 a month they are looking at.

Mr. SCHROCK. How much?

Ms. PIERNO. $4 a month that would actually pay for the Onancock upgrade as well as all the major wastewater treatment plans.

Mr. SCHROCK. I just do not want Onancock sued to the point that they are going to—that just does not make no sense.

Ms. PIERNO. It is always a last——

Mr. SCHROCK. Resort.

Ms. PIERNO [continuing]. Resort. We really take it very seriously, but unfortunately, we just do not feel that the EPA is taking this action as serious as they need to. They continue to allow expansions, new permits, without having those reductions in place, we just feel that is unacceptable.

Mr. SCHROCK. Thank you, Mr. Chairman.

Chairman TOM DAVIS. Thank you. I just wonder if somebody could describe for me—the bay, obviously the water is consistently moving into the bay and out to sea. How long it takes with stuff coming into the bay, it is point it is non-point, it is a lot of different things in the atmosphere. I am just trying to get a macro picture of what it takes and how long it takes the water to flush out of there once it enters, does anybody have any idea, or does it differ in different places? Does it depend on the season, and the temperature. Anybody have the answer.

Ms. HOFMANN. I think I can make an attempt to answer that. And being a good academic, it would not be a firm answer.

Chairman TOM DAVIS. Politicians do not give firm answers either.

Ms. HOFMANN. How you estimate residence time in a system like the Chesapeake Bay is very difficult to do. And what you estimate residence time for is somewhat dependent on the property you are looking at. If you look at something like salinity, of the numbers that I have seen for that, the flushing time in the bay for salt is on the order of a few months, like 3 to 4 months perhaps. So, if you put salt at the entrance of the Chesapeake Bay right out here you would expect it to go around, come out the bay and be out and done in about 3 months.

All right, that is one example. All right, that is an average number. All right, in years when there is a drought that number is going to be a whole lot longer. Years with a lot of freshwater inflow that number will be a whole lot shorter. So, it is not just dependent on the environmental conditions, that it is also dependent on climatic cycles. That is one issue with the Chesapeake Bay is that it responds to large global climate cycles. Like the El Nino that we have all heard a lot about, and that all has to be factored into when you start worrying about how long water is going to stay in the bay.

Chairman TOM DAVIS. Let me ask Mr. Wallace, you are here representing a group of people who have for years made their living off the water and you see the stock declining, the demand has not declined at all, and probably the demand for fish and crabs and oysters has probably never been higher. But we just do not have the kind of stock. What do moratoriums do to you and how do you view this long term? You said there was some success when they deployed it; on the other hand, there is no guarantee it works sometimes, depending on other factors.

Mr. WALLACE. Well, if you take the bay, for example, the only moratorium that has really brought a stock back is the rock fish. If we were to put a moratorium on the oysters, in my opinion and a lot of fishermen, it is not going to help because while harvesting has been an after-effect, it was not the initial result of the decline. And it is the same with the crabs, which is one of the fisheries I am involved with. If we were to put a moratorium on it, there is still so many other factors; you have an over-abundance of predators from the rock fish, croakers and other finfish that are in the water. You have a lack of grass beds.

So, it is an imbalance that is going there. As we manage things, we need to look at it as a whole. Moratoriums on a particular species are not necessarily going to work because they do not look at the other factors that are affecting the species.

Chairman TOM DAVIS. Is there any aquatic life that are doing very, very well in this environment; while some have decreased, some have increased, or is it because of the dark zones that you have, the dead zones, everything is dying?

Ms. SCHAFFNER. Actually, there is a lot of opportunistic organisms in the bay. They are benefiting from—they are not things that you want to eat. Sea squirts that foul the bottom of boats. Jellyfish, these are things that you would not want to harvest, but there are these populations. A lot of them actually are suspension feeders that seem to be perhaps capitalizing on the fact that the native oyster populations are reduced, for example. We have a lot of production out there and there are things that can use it. They are not things we want to harvest.

Chairman TOM DAVIS. Not things we want to increase though, right.

Ms. SCHAFFNER. It is not clear whether or not they benefit the bay. There is a little story about what is going on up in Maryland where this mussel seems to have come in and might be in some way playing a role in water clarity, gives you an example that we do not know what roles some of these organisms play. Since they are not commercial species, we do not get a lot of funding to study them.

Chairman TOM DAVIS. All right.

Ms. PORTER. Congressman Davis.

Chairman TOM DAVIS. Yes, ma'am.

Ms. PORTER. I do not know how much you know about regulations in the fishing industry, but sanctuaries are an important regulatory method that is being used a great deal. Where you harvest, where you cannot harvest.

Chairman TOM DAVIS. You keep some areas secure.

Ms. PORTER. That is correct. So, that is like a mini-moratorium I guess.

Mr. BOESCH. If I could just add to that comment in response to your question. There are some species, some stock, things that we care about like striped bass, the rock fish that are doing very well. That has been a real success story, and there are others. For example, the largest volume fishery—mass, weight, fishery in the Chesapeake Bay is ask my students menhaden. And the menhaden catches have over the long term been out there. There are some downward trends now, and there are some folks who think that is because we fertilized the bay, and we grow more of this phyto plankton that the menhaden eat. But to bring it back home to the comments that my colleagues at the end of the table indicate, all of these things are connected. So now we have a concern about whether there is sufficient menhaden in the bay to feed striped bass.

And so, this has led the bay program—in the Chesapeake 2000 agreement, one of the things we have not been able to talk about is this commitment to manage the fishery resources as an ecosystem, just as Mr. Wallace indicated. So, that we think about what are the implications of managing one stock to the other. We think about what is the consequence of the health of the environment, sanctuary areas, for those fishery stocks. And that is a grand challenge but that is one that the bay program has taking on as one of its strategic goals.

Chairman TOM DAVIS. Well, the foundation in this testimony noted that the benchmark for a healthy bay score of 100 is based on what Representative Schrock described like the idea of John

Smith's first visit to the bay in the 17th century. I think we acknowledge that the return to that State is probably unachievable.

Ms. PIERNO. Right, no, we are looking at a 70 as far as our mark.

Chairman TOM DAVIS. Is a 70 achievable?

Ms. PIERNO. It is if we do the things that we are committed to doing and put the resources forward.

Chairman TOM DAVIS. Where are we today, if not a 70 today, how would you rate it today?

Ms. PIERNO. Well, the state of the bay report says it is a 27, which I think in anybody's book is an F. I mean it is failing and we are clearly far from reaching that 70 goal, but I think the efforts underway are clearly not sufficient. We have made some progress, but we need to do much, much more.

Chairman TOM DAVIS. What we did is stop the bleeding to some extent?

Ms. PIERNO. Absolutely, and there has been some small steps in progress but again when you look at the constant increase in population, development, and loss of very important buffers and resources, we need to continue to do more in order to just keep up—more cars on the road, more air pollution, pollution coming from other sources even outside the watershed.

Chairman TOM DAVIS. Mr. Murphy, in our previous panel, said the No. 1 thing that you could do though on the point pollution that is entering, is we could do a better job with that. It is expensive, but do you agree with that?

Ms. PIERNO. Absolutely, it is relatively cost effective because you really get the results, you can measure it. Agriculture, Tom Horton once wrote it is a very leaky system and it is really difficult to manage and to really get the same kind of results. You certainly can measure from height. We do know that cover crops and many of the BMPs are very effective. But, certainly upgrading our sewage treatment plants and we have proven technology, we know how to do it. It is just a matter of spending the resources and moving forward quickly.

Chairman TOM DAVIS. And also, you have everybody, every suburban homeowner, that wants to put a deck or something on their back porch wonders why they are being singled out. What effect; of course this is an accumulative effect, but when you are talking the outflow is coming out in the systems that is a very large measurable one setting item, and you can see the results.

Ms. PIERNO. Absolutely.

Chairman TOM DAVIS. And of course the weather.

Ms. PIERNO. And in fact in Virginia you would meet 70 percent of your reduction load by upgrading your wastewater treatment plants to the best technology. So, that is—and of course you need to continue to work on agriculture.

Chairman TOM DAVIS. It is expensive, but politically probably the easiest one to do.

Ms. PIERNO. Yes.

Chairman TOM DAVIS. Because you are not impacting the watermen or the farmers or the developers.

Ms. PIERNO. That is right.

Chairman TOM DAVIS. I appreciate that. Is there anyone that wants to add? This has been very, very helpful for us. Because you know we have different committees with different jurisdictions. Our committee has an oversight of almost everything in the government and all of Federal/State issues, we have the jurisdictions. These kinds of issues we can deal with effectively, that is us. We need to deal with the appropriators, but this has been very, very helpful.

Mr. BOESCH. If I could just say one thing since you invited us to. There is also, you know, our senators that requested a Government Accountability Office evaluation of this, which I think is fine, and your committee and the like. I really hope that we really focus on—I mean we have some issues, some technical issues with monitoring and modeling. These are not show stoppers, they are important to get right so that we can deal with this, as you indicated.

Chairman TOM DAVIS. There is a large consensus of what we need to do from everybody here.

Mr. BOESCH. What it really should be focusing on is how do we get there. How do we get to achieve these goals.

Chairman TOM DAVIS. OK. Well thank you all very much. This meeting is adjourned.

[Whereupon, at 12:38 p.m., the committee was adjourned.]

[Additional information submitted for the hearing record follows:]

BEFORE THE U.S. ENVIRONMENTAL PROTECTION AGENCY,

EPA HEADQUARTERS, WASHINGTON, D.C.,

REGION 2, NEW YORK, NEW YORK,

AND

REGION 3, PHILADELPHIA, PENNSYLVANIA

PETITION OF THE CHESAPEAKE BAY FOUNDATION TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY TO AMEND, ISSUE OR REPEAL RULES AND TAKE CORRECTIVE ACTION TO ADDRESS NUTRIENT POLLUTION FROM SIGNIFICANT POINT SOURCES IN THE CHESAPEAKE BAY WATERSHED

Submitted by:
The Chesapeake Bay Foundation
December 1, 2003

PETITION OF THE CHESAPEAKE BAY FOUNDATION TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY TO AMEND, ISSUE OR REPEAL RULES AND TAKE CORRECTIVE ACTION TO ADDRESS NUTRIENT POLLUTION FROM SIGNIFICANT POINT SOURCES IN THE CHESAPEAKE BAY WATERSHED

I. INTRODUCTION

The Chesapeake Bay Foundation (CBF), with more than 116,000 members, is the largest non-profit organization dedicated to the protection and restoration of the Chesapeake Bay watershed, including its tributaries and its resources. CBF's mission is to reduce pollution, improve fisheries, and protect and restore natural resources such as wetlands, forests, and underwater grasses. The organization is headquartered in Annapolis, Maryland, with offices in Harrisburg, Pennsylvania, and Richmond, Virginia.

CBF petitions the United States Environmental Protection Agency (EPA), under Section 553(e) of the Administrative Procedures Act (APA), 5 U.S.C, § 553(e), to issue, amend, or repeal rules and take corrective action relating to the regulation, control, and permitting of point source discharges[1] of nutrients (nitrogen and phosphorous) from significant[2] sewage and industrial treatment plants in the Chesapeake Bay watershed. These facilities are located in the states of Delaware, Maryland, Pennsylvania, Virginia, New York, and West Virginia, and in the District of Columbia.

BACKGROUND

The Chesapeake Bay is the largest estuary in North America, and the third largest in the world.[3] The land area draining into the Bay (the Bay watershed) encompasses more than 64,000 square miles, and portions of Maryland, Virginia, Pennsylvania, New York, West Virginia, Delaware, and the District of Columbia.[4] The Bay holds about 18 trillion gallons of water, and supports

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[1] This Petition does not address permits regarding stormwater and Confined Animal Feeding Operations (CAFOs). Any reference to "point sources" specifically excludes those governing stormwater discharges and CAFOs, as defined under the Clean Water Act. 33 U.S.C § 1251, et seq.

[2] The word "significant," when used throughout the Petition to describe a facility or point source refers to a facility or point source identified as such by the Environmental Protection Agency Chesapeake Bay Program (CBP). See CBP, Nutrient Reduction Technology Cost Estimations for Point Sources in the Chesapeake Bay Watershed (2002). According to the CBP, significant municipal facilities, in general, are municipal wastewater treatment plants that discharge flows of equal to or greater than 0.5 million gallons per day. However, differences do exist among Bay watershed states. For Virginia, these facilities are those that have a design flow of 0.5 million gallons per day or greater, or are located below the fall line, regardless of flow. In contrast, for Pennsylvania, these facilities are those having average annual 1985 flows of 0.4 million gallons per day or greater. CBP identifies significant industrial facilities as those which discharge equivalent or greater amounts of nutrients as compared to municipal wastewater treatment of 0.5 million gallons per day. Both the Philip Morris facility and the Onancock facility referenced elsewhere in this Petition are both significant point sources according to the CBP.

[3] Chesapeake Bay Foundation (CBF), The Chesapeake Bay Fact Sheet (2003).

[4] General information such as this can be found at http://www.chesapeakebay.net/wshed.htm (June 11, 2003), the "Watershed Profiles" portion of the website for the CBP.

more than 3,600 species of plants, fish, and animals, including 348 species of finfish, 173 species of shellfish, and over 2,700 plant species.[5]

A. Economic and Recreational Benefits of The Chesapeake Bay

The Bay is vitally important economically; a 1989 study estimated the value of the Bay to be $678 billion.[6] The Bay produces 500 million pounds of seafood per year[7] and the Bay's commercial harvest has a net worth of over $1 billion per year.[8] Moreover, it is estimated that travel and tourism alone generated $33.5 billion in the year 2000 to the economies of Maryland and Virginia. Recreational boating adds approximately $950 million a year to the economies of these states.[9]

B. The Chesapeake Bay Watershed is Polluted by Excess Nutrients

Water pollution and impairment from excess nutrients is a nationwide problem. EPA estimates that as much as half of the waters surveyed by states do not adequately support aquatic life because of excess nutrients.[10] The Chesapeake Bay follows this trend.[11]

In the summer of 2003, due to excessive levels of nutrients, the Bay experienced widespread algal blooms[12] and one of the largest ever recorded "dead zones"-- an area of water with low levels of dissolved oxygen because of excessive nutrients and sediment.[13] The lack of oxygen was so critical that the Bay displayed "crab jubilees," where crabs actually left the waters of the

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[5] Id.
[6] CBP, Backgrounder: Restoring and Protecting the Chesapeake – How much will it Cost? (2003).
[7] Id.
[8] Howard R. Ernst, Chesapeake Bay Blues 11 (2003).
[9] Jan Cigliano and George E. Hartman, Maryland's Governor Should Be Thinking Tourists, Not Chickens, Wash. Post, Aug. 10, 2003.
[10] EPA, Eco-regional Nutrient Criteria Fact Sheet (2001).
[11] EPA succinctly describes nutrient pollution in the Bay as follows:

> Nutrients have always existed in the Bay, but not at the present excessive concentrations. When the Bay was surrounded primarily by forest and wetlands, very little nitrogen and phosphorus ran off the land into the water. Most of it was absorbed or held in place by the natural vegetation. Today, much of the forest and wetlands has [sic] been replaced by farms, cities, and suburbs. As the use of the land has changed and the watershed's population has grown, the amount of nutrients entering the Bay's water has increased tremendously. Excess amounts of phosphorus and nitrogen cause rapid growth of phytoplankton, creating blooms that reduce the amount of sunlight available to submerged aquatic vegetation (SAV). Without sufficient light, plants cannot photosynthesize and produce the food they need to survive. The loss of sunlight can kill the grasses. Algae may also grow directly on the surface of SAV. Unconsumed algae will ultimately sink and be decomposed by bacteria in a process that depletes bottom waters of oxygen. Like humans, most aquatic species require oxygen. When oxygen in deep water is depleted, fish and other species will die unless they move to other areas of suitable habitat.

CBP, What is Nutrient Pollution? at http://www.chesapeakebay.net/info/nutr1.cfm (October 8, 2003).
[12] CBF, More Algal Blooms in MD Waters (2003).
[13] Anita Huslin, Pollution, Algae Leave Chesapeake Life Gasping, Wash. Post, Aug. 7, 2003.
[14] Id.

Bay for land in a desperate search for oxygen.[14] This lack of oxygen is not a new problem for the Bay. From the 1950s to the 1990s, the volume of the "dead zone" has increased significantly.[15]

According to EPA's Chesapeake Bay Program (CBP), in a typical year, the Bay receives about 285 million pounds of nitrogen and 19.1 million pounds of phosphorous from pollution sources such as farms, sewage treatment plants, storm water runoff, industrial wastewater, and air deposition.[16] Recent monitoring data show that over the past ten years, nitrogen and phosphorous loadings have actually averaged higher, at levels of 320 million pounds of nitrogen and 20 million pounds of phosphorous.[17] This year's excessive precipitation is projected to contribute a staggering 459 million pounds of nitrogen to the Bay in 2003[18]-- among the highest amounts of nitrogen pollution that has entered the Bay in a single year.[19]

Of the nutrient loadings entering the Bay annually, sewage and industrial point sources constitute the second largest source of nutrient pollution (behind only agriculture) in the Chesapeake Bay watershed.[20] Approximately 21% of the nitrogen loads and 22% of the phosphorous loads emanate from point sources.[21] In total, approximately 71.1 million pounds of nitrogen, and 5.6 million pounds of phosphorous, enter the Bay watershed from sewage and industrial point sources each year.[22]

C. The Chesapeake Bay and its Tidal Tributaries are Listed on the CWA § 303(d) List of Impaired Waters

Due to excess nutrients from point and non-point pollution sources, the waters of the Chesapeake Bay and its tidal tributaries are classified as "impaired waters" (water quality limited segments) under § 303(d) of the Clean Water Act (CWA), 33 U.S.C. § 1313(d).[23] Waters that are placed on this "dirty waters" list fail to attain water quality standards even after the application of technology-based effluent limits required by Sections 301 and 306 of the CWA, 33 U.S.C. §§ 1311 and 1316.[24]

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[15] James D. Hagy, Eutrophication, Hypoxia and Trophic Transfer Efficiency in Chesapeake Bay, University of Maryland Center for Environmental Science (2002).
[16] CBP, Chesapeake Bay Program Announces New Reduction Goals To Restore The Bay (2003).
[17] CBF, New CBF Analysis Shows Nitrogen Pollution Worse Than Previously Thought (2003).
[18] Dennis O'Brien, Bay's Nitrogen Pollution Rises To 7 Year High, Balt. Sun, Oct. 16, 2003.
[19] Rusty Dennen, More Bad News For The Bay, Free-Lance Star, Oct. 16, 2003.
[20] CBP, State of Chesapeake Bay, at 31-44 (2002).
[21] CBP, Nutrient Reduction Technology Cost Estimations for Point Sources in the Chesapeake Bay Watershed, at tables IX-C and IX-F (2002). (Stating that, of the point source loadings of nitrogen, approximately 87% of the point source load is from sewage treatment plants, and 13% of the load is from industrial facilities. With phosphorous, 80% of the point source load emanates from sewage, and 20% emanates from industrial sources.)
[22] Id.
[23] Information on Maryland's § 303(d) list can be found at: http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/index.asp (Oct. 8, 2003). Information on Virginia's § 303(d) list can be found at: http://www.deq.state.va.us/wqa/303d.html (Oct. 8, 2003).
[24] 40 C.F.R. § 130.2(j). [Note: under Section 303(d)(1)(C) of the Clean Water Act (CWA), 33 U.S.C. § 1313(d)(1)(C), and regulations at 40 C.F.R. § 130.7(c), a state must establish a Total Maximum Daily Load (TMDL) for all water quality limited segments listed on the § 303(d) list. A TMDL is a "pollution budget" for a waterbody that includes the maximum amount of point and non-point source pollution a waterbody can withstand (with a margin of safety) and still attain water quality standards; the precise definition of what constitutes a TMDL

The State of Maryland listed Maryland's portion of the Bay and its tidal tributaries on its 1996 and 1998 § 303(d) lists, and refined the listing in 2002.[25] In Maryland, the waters are listed as impaired for nutrients in the Upper and Middle Chesapeake Bay, and for dissolved oxygen and nutrients in the Lower Chesapeake Bay.[26] Also, several tidal tributaries are listed as impaired for nutrients and dissolved oxygen as well as sediment, PCBs, toxics, and metals at other locations. The source of the impairment in Maryland is listed as point, non-point, and natural sources in the Bay, and non-point, natural, and legacy in the tidal tributaries.[27]

The Commonwealth of Virginia failed to list portions of the Bay and its tidal tributaries on its § 303(d) list in 1998.[28] On May 18, 1999, EPA Region III overrode the Commonwealth's decision and included portions of the Chesapeake Bay and several tidal tributaries in Virginia on the 1998 § 303(d) list of impaired waters.[29] In Virginia, the mainstem and tidal tributaries of the Bay are listed as impaired for "Dissolved Oxygen (Nutrients); Designated Use Standard (Benthic); and Nutrient Enriched Waters Designation."[30] The source of the impairment in Virginia is "Non-point Sources; Municipal Point Sources."[31] In addition, many local water segments throughout the Bay watershed are listed on the § 303(d) lists of the various Bay watershed states, some due to direct nutrient impairment and others due to impairments considered nutrient related, e.g., fecal coliform.[32]

D. Bay Watershed Jurisdictions Attempted to Cooperatively Address Impairment in The Bay

EPA agreed to allow Maryland and Virginia to work with other Bay watershed states to attempt a cooperative, voluntary approach to removing Bay waters from the Maryland and Virginia § 303(d) lists prior to the imposition of a Total Maximum Daily Load (TMDL). This approach was set forth in the *Chesapeake 2000 Agreement* (C2K) that was signed by Maryland, Virginia, Pennsylvania, the District of Columbia, the United States, and the Chesapeake Bay Commission. Other Bay watershed states, including Delaware (September 2000), New York (November 2000) and West Virginia (June 2002) signed a Memorandum of Understanding (MOU) to participate in the water quality and nutrient reduction elements of C2K with the original signatories of C2K.

In attempting to implement C2K, EPA's CBP took the lead in gathering Bay jurisdictions and other stakeholders to carry out the agreement. EPA and the Bay watershed states established numerous committees, workgroups, and subcommittees that met over the course of several years to discuss these issues. The primary vehicle for the discussion focused on water quality and nutrient pollution was the Water Quality Steering Committee (WQSC). EPA precluded CBF

is found at 40 C.F.R. § 130.2(i). Schedules for the submission of TMDLs are determined by the relevant Regional Administrator of EPA and the state, 40 C.F.R. § 130.7(d)(1).]

[25] See n. 23.

[26] Id.

[27] Id.

[28] See http://www.epa.gov/fedrgstr/EPA-WATER/1999/January/Day-26/w1652.htm (Oct. 8, 2003).

[29] Availability of Final Decision Document on Virginia's Section 303(d) Waters, 64 Fed. Reg. 26,959 (1999).

[30] See n. 23.

[31] Id.

[32] CBP, Water Quality Steering Committee Rep., at http://www.chesapeakebay.net/committee.htm (2003).

from serving as a voting member of the WQSC; EPA and the Bay watershed states served as decision makers.

On March 21, 2003, after several years of deliberations and innumerable meetings, and pursuant to recommendations from the WQSC, cabinet-level representatives of the EPA, Maryland, Virginia, Pennsylvania, New York, Delaware, West Virginia, and the District of Columbia agreed to reduce nitrogen loading to the Bay to 175 million pounds per year (from a calculated load of 285 million pounds per year) and phosphorous to 12.8 million pounds per year (from a calculated load of 19.1 million pounds per year).[33]

The Bay watershed states are not scheduled to begin implementing measures to reach these reduced loads until the completion of tributary strategies in April 2004. This April 2004 deadline is approximately two years behind schedule per the provisions of C2K.

E. The Bay Nutrient Loading Allocations Agreed to by The Bay Watershed Jurisdictions Fail to Ensure the Attainment of Water Quality Standards and are Based on Flawed Assumptions

The agreement to reduce annual nitrogen loadings to 175 million pounds per year, and phosphorous to 12.8 million pounds per year was a political compromise. It was not based on fully achieving water quality standards in the Bay. In fact, the CBP data establishes that approximately 17% of deepwater in the mainstem segment of the Bay (CBP segment CB4) will not attain dissolved oxygen criteria and will remain impaired even if the nitrogen and phosphorous loading goals are reached.[34]

Moreover, several flawed assumptions underlie the adopted goals. First, the nitrogen loading goal assumes that 8 million pounds per year of nitrogen load will be attained by the enactment of the federal Clear Skies Initiative (CSI) legislative proposal. Recent indications are that the CSI proposal will not be enacted into law.[35] The reduction goals contain no contingency plan should Congress fail to enact CSI. Another major flawed assumption is the calculated efficiencies for nutrient reductions from the use of Best Management Practices (BMPs).[36] The CBP's Scientific and Technical Advisory Committee (STAC) recently concluded that the goals rely on efficiencies that were overstated by 20-30%.[37] These flawed assumptions mean that significantly greater reductions will be necessary to meet the 175 million and 12.8 million pounds per year goals.

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[33] See n. 16.

[34] EPA originally supported a 160 million pound per year nitrogen loading goal before it agreed to the 175 million pound annual nitrogen loading goal. Even the more stringent 160 million pound per year annual nitrogen loading goal, which EPA and the Bay watershed states failed to adopt, would have, if attained, resulted in approximately 12% non-attainment of dissolved oxygen criteria water quality standards in the deep waters of the main stem (segment CB4).

[35] Darren Samuelsohn, As Clear Skies' Prospects Dim, New Mercury Regulation To Gain Attention, Greenwire, September 29, 2003. [Note: CBF has requested an analysis of how the CSI proposal would result in the projected reduction of 8 million pounds of nitrogen per year into the Bay. CBF requested the documentation from EPA on March 26, 2003. To date CBF has not received this documentation.]

[36] BMPs are on-the-ground practices implemented to reduce non-point source pollution.

[37] CBP, STAC Chesapeake Bay Program Phase 4.3 Watershed Model Non-Point Source BMPs (2003).

F. The CBP's Water Quality Criteria for the Bay are Generally Weaker than Existing Water Quality Standards Already in Place in Maryland and Virginia

In April 2003, after years of discussion by the WQSC, the CBP published water quality criteria for the Bay titled, "Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll *a* for the Chesapeake Bay and its Tidal Tributaries." The water quality criteria for dissolved oxygen in the document are actually less protective of water quality, in many respects, than existing standards. For example, the current Maryland dissolved oxygen water quality criterion is a minimum of 5 mg/l (instantaneous minimum) for surface waters, and 6 mg/l (daily average) for certain natural trout waters.[38] Similarly, in Virginia, the current minimum dissolved oxygen criterion is 4 mg/l (instantaneous minimum) and 5.0 mg/l (daily average) in estuarine and non-tidal waters.[39] In contrast, the CBP's instantaneous minimum deepwater dissolved oxygen criteria are 1.7 mg/l from June 1 to September 30, and 3.2 for the remainder of the year. These less stringent criteria are not sufficient to protect aquatic life, will require less reductions than current criteria, and are unlikely to drive improvements in water quality. Rather, they may in fact allow further degradation and impairment of the Bay.[40]

G. CBF is Compelled to File This Petition on Behalf of The Chesapeake Bay

In light of the current failure of the CBP to meet the deadlines provided in C2K for water quality improvement, and the failure of EPA and the Bay watershed states to take adequate measures to reduce nitrogen and phosphorous pollution from point sources, CBF is compelled to petition EPA to change its rules and regulations and seek corrective action addressing nitrogen and phosphorous pollution in the Chesapeake Bay. The focus of the Petition is on point sources because the CWA currently provides a clear and definitive regulatory handle on these sources.

II. CBF PETITIONS EPA TO AMEND, ISSUE, OR REPEAL RULES TO ELIMINATE NITROGEN AND PHOSPHOROUS POLLUTION IN THE CHESAPEAKE BAY WATERSHED FROM SIGNIFICANT SEWAGE AND INDUSTRIAL TREATMENT PLANTS

In order to restore the Chesapeake Bay and its tributaries, improve water quality, and ensure compliance with the CWA, CBF petitions EPA to take the following actions.

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[38] COMAR 26.08.02.03-3.

[39] 9 VAC 25-26-50.

[40] CBF provided extensive comments on the flawed scientific, technical, procedural, legal, and policy underpinnings of the CBP criteria proposal. CBF also highlighted the incongruity and failed logic of less stringent criteria serving as drivers for improved water quality in the Bay and its tidal tributaries. To date, CBF has received no response to its comments and the CBP appears to have largely ignored them in its criteria proposal.

A. EPA Must Amend Secondary Treatment Requirements to Include a Technology-Based Effluent Limit of 3 mg/l for Total Nitrogen

The CWA specifies minimum levels of technology that must be applied by publicly owned treatment works (POTWs)[41]. EPA must amend its regulations to specify technology-based effluent limits of 3 mg/l for total nitrogen in the Secondary Treatment regulations[42] in order to adequately address nitrogen discharges from these point sources into the Bay watershed. By doing so, nitrogen discharges from POTWs can be reduced by over 73%. This could result in 41% of the reductions required to meet the C2K 175 million pound per year total nitrogen goal for the Chesapeake Bay.

Section 301(b)(1)(B) of the CWA, 33 U.S.C. § 1311(b)(1)(B), provides, in relevant part, that "there shall be achieved ... for publicly owned treatment works ... effluent limits based upon secondary treatment as defined by the Administrator pursuant to Section 304(d)(1) of this title ...." Section 304(d)(1), 33 U.S.C. § 1314(d)(1), provides that "the Administrator ... shall publish ... from time to time ... information, in terms of amounts of constituents and chemical, physical, and biological characteristics of pollutants, on the degree of effluent reduction attainable through the application of secondary treatment." The key to the CWA scheme for establishing technology-based effluent limits for POTWs is what is considered "secondary treatment." CBF petitions EPA to amend the secondary treatment regulations at 40 C.F.R. Part 133 to specify technology-based effluent limits for total nitrogen of 3 mg/l (annual average). This technology is both achievable and affordable.[43]

The term "secondary treatment" is not defined in the CWA. In 1984, EPA promulgated regulations at 40 C.F.R. § 133.102 specifying minimum levels of effluent quality that constitute secondary treatment.[44] These secondary treatment requirements have remained static since 1984. The current effluent quality required to meet secondary treatment is woefully inadequate in removing nutrients such as nitrogen from POTW effluent. As detailed above, excess nutrients have caused the Chesapeake Bay to be placed on EPA's § 303(d) "dirty waters" list and have

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[41] The term "Publicly Owned Treatment Works" is defined at 40 C.F.R. § 403.3(o) as "a treatment works as defined by Section 212 of the Act, which is owned by a State or municipality (as defined by section 502(4) of the Act). This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes and other conveyances only if they convey wastewater to a POTW Treatment Plant. The term also means the municipality as defined in Section 502(4) of the Act, which has jurisdiction over the Indirect Discharges to and the discharges from such a treatment works."
[42] See 40 C.F.R. Part 133.
[43] See CBP, Draft Technical Support Document for the Identification of Chesapeake Bay Designated Uses and Attainability (2002). Also, capital and operation and maintenance costs for the installation and operation of these technologies are affordable for POTWs in many communities in the Bay watershed according to EPA guidance, because the total annual pollution control cost per household, divided by median household income, and multiplied by 100, is less than 1-2%. See EPA, Economic Guidance for Water Quality Standards (1995).
[44] Secondary treatment includes: (1) A 30-day average biochemical oxygen demand (BOD_5) that does not exceed 30 mg/l; a 7-day average that shall not exceed 45 mg/l, and a requirement that the 30-day average percent removal shall not be less than 85 %. At the option of the National Pollutant Discharge Elimination System (NPDES) permitting authority, specified levels for carbonaceous biochemical oxygen demand ($CBOD_5$) may be substituted for the BOD_5 treatment requirement; (2) A 30-day average suspended solids (SS) limitation that does not exceed 30 mg/l; a 7-day average SS limit that does not exceed 45 mg/l; and a requirement that the 30-day average percent removal shall not be less than 85 %; and (3) The pH of the effluent must, subject to certain exceptions, be maintained between 6.0 and 9.0.

compromised the Bay ecosystem. Since 1984, there have been numerous developments in wastewater treatment technology that enable POTWs to feasibly and cost-effectively reduce total nitrogen in effluents by applying nutrient reduction technology (NRT).[45]

The underlying science of nitrogen removal from sewage treatment plants is fairly simple. NRT and BNR use microorganisms like bacteria to break down the organic material in tanks that contain nitrogen wastewater. In general, the water is pumped through a succession of tanks, alternating between ones that contain oxygen and ones that do not. Within each tank are bacteria specifically suited for survival under those conditions. The bacteria within the aerobic tanks (those containing oxygen) have the ability to break down organic nitrogen and ammonia into nitrate (a process referred to as "nitrification"). Then the organisms in the anoxic tanks (those without oxygen) further break down the nitrate into nitrogen gas by stripping the oxygen from the nitrates (a process referred to as "denitrification"). The nitrogen gas then escapes harmlessly into the atmosphere.

Nutrient reduction technology is widely in use throughout the developed world and by simply specifying a total nitrogen effluent limit of 3 mg/l (annual average) as an element of secondary treatment, a POTW has the flexibility to use whatever techniques it chooses, so long as the POTW attains a 3 mg/l total nitrogen (annual average).

Most significantly, placing a 3 mg/l total nitrogen limit on POTW effluent would remove a projected 45,339,429 pounds per year of nitrogen from the Bay watershed.[46] As mentioned above, this requirement alone can reduce the nitrogen contributions from POTWs in the watershed by over 73%, and can achieve approximately 41% of the reductions needed to meet the 175 million pound per year total nitrogen goal for the Chesapeake Bay.

B. EPA Must Amend Best Conventional Technology Requirements to Include a Technology-Based Effluent Limit Guideline of 3 mg/l for Total Nitrogen

The CWA specifies minimum levels of technology that must be applied by industrial point sources; Section 301(b)(2)(E) of the CWA, 33 U.S.C. § 1311(b)(2)(E), provides that effluent limitations for conventional pollutants from point sources other than POTWs shall achieve the Best Conventional Pollutant Control Technology (BCT) "as determined by regulations issued by the Administrator [of EPA] pursuant to Section 304(b) ... " of the CWA, 33 U.S.C § 1314(b). Section 304(b) provides for the development of effluent limit guidelines (ELGs) for point source categories other than POTWs. Although there are ELGs in place for at least 55 industries set forth in federal regulations at 40 C.F.R. §§ 401-471, there is no overarching regulation requiring industrial point source dischargers to employ BCT for the removal or adequate minimization of total nitrogen[47] from their discharges. EPA must amend its regulations to specify a BCT effluent

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[45] CBP, Nutrient Reduction Technology Cost Estimations For Point Sources In The Chesapeake Bay Watershed Rep., at table X-A, at 98-106 (2002) (stating that BNR can achieve minimum effluent quality of 3 mg/l (annual average) for total nitrogen). See also Clifford W. Randall, Ph.D., et al, Evaluation of Wastewater Treatment Plants for BNR Retrofits Using Advances in Technology Rpt. (1999).

[46] See n. 20, Table IX-C.

[47] EPA regulations at 40 C.F.R. § 401.16 list the pollutants the EPA regulates as "conventional" pollutants for CWA purposes. One category of conventional pollutants is pollutants that exhibit "Biochemical oxygen demand (BOD)". Both nitrogen and phosphorous in water exhibit BOD. See, e.g. Montgomery Environmental Coalition v. Costle,

limit guideline of 3 mg/l for total nitrogen[48] in order to adequately address nitrogen discharges from these point sources into the Bay watershed.

Reducing total nitrogen from industrial point source effluent to a discharge level of 3 mg/l would remove a projected 5,590,518 pounds per year of nitrogen from the Bay watershed.[49] This requirement can reduce the nitrogen contributions from industrial point sources in the watershed by over 61%, and can achieve approximately 5% of the reductions needed to meet the 175 million pounds per year total nitrogen goal for the Chesapeake Bay.

EPA must issue a rule under Section 304(b) specifying BCT of 3 mg/l for total nitrogen from industrial point source discharges into the Chesapeake Bay watershed. This limit represents treatment levels and technologies that are both technologically achievable and affordable, and would ensure that industrial dischargers install technologies that adequately remove total nitrogen from their wastewater before discharging it into the Bay watershed.

C. EPA Must Adopt a Rule that Bay Watershed States Implement Adequate, Enforceable Effluent Limitations in NPDES Permits for Existing Discharges of Nitrogen and Phosphorous from Point Sources in the Bay Watershed

To date, the Bay watershed states have, with only a few exceptions, failed or refused to include adequate, enforceable effluent limits for total nitrogen and total phosphorous in existing NPDES permits for significant nutrient point source discharges. In addition, EPA has failed or refused to require the states to issue NPDES permits with such limits, which must be included in permits for dischargers of nitrogen and phosphorous in the Chesapeake Bay watershed.

1. The discharge of nitrogen and phosphorous from a point source into waters of the United States is an addition of pollutants that requires adequate, enforceable effluent limitations for these parameters in the NPDES permit

Under the CWA, the discharge of nitrogen and phosphorous by a point source into navigable waters is an addition of pollutants that requires an effluent limit under an NPDES permit. Thus, Bay watershed states must include adequate, enforceable effluent limits for total nitrogen and total phosphorous in NPDES permits issued. To do otherwise is to impermissibly allow the discharge of pollutants into the Bay watershed without any enforceable effluent limits or controls.

The CWA is based on the "fundamental premise" that the unauthorized "discharge of any pollutant by any person shall be unlawful."[50] Section 301(a) of the CWA, 33 U.S.C. § 1311(a), provides that the discharge of any pollutant by any person is unlawful unless it is in compliance with Sections 301, 302, 306, 307, 318, 402, and 404 of the Act, 33 U.S.C. §§ 1311, 1312, 1316,

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207 U.S. App. D.C. 233, 646 F.2d. 568, 575 (D.C. Cir. 1980) (excess nutrients result in a proliferation of algae whose subsequent death and decay use up dissolved oxygen and thus threaten other forms of aquatic life).

[48] See 40 C.F.R. subchapter N.

[49] See n. 20, Table IX-C.

[50] Natural Resources Defense Council v. EPA, 822 F.2d 104, 109 (D.C. Cir. 1987); Environmental Protection Information Center v. Pacific Lumber Company, No.C 01-2821 MHP (N.D. Cal. 2003), slip op. at 3.

1317, 1328, 1342, and 1344. Moreover, under Section 402(a) of the CWA, 33 U.S.C. § 1342(a), a NPDES permit is required when a person seeks permission from government (EPA, or a NPDES-delegated state) to add pollutants from a point source to navigable waters of the United States. Correspondingly, the federal regulations at 40 C.F.R. § 122.4(a) provide that no permit may be issued when the conditions of the NPDES permit do not provide compliance with the applicable requirements of the CWA or relevant regulations.

All of the elements that necessitate a NPDES permit apply to such discharges. First, it is clear that nutrients such as nitrogen and phosphorous constitute "pollutants"[51] when added to surface water.[52] Second, it is equally clear that significant sewage and industrial waste discharge facilities in the Bay watershed are "point sources,"[53] and that the placement of nutrients in the Bay watershed is a "discharge of a pollutant"[54] into "navigable waters" or "waters of the United States."[55] In sum, there is no legal justification why NPDES permits that are issued in the Bay watershed do not contain adequate, enforceable effluent limits for total nitrogen and total phosphorous.

2. Significant sewage and industrial dischargers of nutrients in the Chesapeake Bay watershed adversely impact the attainment of water quality standards and exacerbate impairment in the Bay and its tidal tributaries

NPDES permits cannot be issued if they "allow state water quality standards to be violated."[56] Section 301(b)(1)(C) of the CWA, 33 U.S.C. § 1311(b)(1)(C), specifies the fundamental precept that NPDES permits must achieve effluent limitations necessary to meet "water quality

[51] The term "pollutant" is defined in Section 502(6) of the CWA, 33 U.S.C. § 1362(6), as:

> dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. This term does not mean (A) sewage from vessels or a discharge incidental to the normal operation of a vessel of the Armed Forces' within the meaning of section 312 of this title; or (B) water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground or surface water resources.

[52] National Wildlife Federation v. Gorsuch, 530 F. Supp. 1291, 1310-11 (D.D.C. 1982), *rev'd on other grounds*, 693 F.2d 156 (D.C. Cir. 1982).

[53] The term "point source" is defined in Section 502(14) of the CWA, 33 U.S.C. § 1362(14) as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture."

[54] The terms "discharge of a pollutant" and "discharge of pollutants" are defined in Section 502(12) of the CWA, 33 U.S.C. § 1362(12), as "(A) any addition of any pollutant to navigable waters from any point source; (B) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft."

[55] The term "navigable waters" is defined in Section 502(4) of the CWA, 33 U.S.C. § 1362(4) as " the waters of the United States, including the territorial seas." The term "waters of the United States" is defined in great detail at 40 C.F.R. § 122.2.

[56] Trustees for Alaska v. EPA, 749 F.2d 549,556-57 (9th Cir. 1984).

standards ... established pursuant to any State law or regulations ... or any other Federal law or regulation, or required to implement any applicable water quality standard ... ."

The Bay and its tidal tributaries continue to fail to achieve the numeric standards set for dissolved oxygen. This is evidenced by the magnitude of the "dead zone" and the explicit listing of dissolved oxygen exceedances in Maryland and Virginia as the rationale for listings on the § 303(d) list. The state-sanctioned addition of more nutrients in NPDES permits will further exacerbate the failure to achieve both the dissolved oxygen water quality criteria and other water quality standards.

Excess nutrient discharges also result in the continued failure of the Bay and its tidal tributaries to attain narrative general water quality standards.[57] Both Maryland and Virginia water quality standards provide that all state waters shall be free from sewage and industrial waste pollution in amounts which are inimical or harmful to human, animal, plant or aquatic life.[58] It is beyond doubt that new and continuing NPDES permitted discharges of total nitrogen and total phosphorous are a major factor in the interference with Maryland and Virginia's designated uses for the Bay and its tidal tributaries, thus violating the general standard. Indeed, Virginia's Bay and tidal waters are listed on the §303(d) list due, in part, to § 303(d) designated use impairment. Additionally, in Maryland there is no dispute that excess nutrient discharges from NPDES-permitted significant sewage and industrial point sources change chemical or physical conditions in the surface waters, directly or indirectly interfering with designated uses.

3. The discharge of nutrients into the Chesapeake Bay watershed has a reasonable potential to cause or contribute to excursions of water quality standards in the Bay and its tidal tributaries

EPA regulations further specify that NPDES permit writers must include a water quality-based effluent limit in a permit if a discharge has the "reasonable potential" to cause or contribute to an excursion above a state water quality standard, including a narrative standard.[59] If there is a "reasonable potential," the regulations unambiguously provide that "the permit must contain effluent limits for that pollutant."[60]

On September 30, 2003, EPA Assistant Administrator G. Tracy Mehan affirmed EPA's view that the Commonwealth of Virginia has "both broad and specific authorities in their standards to control nitrogen."[61] Moreover, EPA stated in the letter that:

> Virginia's standards provide a basis for such controls whenever the Commonwealth determines that the discharge causes or has the reasonable potential to cause or contribute to an exceedance of applicable numeric criteria, interferes with designated uses and/or

[57] 40 C.F.R. § 122.44(d)(1) provides that permits shall achieve water quality standards "including state narrative criteria for water quality."
[58] COMAR 26.08.02.03B(2)(d), (f) and 9 VAC 25-260-20.
[59] 40 C.F.R. § 122.44(d)(1)(i).
[60] 40 C.F.R. § 122.44(d)(1)(iii).
[61] Letter from G. Tracy Mehan, EPA Assistant Administrator, to The Honorable Albert Pollard, Jr., Delegate, Virginia House of Delegates, September 30, 2003.

> is harmful to plant or aquatic life ('reasonable potential determination'). When a permitting authority determines the discharge has reasonable potential, based on a review of site-specific factors, it must include an effluent limitation that is as stringent as necessary to meet water quality standards.

Although the EPA letter addresses Virginia, it is equally applicable to other states in the Bay watershed because they have similar water quality standard and permit schemes.

The "reasonable potential" analysis provides that effluent limits are needed, not for every pollutant that is discharged, but for pollutants that may cause or contribute to a violation of water quality standards. As EPA stated in the Preamble to the rule establishing the "reasonable potential" provision, "all major POTWs and major industrial discharges will need to be evaluated to determine whether they have a reasonable potential to cause excursions above water quality criteria."[62] With regard to the impact of nutrient pollutants on water quality standards, the states in the Bay watershed have not undertaken such an evaluation in issuing NPDES permits, nor has EPA required them to do so.

Importantly, EPA notes that a discharge has the reasonable potential to cause or contribute to a violation of a water quality standard if it results in the discharge of "a pollutant at a level that is exceeding or may exceed a waste load allocation [WLA] for that discharge."[63] A WLA is defined in 40 C.F.R. § 130.2(h) as "the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution." A TMDL is a "pollution budget" for a waterbody that includes a WLA for point sources, a load allocation (LA) for non-point sources, and a margin of safety.[64] Because the Bay and its tidal tributaries are already exceeding their pollution budgets for nutrients, as indicated by the inclusion of these waters on the § 303(d) impaired waters list, there are no available load or waste load allocations for nutrients. As such, any discharge of nutrients by a significant sewage or industrial point source in the Bay watershed has the reasonable potential to cause or contribute to an exceedance of narrative and numeric water quality standards in the Bay and its tidal tributaries. Accordingly, such dischargers require an effluent limit for the discharge of nutrients. It is impermissible to allow the substantial addition of already-impairing pollutants to waters already impaired by those pollutants.

EPA and the states are not lawfully permitted to continue to ignore discharges of nitrogen and phosphorous from point sources when such discharges have the reasonable potential to cause or contribute to a violation of dissolved oxygen, phosphorous, nitrogen, and narrative general water quality standards, or designated uses in the Bay, its tidal tributaries, or local receiving waters. Thus, the failure of Bay watershed jurisdictions to include adequate enforceable effluent limits for total nitrogen and total phosphorous in the NPDES permits of significant sewage and industrial dischargers violates the CWA. NPDES permits that are issued to significant point

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[62] National Pollutant Discharge Elimination System: Surface Water Toxics Control Program, 54 Fed. Reg. 23,868 (1989).
[63] Id.
[64] 40 C.F.R. § 130.2(i).

source nutrient dischargers in the watershed must include adequate enforceable effluent limits for total nitrogen and total phosphorous.

EPA must issue a clarifying rule specifying that Bay watershed states must include adequate, enforceable effluent limits for total nitrogen and total phosphorous when action is taken on an NPDES permit that contains a significant nitrogen or phosphorous discharge component, or else EPA will object to the state's issuance of the permit.

D. EPA Must Require that NPDES Permits in the Bay Watershed Shall Not Be Issued for a New or Expanded Discharge of Nutrients Unless: (1) The Permit Contains a Zero Discharge NPDES Effluent Limit for Total Nitrogen and Total Phosphorous; (2) The State Inserts Compliance Schedules for Nutrient Reductions Into Existing NPDES Permits in The Watershed; and (3) The State Has Completed a TMDL for Nutrients for the Impaired Segment in Which the Discharge is Proposed

Section 301(a) of the CWA, 33 U.S.C. § 1311(a), provides that the discharge of any pollutant by any person is unlawful unless it is in compliance with Sections 301, 302, 306, 307, 318, 402, and 404 of the Act, 33 U.S.C. §§ 1311, 1312, 1316, 1317, 1328, 1342, and 1344. If a new discharge is proposed into a water that is listed on the § 303(d) list (i.e., an impaired water), EPA regulations at 40 C.F.R. § 122.4(i) specify precise procedures and requirements that must be met before the discharge can be allowed.

1. NPDES permits shall not be issued to a new or expanding discharger of nutrients in the Chesapeake Bay watershed unless the permit contains an effluent limit of zero for nutrients

EPA regulations at 40 C.F.R. § 122.4(i) provide that no NPDES permit shall be issued to a new source or new discharge if the discharge will cause or contribute to the violation of water quality standards. A person proposing a discharge must demonstrate, *inter alia*, that: (1) there are sufficient remaining pollutant load allocations to allow for the discharge and (2) existing discharges into that segment are subject to compliance schedules designed to bring the segment into compliance with applicable water quality standards.[65]

Because of the nutrient impairment in the Chesapeake Bay watershed, there are no sufficient available remaining pollutant load allocations to allow for a new discharge. Moreover, with states having failed to include effluent limits for total nitrogen and total phosphorous, there are no compliance schedules designed to bring impaired segments into compliance with applicable water quality standards. Accordingly, no new source or new discharge can obtain a NPDES permit to discharge nutrients into the Chesapeake Bay watershed and comply with Section 122.4(i).

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[65] In interpreting Section 122.4(i), EPA stated that "[a] new discharger... would not be eligible for coverage... if its discharge would cause or contribute to a violation of a water quality standard." 65 FR 64,746, 64,795 (2000).

The proper application of Section 122.4(i) allows for new discharge permits to be issued into impaired waters if there are sufficient existing waste load allocations for the pollutant to be discharged, and there are compliance schedules placed in permits for existing discharges. One way to address these requirements is for EPA to issue a rule allowing for the permit to be issued with an effluent limit of zero for the pollutants causing the impairment, coupled with a requirement to re-open the permits of existing dischargers to insert compliance schedules for the pollutant. The rule must also ensure that the examination of a proposed new or expanded discharge occurs in conjunction with reviews of existing state-issued permits with discharges into the same impaired waterbody.

2. Permits for new or expanded discharge of nutrients shall not be issued unless Bay watershed states re-open existing NPDES permits with nutrient discharges and insert enforceable compliance schedules containing adequate, enforceable effluent limitations for total nitrogen and total phosphorous into the existing permits

The federal regulation at 40 C.F.R. § 122.4(i) requires that when new discharges are proposed into impaired waterbodies, existing permittees discharging into the waterbody must be subject to compliance schedules that bring the existing discharges into compliance with water quality standards. This regulation, by the admission of EPA counsel, has been ignored.[66] The Bay watershed states have failed or refused to require existing point source dischargers into an impaired waterbody to enter into a compliance schedule to reduce nutrients when a new point source discharge of nutrients is proposed into the impaired waterbody. The only way to ensure that this provision is complied with by the states is for EPA to review proposed NPDES permits and object to the failure of a Bay watershed state to include compliance schedules for existing dischargers into or otherwise affecting the impaired waters in the Bay and its tidal tributaries.

Where a state-issued NPDES permit fails to include an effluent limitation in a permit for a newly proposed discharge, or where the state fails to address existing discharges of nutrients by including enforceable compliance schedules for total nitrogen and total phosphorous in their discharge permits, EPA must object to the state's issuance of the permit under Section 402(d)(2)(B) of the CWA, as such a permit fails to comply with the CWA and its regulation at 40 C.F.R. § 122.4(i).

3. NPDES permits for a new or expanded discharge into an impaired waterbody shall not be issued until a TMDL has been completed for the impaired segment

Caselaw supports the proposition that Maryland and Virginia, and the other Bay watershed states, are prohibited from issuing a NPDES permit for a new source or new discharger of nutrients unless a TMDL has been completed for the impaired segment into which the discharge has been proposed.[67] Under Section 122.4(i) and relevant caselaw, no new NPDES discharge

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[66] EPA Region III Attorney Christopher A. Day stated on October 30, 2001 at a meeting of the Chesapeake Bay Program Water Quality Steering Committee that this regulation has been "ignored."
[67] San Francisco Baykeeper, Inc. v. Browner, 147 F. Supp. 2d 991, 995 (N.D. Cal. 2001), *aff'd in relevant part*, 297 F.3d 877 (9th Cir. 2002). (The court, in explaining the statutory framework regarding impaired waters, held that

permit can be issued in the Bay watershed until a TMDL is in place for the impaired waters in the Bay and its tidal tributaries. EPA could address this situation by issuing a rule specifying that states may issue NPDES permits with effluent limits of zero in such situations, coupled with requirements that a TMDL be completed for the impaired segment, and existing discharge permits be opened for the insertion of enforceable compliance schedules. Moreover, the requirement to prohibit the issuance of new point source discharge permits into impaired waters prior to the completion of a TMDL also applies to the expansion of existing discharge loads.[68]

EPA therefore must require that NPDES permits in the Bay watershed shall not be issued for a new or expanded discharge of nutrients unless: (1) the permit contains a zero discharge NPDES effluent limit for total nitrogen and phosphorous; (2) the state inserts compliance schedules for nutrient reductions into existing NPDES permits in the watershed; and (3) the state has completed a TMDL for nutrients for the impaired segment in which the new or expanded discharge is proposed. This will ensure that EPA properly exercises its federal oversight authority so that no new nutrient load is added to already impaired Bay waters and their tidal tributaries from new or expanding sewage or industrial point sources.

E. EPA Must Review State NPDES Permit Actions on Requests for New or Expanded Discharges of Nutrients from Point Sources into The Chesapeake Bay Watershed and Object Unless the State Has Completed a TMDL for Nutrients for the Impaired Segments in Which the Discharge is Proposed and the State Requires That the Permit Contain: (1) A Zero Discharge NPDES Effluent Limit for Total Nitrogen and Total Phosphorous; and (2) Compliance Schedules for Nutrient Reductions In Existing NPDES Permits in The Watershed

EPA must adopt a rule specifying that it will review state NPDES permit actions to ensure that no new or expanded nutrient discharge load is authorized into nutrient impaired waters from new or expanding point sources in the Chesapeake Bay watershed unless the state has completed a TMDL for nutrients for the impaired segment and: (1) the permit contains an enforceable effluent limit of zero nutrient load for the pollutants causing the impairment; and (2) the state re-opens the permits of existing NPDES-permitted dischargers of nutrients and inserts compliance schedules for nutrient reductions designed to bring the segment into compliance with water quality standards. The rule must further specify that if the state-issued permit fails to meet these conditions, EPA will object to the issuance of the permit.

EPA has existing authority to review and object to state-issued NPDES permits that do not contain adequate, enforceable effluent limitations for total nitrogen and total phosphorous and otherwise do not meet the requirements of Section 402(d)(2)(B) of the CWA, 33 U.S.C. § 1342(d)(2)(B). That section delineates EPA's authority to object to proposed state-issued

under 40 C.F.R. § 122.4(i), "there cannot be a new source or a new discharger if the waterbody is a WQLS [water quality limited segment] impaired waterway unless the state completes a TMDL for that WQLS beforehand.").

[68] Friends of the Wild Swan v. EPA, 2003 U.S. App. LEXIS 15271(9th Cir. July25, 2003). (The court upheld a district court judge's order preventing the State of Montana from issuing any NPDES permits for new or increased discharges into § 303(d) impaired waters until the completion of a TMDL.).

NPDES permits, within 90 days of the date of transmittal of the proposed permit by the state to EPA, if the permit is "outside the guidelines and requirements of this Chapter."

As noted elsewhere within this Petition, various provisions of the CWA, 40 C.F.R. § 122.4(i) of the federal regulations, and relevant caselaw, constitute "guidelines and requirements" that require that states do not issue NPDES permits for new or expanded discharges of nutrients into the Chesapeake Bay watershed unless the permit satisfies the requirements set forth above.

F. EPA Must Review All State NPDES Permitting Actions on Significant Industrial and Sewage Discharges of Nutrients in The Chesapeake Bay Watershed to Ensure that Adequate, Enforceable Effluent Limits for Total Nitrogen and Total Phosphorous That Attain Water Quality Standards Are Included in the Permit, and Object to Permits That Fail to Contain Such Limits

EPA does not review significant point source NPDES discharge permit actions taken in Bay watershed states to determine whether a permit contains enforceable effluent limitations for total nitrogen and total phosphorous, and whether the lack of such limits will cause or contribute to an excursion above water quality standards. As a consequence of its failure to review such permits, EPA does not object to state-issued NPDES permits in the Bay watershed that fail to contain adequate, enforceable effluent limitations for total nitrogen and total phosphorous.

EPA's failure to review state-issued NPDES permits for the presence of adequate, enforceable total nitrogen and total phosphorous effluent limits, and to object to the issuance of these permits, where appropriate, is not a matter of a lack of EPA's legal authority, but rather a lack of political will. EPA has existing authority to review and object to state-issued NPDES permits that do not contain adequate, enforceable effluent limitations for total nitrogen and total phosphorous: that is, if the permit is "outside the guidelines and requirements" of the CWA, EPA has the authority to object within 90 days of the date of transmittal of the proposed permit by the State to EPA.[69]

As recited above, it is clear that the absence of adequate, enforceable total nitrogen and total phosphorous effluent limits in state-issued NPDES permits that discharge into, or otherwise adversely affect, waters impaired by nutrients contravenes "guidelines and requirements" of the CWA. EPA must, through either an interpretive or legislative rule, exercise its authority under Section 402(d)(2)(B) of the CWA, 33 U.S.C. § 1342(d)(2)(B), to review state-issued NPDES permits in the Bay watershed that fail to contain adequate enforceable effluent limits for total nitrogen and total phosphorous, and object to such permit actions.

1. Several "guidelines and requirements" form the basis for an EPA objection to state-issued NPDES permits in the Bay watershed

There are numerous "guidelines and requirements" that form the basis for an EPA objection to state-issued NPDES permits in the Bay watershed:

[69] Section 402(d)(2)(B) of the CWA, 33 U.S.C. § 1342(d)(2)(B).

- Each NPDES permit shall include conditions meeting requirements including, *inter alia*, that the permit "achieve water quality standards established under Section 303 of the CWA, including State narrative criteria for water quality." 40 C.F.R. § 122.44(d)(1).
- Effluent limitations must control all pollutants that "are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative water quality criteria for water quality." 40 C.F.R. § 122.44(d)(1)(i).
- A permitting agency must, in developing water-quality based effluent limits, ensure that the level of water quality to be achieved by limits on point sources "complies with all applicable water quality standards." 40 C.F.R. 122.44(d)(1)(vii)(A).
- A permitting authority shall ensure that effluent limits must be consistent with a wasteload allocation. 40 C.F.R. § 122.44(d)(1)(vii)(B).
- Permits shall incorporate any more stringent limitations, treatment standards, or schedule of compliance requirements established under state or federal law. 40 C.F.R. § 122.44(d)(5).
- If a permitting authority determines that a discharge has the reasonable potential to cause a violation of water quality standards, "the permit must contain effluent limits for that pollutant." 40 C.F.R. § 122.44(d)(1)(iii).

Other requirements relate specifically to ensuring that state-issued NPDES permits ensure the protection and attainment of water quality standards in all affected states. These requirements are directly applicable to state-issued permits in the Bay watershed that discharge nutrients since nutrients accumulate and impact downstream waters such as those of the Bay proper. One requirement, set forth at 40 C.F.R. § 122.4(d), is that no NPDES permit can be issued where conditions cannot ensure compliance with the water quality standards of all affected states.

2. The state-sanctioned addition of nutrients by point sources under the authority of NPDES permits that fail to contain adequate, enforceable effluent limits for total nitrogen and total phosphorous violates the "guidelines and requirements" of the CWA

As discussed elsewhere in this Petition, the addition of nutrients from significant sewage and industrial point sources in the waters of the Bay watershed has the reasonable potential to cause or contribute to violations of: (1) the dissolved oxygen standards; (2) phosphorous and nitrogen standards; (3) the narrative general water quality criteria; and (4) designated uses, in both Maryland and Virginia. Under CWA regulations at 40 C.F.R. § 122.44(d)(1)(iii), where a discharge of a pollutant has the reasonable potential to cause or contribute to a violation of water quality standards, the NPDES permitting entity must include a water quality-based effluent limit in the permit for that pollutant. This regulatory requirement falls within the aforementioned "guidelines and requirements" provisions of the CWA that forms the basis for an EPA objection under Section 402(d)(2)(B) of the CWA, 33 U.S.C § 1342(d)(2)(B) if a state fails to adhere to it.

Despite the legal mandate of 40 C.F.R. § 122.44(d)(1)(iii), and other authorities recited above, EPA fails to even review state-issued NPDES permits in the Bay watershed to ascertain whether the nutrients discharged from a NPDES-permitted facility will cause or contribute to a violation of water quality standards. This failure to review such permits, and object to the permits if they fail to contain such limits, is unconscionable given that the Bay and its tidal tributaries are on the Section 303(d) list of impaired waters due in no small part to the nutrients these facilities are discharging. EPA must review state-issued NPDES permits in the Bay watershed to ensure that such permits contain adequate, enforceable effluent limits for nutrients. Where there are no such limits, or the limits are inadequate, EPA must object to the issuance of such permits.

3. EPA's failure to review and object to state-issued new, renewed, reissued, or amended significant sewage and industrial point source discharge permits in the Bay watershed that fail to contain adequate enforceable effluent limits for total nitrogen and total phosphorous has resulted in continuing exceedances of Bay water quality standards in Maryland and Virginia

EPA's failure to review and object to new, renewed, reissued, or amended significant sewage and industrial point source discharges lacking effluent limits for total nitrogen and total phosphorous has resulted in continuing exceedances of Bay water quality standards in Maryland and Virginia. If a NPDES permit is issued, renewed, amended, or reissued without enforceable effluent limits for total nitrogen and total phosphorous, the issuing state is sanctioning a discharge that has the reasonable potential to cause or contribute to an excursion above a state water quality standard and impact designated uses. These state-issued NPDES permits are "outside the guidelines and requirements " of the CWA pursuant to Section 402(d)(2)(B). And, as the regulation at 40 C.F.R. § 123.44(c)(8) explicitly provides, EPA may object if "the effluent limits of a permit fail to satisfy the provisions of 40 C.F.R. § 122.44(d)," as these permits do. It is appropriate for EPA to exercise its authority to object to such permits when the required effluent limits are not included. EPA must, as a matter of agency practice, through either an interpretive or legislative rule, exercise its authority under Section 402(d)(2)(B) of the CWA, 33 U.S.C. § 1342(d)(2)(B), to object to state-issued NPDES permits in the Bay watershed that fail to contain adequate, enforceable effluent limits for total nitrogen and total phosphorous.

G. EPA Must Review All State NPDES Permit Actions and Object to Permits That Fail to: (1) Contain Adequate Limits for Total Nitrogen and Total Phosphorous Consistent With the March 2003 Bay Nutrient Reduction Allocations; or (2) Ensure That the Discharge of Nutrients Does Not Adversely Affect the Water of Another State

On March 21, 2003, the CBP partners committed to reducing nitrogen loading to the Bay to 175 million pounds per year, and phosphorous loading to 12.8 million pounds per year. These goals and concurrent allocations among the states were agreed to as part of an attempt to remove the Bay from the Section 303(d) list.

The allocations agreed to in March 2003 constitute "requirements and guidelines" under the CWA. They are "requirements" because they must be implemented to remove the Bay and its tidal tributaries from the Section 303(d) list.[70] The Bay allocations set forth a plan, pollution

[70]In fact, the Bay allocations are the functional equivalent of a TMDL. They arguably satisfy the legal definition of a TMDL as that term is described in Section 303(d)(1)(C) of the CWA and in 40 C.F.R. § 130.2(i). Section 303(d)(1)(C) specifies that states shall establish TMDLs for impaired waters at a level necessary to implement the

budget, and an allocation among states (in the form of necessary reductions) to address the impairment of the Bay as required by the CWA. In this manner, such Bay allocations constitute "requirements" for CWA purposes. Alternatively, if the Bay allocations are not "requirements," they are certainly "guidelines." Although there is no definition in the CWA of what constitutes a "guideline," common usage of the word is "an indication or outline of policy or conduct."[71] Clearly, the establishment of reduction goals for nitrogen, phosphorous, and sediment constitute "outlines of policies or conduct" needed to remove the Bay from the Section 303(d) list and restore the Bay. As such, the numerical reduction goals constitute "guidelines."

The "requirement" in Section 303(d)(1)(C) for states to address impairment, coupled with the "requirements" and/or "guidelines" set forth in the Bay allocations, triggers EPA's authority to object to any NPDES permit issued by a Bay watershed state that fails to include adequate, enforceable effluent limits for total nitrogen and total phosphorous that are consistent with the Bay allocation.

Review and objection by EPA is critical. Any state-permitted discharge of nutrients without adequate, enforceable effluent limits for total nitrogen and total phosphorous will exacerbate the already-impaired status of the Chesapeake by authorizing additional nutrient loads.[72]

In addition, EPA must ensure that the discharge of nutrients in one state does not adversely affect the waters of other states. The states of Maryland, Virginia, Pennsylvania, New York, Delaware, and West Virginia each have delegation from EPA to issue federal NPDES permits within their jurisdictions.[73] To that end, each state has a Memorandum of Agreement (MOA) with EPA that sets forth the obligations, agreements and responsibilities of EPA and each state *vis a vis* each other.[74] Each state's MOA allows for EPA to waive its review for various categories of permits. However, EPA is prohibited from waiving its review responsibilities for, *inter alia*, "discharges which may affect the waters of a state other than the one in which the discharge originated."[75] Since discharges of nitrogen in areas upstream of the Bay impact the waters of the Bay proper,[76] state-issued NPDES permits in parts of Pennsylvania, Maryland, Delaware, West Virginia, New York, Virginia and the District of Columbia "may affect waters of a state other than the water in

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applicable water quality standards with seasonal variations and a margin of safety to take into account any lack of knowledge concerning the relationship between effluent limitations and water quality. A TMDL is defined in 40 C.F.R. § 130.2(i), in relevant part, as: "The sum of the individual WLAs [wasteload allocations] for point sources and LAs [load allocations] for non-point sources and natural background."

[71] The Merriam-Webster Dictionary (3rd ed. Pocket Books, 1974).

[72] In addition, it is important that EPA adopt a rule to review and object to state-issued NPDES permits in the watershed because the agreed-to Bay allocations are, as noted previously, serving as the functional equivalent of TMDL. Under the CWA, a TMDL is required to be developed forthwith to address Section 303(d) listed waters.

[73] The District of Columbia NPDES program has not been delegated and is operated by EPA.

[74] Under Section 402(d)(1) of the CWA, 33 U.S.C. § 1342(d)(1), each state must provide copies of permits it issues to EPA. EPA has the right under Section 402(d)(2), 33 U.S.C. § 1342(d)(2), to object to the issuance of an NPDES permit by a state.

[75] 40 C.F.R. § 123.24(d)(2).

[76] EPA's Chesapeake Bay Program estimates that, as of the year 2000, Pennsylvania contributes 40% of the nitrogen load (from point and non-point sources) that reaches the Bay; Maryland contributes 20% of the load, Virginia 27%, New York 7%, West Virginia 2%, Delaware 2%, and the District of Columbia 2%. CBP, Water Quality Steering Committee Nutrient Loading Table (2003) (included in CBP, Conference Call Materials. "Chesapeake Bay Program Delivered Loads by Basin-State" (2003)). http://www.chesapeakebay.net/pubs/subcommittee/wqsc/doc-Loads_by_Basin-State-03-16-2003.pdf

which the discharge originated." EPA must revisit and modify its MOAs with these jurisdictions to ensure that they do not waive the review of NPDES permits affecting the waters of other states. EPA must then notify the states that any such waivers currently in existence are hereby rescinded. [77]

H. EPA Must Revisit its Agreements With Maryland and Virginia That Postpone the Development of TMDLs for Waters of the Mainstem of The Chesapeake Bay and Tidal Tributaries Until 2011

Under Section 303(d)(1)(C) of the CWA, 33 U.S.C. § 1313(d)(1)(C), and regulations at 40 C.F.R. § 130.7(c), a state must establish a TMDL for all water quality limited segments listed on the § 303(d) list. TMDLs are critical in addressing impairment because "they tie together point-source and nonpoint-source pollution issues in a manner that addresses the whole health of the water."[78] Although there is no precise date specified in the CWA as to when TMDLs must be developed, caselaw has held that TMDLs must be prepared in a reasonable timeframe after a waterbody is listed on the § 303(d) list.[79] EPA is allowing Maryland and Virginia until 2011 to prepare TMDLs for the Bay and its tidal tributaries. This time frame is not reasonable. By all indications, the Bay is in dire straits from excess nutrient loading. By allowing TMDLs for Maryland and Virginia to be delayed until 2011, EPA is giving its imprimatur to further delay.[80] EPA has violated the CWA and APA by failing to require the jurisdictions of Maryland and Virginia to prepare TMDLs for waters of the mainstem Bay and its tidal tributaries that are on the Section 303(d) list of impaired waters within a reasonable timeframe.

EPA needs to exercise its federal oversight responsibilities over the state drafting of TMDLs in the Bay watershed by promulgating a rule establishing TMDL schedules for Maryland and Virginia, requiring that TMDLs for the Bay watershed be completed by June 15, 2004. The rule must also provide that no NPDES permits for new or expanded discharges can be issued in Bay watershed states until TMDLs have been completed by Maryland and Virginia.

[77] 40 C.F.R. § 123.24(e)(1).

[78] Sierra Club v. Meiberg, 296 F.3d 1021,1025 (4th Cir. 2002).

[79] For example, in Idaho Sportsman's Coalition v. EPA, 951 F. Supp. 962, 969 (W.D. Wa. 1996), the court held that a 5 year time frame for the development of TMDLs was appropriate. Also, in Meiburg, the court approved a Consent Decree that allowed a 7 year timeframe for the preparation of TMDLs for most impaired segments, but that specified that TMDLs for 20% of the waters on Georgia's 1996 § 303(d) list be completed within a year. Id. at 1027.

[80] Moreover, the current schedule fails to require Bay watershed jurisdictions to formulate a "pollution budget" for point and non-point sources in the Bay in a timely manner. This is what an expedited TMDL would require. It would also require Bay watershed states to plan for needed reductions and begin the implementation of nutrient reduction measures in point source NPDES permits and the non-point source nutrient load that impacts the Bay, without further delay.

I. EPA Must Issue a Rule to Implement Section 117(g)(1) of the CWA That Requires EPA to Coordinate With Bay Watershed States to Ensure the Implementation of Measures to Achieve and Maintain the Bay Allocations for Nitrogen and Phosphorous Agreed to By CBP Partners in March of 2003, and Water Quality Requirements Necessary to Restore Living Resources in the Bay and Its Watershed

Section 117(g)(1) of the CWA, 33 U.S.C. § 1267(g)(1), specifies that EPA's CBP, in coordination with the members of the Chesapeake Executive Council, "shall ensure that management plans are developed and implementation is begun by signatories of the Chesapeake Bay Agreement to achieve and maintain: (A) the nutrient goals of the Chesapeake Bay Agreement for the quantity of nitrogen and phosphorous entering the Chesapeake Bay and its watershed; [and] (B) the water quality requirements necessary to restore living resources in the Chesapeake Bay ecosystem... ."

To date, EPA has maintained a hands-off approach to implementation, and has left such matters entirely to the Bay watershed states. This lack of federal oversight contravenes the language of Section 117(g)(1)(A) and (B).

EPA must issue a rule that specifies how it will engage in implementation oversight efforts to fulfill its statutory duty to ensure that management plans are developed and implementation occurs in the Bay watershed states. These rules must specify that EPA will review all state-issued NPDES permits in the watershed to ensure that such permits contain adequate, enforceable effluent limitations for total nitrogen and total phosphorous that are consistent with the agreed-to Bay allocations for nitrogen and phosphorous. Where a state fails to include such measures in an NPDES permit, EPA must object to the issuance of the permit under its authority in Sections 117(g)(1) and 402(d)(2)(B) of the CWA.

The presence of EPA oversight in these matters could preclude attempts by Bay watershed states to ignore their recent commitments under the Bay allocation. Oversight could also preclude states from failing to incorporate limits for substances that cause or contribute to violations of water quality standards when reissuing NPDES permits (e.g., for Philip Morris into the James River, and the Onanacock sewage treatment plant into Eastern Shore waters).

J. EPA Must Require That at Least 25% of Federal CWA Section 106 Grant Funds to Bay Watershed States Be Allocated to the Implementation of Nutrient Reduction Technology by Significant Sewage Treatment Plants in These Jurisdictions

Section 106 of the CWA, 33 U.S.C. § 1256, and federal regulations at 40 C.F.R. Part 35, set forth legal requirements for the disposition of federal funding to states to operate their pollution control programs. Section 106(a) specifies that such grants can be given to states to assist them in administering programs for the prevention, reduction, and elimination of pollution. Section 106(f)(3) provides that grants are made based on the condition that the state submits, for EPA's approval, an annual program plan for the prevention, reduction, and elimination of pollution in accordance with the purposes and provisions of the CWA, and in such form and content as EPA may prescribe. This annual workplan may be based on regional supplemental guidance and national program guidance, 40 C.F.R. § 35.107(a)(1). In addition, the agreement between EPA and each state shall set out the roles and responsibilities of EPA and the state in carrying out the commitments in the workplan, 40 C.F.R. § 35.107(b)(2)(v). EPA is authorized under Section 106(f) to condition its grants, and may conditionally approve state applications for funds. 40 C.F.R. § 35.11(b).

In short, EPA has broad latitude in steering states that seek EPA Section 106 grant money into carrying out national and regional program objectives. Certainly, in the Chesapeake Bay region, efforts to restore the Bay and its watershed by reducing nutrient loadings in the watershed are of primary importance. Yet, EPA has not adequately reflected this priority in its Section 106 grants to Bay watershed states. Now is the time for EPA to require Bay watershed states to use Section 106 funds for the implementation of important nutrient reduction efforts, particularly for those sources that are required to obtain NPDES permits under the CWA and are also large sources of nutrient loads.

EPA must adopt a rule specifying that Bay watershed state program plans shall include a component for using 25% or more of the Section 106 grant money for the implementation of nutrient reduction measures by sewage treatment plants.

K. EPA Must Withdraw Approval of the Delegated NPDES Programs for The Bay Watershed States Unless it Grants the Relief Requested in This Petition

Under the cooperative federalism scheme established in the CWA, EPA may delegate the administration of the NPDES program within a state to the state.[81] In the Bay watershed, every state, with the exception of the District of Columbia,[82] has received delegation from EPA to administer the NPDES program. Once a program is delegated, the state program must, under Section 402(c)(2) of the CWA, 33 U.S.C. § 1342(c)(2), "at all times be in accordance with this section and guidelines promulgated pursuant to section 304(i)(2)." Section 304(i)(2), 33 U.S.C. § 1314(i)(2), sets forth EPA's responsibility to promulgate guidelines for "the minimum procedural and other elements of any state program under Section 402."

Section 402(c)(3) of the CWA, 33 U.S.C. § 1342(c)(3), authorizes EPA to withdraw approval of a state's NPDES program which is not operated in accordance with Section 402.[83] EPA's regulations at 40 C.F.R.§123.63 flesh out Section 402(c)(3) by setting forth the criteria for EPA's withdrawal of approval of a state's NPDES delegation. The regulation provides that EPA may withdraw approval of a state NPDES program when the operation of the state program fails to comply with the requirements of the CWA, including "failure to exercise control over activities required to be regulated under this Part, including failure to issue permits."[84] Also, Section 123.63(a)(2)(iii) authorizes program withdrawal where a state fails to inspect and monitor activities subject to regulation. Moreover, Section 123.63(a)(5) specifies that EPA may

[81] See 33 U.S.C. § 1342(c)(1).
[82] The District of Columbia is a state for CWA purposes. See Section 502(3) of the CWA, 33 U.S.C § 1362(3).
[83] EPA v. California, 426 U.S. 200, 208, 96 S.Ct. 2022, 2026 (1976).
[84] See 40 C.F.R. § 122.63(a)(2)(i).

withdraw program approval if a state "fails to develop an adequate regulatory program for developing water quality-based effluent limits in NPDES permits."[85]

The states in the Bay watershed have, except in a few instances, failed or refused to issue NPDES permits for the control of nitrogen and phosphorous from point sources. In many cases, EPA has not even required point source facilities that discharge significant amounts of nitrogen and phosphorous to monitor their discharge loadings. By so doing, the states have failed to comply with, *inter alia*, Section 402 of the CWA, and regulations at 40 C.F.R. § 123.63. The states have seriously neglected their obligations under the CWA, to the detriment of the Bay and its watershed, by failing to require adequate, enforceable effluent limits for total nitrogen and total phosphorous from significant sewage and industrial point sources. These egregious failures on the part of the Bay watershed states justify the strong federal action of withdrawing the delegations to the Bay watershed states to issue NPDES permits.

A recent district court decision supports the case for EPA to withdraw delegation.[86] In fact, EPA's failure to require Bay watershed states to issue NPDES permits for significant point source dischargers of nutrients that include adequate, enforceable effluent limits for total nitrogen and total phosphorous, is actionable under the citizen suit provisions of Section 505 of the CWA, 33 U.S.C. § 1365. In order to remedy this, EPA must issue a rule requiring Bay watershed states to issue NPDES permits to significant point source dischargers of nutrients with adequate, enforceable effluent limits for total nitrogen and total phosphorous. The rule must provide that the failure of the Bay watershed states to do so will result in NPDES program withdrawal because the CWA and federal regulations require states to operate their NPDES regulatory programs in accordance with the CWA. EPA risks subjecting itself to liability if it fails to remedy these inadequacies in the state NPDES programs.

III. CONCLUSION

Water quality in the Chesapeake Bay and its tidal tributaries is seriously impaired from excess nutrient loadings from anthropogenic pollution sources in the Bay watershed states. Nutrient pollution from significant sewage and industrial point sources in the watershed is the second largest source of nutrient pollution in the watershed. Despite the findings by EPA and the Bay watershed states of pervasive nutrient impairment - and the identification of point sources as the second largest source of nutrient pollution in the Bay watershed by EPA - EPA has failed or refused to require Bay watershed states to issue NPDES permits with adequate, enforceable effluent limitations for total nitrogen and total phosphorous that assure attainment of water quality standards and are consistent with the allocations of nitrogen and phosphorous adopted by the CBP partners on March 21, 2003.

EPA has also failed to review state NPDES permit actions in the Bay watershed to determine whether the permits contain adequate, enforceable limits for the control of nitrogen and

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[85] See Upper Chattahoochee Riverkeepers Fund v. City of Atlanta, 953 F.Supp. 1541, 1544 (N.D. Ga. 1996).

[86] In Save the Valley, Inc. v. EPA, 223 F.Supp. 2d 997, 1013-1014 (S.D. Ind. 2002), the State of Indiana failed to adopt an adequate NPDES regulatory program for Concentrated Animal Feeding Operations (CAFOs) despite EPA's insistence, over a period of years, that Indiana adopt NPDES permit requirements for CAFOs. The district court ordered EPA to withdraw Indiana's NPDES program if Indiana had not amended its NPDES program to require permits for CAFOs within 9 months after the entry of judgment.

phosphorous, and has failed to object to NPDES permits in the Bay watershed that do not contain such limits. In addition, EPA has not updated technology-based secondary treatment standards and effluent limit guidelines to include technologically available and affordable nutrient reduction technologies for, respectively, sewage treatment plants and industrial point sources. Moreover, EPA has failed to make Bay watershed states comply with applicable regulations and caselaw when issuing NPDES permits to new or expanded point source discharges of nitrogen and phosphorous in the Bay watershed. EPA has the authority and duty to address these issues and others detailed in this Petition. Finally, if the Bay watershed states continue to fail to operate their NPDES programs in accordance with the requirements of the CWA, EPA must withdraw its NPDES delegations to those Bay watershed states.

IV. REQUEST FOR RELIEF

For the foregoing reasons, CBF respectfully requests that EPA take the following actions as expeditiously as possible, but in no case later than June 15, 2004:

A. **Update Secondary Treatment Requirements** - Issue a rule amending the secondary treatment regulations at 40 C.F.R. Part 133 to redefine secondary treatment to include a requirement that POTWs in the Chesapeake Bay watershed achieve effluent limits of 3 mg/l of total nitrogen (annual average).

B. **Update Effluent Limit Guidelines** - Issue a rule amending the regulations at 40 C.F.R. Subchapter N to establish an overarching Best Conventional Technology (BCT) Effluent Limit Guideline (ELG) of 3 mg/l of total nitrogen (annual average) for industrial point source dischargers in the Chesapeake Bay watershed.

C. **Require Implementation of Adequate, Enforceable Effluent Limitations for Existing Discharges of Total Nitrogen and Total Phosphorous in NPDES Permits for Point Sources in the Chesapeake Bay Watershed** - Issue a rule requiring that Chesapeake Bay watershed states include adequate, enforceable effluent limits for total nitrogen (annual average) and total phosphorous (annual average) that attain water quality standards, and are consistent with implementation measures necessary to achieve the agreed-to allocations for nitrogen and phosphorous when the state takes action to renew, reissue, modify, or amend an existing NPDES permit of a point source that discharges nitrogen and/or phosphorous in the Chesapeake Bay watershed.

D. **Require That No NPDES Permit be Issued by a Chesapeake Bay Watershed State for a New or Expanded Discharge of Nutrients Unless Several Conditions are Met** - Issue a rule specifying that no NPDES permit may be issued by a Chesapeake Bay watershed state that authorizes a new or expanded discharge of nutrients into, or otherwise affecting, an impaired water segment, unless: (1) the permit contains an enforceable effluent limit of zero nutrient load for the pollutants causing the impairment, (2) the state re-opens the permits of existing NPDES-permitted dischargers of nutrients and inserts compliance schedules for nutrient reductions designed to bring the segment into compliance with water quality standards, and (3) the state has completed a TMDL for nutrients for the impaired segment.

E. **Review State NPDES Permit Actions on Requests for New or Expanded Discharges of Nutrients From Point Sources Into the Chesapeake Bay Watershed -** Adopt a rule specifying that EPA will review state NPDES permit actions to ensure that no new or expanded nutrient discharge load is authorized into nutrient impaired waters from new or expanding point sources in the Chesapeake Bay watershed unless: (1) the permit contains an enforceable effluent limit of zero nutrient load for the pollutants causing the impairment, (2) the state re-opens the permits of existing NPDES-permitted dischargers of nutrients and inserts compliance schedules for nutrient reductions designed to bring the segment into compliance with water quality standards, and (3) the state has completed a TMDL for nutrients for the impaired segment. The rule must further specify that if the state-issued permit fails to meet these conditions, EPA will object to the issuance of the permit by the state.

F. **Review All State NPDES Permit Actions in the Chesapeake Bay Watershed to Ensure That Adequate, Enforceable Effluent Limits for Total Nitrogen and Total Phosphorous That Attain Water Quality Standards Are Included in the Permit -** Issue or amend a rule providing that EPA will review state NPDES permit actions in the Chesapeake Bay watershed, and object to state-issued NPDES permits for significant industrial and sewage discharges into or otherwise affecting waters impaired by excessive nutrients in the Chesapeake Bay watershed that fail to contain adequate, enforceable effluent limits for total nitrogen and total phosphorous that attain water quality standards.

G. **Review All State NPDES Permit Actions in The Chesapeake Bay Watershed to Assure Consistency With The Chesapeake Executive Council Bay Allocation Agreement -** Adopt a rule providing that it will review NPDES permit actions in the Chesapeake Bay watershed to ascertain if the permit includes adequate, enforceable effluent limits for total nitrogen and total phosphorous consistent with implementation measures necessary to achieve the agreed-to allocations for nitrogen and phosphorous. The rule must also specify that EPA will object to state-issued NPDES permits that fail to contain such limits.

H. **Review State NPDES Permit Actions in The Chesapeake Bay Watershed to Ensure That Any Discharge of Nutrients Does Not Adversely Affect Waters of Another State -** Issue a rule providing that it will review state NPDES permit actions in the Chesapeake Bay watershed and object to state-issued NPDES permits for significant industrial and sewage discharges where nutrients in the discharge may adversely affect waters of another state.

I. **Rescind the EPA Review Waiver for Any NPDES Permit in The Chesapeake Bay Watershed That Involves the Discharge of Nutrients That May Affect Waters of Another State -** Issue a rule notifying Bay watershed states that any waivers of review given by EPA to the state for a point source discharge that may involve the discharge of nitrogen or phosphorous, where the nutrients may affect waters of another state, are hereby rescinded.

J. **Revisit MOAs With Chesapeake Bay Watershed Jurisdictions to Ensure That Review of Any State Permit Action That Involves the Discharge of Nutrients That May Affect Waters of Another State is Not Waived by EPA** - Revisit Memoranda of Agreement (MOAs) with Chesapeake Bay watershed jurisdictions to ensure that the MOAs do not waive the review of any state NPDES permit action in the Chesapeake Bay watershed that does not restrict the discharge of nutrients where that discharge may adversely affect the waters of another state.

K. **Revise TMDL Completion Schedules for Maryland and Virginia** - Issue a rule establishing TMDL schedules for Maryland and Virginia providing that TMDLs for impaired waters in the Bay watershed be completed by June 15, 2004. The rule must also provide that NPDES permits shall not be issued in the Maryland and Virginia portions of the Chesapeake Bay watershed until TMDLs have been completed by Maryland and Virginia.

L. **Require That States Use at Least 25% of Section 106 Funds for Nutrient Reduction Measures** - Adopt a rule specifying that Chesapeake Bay watershed state program plans shall include a component for using 25% or more of the Section 106 grant money in each Bay watershed state for the implementation of nutrient reduction measures by sewage treatment plants in the watershed.

M. **Carry Out Its Duties Under Section 117(g)(1) of the CWA** - Issue a rule that specifies that it will engage in implementation oversight efforts to fulfill its statutory duty under Section 117(g)(1) to ensure that management plans are developed and implementation is begun by the Bay watershed states by specifying that EPA will review all state-issued NPDES permits in the watershed to ensure that such permits contain adequate, enforceable effluent limitations for total nitrogen and total phosphorous that are consistent with the agreed-to Bay allocations for nitrogen and phosphorous, and objects to permits that fail to contain such limits.

N. **Require Chesapeake Bay Watershed States to Take Necessary Measures and Use Necessary Means to Attain Nutrient Reductions From Point Sources** - Issue a rule specifying that Chesapeake Bay watershed states must use all necessary means and take all necessary measures, including the use of Section 106 grant funds, to attain nutrient reductions that attain water quality standards and are consistent with implementation measures needed to achieve the agreed-to allocations for nitrogen and phosphorous. The rule must detail extended federal oversight efforts over state permit and program actions that involve nutrient loadings to the Chesapeake Bay watershed.

O. **Withdraw NPDES Program Delegation to Chesapeake Bay Watershed States That Fail to Issue NPDES Permits With Adequate, Enforceable Effluent Limitations for Nitrogen and Phosphorous** - Issue a rule providing that the failure of Chesapeake Bay watershed states to issue NPDES permits to significant point source dischargers of nutrients with adequate, enforceable effluent limits for total nitrogen and total phosphorous will result in withdrawal of the state's delegated authority to administer the NPDES program within its jurisdiction.

P. Grant Other Relief - By June 15, 2004, grant such other relief as may be appropriate.

Respectfully Submitted,

THE CHESAPEAKE BAY FOUNDATION, INC.

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CERTIFICATE OF SERVICE

I hereby certify that on this ______ day of December, 2003, the foregoing "Petition of the Chesapeake Bay Foundation To The United States Environmental Protection Agency To Amend, Issue Or Repeal Rules And Take Corrective Action To Address Nutrient Pollution From Significant Point Sources In The Chesapeake Bay Watershed" was served on the following persons by certified mail, postage prepaid to:

The Honorable Michael O. Leavitt, Administrator
United States Environmental Protection Agency
Ariel Rios Building
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Washington, D.C. 20460

The Honorable Donald S. Welsh, Regional Administrator
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Philadelphia, PA 19103-2029

The Honorable Jane M. Kenny, Regional Administrator
U.S. Environmental Protection Agency Region 2
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New York, NY 10007-1866

The Honorable Rebecca Hanmer, Director
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The Honorable Kathleen A. McGinty, Secretary
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The Honorable W. Tayloe Murphy, Jr., Secretary
Virginia Department of Natural Resources
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Richmond, VA 23219

The Honorable C. Ronald Franks, Secretary
Maryland Department of Natural Resources
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The Honorable Kendl P. Philbrick, Deputy Secretary
Maryland Department of the Environment
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The Honorable Stephanie R. Timmermeyer, Secretary
Department of Environmental Protection
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Charleston, West Virginia 25301

The Honorable Erin M. Crotty, Commissioner
Department of Environmental Conservation
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The Honorable John Hughes, Secretary
Department of Natural Resources and Environmental Control
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Dover, Delaware 19901

The Honorable James A. Buford, Director
District of Columbia Department of Health
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Respectfully Submitted,

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Report

from the
CHESAPEAKE BAY FOUNDATION

SEWAGE TREATMENT PLANTS: THE CHESAPEAKE BAY WATERSHED'S SECOND LARGEST SOURCE OF NITROGEN POLLUTION

Most Plants Don't Utilize Available Technology To Reduce Nitrogen Pollution

October 29, 2003

Report

from the
CHESAPEAKE BAY FOUNDATION

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The Chesapeake Bay Foundation
gratefully acknowledges the review of this document by the
Chesapeake Bay Program,
Maryland Department of the Environment,
Virginia Department of Environmental Quality, and
Pennsylvania Municipal Authorities Association.

The conclusions contained in this report are those of the Chesapeake Bay Foundation and may not necessarily reflect the views of the reviewing organizations.

BACKGROUND

For 20 years, Chesapeake Bay scientists have known that nitrogen pollution is the most significant problem facing the Bay, degrading habitat for key plants and animals in the Bay's ecosystem, including underwater grasses, crabs and oysters. In 2003, the Chesapeake suffered one of the largest "dead zones" (areas of low or no dissolved oxygen) on record, stretching at one point 150 miles from Baltimore to the York River. Excess nutrients were one of the leading culprits along with climatic factors. Low dissolved oxygen levels are also a problem in many tributaries. Existing dissolved oxygen standards, adopted by the Bay states under the federal Clean Water Act, are violated routinely. As a result of nitrogen pollution, the Chesapeake Bay now functions at barely one-quarter of its estimated potential.

In 1998, a majority of the mainstem of the Bay and major parts of its tidal tributaries were added to Virginia and Maryland's "Impaired Waters List" (also known as the EPA's "Dirty Waters List"). Earlier this year the Chesapeake Bay Program determined that water quality would improve and substantial progress could be made toward removing the Bay from the "Dirty Waters List" if nitrogen pollution was reduced by 110 million pounds per year.

Nitrogen entering the Bay from sewage treatment plant (STP) effluent, agriculture, air deposition and urban runoff, and other sources stimulates "blooms" (population explosions) of microscopic plants called algae. While they are alive and drifting in the water column, the algae decrease water clarity, blocking sunlight from underwater Bay grasses. When algae die, they sink to the bottom, and the bacterial process of decay removes oxygen from the water.

Wastewater discharged from sewage treatment plants is the second largest source of nitrogen pollution to the Chesapeake Bay[1]. When approximately 12 million of the 16 million residents of the watershed flush their toilets, the wastewater goes to STPs, which discharge into the Chesapeake Bay and its tributaries.

There are 304 "significant" STPs in the watershed, which discharge 1.5 billion gallons of wastewater each day. These plants contribute about 52 million pounds of nitrogen pollution annually to the Bay and its tributaries. To date, more than two-thirds of those plants do not use any technologies to remove nitrogen pollution, and only ten plants are currently reducing nitrogen pollution to state-of-the-art levels, according to the most recent data available (2002).

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[1] Agriculture contributes 42% of the nitrogen loading and is the largest source of nitrogen pollution to the Bay. CBF is working on both the voluntary and regulatory fronts to secure the necessary nitrogen reductions from agriculture.

STPs that do not include nutrient removal technologies have wastewater discharge concentrations of approximately 18 milligrams of nitrogen per liter (18mg/L) or more. With advanced applications of Nutrient Reduction Technology (NRT) or Biological Nutrient Removal (BNR), plants can reduce discharge concentrations to 3 mg/L or less. Upgrading the watershed's "significant" STPs with advanced BNR would reduce their collective discharge of nitrogen from 52 to 13 million pounds. This 39-million-pound reduction alone would account for more than one-third of the 110 million pound/yr nitrogen reduction goal that scientists believe will make substantial progress toward meeting the commitments of *Chesapeake 2000*, the current multi-jurisdictional Bay agreement.

EPA has recently confirmed that the states currently have the authority and obligation to set permit limits for nitrogen pollution from STPs. To date, however, the states have written few permits with such limits.

STPs BY STATE

Table 1 presents the number of "significant" STPs by jurisdiction. The definition differs slightly by state, but in general, a "significant" discharger either:

Discharges more than 0.5 million gallons per day (MGD);

Discharges less than 0.5 MGD but is located below the fall line and therefore has a more direct impact on water quality in tidal tributaries or the Bay main stem;

Discharges 0.4 MGD or more in Pennsylvania.

Table 1: Number of STPs by Jurisdiction

Jurisdiction	# Of Significant Facilities
DC	1
Maryland	65
Virginia	81
Pennsylvania	123
West Virginia	9
Delaware	3
New York	22
TOTAL	**304**

STP ASSESSMENT

The Chesapeake Bay Foundation conducted a review of the most recent STP data available from the Chesapeake Bay Program (2002 reports) from Maryland, Virginia, Pennsylvania, and the District of Columbia. The loads from the STPs in these four jurisdictions are about 94% of the total nitrogen load from all STPs in the Bay watershed.

Each plant was evaluated based on the annual average concentration of total nitrogen in the plant's discharge. A plant was rated as "Excellent" if it achieved 3 mg/L or less, "Good" if the nitrogen pollution was between 3.1 to 5 mg/L, "Needs

Improvement" if it ranged from 5.1 to 8 mg/L, and "Unsatisfactory" if it discharged > 8.1 mg/L. Table 2 presents the total number of "significant" dischargers in each total nitrogen concentration grade category by state.

Bay Program models show that significant reductions in nitrogen pollution from agriculture, air deposition, stormwater management and STPs, will still not be enough to achieve the *Chesapeake 2000* goal. That is why CBF scientists believe it is critical that STPs decrease their total nitrogen concentrations to 3 mg/L or less. Table 2 shows that about 96% of the plants do not meet the 3 mg/L concentration level.

Table 2: Number of Plants by Total Nitrogen Concentration (annual average)

State	Excellent	Good	Needs Improvement	Unsatisfactory	Data Not Available
	< 3 mg/L	3.1 – 5 mg/L	5.1 – 8 mg/L	> 8.1 mg/L	
DC			1		
MD	5	9	17	32	2
VA	2	5	15	59	
PA	3	7	13	97	3
Total	10	21	46	188	4

While some improvements at STPs have been made since 2002, and other improvements can be expected in the next few years, *Chesapeake 2000* commitments cannot be met and the health of the Chesapeake Bay cannot be significantly improved without tremendous improvements in removing nutrients by all nitrogen load sources. This includes implementing state-of-the-art technology at "significant" STPs.

NITROGEN LOADS AND CONCENTRATIONS FROM STPs

When analyzed by the concentrations of nitrogen and the volume of wastewater discharged into the Chesapeake Bay, it is clear that the few plants operating to remove nitrogen pollution to the 3 mg/L concentration level treat only a very small percentage of total STP wastewater.

Figure 1: Volume of Wastewater Discharged by Total Nitrogen Concentration

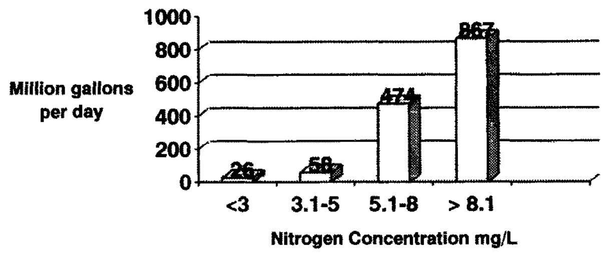


Figure 1 shows that less than 2% of the wastewater flow is treated to the 3 mg/L concentration level, which CBF believes will be necessary to restore the Chesapeake Bay.

An important point about nitrogen loads from STPs is that with the watershed's population projected to grow by 1 million to 17 million people by 2010, the associated nitrogen load from STPs will increase unless the plants reduce the total nitrogen *concentration* in their discharges.

Table 3 clearly illustrates the necessity for reducing nitrogen concentration in order to significantly reduce nitrogen loads (total pounds) to the Bay. The table compares the amount of flow (million of gallons of wastewater discharged per day or MGD) and total nitrogen loads (pounds per year) within each concentration category. For example, compare the "Needs Improvement" and "Unsatisfactory" categories. Note that while the "Unsatisfactory" category has approximately twice as much flow, its total nitrogen load is more than 4 times higher than the "Needs Improvement" category. This explanation is simple: plants in the "Unsatisfactory" category do a much poorer job of removing nitrogen from their discharges. "Unsatisfactory" plants contribute 61% of the flow from all of the Bay's STPs, yet they contribute 80% of the total nitrogen load. Reducing their concentrations to 3 mg/L would slash their contribution to the Bay's nitrogen load by 85%.

Table 3: Total Nitrogen Flow (MGD) and Load (pounds per year) by Concentration Category

	EXCELLENT (< 3 mg/l)		GOOD (3 – 5.0 mg/l)		NEEDS IMPROVEMENT (5.1 – 8 mg/l)		UNSATISFACTORY (> 8.1 mg/L)		TOTAL FLOW	TOTAL LOAD
	Flow	Load	Flow	Load	Flow	Load	Flow	Load		
DC					312.0	6,177,288			312.0	6,177,288
MD	8.8	72,065	35.6	461,272	65.5	1,425,576	228.1	8,458,235	337.9	10,417,148
VA	1.5	6,912	12.5	157,269	62.5	1,239,889	421.2	21,821,442	497.8	23,225,512
PA	16	47,708	10	128,304	34	767,887	218	10,777,520	277.5	11,721,419
Total	**26.0**	**126,685**	**58.4**	**746,845**	**473.9**	**9,610,640**	**866.8**	**41,057,196**	**1,425.1**	**51,541,367**

STPs– TOTAL NITROGEN LOAD BY COUNTY

Appendix A provides a listing of STPs by state, grouped by average nitrogen discharge concentrations for 2002. The 10 plants that are achieving 3 mg/L total nitrogen or less are listed in Table 4. Clearly, the record of these 10 plants demonstrates that total nitrogen concentrations of 3 mg/L or less can be achieved with currently available technology. For some plants, space limitations may make achieving this goal more difficult.

Table 4: STPs Achieving Average Total Nitrogen Concentrations Less Than 3 mg/L – 2002 data

State	Facility	County	Flow (MGD)	TN Concentration (mg/L)	TN Load (Pounds per year)
MD	Fort Meade	Anne Arundel	1.8	2.3	12,222
	Chesapeake Beach	Calvert	0.7	2.6	5,350
	MD Correctional Inst.	Washington	1.0	2.5	7,126
	Taneytown	Carroll	0.6	2.7	4,771
	Broadneck	Anne Arundel	4.8	2.9	42,595
VA	Farmville	Prince Edward	0.9	0.5	1,488
	Remington Regional	Fauquier	0.6	2.9	5,424
PA	Marysville	Perry	0.6	0.7	1352
	Upper Allen Township	Cumberland	0.5	1.6	2,436
	Gregg Township	Union	0.7	2.9	5,906

STP – NITROGEN LOAD AND CONCENTRATION BY COUNTY

These data are presented in Appendix B. There are 15 counties with STP discharges to their waterways of over a million pounds of nitrogen per year.

- The 50 plants in the counties with STP discharges of over a million pounds generate 597 MGD of wastewater, or 42% of the total flow from STPs, and over 29 million pounds, or 56% of the total nitrogen load from STPs each year.
- The average concentration of these plants is 17.4 mg/L, well into the "Unsatisfactory" category.
- Most of these large plants are concentrated in densely populated areas, so their combined effluents contribute a great deal of stress to local waterways as well as to the Bay.

These plants have the potential to play powerful roles in cleaning up the Chesapeake system, if they are made priorities for upgrades. For example, in Maryland the two plants with the most loads both discharge into Baltimore area waters. In Virginia, plants in Alexandria, Arlington, and Fairfax join Blue Plains in the District of Columbia to discharge to the Potomac. Also in Virginia, the waterways of Hampton Roads receive a large collective load of nitrogen from plants in Hampton, Newport News, Virginia Beach, Norfolk, Portsmouth, Chesapeake, and Suffolk. In Pennsylvania, the Lancaster - York - Dauphin County area generates a great deal of the flow and load.

UPGRADING STPS - THE TECHNOLOGICAL FIX: NRT/BNR

NRT/BNR technology was developed as a cost-effective way to reduce nutrient pollution in the Chesapeake Bay watershed in the 1980s. At the plants that have this technology, it has proven to be very effective. Sewage treatment plants that do not use NRT technology for nitrogen removal will discharge, on average, 18 mg/L or more of total nitrogen in their effluent. Fortunately, NRT/BNR technology is available to reduce nitrogen effluent concentrations to 3 mg/L (average concentration over the course of a year). This level of treatment is currently considered "state-of-the-art."

Although the design, construction, and operation of BNR facilities are complex, the underlying science of how they work is fairly simple. NRT and BNR use microorganisms like bacteria to break down the organic material that contains nitrogen in wastewater. In general, the water is pumped through a succession of tanks, alternating between ones that contain oxygen and ones that do not. Within each tank are bacteria specifically suited for survival under those conditions. The bacteria within the aerobic tanks (those containing oxygen) have the ability to break down organic nitrogen and ammonia into nitrate (a process referred to as "nitrification"). Then the organisms in the anoxic tanks (those without oxygen) further break down the nitrate into nitrogen gas by stripping the oxygen from the nitrates (a process referred to as "denitrification"). The nitrogen gas escapes harmlessly into the atmosphere.

To date, most STPs that have implemented NRT/BNR technology are not designed to operate at peak effectiveness and do not reduce effluent nitrogen concentrations to 3 mg/L. There are no watershed-wide requirements to reduce nitrogen pollution, **and the states have, except in a few instances, failed or refused to impose adequate, enforceable total nitrogen effluent limits on STPs**. For example, in Virginia, sewage treatment plants that have accepted state cost-share money to install NRT/BNR are required only to reduce nitrogen total concentrations to 8 mg/L, and there is no incentive to go further.

As we work to reduce nitrogen loading from all sources, it is critical that STPs implement these upgrades to achieve their share of the overall reductions. After achieving their share, additional reduction of nitrogen pollution by STPs could alleviate the need for even more expensive reductions that municipalities need to undertake to reduce stormwater runoff from urban areas, which includes a significant nutrient component.

THE COSTS OF UPGRADING

While there have been a number of estimates on the cost of upgrading the watershed's STPs, it is very difficult to come up with a firm estimate for costs on which everyone agrees. Maryland's Department of the Environment has estimated the cost of upgrading plants in Maryland at between $5 and $14 per household per year.

The Chesapeake Bay Program assembled a task force of representatives from local, state and federal government, municipal wastewater agencies, and consultants who specialize in nutrient reduction technology. This task force issued a report in November 2002 titled *Nutrient Reduction Technology Cost Estimates for the Point Sources in the Chesapeake Bay Watershed.* The report concluded that the cost for upgrading all of the Bay's "significant" sewage treatment plants to a nitrogen concentration of 5 mg/L and 3 mg/L is $2.7 and $4.4 billion respectively. While the estimated range for these upgrades is large, the costs can be minimized if STPs implement upgrades to the NRT/BNR process while undertaking routine capital improvements.

THE NEXT STEPS

Key steps to achieving the *Chesapeake 2000* nutrient reduction goals are:

Ensure the implementation of measures to achieve the Chesapeake Bay Program's basin-specific nitrogen reduction goals in each state, achieving as much of each basin's reductions from sewage treatment plants as possible.

On state and federal levels secure new legislation, regulations, guidance, or policy direction supporting enforceable 3-mg/L total nitrogen permits limits for the most "significant" STPs in the watershed.

Secure "binding" commitments at either the federal (EPA) or state level (Governor, Secretariat, legislature or state agency) that guarantee widespread implementation of Nutrient Removal Technologies/Biological Nutrient Removal and nutrient pollution permit limits at sewage treatment plants throughout the Bay watershed.

Clearly, STPs can reduce nitrogen loads significantly by using available technology. This reduction is not occurring throughout the watershed at the rate needed to meet the goals of *Chesapeake 2000* by 2010. The lack of timely action creates the need for binding commitments to serve as the driving force for sewage treatment plant upgrades and increased funding. Such commitments can be achieved in numerous ways, including: state or federal requirements on sewage treatment plant discharges (nitrogen effluent limits or technology requirements); Governors' Executive Orders or state policies issued by Natural Resource or Environmental Protection Secretaries; or new laws, regulations, policies, or guidelines.

CBF is committed to obtaining the nutrient reductions necessary from all sectors, including agriculture, STPs, stormwater runoff, air deposition, and other major contributors of nutrient load, in order to remove the impairment to the Chesapeake Bay. Upgrading wastewater treatment plants with NRT is a reasonable, proportional, and achievable step toward that end.

Embargoed until 10:30 am on July 28, 2004

Manure's Impact on Rivers, Streams and the Chesapeake Bay

Keeping Manure Out of the Water

Improving manure management to benefit the Chesapeake Bay, Its Rivers, Streams, and the Watershed's Farmers

A Report by the Chesapeake Bay Foundation
July 28, 2004

CHESAPEAKE BAY FOUNDATION
Save the Bay

Manure's Impact on Rivers, Streams and the Chesapeake Bay

CHESAPEAKE BAY FOUNDATION

BACKGROUND

More than thirty years have passed since Congress first promised the American people that their government would stop the flow of pollution into our rivers and bays and restore them to vibrant health. The Clean Water Act of 1972 made it a "national goal" to bring back "the chemical, physical and biological integrity of the Nation's waters" and to end "the discharge of pollutants into the navigable waters" of America by 1985.

That target date is far behind us now, and on the shores of the Chesapeake Bay, as well as on the banks of thousands of miles of its streams and rivers, the Clean Water Act's promise is still unfulfilled. A generation of children has grown up with a diminished birthright. Few of them have the chances all should enjoy: to swim in a local river, dip a net into clear water chasing crabs, or stretch out on the banks of a neighborhood stream watching fish rise to feed on newly hatched damsel flies.

Local rivers and streams are no longer sparkling and thriving with aquatic life, and many are seriously damaged by pollution and in need of restoration, according to the U.S. Environmental Protection Agency. The Bay's seafood harvests are in decline, its watermen are losing work that helped our region prosper, and all of us are losing a way of life that makes Bay Country unique, from the Tidewater to the Great Shenandoah Valley and the mighty Susquehanna.

The vast Chesapeake watershed feeds the most productive bay ecosystem in the nation. Scientists have studied it more and understand it better than perhaps any water body in the world. In an era when people tended to think that pollution came solely from poisons like DDT, Bay scientists were among the first to realize what the world now understands: Too much of a good thing can amount to a deadly overdose.

Human settlement in the Bay watershed has sharply increased the amounts of two key elements, nitrogen and phosphorus, flowing into Bay waters. These natural plant nutrients are essential to healthy ecosystems. But in excess, they cause explosive growths of algae and other underwater plants, which literally suffocate other forms of Bay life. Bay scientists' computer models estimate that the Chesapeake now gets hundreds of millions of pounds of nitrogen and tens of millions of pounds more phosphorus than it did in the 1620s, when Captain John Smith encountered a Bay in perfect natural balance, so bursting with health and productivity that the English explorer joked about catching fish with a frying pan.

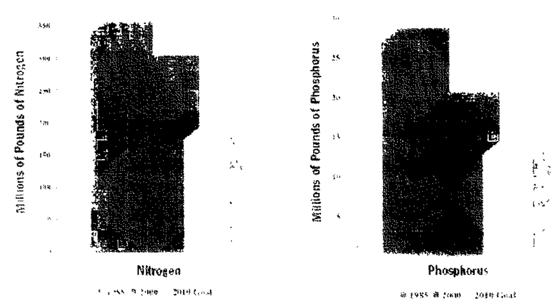
The Chesapeake Bay is choking on nutrient pollution from a myriad of sources – from urban runoff, industry, automobiles, and human sewage, but the largest source is agriculture and, increasingly, from the manure produced by livestock, which now outnumber the watershed's human population by 11 to 1. Most of that manure is spread on the surface of nearby cropland, and studies show that within two years as much as half of its nutrient pollution washes out of the soil and into rivers and streams or seeps into groundwater. Both of these pathways lead to pollution in local waterways and, ultimately, in the Bay.

Since 1983, the Bay has been the focus of a pioneering restoration program that now involves six states, the District of Columbia, and the federal government and affects all of the region's 16 million citizens. The most basic goal is to sharply reduce the amount of nitrogen and phosphorus reaching the Bay and its tributaries. Twenty years of concerted effort have reduced the flow of nitrogen into the Bay by 15 percent, even as population grew by 17 percent. This is a significant achievement -- but the payoff, a healthier Bay, still hasn't been achieved. Recognizing the need to do more, government leaders set even more ambitious nutrient reduction goals when they reaffirmed their commitment in the Chesapeake Bay 2000 Agreement.

The Bay restoration effort is at a tipping point, on the brink of either success or failure. The outcome may have global significance. Nutrient overdoses threaten coastal communities around the world, with potentially severe consequences: infestations of toxic algae, diminished seafood production, and lost recreation and tourism opportunities.

Scientists at the Chesapeake Bay Program have recently finished an analysis of the nitrogen and phosphorus reductions that would restore healthy oxygen levels, improve water clarity, permit Bay grasses to rebound, and take the Chesapeake and its tributaries off the "impaired waters" list by the year 2010. This would meet the Clean Water Act's ultimate goal: clean streams and rivers flowing into a restored Bay. The scientists found nitrogen flows into the Bay would have to be cut by an additional 39 percent, from 285 million pounds a year to 175 million. Phosphorus flows would need to be reduced by an additional 33 percent, from 18 million pounds a year to 12.8 million.

Chesapeake Bay Nitrogen and Phosphorus Pollution



Source: EPA Chesapeake Bay Program

In the Chesapeake 2000 Agreement, leaders from Virginia, Maryland, Pennsylvania, the District of Columbia and the federal Environmental Protection Agency pledged that by 2010 nutrient levels would fall low enough to allow the grasses to cover 185,000 acres. They also committed to making sure that the nutrient reductions accomplish two other key elements of the restoration: permitting dissolved oxygen to return to appropriate levels throughout the Bay and improving water clarity by reducing levels of chlorophyll A, a plant pigment used to measure algae growth.

Once these lower nutrient levels are reached, the Bay region leaders also agreed to a nutrient "cap" to ensure that future pressures from population growth, land development, and economic growth do not erode the progress made in nutrient reductions. However, to date, none of the Bay states has proposed a set of policies to accomplish this.

The challenge is significant. Progress needs to be three times as fast as it has been up till now or the new pollution reduction goals will not be met. Governments at every level, along with businesses and citizens, must focus on actions that will yield measurable, significant, and permanent pollution reductions and result in real water quality improvements.

Data compiled by the Chesapeake Bay Program show that animal waste and human waste (sewage systems and septic tanks) contribute 40 percent of the nitrogen that drains into local streams, rivers, and the Bay. In effect, we are still using the Bay and its tributaries to dispose of our wastes. The old adage that the "the solution to pollution is dilution" is an outdated, environmentally destructive notion that needs to be banished from 21st century America. Nutrients are a valuable resource and should be managed more efficiently for both economic and environmental benefit. The Bay watershed, which encircles the capital of one of the most technologically advanced nations on Earth, should be a global leader in this effort.

Last year, the Chesapeake Bay Foundation issued a Sewage Report, that analyzed the amount of pollution being discharged by sewage treatment plants in the watershed and called for the implementation of available, affordable technology to reduce that pollution. Agriculture is the largest source of nitrogen and phosphorus pollution in the watershed. This report is designed to analyze the impact of animal waste on local rivers, streams, and the Chesapeake Bay and identify steps that must be taken to reduce this pollution.

LOTS OF ANIMALS MEANS LOTS OF MANURE:

As public consumption of meat products has increased in recent decades, the number of livestock in the watershed has grown, and livestock operations have become more concentrated. There are six major types of animal operations in the Chesapeake Bay watershed: dairy cows, beef cattle, pigs, egg production, broilers (chicken meat), and turkeys. Taken together, there are 185 million livestock animals present in the Bay watershed at any one time – more than 11 times the human population. These animal operations excrete 44 million tons of manure each year containing nearly 600 million pounds of nitrogen.

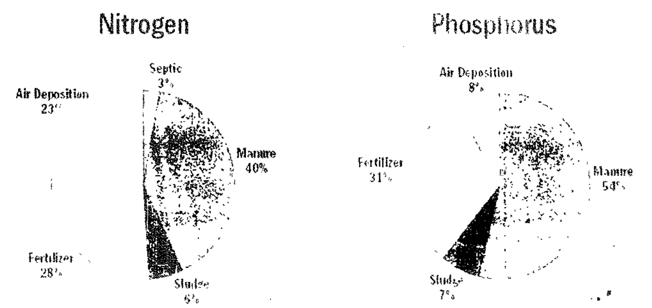
Animal Manure Generated in Bay Watershed

Animal Type	Number of Animals	Pounds of Nitrogen	Pounds of Phosphorus
Beef	1,846,923	208,979,305	74,153,947
Dairy	697,595	161,380,163	25,103,581
Swine	1,254,026	38,448,422	14,647,018
Poultry	181,560,180	185,873,604	51,780,397
Total	185,358,723	594,681,494	165,684,943

Sources: EPA Chesapeake Bay Program, 2003

The Chesapeake Bay has more land draining into it relative to its volume of water than any other bay in the world. This fact alone makes it extremely vulnerable to the pollutants that come off the land. Of the nitrogen and phosphorus that are placed on the land, animal manure is the largest source. According to data compiled by the Chesapeake Bay Program, animal manure accounted for 40 percent of the total nitrogen and 54 percent of the total phosphorus deposited on the land – which has a limited capacity to absorb and retain it and in many places has already exceeded that capacity. That pollution has seriously damaged the health of local rivers, streams, and the Chesapeake Bay.

Sources of Nitrogen and Phosphorus Applied to the Land in Chesapeake Bay Watershed



Source: EPA Chesapeake Bay Program

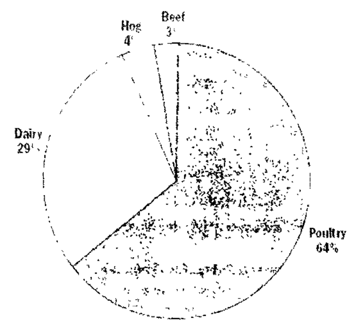
Manure can be both a waste product and a resource. It is spread on farm fields for two reasons: to fertilize crops, and at times simply, because there is not enough storage for all of the manure. Once it is put onto farm fields, there are numerous in which nutrients are lost from the cropland and wind up in streams and rivers. Soon after it is spread, large amounts of ammonia gas, a nitrogen compound, can escape into the atmosphere. Much of that ammonia falls on land nearby, contributing to air and water pollution. About half of the manure's nitrogen is in a form plants cannot absorb until soil microbes break it down into ammonium, nitrate, and other usable forms. The plants take all the nutrients they need through their roots and leave the rest in the soil, where nutrients can build up past the soil's capacity to hold them. Then these nutrients can seep into groundwater, which flows invisibly into the Bay, or be washed by rain into streams that feed the Bay. Manure nutrients can build up the soil's phosphorus levels to the point where no additional phosphorus fertilizer is needed for crops. At that point, the farmer must find another use for the manure, either someone else's crop field or an alternative use. However, if another use is not available, then, from the farmer's point of view, the manure is no longer a resource but a waste with no obvious means of disposal -- and from the environmental point of view, it is a dangerous pollutant.

Over the last 15 to 20 years, the total amount of manure has not changed substantially, but the nutrient quantities have. Poultry manure is higher in nutrients than cow manure, and the poultry industry has been expanding in the region, while milk and beef production have declined. The amount of manure nutrients generated in the watershed has grown about 17% since the early 1980s.

One of the most significant changes in animal agriculture is the use of confined animal operations. These are large barns or sheds specifically designed to house a very large number of animals – from hundreds to thousands -- in close quarters, where they are fed, watered, and medicated in standardized amounts. Nearly all poultry and most pigs and some dairy cows are raised in confinement, whereas beef are still primarily raised in pastures and only moved to confined operations prior to being slaughtered.

By confining the animals in a single place, large amounts of manure are collected and stored in facilities such as a waste pit, lagoon, or a storage shed This collected waste is referred to as "recoverable manure" to distinguish it from the manure of free-ranging animals, which is difficult if not impossible to collect. Recoverable manure can be applied to cropland as fertilizer, the most common use. Even though poultry only generates 15 percent of the Bay region's total manure by weight, it comprises two-thirds of the recoverable manure nitrogen. Conversely, beef, which generates one-third of the total manure nitrogen, produces only three percent of the recoverable manure. A total of 232 million tons of recoverable manure nitrogen is generated in the Bay watershed annually.

Recoverable Manure Nitrogen by Animal Type in Bay Watershed



Source: Weber and Kellogg, 2001

MANURE FERTILIZER IS INHERENTLY INEFFICIENT

For centuries, manure has been used to fertilize crops. Prior to World War II, manure was the dominant source of fertilizer. While manure provides numerous benefits to soil quality, it has significant drawbacks as well.

- Manure is bulky and difficult to transport long distances, so it is usually spread close to the farm where it was produced—which over time leads to build up of nutrients in the soil, making them more susceptible to runoff.

- Manure's nutrient content varies more than that of manufactured fertilizer. That makes it difficult to apply exactly the amount needed. Standard agricultural recommendations call for testing the nutrient content of manure before spreading it, but that isn't always done, and farmers often use general estimates to decide how much to use.

- Manure spreaders commonly used today cannot precisely apply small amounts of nutrients.

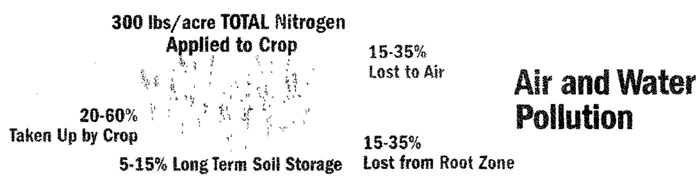
- Manure must be applied before the crop emerges from the ground or it will bury the young plants. But when using commercial fertilizer, farmers can apply it in two separate batches—one when the crop first goes into the ground and another when the crop is about to begin a growth spurt. If farmers test the soil's nutrient content before the second application, they can often use less nitrogen, save money, and reduce the likelihood of polluted runoff. The need to apply manure early in the growing cycle eliminates that option.

- Manure's ratio of phosphorus to nitrogen is higher than the ratio that crops need. Thus a farmer who applies enough manure to meet the crop's need for nitrogen is over-applying phosphorus. The unused phosphorus builds up in the soil, and these elevated levels can greatly increase phosphorus pollution. If farmers limit manure applications to prevent phosphorus buildup in the soil, they must also apply commercial fertilizer to meet the crop's nitrogen needs, therefore requiring additional time and cost from the farmer.

- Crops can take up only a fraction of the total nutrients contained in manure The rest may volatilize into the air, leach into ground water, or run off the surface when it rains Many Bay watershed farmers must prepare "nutrient management plans" designed to minimize fertilizer waste and polluted runoff. But typically the plans compensate for evaporated or unusable nutrients by increasing the amount of manure applied, often resulting in more nitrogen and phosphorus than the plants can absorb.

Recent research at the University of Maryland and the USDA has shown that if manure is not properly incorporated into the soil, 15 to 35 percent of its nitrogen can volatilize, escaping into the air. Most of the remaining nitrogen is in a form that plants can't use until soil bacteria decompose it, and that process takes time. About 50 percent of the manure nitrogen is unavailable to the plant during the first growing season and remains in the soil after the crop is harvested, making it susceptible to leaching and runoff. An additional 20 percent of the total nitrogen may be broken down by bacteria and available for the next year's crop. Of the amount that is unused by the crop, 5 to 15 percent stays in the soil for numerous years. The exact fate of manure's nitrogen will vary from year to year depending on the weather conditions, plant growth, and a farmers' management practices. However, in general, over a typical two-year crop cycle roughly 50 percent of the manure nitrogen applied to the land may be vented into the air or washed into ditches and streams and eventually may enter local waterways and the Bay.

Typical Nitrogen Budget for Corn Using Manure as Fertilizer



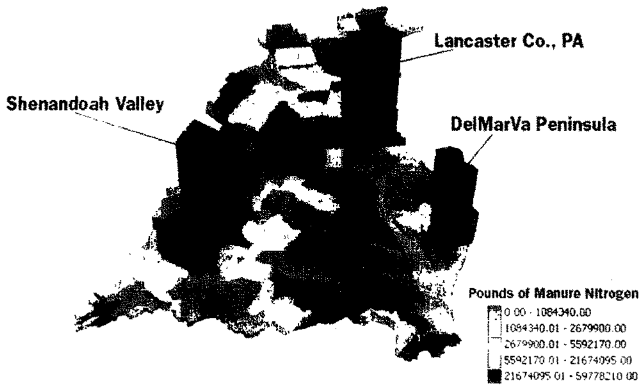
Source: USDA Agricultural Research Service, 2004

LIVESTOCK-RAISING REVOLUTION LEADS TO BAY POLLUTION

Gone are the days when every farm had a small number of livestock, with chickens, pigs, and cattle sharing the same barnyard. In order to achieve economies of scale, animal farmers today specialize in a particular type of livestock. The number of animals commonly raised on a single farm is now five times greater on dairy farms, ten times greater on hog farms, and 100 times greater on chicken farms than it was fifty years ago. Additionally, large, multinational corporations that now dominate much of poultry and hog production have consolidated most of the meat production process. These large corporations have created networks of farms and supporting businesses to carefully control the steps in producing the meat, from the animals' birth to feeding, slaughtering, and the preparation of ready-to-eat foods. As a result, animal production has concentrated in regions where the consolidated infrastructure for meat production is located. Because of this specialization and concentration, rather than animal production being spread out across the landscape, there are far greater numbers of livestock in certain regions of the country.

Although agricultural production is widespread throughout the Chesapeake watershed, there are three major animal production regions with the greatest concentrations of livestock: the Lower Susquehanna River in Pennsylvania, the Shenandoah Valley in Virginia and West Virginia, and the Delmarva Peninsula in Delaware, Maryland, and Virginia. The Delmarva Peninsula is dominated by integrated chicken production. The Shenandoah Valley also has a large network of chicken farms as well as turkey production and considerable beef and dairy farms. The Susquehanna Valley has very diverse and still mostly independent animal production led by dairy and beef operations along with eggs and some hog and chicken farms.

Total Manure Nitrogen in Chesapeake Bay Watershed Counties



Source: EPA Chesapeake Bay Program

MANURE HOT SPOTS

The three manure hot spots in the Bay watershed cover 23 percent of the watershed's land area but contain 54 percent of all manure nitrogen. In these hot spots, the water quality issues of manure are the most acute and must be the focus for solutions:

- Lancaster County, PA, in the Susquehanna River basin, has the second-highest agricultural production of any county east of the Mississippi River and ranks fifth in livestock production nationally. The county, which represents only 1.5 percent of the area in the watershed, produces more nitrogen from manure than any other county in the Bay's drainage area – 72 million pounds a year, about 12 percent of the total nitrogen from all manure sources in the watershed.

- The Delmarva Peninsula is one of the top chicken producing regions in the nation, led by Sussex County, Delaware, the nation's highest chicken producing county. Also, Worcester County and Somerset County in Maryland, although they do not produce the sheer number of chickens as Sussex County, the number of chickens raised per acre of cropland to receive the manure is higher.

- Rockingham County, VA, located in the Shenandoah Valley, is the largest turkey producer in the nation and the largest dairy and chicken producer in Virginia. Its animal operations have more excess manure than any other county in the nation according to calculations from USDA.

In these concentrated animal production regions, large amounts of feed, along with the nitrogen and phosphorus they contain, are imported to meet the demand of all of the animal operations. This creates a huge imbalance between the amount of nutrients coming into the region as feed and the amount going out as agricultural products. This imbalance can occur on individual farms as well when an animal producer does not have enough land to handle all of their manure. As a result, large amount of nutrients leave the region through the air and water in the form of pollution.

When a nutrient imbalance exists on a farm, in a county or in a region, there is more manure than the crops in that same area can utilize. It is this excess manure that is the most likely to find its way into groundwater, local streams and the Bay. Bay states have yet to compile data tracking of when and where manure is applied to the land. Therefore estimates of excess manure vary substantially depending on the assumptions that are made. For example, most estimates assume that the manure is spread on all the cropland in a county, and that no commercial fertilizer is added to the county's nutrient supply.

Using the best available information, the USDA's Natural Resource Conservation Service (NRCS) has calculated excess manure for each county in the country. The USDA information shows that the three Chesapeake manure hot spots have huge amounts of excess manure. When these figures are compared to a similar analysis completed by USDA's Economic Research Service (ERS) for the entire Bay watershed using national averages for amount of land where manure is applied, it shows that the three manure hot spots contain the vast majority of the total excess manure in the entire watershed. This excess manure has damaged local streams and rivers and delivers very large amounts of nitrogen and phosphorus to the Bay.

These estimates are based on the amount of phosphorus available compared to what the crops need. Until recently scientists thought that unneeded phosphorus would bind to the soil and stay put, but research has now established that once the soil reaches a saturation point, it begins releasing phosphorus into surface and ground water. Recognizing this, the Bay states have drawn up new requirements that farmers include phosphorus in their nutrient management plans, and the states are at different stages in the process of phasing in these new rules.

Excess Manure Calculations

For Animal Production Regions in Chesapeake Watershed Under Phosphorus Based nutrient management plans

Location	County Excess Manure Tons
Lower Susquehanna (NRCS)	286,196
Middle Delmarva (NRCS)	257,268
Shenandoah (NRCS)	600,070
Total Bay Watershed (ERS)	1,500,000

Deadlines are now upon farmers to start applying manure based on a crop's phosphorus needs. Virginia started requiring poultry growers to have phosphorus based plans in

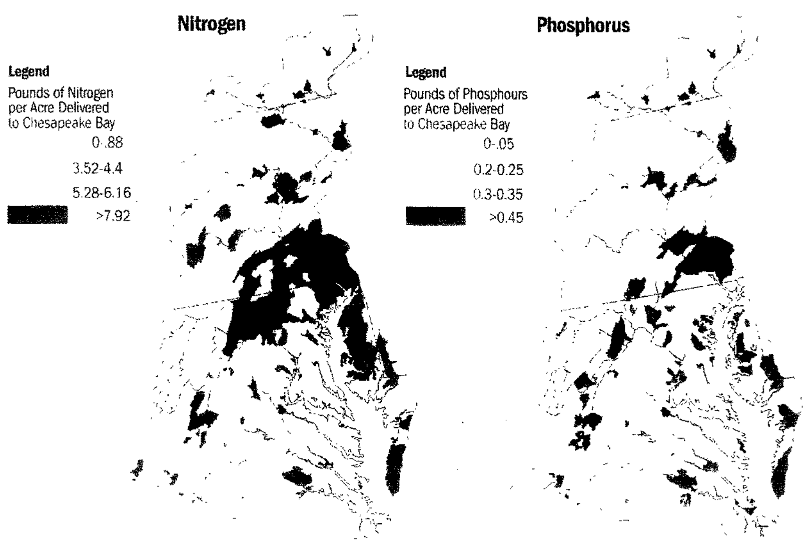
2001 and will be revising their regulations for other operations by the end of 2005. Delaware began requiring phosphorus based plans in 2003 and will reach full implementation in 2007. Pennsylvania ruled in May 2004 that all new nutrient management plans required under their nutrient management law must address phosphorus as well as nitrogen. In Maryland, the deadline for including phosphorus in nutrient management plans for manure applications was July 1, 2004, but implementation of that plan is not required until July 2005.

As nutrient management programs have begun to more fully address manure applications, additional needs have been identified. Pennsylvania, which enacted the first nutrient management law in the watershed, is now expanding the program to include farms that receive exported manure as well as requiring certification by manure transporters and setbacks from streams for manure applications. Maryland, Delaware, and Virginia have all started manure transport programs to help move excess manure out of hot spots. Maryland has also increased funding to pay farmers to plant winter cover crops that help soak up excess nutrients after crops are harvested.

TOO MUCH MANURE—A RESOURCE BECOMES A POLLUTANT

The amount of nitrogen and phosphorus actually reaching the Bay varies according to local factors, such as soil types, proximity to major rivers and to the Bay, and the size of streams that drain the area. Healthy, small streams

Geographic Sources of Nitrogen and Phosphorus Polluting the Chesapeake Bay in 1997



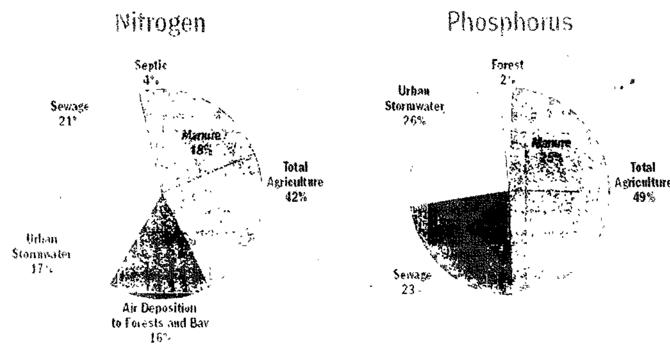
Delivered yields of total nitrogen and total phosphorus from all sources in the Chesapeake Bay watershed, 1997.
[Delivered yield is the amount (load per area) of total nitrogen that is generated locally for each stream reach and weighted by the amount of instream loss that would occur with transport from the reach to the Bay.]

Source: Adapted from USGS, draft data, 1997.

can absorb large amounts of nutrient-laden runoff from farmland, passing it along to plant life along their banks and in the streams themselves. Large rivers with higher volumes of water absorb relatively fewer nutrients, so a greater proportion of the nitrogen and phosphorus washing off land along their shorelines actually ends up in the rivers and the Bay. The U.S. Geological Survey has done an area-by-area assessment of the nitrogen and phosphorus reaching the Chesapeake, after factoring in the cleansing effects of small streams. The map below illustrates the USGS finding that the region's three animal production hot spots generate large flows of pollution into the bay.

Of the nitrogen and phosphorus that reach the Bay, agriculture is the largest source and animal manure is the largest agricultural component. Chemical fertilizers and airborne pollutants such as ammonia gas—a common manure by-product – make up the rest of the agricultural sources. This makes animal manure not only the largest source of nitrogen and phosphorus deposited on the land, but also the second largest source that reaches the Bay, behind sewage, which is deposited directly into the water. Animal manure is a major source of the Bay's pollution and must be addressed swiftly and comprehensively.

Sources of Nitrogen and Phosphorus Pollution Reaching the Chesapeake Bay



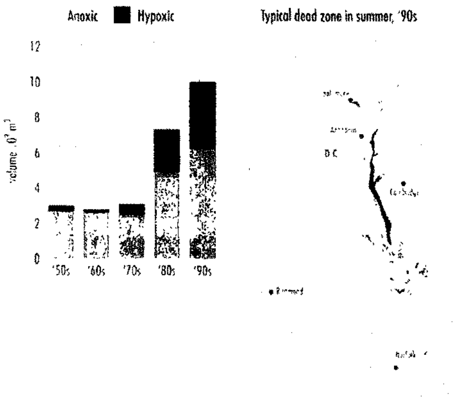
Source: EPA Chesapeake Bay Program

DEAD ZONES DRIVE BAY CREATURES FROM VITAL HABITAT

The excess nutrients from manure and other sources such as sewage treatment plants trigger excessive algae growth (blooms), which eventually die and decompose in a process that consumes oxygen. Algae blooms use up so much oxygen that parts of the bay become low in oxygen, or hypoxic, and sometimes completely void of it, or anoxic. These "dead zones," cannot sustain healthy aquatic life, and represent a major loss of important habitat for fish, crabs, oysters, and other species of historic economic and cultural importance. Every year dead zones are found in deep water, which contains less oxygen than surface waters to begin with. But when wind patterns affect the bay's circulation, the dead zones can move into shallow water, forcing fish and crabs to flee and killing those left behind such as ones caught in watermen's nets or traps.

In spite of the nutrient reductions achieved so far, dissolved oxygen levels in the Bay and its tidal tributaries have shown little improvement. On average, monitoring data shows the Bay's main body has unhealthy or lethally low oxygen levels from May through October or November.

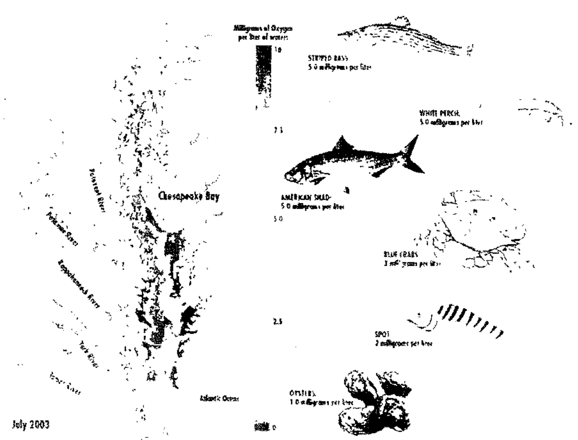
Increasing Hypoxia: Five Decades of Trends



In July 2003, the Bay suffered one of the largest areas of oxygen depletion since the Chesapeake Bay Program began monitoring oxygen levels 20 years ago. The affected area, approximately 40 percent of the Bay's central portion, or mainstem, began at the Patapsco River near Baltimore and stretched more than 100 miles south to the mouth of the York River near Hampton Roads.

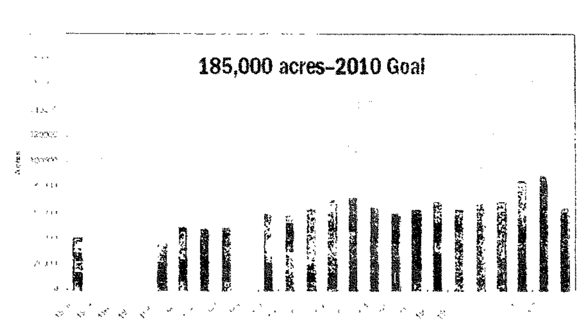
Excess algae also blocks sunlight from reaching the bottom, making it impossible for underwater grasses to survive. These grasses, known as submerged aquatic vegetation or SAV, are essential to a healthy Bay. They produce oxygen that is added to the water column, improve water clarity by holding bottom sediments in place with their roots, and provide irreplaceable shelter and feeding grounds for the bay's most important aquatic species, including blue crabs, striped bass, spot, croaker and many others.

Dead Zone 2003



Scientists think underwater grasses probably once grew in much of the sandy or muddy shallows of the bay and its tributaries – any place where the grasses could sink roots and get the sunlight they need. But in the 1960s they began disappearing at an alarming rate. Underwater grasses are so important that scientists at the Virginia

Chesapeake Bay Underwater Grasses



Institute of Marine Sciences conduct an aerial survey each year to map their extent. They reached an all-time low in 1984, when they covered less than 10 percent of their potential habitat. They have since rebounded, but still grow in less than half the acreage they did before the decline began. Additionally, in 2003 when nitrogen pollution levels were the second highest in 15 years, the grasses declined by 30 percent.

MANURE POLLUTION HARMS LOCAL WATERS

Nutrients

Similar to impacts in Bay waters, excess manure nutrients often exceed local waterways' capacity to absorb them, with devastating results. Just as in the open Bay, reduced levels of oxygen in these rivers and streams can drive away aquatic life, inhibit aquatic plants' and animals' ability to survive and reproduce, and cause fish kills. When algae growth blocks light penetration, these waterways can lose their underwater grasses, which provide essential local habitats for aquatic creatures.

Some of the excess nutrients from cropland move through surface soils and bottom sediments into groundwater, with potentially serious, long-term consequences. Groundwater is a source of well water for human and animal consumption. It is also the source of more than one-half of all the water flowing in most of the streams of the Chesapeake watershed, according to recent USGS research.

Locally high nitrogen levels pose a potential risk to human health and the health of young livestock. High levels of nitrate in drinking water can cause "blue baby syndrome," a potentially fatal condition that prevents infants' blood from absorbing oxygen. The evidence on many other human health effects is not conclusive, but some studies have linked high nitrate levels to bladder cancer and other cancers. High nitrate levels have also been shown to cause spontaneous abortions in cattle. The federal government sets 10 milligrams per liter as the maximum allowable amount of nitrate in drinking water, and government data shows groundwater levels are often higher than that in the animal agriculture hot spots.

The U.S. Geological Survey (USGS) has conducted in-depth investigations of the Delmarva, the Susquehanna, and the Potomac River Basin as study sites for its National Water Quality Assessment program, which analyzes water samples from selected streams and aquifers. The assessment found that nutrient levels in shallow groundwater in the three Chesapeake manure hot spots are among the highest in the country. Additionally, federal and state monitoring and studies have further documented deteriorated groundwater and stream conditions in these regions.

- In the Lower Susquehanna, the USGS found nitrate levels exceeding 10 milligrams per liter in 36 to 45 percent of its groundwater samples. Pennsylvania has 12,262 miles of streams that are listed as "impaired," or unable to meet the Clean Water Act's description of healthy waterways. The Pennsylvania Department of Environmental Protection says agriculture is the source of the impairment for 3,903 miles of streams -- about one-third of all the state's tainted waters. The state's data do not show how much of the impairment is specifically due to animal manure. But in a separate study in 1998, the USGS concluded that animal manure used as fertilizer was the Lower Susquehanna's main nitrogen source

- Nitrate is widespread in shallow groundwater on the Delmarva Peninsula, including parts of the underground aquifer used for drinking water. About one-third of the shallow wells sampled had nitrate levels above the federal safe drinking water standard. A recent USGS study found the highest concentrations were beneath sandy soils and might be related to the presence of manure piles. According to the Maryland Department of the Environment, approximately 71 percent of the stream segments on the Delmarva Peninsula are unable to support healthy populations of fish or the bottom-dwelling creatures that are a key link in the aquatic food chain. Statewide, 51 percent of streams are listed as impaired, or unhealthy, due to nutrient pollution. Data from the Maryland Biological Stream Survey shows the same trend: nitrate concentrations in Maryland streams generally increase in tandem with increasing proportions of agriculture.

- In the Shenandoah Valley, the USGS found nitrate concentrations were among the nation's highest. Nearly one-fourth of water samples taken from the Potomac Watershed and areas of porous rock showed nitrate levels above the federal 10-milligram standard. When compared to natural conditions, nitrate levels were elevated in farm areas more often than in non-farming areas. In a study of the entire Potomac River basin, the USGS concluded that animal manure accounted for 29 percent of the nitrogen and 45 percent of the phosphorus distributed throughout the basin, with the greatest inputs of nitrogen and phosphorus in the Shenandoah Valley. A study of water quality and fish in Muddy Creek, a tributary of the Shenandoah River in Rockingham County, Virginia, found that nutrient levels were in the top 25 percent of all streams sampled nationwide, and the fish communities were correspondingly more pollution tolerant.

Green Run Watershed Study

Upper Pocomoke River, Maryland and Delaware

The upper Pocomoke River basin is in the heart of the Delmarva poultry country and has some of the highest concentrations of poultry farms in the country. It has streams that are impaired by nitrogen and phosphorus and high groundwater nitrate levels. It is also the location of a small watershed study that may hold the key to achieving local and Chesapeake Bay water quality goals.

Beginning in 1998, the Maryland Department of Natural Resources and the local county conservation district teamed up to compare universal adoption of agricultural practices in one watershed to the current levels of implementation in the neighboring watershed. For four years, all of the farmers in one small watershed employed three practices: nutrient management, winter cover crops, and moving all poultry manure outside the watershed.

Over the course of the four years, nitrogen levels in the stream dropped by 25 percent in the study watershed while they remained unchanged in the unaltered watershed. The total amount of nitrogen put onto cropland was cut in half, primarily due to the replacement of manure with commercial fertilizer applied according to nutrient management plans. Additionally, cover crops helped absorb leftover nitrogen after crop harvest. Phosphorus runoff stayed the same in both the study watershed and the unaltered watershed most likely due to high levels in the soil that existed prior to the study and that will take additional years to decrease.

This study shows both the promise and the challenge of reducing nutrient pollution from manure. Clearly, achieving large reductions in nutrient runoff and the associated dramatic improvements in water quality is possible and in a relatively short period of time. However, these results required 100 percent participation by the farmers and significant changes to their operations. Replicating those two factors across the Chesapeake watershed will be much more difficult.

Bacteria

Both human and animal waste pose a significant threat to surface waters within the Chesapeake Bay watershed by introducing disease-producing organisms to areas in which we swim, fish, and enjoy other kinds of recreation. They can also contaminate shellfish beds, closing them to harvest. State environmental agencies check for fecal matter in waterways by testing samples for a group of indicator bacteria known as fecal coliforms, including Escherichia coli, which can cause human health problems.

- In Virginia, more than half of the state's rivers that are designated as impaired by the Department of Environmental Quality are degraded by fecal matter. The same is true in the Shenandoah Valley, where over 500 miles of streams are impaired by fecal coliforms.

- In Maryland, approximately 15 percent of impaired waters are due to the presence of fecal coliforms; however on the Delmarva Peninsula, about 57 percent of stream segments are impaired by the fecal bacteria.

- Pennsylvania does not routinely test for bacterial contamination in surface or groundwater, making it impossible to assess the scale of the problem. However, fecal bacterial contamination was found in nearly 70 percent of household wells in the Lower Susquehanna River Basin, with higher levels of contamination in agricultural areas than in forested ones, according to a USGS study.

Fecal contamination originates from a variety of sources, including humans, livestock, poultry, and wildlife. There are few studies that definitively identify the cause of high fecal coliform levels. However, scientists have developed new "bacterial source tracking" (BST) techniques that employ genetic fingerprinting and similar methods to identify the various warm-blooded animals contributing to fecal pollution. In Virginia, several studies have used BST to estimate relative sources of bacterial contamination.

BST Studies in VA

Bacterial source tracking (BST) techniques have been employed on several local streams in the Shenandoah Valley of Virginia Researchers from James Madison University isolated fecal bacteria from two creeks in a cattle-grazing area in Rockingham County, Virginia, and found cattle contributed to 72 percent of the samples from Cooks Creek and 68 percent of those from Muddy Creek. A similar study conducted by Virginia Tech scientists in rural Page Brook, an impaired stream in Clarke County, identified beef cattle that had "unrestricted access" to the brook as the source of fecal bacteria found in 78 to 86 percent of bacteria samples taken during the warm season. After fences were installed at the most contaminated site to exclude livestock from direct access to the stream, the number of fecal coliforms was reduced by 96 percent during warm season sampling

A USGS study released last year used genetic fingerprinting to identify sources of E. coli on two streams impaired by fecal coliform bacteria in the Shenandoah Valley. The study identified multiple sources of fecal contamination in both streams -- Christians Creek, an agricultural watershed in Augusta County, and Blacks Run, an area of mixed urban and agricultural land use in Rockingham County. In both cases, cattle and poultry were the top two sources of fecal bacteria. Even though the Blacks Run watershed is two-thirds urban and one-third rural, agriculture contributed more than 55 percent of the E. coli contamination.

Bacteria levels followed a seasonal pattern that paralleled agricultural practices, the USGS study found. From April to September, when cattle numbers increase, cattle bacteria sources increased. Poultry growers typically spread chicken manure on fields in the cooler months, and the researchers found more poultry bacteria during those months The total fecal bacteria levels were highest in the summer and early fall.

EMERGING ENVIRONMENTAL ISSUES RELATED TO MANURE

Trace Metals

Animal feed contains copper, zinc, and selenium.

which are essential micronutrients. However, the feed often has more of these trace metals than the animals can absorb; the excess is excreted into animal manure, according to researchers at the University of Delaware. Arsenic goes into poultry feed to stimulate the animals' weight gain, help them process feed more efficiently, and make their meat a more attractive color. As a result, poultry manure contains arsenic. A study by researchers in Alabama found that when manure is applied to the land repeatedly, toxic metals can build up in the soil. At present, there is no strong evidence linking land application of poultry manure to trace metal contamination in water or sediments. Because arsenic poses a cancer risk to humans, the USGS and Johns Hopkins University have studies underway to determine what ultimately happens to manure arsenic.

Hormones

Hormones are potentially the most troublesome of the manure-related contaminants. They are endocrine disruptors – natural or manmade substances that can change the endocrine systems of creatures exposed to them in the environment. The endocrine system governs basic physiology, such as the development and functioning of reproductive organs. Documented effects of endocrine disruptors in fish and wildlife vary, from subtle changes in the physiology and sexual behavior of species to obvious deformities of the reproductive organs.

Naturally produced estrogen and testosterone are among the hormones found in manure. While some cattle-raising facilities use synthetic hormones, most of the hormones contained in manure from the Bay watershed are naturally produced. The synthetic hormones from cattle-raising facilities have been linked to reproductive effects in fish. When fathead minnows, a widespread aquatic species, were exposed to very low levels (in the parts per billion range) of a synthetic growth promoter in laboratory studies, EPA researchers found that the females showed reduced fecundity and masculine traits. Researchers at the University of Maryland found that exposure to naturally produced substances found in poultry manure can have similar effects. In laboratory studies, they exposed fathead minnows to water extracted from poultry manure and found that the minnows' reproductive organs were affected. The Maryland researchers suspect that estrogen in the litter is at least partially responsible.

The question of whether hormones contained in manure are escaping into the environment and harming wildlife is a new and controversial area of research. There is a growing body of evidence

Removing the North Fork River from EPA's "Dirty Waters" List

South Branch of the Potomac, West Virginia

When the North Fork River was placed on EPA's "Dirty Waters" list in 1996, local farmers, citizens and a multiagency project team set out to clean up the river. The farms in the watershed are dominated by intensive beef and poultry operations that are located on flood-prone areas adjacent to the river. Water quality was impaired by nutrient and fecal bacteria pollution and a USGS study found a strong relationship between fecal bacteria concentration in streams and the numbers of animal operations per mile.

Through a combination of federal and state funding sources and substantial private investment by the farmers themselves, a multitude of agricultural practices were installed including feedlot relocation, stream fencing, alternative watering systems for cattle, animal waste storage, barnyard improvement, streamside buffers, and composting facilities. Nutrient management plans were implemented more widely and livestock feed was altered to improve phosphorus efficiency. Many of the practices benefited farmers economically as well as improving water quality.

As a result of this coordinated effort and funding, nitrate and fecal bacteria levels decreased in the stream to the point where the state and EPA removed the North Fork River from the impaired waters list in September 2003. In achieving this remarkable accomplishment, more than 85 percent of the farm operations participated in a full suite of agricultural practices. This success story demonstrates that reducing pollution from agricultural operations is achievable, but it will take widespread implementation and must address all aspects of farming operations.

suggesting that the runoff from livestock facilities contains hormones, and that the hormone levels are high enough to harm aquatic organisms. For example, a study conducted on the Eastern Shore of Maryland found that run-off from fields to which chicken litter had been applied contained estrogen at levels known to elicit reproductive effects in fish. A recent U.S. Fish and Wildlife Service study conducted in the Chesapeake watershed found estrogen in surface waters on the Delmarva Peninsula, but not at a Patuxent River site on Maryland's Western Shore that was distant from large-scale animal agriculture. The Fish and Wildlife Service researchers tested the blood of male carp for a substance called vitellogin, a biological tracer that signals exposure to endocrine disruptors, and found it in significantly higher levels in Delmarva fish than in fish collected from the Patuxent. Similarly, Clemson University found detectable levels of estrogen in ponds that received run-off from beef cattle pastures, and female painted turtles in those ponds had higher levels of vitellogenin than turtles from ponds that had no run-off. According to a study of Nebraska cattle feedlots led by a St. Mary's College researcher, natural and synthetic hormones were detected in downstream waters. The researchers concluded the hormones were probably having harmful reproductive effects on fathead minnows living downstream.

Antibiotics

The Union of Concerned Scientists estimates that as much as 86 percent of the antibiotics used in the United States is given to livestock. Growers give pigs, cattle, and poultry low doses of antibiotics to promote growth and higher doses to treat disease. The animals excrete large amounts of the antibiotics, unchanged. Thus the chances are high that these antibiotics will end up in the environment. For example, the Fish and Wildlife Service's Chesapeake study found low levels of tetracycline in poultry manure, and also found measurable concentrations of tetracyclines in streams adjacent to agricultural fields on the Delmarva Peninsula. In a nationwide study, USGS found at least one type of antibiotic in 48 percent of the streams surveyed. The ecological consequences of widespread antibiotic contamination are not fully known, but doctors who specialize in infectious diseases fear that if microbes are exposed to antibiotics in the environment they may develop resistant strains, making the drugs ineffective in the treatment of human and animal illnesses. Antibiotics also could alter microbial processes that are important to the functioning of healthy aquatic ecosystems.

Air Pollution

The Bay states' ambitious new nutrient reduction goals make it essential to identify all the sources of nitrogen pollution in the Chesapeake Bay watershed and to reduce them. With that in mind, scientists are evaluating livestock production as contributor to atmospheric nitrogen pollution. The Chesapeake Bay Program estimates that 27 percent of the nutrient nitrogen reaching the bay comes in the form of airborne ammonia and nitrate. The main agricultural sources of atmospheric ammonia are confined livestock operations, which use fans to vent the potentially lethal concentrations of ammonia gases emitted by large amounts of animal waste in a small, enclosed space. Manure storage and handling can also allow ammonia to be lost to the air with uncovered pits and lagoons for liquid waste being the most susceptible. Researchers at the Universities of Maryland and Delaware estimate that ventilation from poultry houses on the Delmarva Peninsula emits over 40 million pounds of ammonia nitrogen each year.

Manure spread as fertilizer can also raise atmospheric ammonia concentrations. Generally, the greatest amount of nitrogen is lost between the time the manure is applied and the time it is worked into the soil. USDA researchers estimate that manure spread on the soil commonly can release from 5 to 35 percent of its total nitrogen into the air, depending on management practices and environmental conditions. Surface applications of liquid manures can lead to the largest and most rapid losses.

Recently, regulators have paid greater attention to air pollution from animal operations, specifically ammonia and small particulate matter. States are currently in the process of determining what areas exceed air quality standards for these pollutants and will require emission control measures to be implemented. As research and monitoring increasingly show that animal operations are a significant source of these pollutants, strategies must be developed to control emissions. Feed adjustments, manure amendments, exhaust filters for confined livestock operations, and avoiding surface application of manure on cropland have all shown promise in reducing manure emissions. These measures will reduce water pollution to streams and the Bay as well as improve air quality.

KEEPING MANURE OUT OF THE WATER

Throughout history, the impacts of human waste from the concentration of people in cities and towns created obvious, grave environmental and health problems. Conversely, animal populations were more dispersed across the countryside, making it possible for the land to better absorb their manure. But large-scale animal production has now concentrated livestock animals in similar if not greater densities than human populations. Therefore, specific actions must be taken to prevent animal waste from polluting local waters and the Bay. The problem has become so pervasive that much greater investments in manure management must be made if we are to achieve healthy waters throughout the Bay watershed.

Three key strategies must be used to attack the problem:

- Reduce the amount of pollutants in manure.
- Ensure that there are adequate safeguards to prevent runoff when manure is applied to land.
- Create alternative, non-polluting uses for all excess manure.

Farm operations vary greatly and so do their environmental settings. Thus no single approach will be enough to restore the region's impaired streams and rivers and clean up the Chesapeake Bay. Rather, the problem of manure pollution must be approached strategically, with cost-effective strategies specifically designed for each sector of the farm economy. Taken together, these strategies can make the necessary reductions in manure pollution and sustain a healthy farm economy.

The Chesapeake Bay region's agriculture, like the entire nation's farm economy, does not operate under the same laws of supply and demand that govern most other businesses. The agricultural economy has been shaped for decades by commodity price supports, federal government purchasing programs, and a myriad of other market-altering programs. The programs are intended to support farmers and farming, to provide the nation with inexpensive food, and to develop a strategic advantage in the international market. Under this managed approach, the demand for basic farm commodities does not fluctuate much, and neither do the commodities' prices. This makes it very difficult for farmers to pass along any increased costs to consumers. Farmers cannot raise their rates, as a wastewater treatment facility can. Nor can they change their products' features or packaging to make them more appealing to consumers. They must sell a standard commodity in a global market. Therefore, financial incentives and technical assistance are important to successful manure management strategies.

Reducing Manure Nutrients

When it comes to manure, the common saying "garbage in, garbage out" might be paraphrased, "pollution in, pollution out." The pollutant content of manure is determined by the animal feed. Better feed management can be one of the most cost-effective means for reducing manure pollution. Feed management is also one of the few methods available to reduce the pollution from non-recoverable manure that is directly deposited on pastures by grazing animals, and can allow better management of recoverable manure that is spread on the land. Moreover, feed alterations can change the chemical properties of manure in such as way as to reduce ammonia losses. Promising research has been conducted to develop feed adjustments to reduce the amount of nutrients in manure, particularly for poultry and dairy. Since mounting evidence shows there is reason for concern about the human and environmental risks of trace metals and pharmaceuticals in manure, additional work is needed to reduce the level of these compounds.

Poultry growers are already adopting poultry feed adjustments to reduce the phosphorus levels in manure, and these adjustments are required in some Bay states. Recent research has demonstrated that phosphorus content in manure can be reduced by 40 to 50 percent without affecting the health or marketability of the bird by avoiding surplus phosphorus in feed and adding phytase, an additive that allows chickens to absorb more phosphorus from their feed. Phytase additions are being used in nearly all poultry operations throughout the watershed. On the Delmarva Peninsula the overall result has been an 16 percent reduction in manure phosphorus.

Hogs and poultry absorb nutrients in similar ways and much of the early research on the use of phytase was conducted on hogs. It is widely used in Pennsylvania and has reduced phosphorus in hog diets by approximately 16 percent. Agricultural researchers in Maryland and North Carolina are trying to refine phytase and other feed management techniques to make them more effective for hog and poultry operations. The costs of these changes, and new information about the maximum reductions that are possible without harming productivity, will be the controlling factors in programs to reduce nutrients in feed.

Recent research in the development of dairy feed indicates that excess nitrogen and phosphorus levels could be significantly lowered without reducing milk production or nutritional value. With less nitrogen in dairy feed, the amount of nitrogen that ends up in waterways could be reduced by as much as 40 percent. Since a significant portion of dairy manure is non-recoverable – on pasture land rather than in a barn where it can be collected and managed – reducing the nitrogen content of manure is the only feasible way to reduce pollution from such a diffuse source.

Reducing nitrogen in cattle feed could also save the dairy industry money. Most dairy feed contains supplements to boost its protein content, but both university and industry research indicates that protein supplements can be reduced substantially with no ill effects on the milk's quantity or quality. Scaling back the amount of crude protein in dairy feed could yield overall savings to the dairy industry in the Bay watershed of about $18 million per year.

Some dairies are switching from confined operations and formulated feeds to pastured dairies where grass is the primary feed for the cows. This approach can substantially reduce polluted runoff from these operations and avoid the nutrient pollution associated with applying manure to cropland. Although milk production is normally lower on grass-based dairies than confined operations, they often are more profitable because of lower costs.

Safeguards for Land Application

When manure is applied to cropland as fertilizer, there is an inherent pollution risk. Since land application is currently the preferred use of manure, strategies must be employed to minimize polluted runoff or leaching. Steps must be taken to minimize losses when the manure is applied. Manure must be incorporated into the soil soon after application. This effectively prevents ammonia from escaping into the air, prevents soluble nitrogen and phosphorus from running off in surface water during a rainstorm, and slows down phosphorus saturation in the soil surface.

Currently, the vast majority of manure is spread onto the soil before planting, although some liquid forms of manure are injected into the soil. In order to till manure into the soil, farmers must do extra work at one of their busiest times of year, and they must have the appropriate equipment. Furthermore, many farmers have been encouraged to use no-till techniques, leaving crop stubble in their fields and leaving soil surfaces undisturbed, in order to reduce erosion. More research is needed to determine which types of landscape can tolerate manure tillage without increased erosion and how much tilling must be done to prevent nutrients from seeping into waterways.

After crops are harvested, significant amounts of nutrients remain in the soil that can be subject to leaching or surface runoff during the late fall, winter, and early spring. Winter cover crops are highly effective at holding nutrients on the field between growing seasons. Cover crops are one of the most cost-effective means to reduce nutrient pollution and must be more widely planted each year. Planting cover crops at the optimum time is often a major logistical obstacle to farmers trying to harvest fall crops. Innovative incentives and alternative planting methods that address farmers' time constraints are needed for greater adoption of this important practice.

Finally, even with extremely careful management of manure applications and the use of manure cover crops, nitrogen and phosphorus will still be lost from a modern crop field striving for maximum yield. Therefore, riparian buffers – streamside strips of trees, shrubs, and grasses that capture nitrogen and phosphorus from runoff and groundwater ––are a crucial final line of defense. Riparian buffers can remove up to 90 percent of pollutants in certain landscapes when managed properly. Forested riparian buffers greatly increase the ability of headwater streams to remove nutrients, thereby providing an additional filter before nitrogen and phosphorus pollution can reach major rivers, lakes, and the Bay.

Transporting Excess Manure out of Manure Hot Spots

The most widely applied use for excess manure is to transport the manure to other regions that need fertilizer for their crops Consequently most Bay states now help pay for the transport of manure out of manure hot spots. In order to transport all of the excess manure in the Chesapeake Bay watershed to areas that can use it as fertilizer, a USDA Economic Research Service report determined that 60 percent of all cropland in the watershed would need to utilize manure. Current data suggests that between 10 and 20 percent of cropland now receive manure. Transporting this amount of manure would have an overall cost estimated at about $150 million per year.

While transporting manure is an important component to addressing excess manure in the short term, there are numerous drawbacks that require that alternative uses of manure be developed for long term sustainability. Moving manure out of the hot spots will help reduce polluted runoff from those areas but recent research indicates that it likely will increase nutrient pollution in the receiving areas unless adequate safeguards are implemented. Also, transported manure must be tracked closely and coordinated regionally to prevent manure from being moved from one hot spot to another. Additionally, many landowners are likely to refrain from accepting manure due to logistical, environmental, and financial reasons. Therefore, it is essential that alternative uses of manure that are economically and environmentally sustainable be developed immediately

Alternative Uses of Excess Manure

Abandoned mine reclamation

The Chesapeake Bay states contain hundreds of thousands of acres of abandoned mine lands that support little or no vegetation. As a result, acid runoff from mine residues flows across these barren areas and into local streams. The nutrients contained in manure are of tremendous value in restoring vegetative cover in these areas when combined with lime applications to balance the soil's pH. High concentrations of phosphorous and potassium promote critical root growth that is essential for plant survival in these difficult environments. The higher concentrations of phosphorus in poultry manure are particularly useful. The organic matter contained in the manure is also an essential addition to the soil. As streams recover from acid mine drainage, they absorb more nutrients, becoming natural helpers in the effort to reduce nutrient pollution.

Energy production

Farmers often view manure as an asset because its nutrients can fertilize crops. However, manure also has value as an energy source. The energy value of the 14 million tons of recoverable manure generated in the Bay watershed each year is 70 trillion Btu, which is roughly equivalent to 2.6 million tons of coal or 400 million gallons of gasoline. With increasing energy costs and concerns of energy security facing the nation, there is new interest in bioenergy from manure and other agricultural materials. Bioenergy also has the potential to provide a major new industry and economic boost to rural America.

Numerous technologies produce energy from animal waste, and the methods are continually being refined to make them make them more efficient and profitable. Generally, manure can be converted to energy through four processes: combustion, pyrolysis, thermal gasification, and biogasification.

Combustion is the process of burning dry manure such as poultry litter to produce heat or steam to run a turbine. A British company has built four large poultry litter combustion plants in Europe and is in the process of commissioning one in Minnesota. Combustion technologies are the most developed and commercially available of the animal waste energy processes, but concerns remain about air emissions and energy prices compared to traditional sources.

Both pyrolysis and thermal gasification break down the manure into more concentrated products such as oils or hydrogen gas that have more concentrated energy content and therefore can be readily used as fuels. There are relatively few pyrolysis or thermal gasification plants in the United States. Most of them currently process wood wastes and have only utilized manure on an experimental basis.

Biogasification allows bacteria to breakdown liquid manures, such as dairy or hog waste, to produce methane as a fuel source. In 2001, there were 32 biogasfication operations in the United States, most of which utilize dairy waste to produce methane, which is captured as an energy source.

It is beyond the scope of the report to assess each of these processes and technologies, but each has been demonstrated successfully, and commercial scale examples exist in the United States, Europe, and Canada. Industry research suggests that new energy production facilities are becoming more economically feasible. However, air emissions are a potential drawback with some processes, particularly in areas such as the Shenandoah Valley and parts of Maryland where air pollution levels already violate federal clean air standards. These processes' waste products, such as ash, can also contain significant amounts of nutrients, but they are in a denser and more stable form than raw manure and could potentially be marketed as fertilizers.

Composting

Composting remains an effective way to stabilize manure nitrogen, thus minimizing nitrogen losses to the environment when the compost is used. A recent Rodale Institute study compared nitrogen losses from compost, raw manure, and conventional fertilizer, and found that only about 4 percent of the nitrogen applied as compost was lost, while about 9 percent was lost through the other two forms of fertilizer. Compost must still be carefully managed according to university recommendations, as leaching of nitrogen remains a possibility. In the composting process itself, nitrogen can be lost to the atmosphere or through runoff and leaching if compost piles are not managed properly. Though composting facilities sometimes trigger odor complaints, a well-managed composting operation does not cause odor problems. Composted manure can be used in a variety of farming, nursery, greenhouse, and landscaping operations, which can reduce the overall amount of nutrients imported into the Chesapeake Bay watershed. Additionally, composting can be used to suppress ammonia volatilization in poultry litter either by utilizing it in bedding material or as a filter for poultry house exhaust.

Pelletizing

Poultry manure may also be dried and pelletized to produce a fertilizer product that is more balanced and consistent in its nutrient content, as well as pathogen and odor-free. Two such plants have been initiated in the Chesapeake Bay watershed, Perdue AgriRecycle and Harmony Shenandoah Valley. To date these have been the only large-scale alternative uses of manure in the region. Each of them was designed to create a product using raw poultry litter that can be formulated to meet specific crop needs and includes beneficial micronutrients and organic matter. However both plants faced challenges in developing a market for their product, and questions remain about the fate of heavy metals and other additives found in poultry manure.

Perdue AgriRecycle has sold its pellets primarily to non-agricultural users such as golf courses and landscapers, and is producing about 50,000 to 60,000 tons of fertilizer per year. It is currently trying to expand into the retail fertilizer market and export more of its product outside the Bay watershed. Harmony Shenandoah Valley recently shut down its production, reportedly because of an inability to penetrate markets for its fertilizer and problems with an associated power generation facility. The experience of these two plants emphasizes the need to develop markets as well as technology for alternative uses of manure.

RECOMMENDATIONS: KEY ACTIONS THIS YEAR

Animal wastes have a significant impact on our water resources from small creeks and streams to major tributaries and the Bay, but there are actions that can and must be taken to reduce the pollution damaging water quality. There are solutions that are compatible with agriculture and that can improve the bottom line for farmers. Because of the many hidden costs associated with manure pollution, development of alternatives must be jump-started instead of waiting for markets to solve the problem.

Numerous state, federal, and private efforts are actively working to improve manure management and reduce polluted runoff. Substantial resources have been invested in manure storage and handling facilities, and nutrient management programs are stronger now than they have been in the past. In some areas, streamside buffer programs have increased protection for streams by fencing out livestock and filtering runoff. Additionally, the 2002 federal Farm Bill sharply increased funding for livestock related issues. CBF continues to support these integral programs and to forge partnerships to increase adoption and implementation. However, all the current programs are under-funded and insufficient to meet the needs of farmers. The demonstrated success on Green Run and the North Fork clearly show that much greater levels of support and commitment will be necessary for degraded local streams and the Bay to recover.

The following key actions must be taken this year across the watershed to better address pollution from agriculture.

- **Implement Tributary Strategies.** The tributary strategies contain numerous provisions to address nitrogen and phosphorus pollution from manure and agriculture in general. Despite a deadline for completion of April 2004, to date no specific plans or funding sources have been developed to actually implement these strategies. CBF calls on:
  - *The Chesapeake Bay Executive Council to complete implementation plans that include measurable annual benchmarks to insure progress along with necessary funding mechanisms for the tributary strategies by December 2004.*
- **Fund the Chesapeake Bay federal Farm Bill proposal.** The 2002 federal Farm Bill significantly increased funding to reduce water pollution from farms. However, these programs have not been fully funded and fall far short of farmers' needs to achieve local and Bay water quality goals. In July 2002, the Bay states submitted a proposal to the federal Secretary of Agriculture for a $20 million per year Chesapeake Bay Working Lands Nutrient Reduction Pilot Program. Despite having the specific authority under the 2002 Farm Bill and direction from Congress, USDA has yet to implement this program. CBF calls on:
  - *The U.S. Department of Agriculture to fund the Chesapeake Bay Working Lands Nutrient Reduction Pilot Program at $20 million annually through 2007, the remainder of the current farm bill.*
- **Reduce the amount of nutrient pollutants in manure.** Some poultry growers have already changed the composition of their animals' feed which subsequently has reduced manure phosphorous by 16 per-

cent and potentially could cut it by up to 50 percent. Similar changes to feed can also be applied in hog operations. In addition, new research indicates that lower nutrient levels in dairy feed could reduce pollution from cow manure by up to 40 percent, while saving the region's dairy industry as much as $18 million a year. In Pennsylvania, which has two thirds of the region's dairy cows, CBF and the Pennsylvania Department of Agriculture will hold an October summit of farmers, feed producers, scientists, and government agencies to determine the most effective structure for the program. CBF calls on:

- *Pennsylvania's Governor and Legislature to establish a $10 million Dairy Feed Management pilot program to improve dairy feed efficiency as part of a larger agricultural funding initiative in the next legislative session.*

- *Each Bay state, upon completion of the Pennsylvania pilot program, to establish a similar program refined to meet the state's particular needs.*

- **Require safeguards when manure is spread on cropland.** Many available methods to increase the efficiency of manure fertilizer and reduce polluted runoff are not currently included in nutrient management plans and must be more widely adopted. CBF calls for:

  - *The Bay states to ensure that nutrient management programs include readily available safeguards against manure runoff.*

    - *Manure should be appropriately incorporated into the cropland to reduce air releases and surface runoff.*

    - *The timing and amount of manure applied should be closely tied to both the nitrogen and phosphorus needs of the crop.*

    - *Direct discharges of manure to surface waters should be prevented through the use of setbacks and vegetated buffers.*

    - *Cover crops should be encouraged through operational incentives as well as existing financial incentives.*

  - *Full implementation and enforcement of federal water quality permits for Concentrated Animal Feeding Operations (CAFO) to prevent manure runoff.*

- **Establish viable alternative uses for manure.** Since many fields where manure is traditionally applied are already saturated with nutrients, governments and industry should initiate and develop incentives for new technologies that show potential for innovative uses of manure. "Bioenergy" plants, which generate power from manure and other farm products, are already operating on a commercial scale in Europe and Canada and at some sites in the United States. Four different bioenergy processes already exist and are being refined. Manure can also help restore soil fertility on barren land left by mining operations. It is already being turned into compost and pelletized fertilizer, but appropriate markets for the material need to be expanded. Manure can and should be a valuable resource for farmers and can help stimulate rural economies. CBF calls on:

  - *Each Bay state, by June 2005, to prepare a strategy to develop sufficient alternative uses for all excess manure addressing technology, funding, marketing, and implementation needs.*

- *Maryland's Governor and the General Assembly to reinstate its Animal Waste Technology Fund and commit $5 million next year to initiate a competition among private enterprises for the most cost-effective, environmentally friendly alternative uses of manure.*

- *Maryland's Governor and General Assembly to develop a broad-based user fee, with contributions from businesses and consumers, dedicated to providing $25 million annually to ensure the availability of alternative uses and to help farmers implement other needed agricultural practices to address manure runoff.*

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August 18, 2004

The Honorable Tom Davis, Chair
Committee on Government Reform
2157 Rayburn Office Building
Washington DC 20515

Dear Chairman Davis:

The Committee is holding a field hearing entitled "A Model for Success? Monitoring, Measuring and Managing the Health of the Chesapeake Bay", on Friday, August 20, in Hampton, Virginia. We wish to submit this Statement and respectfully request that it be made a part of the record for this important and timely hearing.

BACKGROUND—ARP TECHNOLOGY

ThermoEnergy is a leading-edge technology company with extensive experience in working with local, state and federal jurisdictions to help resolve oxygen deficiencies in water systems; particularly as they relate to nitrogen removal. One of our patented technologies, the Ammonia Recovery Process (ARP), significantly reduces the economic and regulatory burden of nitrogen reduction for sewage treatment plants and comparable sites where effluents are discharged into bodies of water.

ARP meets environmental and regulatory needs by removing and recovering nitrogen from process streams within the wastewater treatment prior to discharge. The recovered nitrogen is then converted into ammonium sulfate; a premium-grade fertilizer that is beneficially used in agriculture worldwide. ARP's small footprint and reasonable capital and operating cost makes it attractive to both large and small wastewater treatment operators. A detailed technical description of the ARP process is included with this statement.

ARP AND THE BAY

The presence of nitrogen in the Chesapeake Bay is the leading cause of algae bloom, which consumes oxygen present in the water, creating an acute problem for the crabs and other aquatic life – eventually creating 'dead zones.' Prof. Robert Diaz of the Virginia Institute of Marine Science, best described this situating in a quote appearing in the Washington Post, August 16, 2004, when he noted, "When you can't breathe, nothing else matters." We are confident that ARP can play a vital role in the Committee's efforts to save the Bay by cost-effectively restoring the oxygen balance for the Chesapeake's aquaculture.

Excess nitrogen also plagues Long Island Sound. ThermoEnergy is in the process of finalizing a contract with the Department of Environmental Protection for the City of New York for a 500,000 gallon per day ARP facility for their Bowery Bay Water Pollution Control Plant. This facility will remove the ammonia from the plants centrate – the aqueous by-product stream from the dewatering process, containing a high concentration of nitrogen (in the form of ammonia). This facility discharges processed wastewater into the East River which ultimately flows into the Sound. As indicated in the accompanying letter, we won this contract only after DEP's staff completed an exhaustive review of [ARP]". A critical part of their decision was based on the positive conclusions reached by evaluators from the US EPA and the Civil Engineering Research Foundation during the large-scale ARP demonstration project at DEP's Oakwood Beach wastewater treatment facility in 1999. They found ARP to be highly effective in eliminating ammonia from DEP's centrate. The results of this demonstration project are available at http://www.cerf.org/evtec/news/reports.htm.

POINTS BEYOND: SUGGESTIONS FOR FOCUS

For the past few years, ThermoEnergy has engaged in extensive discussions with a significant number of municipal jurisdictions who are experiencing serious water quality issues attributable to the presence of nitrogen in discharge streams from their wastewater treatment facilities. Similar problems have been found in Hood Canal, Oregon Coast, Narragansett Bay, Pamlico Sound, Hillsborough, Mobile and Perdido Bays as well as the giant dead zone in the Gulf of Mexico. We have found agencies, institutions, officials and individuals are working to address the nitrogen problem. Like the Chesapeake Bay stakeholders, each has constructed policy and regulatory platforms they believe will best accommodate the interests of those affected by their decisions. With few exceptions, we are confident that the basic infrastructure does not require significant change. The following are some recommendations that we believe will assist the Committee in designing "A Model for Success," bringing us closer to achieving our objective of preserving one of the country's greatest resources – the Chesapeake Bay. It is in this spirit we offer the following Suggestions for Focus. They are: (1) Cost; (2) Technology; and (3) Urgency.

1. Cost

There are two things that drive the wastewater treatment industry – regulations and cost. Improvements required to meet regulatory changes usually involve capital improvements. The costs of these improvements are often times significant, leaving municipal jurisdictions struggling to absorb the cost. This economic challenge is compounded by trying to solve the problem using only conventional wastewater treatment solutions typically offered municipalities by the industry. Further, it is our experience that once a large-scale environmental program such as cleanup of the Bay is announced, resulting in substantial political and media interest, "projected" costs for conventional solutions tend to increase substantially. There is a strong temptation for existing infrastructure providers to use media attention as an invitation to raise prices to clients who are governed by regulation and have few alternatives. In such a regulatory driven and costly environment, virtually every clean water project should include serious technical and financial analysis of alternative, outside-the-box solutions.

2. *Technology Evaluation and Implementation*

The key to better, cost-effective performance is advanced technology. Unfortunately, the wastewater industry is structured in way that discourages new technology from entering the market. Industry providers are paid on a percentage of the projects total cost. The larger the project, the more a provider gets paid, thus what is in the best interest of the taxpayer is diametrically opposed to that of the provider. Conventional biological nitrogen removal upgrades for a single wastewater treatment plant can cost upwards of $1 billion and the entrenched entities have no incentive to look for newer, more cost-effective solutions. The technical and regulatory stakeholders in the Bay region need to identify and support one or more sites where technology advances can be expeditiously evaluated and implemented. We believe it is imperative for the future of the wastewater industry that a forum be created where alternative technologies can be impartially tested and evaluated in order to determine which technologies best meet the regulation vs. cost criteria. Should we fail to do this, the future cost to the taxpayer to preserve our fresh water resources will become untenable. We conducted an informal presentation to EPA and Chesapeake Bay officials earlier this year in an effort to encourage policy people and regulators to give new technology a chance to improve the cost effectiveness of nutrient removal.

3. *Urgency*

Cleanup of the Chesapeake Bay is a major undertaking, not only on its own terms but as a model for future projects. There are many facets to the process at the federal, state and non-governmental level, including, regulatory, policy, economic and judicial issues - all of which need hearings, consultations and actions. The problems of the Bay are well known; having been studied and documented for years. Significant progress has been made in understanding the origins of the problem and the ramifications of inaction. The time has come for legislators to promote a sense of urgency of in responding to what is fast approaching nothing short of a state of emergency.

For example, as of today, EPA has issued for comment a proposal to use permitting authority as an enforcement tool to achieve broad policy objectives. The Chesapeake Bay Foundation has sued the Virginia Department of Environmental Quality to reconsider a discharge permit because the limits allowed for nitrogen are too generous. At the request of Senators Paul Sarbanes, Barbara Mikulski and John Warner, the GAO has agreed to review and critique Bay cleanup programs within three months.

We suggest that these institutions focus their efforts toward a collaborative, common solution and do so at the earliest practicable time. Thus, each forum must be encouraged to be consultative toward others, particularly with regard to effective removal vs. the cost of remediation technologies.

ThermoEnergy is confident that the ARP process will meet the most stringent criteria as a cost-effective, environmentally responsible method of eliminating nitrogen discharge from municipal wastewater treatment facilities within the Chesapeake Bay watershed. Moreover, our experience in dealing with clean water challenges for numerous jurisdictions formed the background for the Suggestions for Focus, which we feel will help expedite the effort to save the Chesapeake Bay.

Thank you for your consideration. If you have any questions, please do not hesitate to contact us at your convenience.

Sincerely,

Dennis C. Cossey
CEO

DCC/hj

Enclosures As Noted

Ammonia Recovery Process (ARP)

Cost Effective, Compact Nutrient Removal

WHAT IS ARP?

This award-winning technology is a reliable, low-cost, environmentally effective method of treating ammonia containing streams. The Ammonia Recovery Process (ARP) extracts ammonia out of sewage treatment liquid (centrate) and livestock waste via chemisorption and converts it into standard, commercial-grade, ammonium sulfate fertilizer. ThermoEnergy Corporation is targeting ammonia recovery from aqueous streams, such as the liquid product resulting from centrifuging anaerobically digested sewage sludge or animal waste. This stream, known as the "centrate" contains approximately 600 to 1,600 parts-per-million (ppm) dilute ammonia.

In a standard activated sludge plant, very little nitrification and denitrification occurs and ammonia flows into receiving waters. In advanced wastewater treatment plants where nitrogen is nitrified and denitrified, a portion of the nitrogen in the treatment plant is converted into N_2 or nitrogen gas. Both of these plants generate primary and waste activated sludges which are typically treated with anaerobic digestion and then dewatered. In the anaerobic digestion process, more than half of the nitrogen in organic nitrogen compounds is converted into ammonia.

Once the anaerobically digested sludge is dewatered, the bulk of the organically bound nitrogen stays with the sludge solids while virtually all of the ammonia nitrogen stays with the water portion or centrate. This centrate is typically recycled to the front of the WWTP. ARP treats the centrate as a relatively concentrated ammonia stream, and returns a very low ammonia stream to the plant.

The first element of the ARP is a column containing an industrial grade ion exchange resin loaded with zinc ions. This zinc-loaded resin column selectively adsorbs ammonia. Regeneration of the ammonia saturated columns is the next critical element. The columns are regenerated using a solution of sulfuric acid and zinc sulfate. The regeneration solution is used repeatedly, until the ammonia concentration builds up. . The ammonia-laden regeneration solution is then further concentrated with an evaporator to about 15% by weight of ammonia, the zinc is precipitated for reuse in the regeneration process, and the ammonium sulfate is sold to fertilizer users.

The ARP is the first cost-effective technology to recover ammonia from water at low concentration. The technology was demonstrated on a wastewater effluent at the Oakwood Beach Water Pollution Control Plant, Staten Island, New York. During the demonstration, the ARP technology consistently removed greater than 90% of the ammonia before the effluent was discharged and converted it to a desirable commodity—ammonium sulfate fertilizer. The ARP pilot plant data and information was subjected to an independent evaluation by EvTech (a component of the Civil Engineering Research Foundation) and the New York City Department of Environmental Protection. This report is available on-line at: http://www.cerf.org/evtec/news/reports.htm

How Does ARP Work?

In many sewage treatment plants, the centrate is sent back to the main influent stream, where most of the ammonia eventually goes to receiving waters, such as Long Island Sound. The ARP demonstration was conducted in response to the Long Island Sound Plan, which includes upgrading sewage treatment plants to help meet the goals of restoring habitat and water quality. Equally important is its application to excess waste (manure) from concentrated animal feeding operations (feedlots). There, the ARP technology would selectively remove ammonia under conditions based on specific waste characteristics, where the physical aspects of the process would be tailored to the individual operations and facilities (e.g., waste lagoons, holding ponds).

The ARP is extremely effective and selective in removing ammonia from aqueous streams.

- The ARP relies on simple physical/chemical processes rather than complex biological processes. It uses chemisorption, a surface chemistry that has a strong chemisorption driving force at both high and low ammonia concentrations. Unlike biological methods, this process is not subject to upsets nor sensitive to ambient temperatures. A ***key*** to the success of the ARP Process is the use of zinc sulfate in the regeneration solution. The zinc sulfate-sulfuric acid solution used in the ARP technology keeps the zinc on the column but removes the ammonia.
- Only standard industrial equipment is used by the ARP, allowing for low-cost, modular construction and consequent efficient maintenance and expansion.
- The compact size of the ARP allows it to be retrofit into existing wastewater treatment plants, often already space-limited. For new facilities using the ARP Process, less land is required for the same plant capacity compared to conventional denitrification methods. In large cities, the value of this land savings is significant.

Why Use ARP?

As a contaminant of our waterways and agricultural soils, ammonia presents conditions that are unsafe for human health and the environment. Political leaders, regulators, scientists, environmental groups, and citizens are raising concerns about ammonia throughout the U.S. and in other countries. Thousands of sewage treatment plants and millions of livestock producing waste contribute a staggering amount of ammonia that fouls the air, aquifers, and surface waters. The harmful health and environmental impacts of ammonia (and its subsequent breakdown product, nitrate ion) heightens the need for ammonia pollution prevention technologies to halt further contamination. ***The ARP meets this need by containing the ammonia within a plant or site and beneficially recovering it rather than discharging it.***

What separates this technology from other ammonia removal techniques is that it does not require large amounts of energy or an array of chemicals; it uses less space; it has no fouling or odor problems; it is not subject to upsets; and it is integrated to enhance existing facilities. As a bonus, instead of generating secondary wastes and other materials that must then be disposed, the process provides beneficial re-use of ammonium sulfate as a consumer ready, widely used product.

The City of New York
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Christopher O. Ward
Commissioner

Alfonso R. Lopez, P.E.
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June 24, 2004

Mr. Dennis Cossey
1300 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Cossey:

As you know, DEP's staff developed and completed an exhaustive review of the Ammonia Recovery Process (ARP) earlier this year as a prelude to negotiating the contract with ThermoEnergy for a 0.5 MGD, ARP demonstration plant to be located at the Bowery Bay Water Pollution Control Plant. This process involved development of contract documents, review and sign-off by the Bureau of Wastewater Treatment's technical staff, its upper management and the Department's First Deputy Commissioner, as well as the DEP's Contracts Officer and legal staff.

Much of the contract-drafting process has been completed and the documents have been forwarded to the New York City DEP's oversight agencies for review and approval. It may require several weeks to complete their review. If acceptable to the oversight groups, the document will then be forwarded to the City Comptroller's office for review and registration.

When this draft contract is approved, signed and registered, DEP will notify ThermoEnergy. Please refer to those sections in the draft contract relating to payment procedures which include a description of the documentation required for all invoices submitted to this Agency.

If you have any questions regarding the contract status and/or the invoice process, please continue to communicate through Mr. Luis Carrio. We look forward to a timely and beneficial outcome for this project, and working with ThermoEnergy Corporation to demonstrate the capabilities of ARP.

Sincerely,

Vincent Sapienza, P.E.
Director, Environmental Affairs
Bureau of Wastewater Treatment

PL/pl

cc: L. Carrio, P. Lai

New York City Department of Environmental Protection DEP

Preliminary Cost Savings for Chesapeake Bay Using Ammonia Recovery Process (ARP)

The typical nitrogen concentration in untreated domestic wastewater of various strengths is shown in Table 1.

Table 1. Nitrogen Composition of Untreated Domestic Wastewater[i]

Nitrogen mg/l	Low Strength	Medium Strength	High Strength
Organic N	8	15	25
Ammonia N	12	25	45
Total WW N	20	40	70

As wastewater is treated with primary settling, aeration and secondary settling, nitrogen is removed. In a standard activated sludge plant, very little nitrification and denitrification occurs and gaseous losses are due to stripping. In advanced wastewater treatment plants where nitrogen is nitrified and denitrified, a portion of the nitrogen in the treatment plant is converted into N_2 or nitrogen gas.

So after the activated sludge process, dissolved nitrogen was either converted into N_2, or lost to the atmosphere by stripping (typically small) or passed into the solids handling portion of the plant in the form of the primary and waste activated sludge. The sludge mixture is typically treated with anaerobic digestion and then dewatered. In the anaerobic digestion process, organic nitrogen compounds are converted into ammonia.

Once the anaerobically digested sludge is dewatered, the bulk of the organically bound nitrogen stays with the sludge solids while virtually all of the ammonia nitrogen stays with the water portion or centrate. This centrate is typically recycled to the front of the WWTP. So, nitrogen entering the plant has only three places to go: out with the treated water, out with the dewatered biosolids or up into the atmosphere as N_2 gas or stripped ammonia.

For the purposes of constructing a generalized mass balance and estimating the effect of the Ammonia Recovery Process (ARP) on a given WWTP, the loss of nitrogen to stripping or nitrification-denitrification can be designated as an unknown (X). While it would be nice to know this value for the sake of completeness, it is not necessary. There are sufficient known elements to construct the balance for the rest of the plant to estimate the impact of ARP. Figure 1 is a schematic generalization of the waste water treatment process typical of the larger waste water treatment plants in the Chesapeake Bay watershed.

The nitrogen values indicated on this diagram are depicted as values equivalent to parts per million of nitrogen in the primary influent stream. Note that the recycle of the ammonia nitrogen in the centrate is typically 31% of the total nitrogen entering the WWTP! This 31% value ranges from 30% to 33% and is typically higher for advanced WWTPs because there is a greater amount of waste activated sludge. In our example in

Figure 1, the aerobic activated sludge portion of the WWTP receives 131% of the actual nitrogen in the domestic wastewater flowing down the sewer. The incremental 31% comes from the recycle of centrate, a highly concentrated ammonia laden stream from the solids handling operations. In order to make direct comparisons, the quantity of nitrogen the centrate is shown as the mg/l of nitrogen the centrate would contribute when mixed with the influent wastewater.

The removal of organic nitrogen in the primary settler as primary solids is a physical process and is unaffected by the ammonia concentration in the main flow. The conversion of fixed nitrogen into biomass in the aeration basin is a function of the carbon – nitrogen ratio. As long as there is sufficient carbon, nitrogen will be removed because it is an essential nutrient for biomass creation. With sufficient carbon available, activated sludge microorganisms are capable of removing nitrogen to very low levels.

With the ARP approach, the ammonia recycle is eliminated and the carbon-nitrogen ratio is shifted to reduce or eliminate the excess of nitrogen in the aeration basin. This enables the existing plant to do a better job of removing ammonia and the majority of WWTPs in the Chesapeake watershed can achieve the 3 ppm nitrogen target for substantially less cost that previously estimated. Table 2 provides estimates of the capital cost savings in comparison to Advances Wastewater Treatment with Nitrification and Biological Nitrogen Removal.

Figure 1. Ammonia Emission of Conventional WWTP with Ammonia Recycle

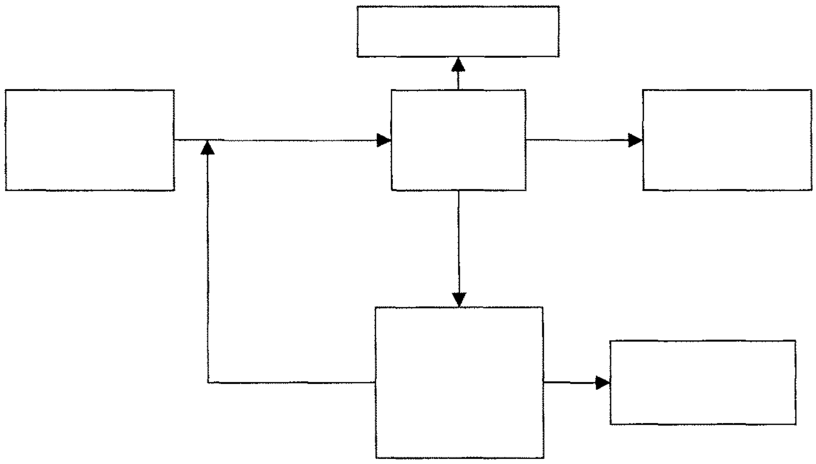

Figure 2. Ammonia Emission of WWTP Modified with Ammonia Recovery Process

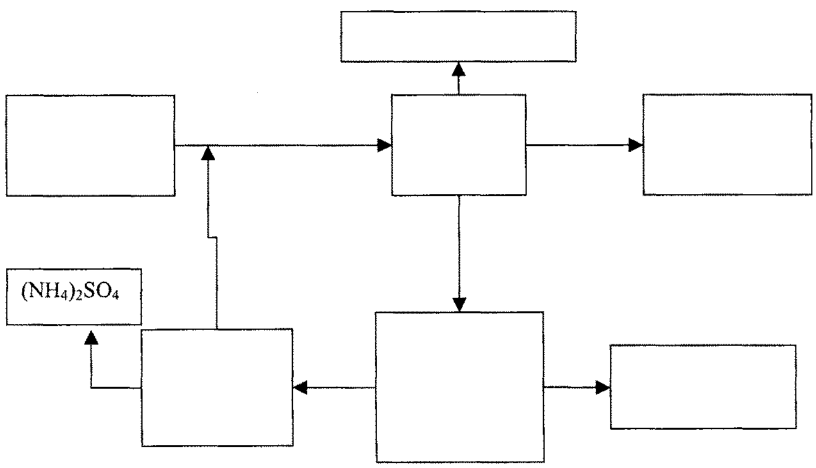

Table 2 shows the cost impact of implementing the Ammonia Recovery Process technology at a variety of different size plants. In most cases, the ARP alone will enable the WWTP to achieve nitrogen emissions below 3 ppm. In these cases, the estimated savings are closer to the high estimates.

In cases where ARP alone is insufficient to enable the WWTP to achieve 3 ppm, some additional treatment will be required and the capital savings associated with implementing ARP would be toward the lower estimate. In all cases, the operating cost for ARP on an ammonia removal basis is lower that the corresponding operating cost of AWT and BNR. What makes this even more remarkable is this result can be accomplished for substantially less cost than previously estimated.

The conclusion is that it would be prudent for the ammonia emitting WWTPs within the Chesapeake Bay watershed to implement ARP where-ever applicable prior to making massive investments in less efficient Nitrification and BNR plant and equipment.

Table 2 Cost Savings Estimates	**Plant Flow - MGD**				
($ in Thousands)	**1**	**10**	**20**	**50**	**100**
Activated Sludge WWTP	$1,272	$7,151	$12,026	$23,910	$40,212
Advanced Treatment w/ Nitrification	$8,330	$69,286	$131,097	$304,577	$576,295
Biological Nitrogen Removal	$2,611	$14,825	$25,152	$50,807	$86,766
Total AS+AWT+Nit+BNR WWTP	$12,213	$91,261	$168,275	$379,294	$703,273
Cost Impact of Centrate Treatment on AWT+ Nit + BNR Addition	$1,632	$12,545	$23,304	$53,006	$98,896
ARP Capital Cost Estimate	$ 520	$2,590	$ 4,210	$ 8,000	$13,000
Capital Cost Savings High Estimate	$10,421	$81,521	$152,039	$347,384	$650,061
Capital Cost Savings low Estimate	$1,112	$9,955	$19,094	$45,006	$85,896

[i] Tchobanoglous, G. et al. "Wastewater Engineering Treatment and Reuse", Metcalf & Eddy, Tata McGraw-Hill, 4th Edition page 186.