Legislative Budget and Finance Committee

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A Cost Effective Alternative Approach to Meeting Pennsylvania's Chesapeake Bay Nutrient Reduction Targets

Conducted Pursuant to Act 2012-87

January 2013

Table of Contents

Report Summary

In the late 1970s, a Congressional study highlighted the problems being caused by high levels of nutrients flowing into the Chesapeake Bay, much of it coming from the Susquehanna River. Since that time, Chesapeake Bay states, including Pennsylvania, have made various efforts to reduce these nutrients.

By 2009, however, it was clear that these efforts were inadequate, and in 2010 the Environmental Protection Agency imposed a Total Maximum Daily Load (TMDL) limit on the nitrogen, phosphorous, and sediment flowing into the bay. The Chesapeake Bay states were required to submit Watershed Improvement Plans (WIP) indicating how they would reduce the level of pollutants to achieve the TMDLs by 2025. By 2017, states are to have achieved 60 percent of the required reductions.

The Pennsylvania Department of Environmental Protection (DEP) submitted its Phase 2 WIP in March 2012, indicating it planned to meet the TMDL targets for nitrogen (the key Chesapeake Bay pollutant) from the following sources:

2011 (Delivered) and 2025 Target Nitrogen Loads for Pennsylvania

Sector	Model-Projected 2011 Progress (lbs/yr) Nitrogen	Phase 2 Watershed Implementation Plan 2025 Planning Target (lbs/yr) Nitrogen	% Difference
Agriculture	59,281,017	35,313,572	-40%
Forest	21,067,076	21,417,135	2
Point Source	11,483,413	9,080,860	-21
Urban/Developed	17,467,177	10,235,505	-41
Septic	2,141,702	1,742,464	-19
Air Deposition to Water	1,042,439	1,042,439	0
Totals	112,482,824	78,831,975	-30

Source: Loads (2011 progress data reported 4/17/12) and Targets (reported 6/27/11) as developed through Phase 5.3.2 of the Chesapeake Bay Watershed Model, reported by EPA.

DEP notes the WIP planning targets have some flexibility at the sector allocation level and may be modified if conditions warrant.

While many point sources (e.g., wastewater treatment plants) have achieved, or are near to achieving, their 2017 TMDL goals, other sectors—primarily agriculture and urban/suburban stormwater—have been less successful. The uncertainties this has created, and the high costs some sectors (e.g., urban/suburban stormwater) will incur to reduce nutrients to compliance levels, was the impetus behind the provision in the fiscal code to study an alternative approach involving the use of a competitive bidding program for nutrient credits rather than sector allocation targets.

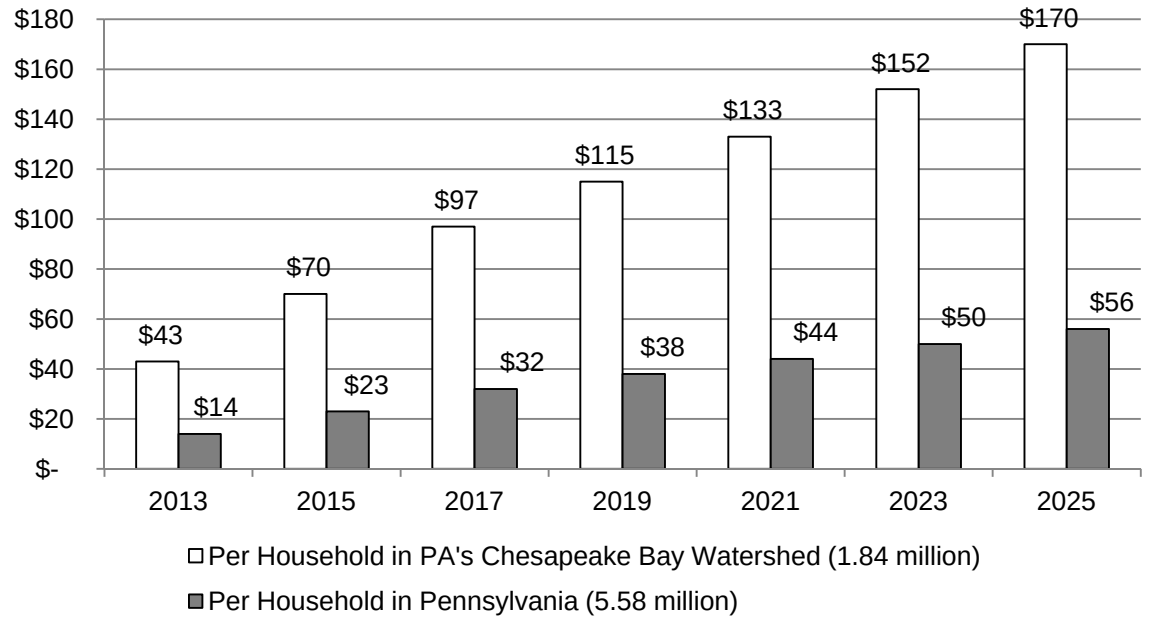
Our outline of a competitive RFP (Request for Proposal) program, which is based in part on an approach taken by the Colorado River Basin Salinity Control Program, includes:

1. DEP establishing the shortfall in nitrogen reductions (i.e., the number of pounds of nitrogen reductions planned to be achieved via the WIP minus the actual reductions achieved) on an annual or biannual basis.
2. DEP developing a formula that would be disclosed to bidders for how it will score proposals. While the cost per pound of nitrogen reduced would be the primary factor, other environmental (e.g., phosphorous reductions in impaired local streams) and economic factors should also be considered when scoring proposals.
3. PENNVEST entering into long-term contracts (15-20 years) with successful bidders to purchase nitrogen credits. Long-term contracts are necessary for capital-intensive advanced technology solutions to be financially viable. Actual payment would not be made, however, until the credits have been achieved and verified.
4. DEP would adjust the number of credits to be purchased on an annual or biannual basis. DEP could also make modifications to the scoring formula between bidding periods.

We estimate a competitive RFP program for the Chesapeake Bay would likely cost between $128 million in 2015 to $313 million in 2025 if no additional nitrogen reductions are achieved from nonpoint sources. Assuming half the nitrogen reductions from nonpoint sources called for in the Commonwealth's current WIP are achieved, the cost of the RFP program would also be cut in half, and therefore range from $64 million in 2015 to $156 million in 2025. These estimates are based on nitrogen reductions at $11 per pound ($10 per pound, plus $1 per pound for transaction costs).

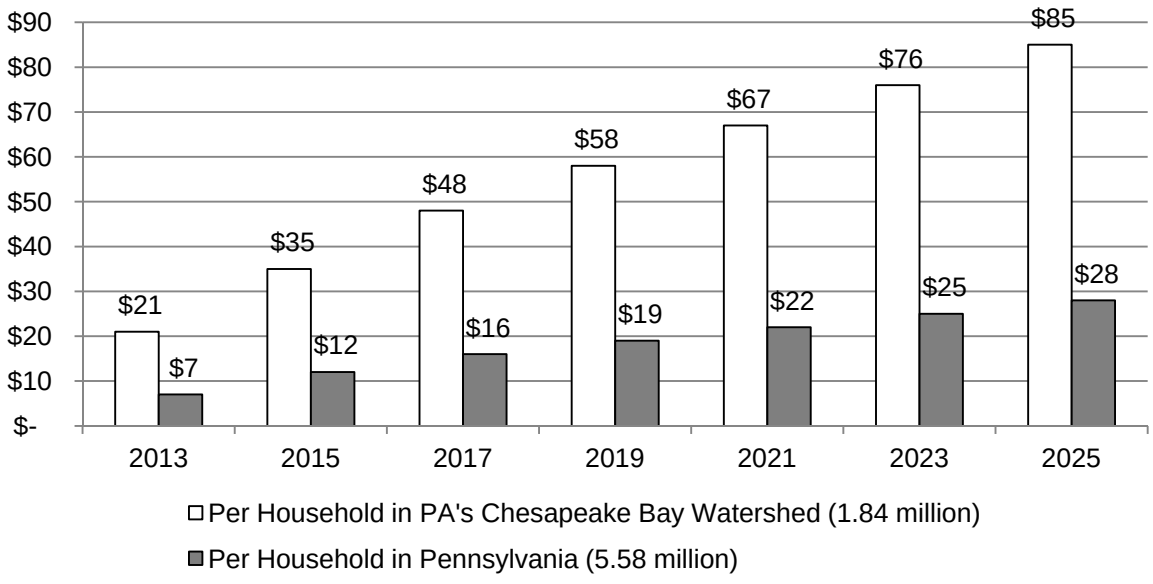
The exhibit on the following page shows the annual per household costs under both scenarios (no additional nitrogen reductions achieved and 50 percent of nitrogen reductions achieved) if they were spread out among Pennsylvania households in the Chesapeake Bay region and if they were spread out among all Pennsylvania households.

Cost Per Household to Meet PA's Nitrogen Reduction Goals
Assuming No Additional Reductions
(At $11 Per Pound Per Year)



Source: Nitrogen reduction targets provided by DEP. Household information from U.S. Census data.

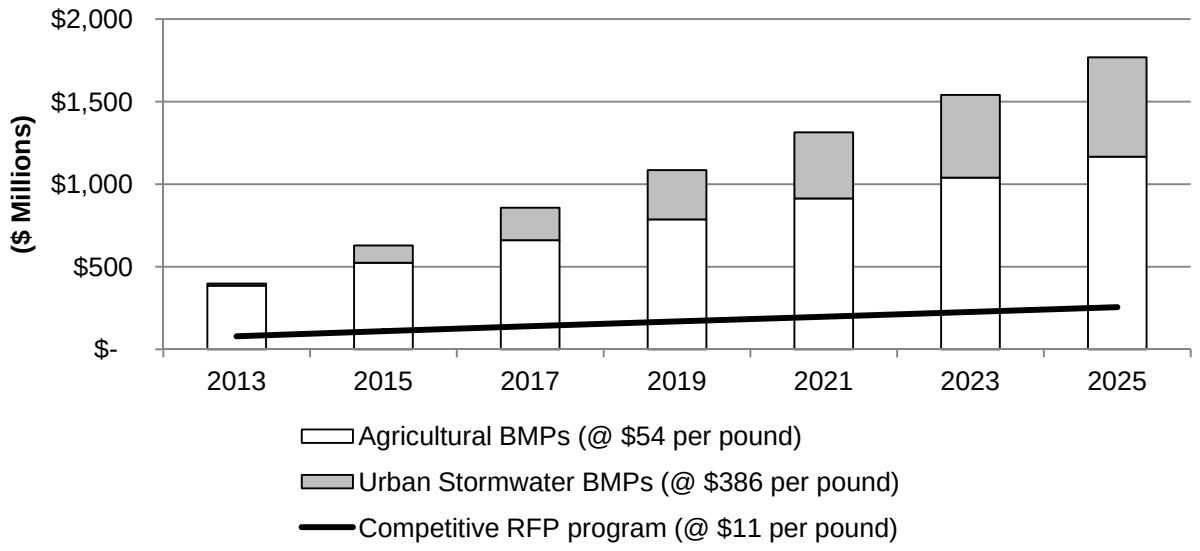
Cost Per Household to Meet PA's Nitrogen Reduction Goals
Assuming 50 Percent of WIP Reductions Are Achieved
(At $11 Per Pound Per Year)



Source: Nitrogen reduction targets provided by DEP. Household information from U.S. Census data.

We also estimated the cost to achieve nitrogen reductions for nonpoint source agriculture and urban runoff from impervious surfaces using best management practices and under a competitive RFP program. These two sources (nonpoint source agriculture and urban runoff from impervious surface) account for about 80 percent of Pennsylvania's total required nitrogen reductions. As shown in the exhibit below, the cost to achieve the nitrogen reductions called for under the WIP for agriculture and urban runoff from impervious surfaces are far lower (approximately 80-85 percent lower) under a competitive RFP program than if achieved through Best Management Practices (BMPs).

Estimated Costs to Achieve All Need Nitrogen Reductions From Nonpoint Source Agriculture and Urban Runoff Using Best Management Practices (BMPs) and Under a Competitive RFP Program



Source: Nitrogen reduction information provided by DEP. BMP costs from Table 4.

Funding for such a program could possibly be achieved by flexing existing funding for nonpoint sources (approximately $187 million in 2010) or through a new funding source, such as the $60 per year "flush tax" Maryland imposes on households living in its Chesapeake Bay watershed.

The report identifies several other issues raised by a competitive RFP program and possible ways those issues could be addressed.

I. Introduction

Act 2012-87, the Fiscal Code, includes a provision (Sec. 1764-F) requiring the Legislative Budget and Finance Committee, in consultation with the Pennsylvania Infrastructure Investment Authority (PENNVEST), to conduct a study of an alternative approach for how the Commonwealth can meet nutrient reduction planning targets contained in any watershed implementation plan.

Study Objectives

The study objectives as enumerated in Act 87 are:

(i) Review the cost and the environmental, recreational, and public health and safety impact and other benefits realized by the Commonwealth and municipalities from reductions of water quality impairment from nutrients in major watersheds.

(ii) Assess the use of competitive bidding for long-term verified nutrient credits rather than sector allocation targets in any watershed implementation plan.

(iii) Analyze funding options, including use of any available federal, state or local funds for the purchase of nutrient credits.

Methodology

Extensive research has been conducted of the problems and possible solutions confronting polluted estuaries in the United States, and the Chesapeake Bay in particular. Much of the information in this report came from such research, as well as information from the Pennsylvania Department of Environmental Protection's (DEP) 2004 Chesapeake Bay Tributary Strategy and DEP's Final Phase II Watershed Implementation Plan (WIP).

Information on the cost and benefits of nutrient credit trading and best management practices (BMPs) came largely from a May 2012 report funded by the Chesapeake Bay Commission entitled *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*.

We conducted field visits to two facilities employing advanced technologies to process manure waste, one at Kreider Farms in Lancaster County, which processes manure from dairy cows, and one at Hillandale Farms in Adams County, which processes chicken manure. Information on these facilities can be found in Appendix A.

During the study we also interviewed representatives from the following organizations: Chesapeake Bay Foundation, Chesapeake Bay Commission, PENNVEST, BION Environmental Technologies, Inc., the Pennsylvania Department of Environmental Protection, EnergyWorks, and the Pennsylvania Municipal Authorities Association. We express our gratitude to all these individuals and organizations for their assistance in this project.

Important Note

This report was developed by the Legislative Budget and Finance Committee staff. The release of this report should not be construed as an indication that the Committee or its individual members necessarily concur with the report's findings and recommendations.

Any questions or comments regarding the contents of this report should be directed to Philip R. Durgin, Executive Director, Legislative Budget and Finance Committee, P.O. Box 8737, Harrisburg, Pennsylvania 17105-8737.

II. Pennsylvania's Chesapeake Bay Program

In the late 1970s, the United States Congress funded a study to analyze the decline in living resources of the Chesapeake Bay, which had been one of the most biologically productive ecosystems on earth before significant human disturbance. The study identified an oversupply of nutrients as the main source of the bay's degradation. High nutrient inputs feed excess algae growth, conversion to different species of algae that do not support the bay's indigenous food chain, low concentrations of oxygen, and reduced light penetration to the submerged aquatic plants that support other components of the bay's food chain.

After the publication of these initial findings, the Chesapeake Bay Program was established in 1983 as a regional partnership with a mission to lead and direct the restoration of the Chesapeake Bay. The executive body of the Chesapeake Bay Program is the Chesapeake Executive Council, which establishes the policy direction of the program and consists of the Governors of Maryland, Pennsylvania, and Virginia, the Administrator of the U.S. Environmental Protection Agency, the Mayor of the District of Columbia, and the Chesapeake Bay Commission Chair.

Since its creation, the Chesapeake Bay Program has been primarily focused on reducing the amount of nutrients and sediment entering the bay. The Chesapeake 2000 Agreement reaffirmed the commitment of the Chesapeake Bay Program to restoration and protection of the Chesapeake Bay by establishing several goals, one of which was to remove the bay from the federal Clean Water Act's list of impaired waters prior to 2010—and thereby staving off a federally mandated total maximum daily load—by addressing nutrient and sediment-related problems.

The Chesapeake 2000 Agreement committed the state partners to develop specific plans, known as Tributary Strategies or Tributary Compliance Plans, designed to reduce nutrient and suspended-sediment loadings to acceptable levels (cap loads) in each of the tributaries throughout the watershed. The Pennsylvania Department of Environmental Protection (DEP) issued its Chesapeake Bay Tributary Strategy (CBTS) in 2005 to address Pennsylvania's commitment to nutrient and sediment reductions in the Chesapeake 2000 Agreement. The Strategy called for reducing nutrient and sediment loads to Pennsylvania streams and the Chesapeake Bay from both point sources (where discharges can be attributed to a specific physical location such as a wastewater discharge pipe or a waste lagoon outflow) and nonpoint sources (such a onsite septic, runoff from forests, poorly managed farmland, and stormwater runoff from city streets and suburban communities). See Appendix B for a map of the Chesapeake Bay Watershed.

Although progress was made under the CBTS, by 2009 it had become clear that the water quality goals of the Chesapeake 2000 Agreement would not be met

by the 2010 deadline. (See Table 1 for 2011 nutrient and sediment loads by state and Exhibit 1 for delivered loads by sector.) As a consequence, in 2009 EPA

Table 1

Comparison of 2011 Nutrient and Sediment Loads to the Chesapeake Bay
by Jurisdiction as Projected by the Phase 5.3.2 Model

State	Nitrogen (lbs/yr)	Percent
Pennsylvania	112,470,000	45%
Virginia	62,620,000	25
Maryland	50,150,000	20
New York	10,280,000	4
West Virginia	5,400,000	2
Delaware	4,250,000	2
District of Columbia	2,120,000	1
Totals	247,290,000	

State	Phosphorous (lbs/yr)	Percent
Virginia	4,796,000	26%
Pennsylvania	8,297,000	45
Maryland	3,129,000	17
West Virginia	878,000	5
New York	818,000	4
Delaware	330,000	2
District of Columbia	80,000	0.4
Totals	18,328,000	

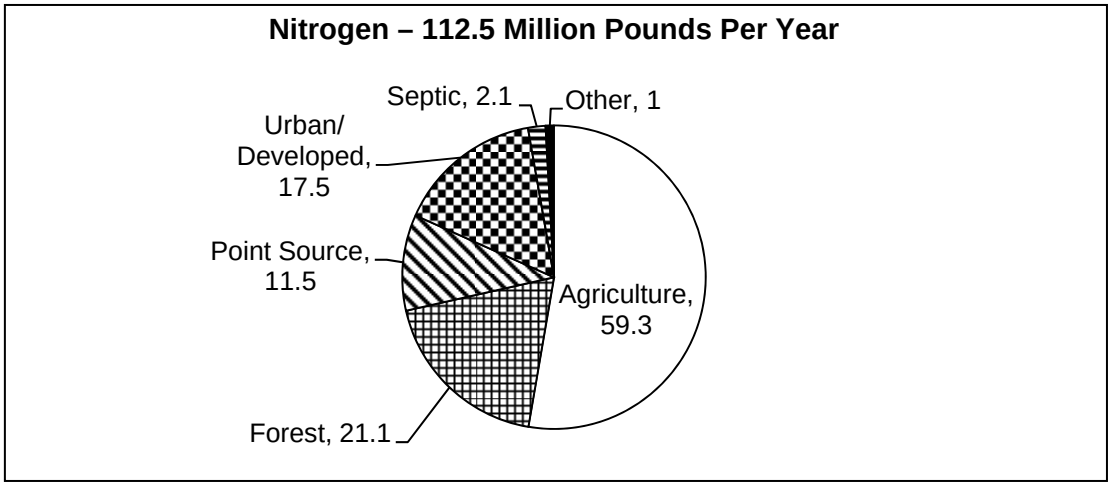
State	Total Suspended Solids[a] (lbs/yr)	Percent
Virginia	2,512,800,000	30%
Pennsylvania	3,627,400,000	44
Maryland	1,331,600,000	16
West Virginia	314,800,000	4
New York	381,200,000	5
Delaware	92,400,000	1
District of Columbia	19,000,000	0.2
Totals	8,279,200,000	

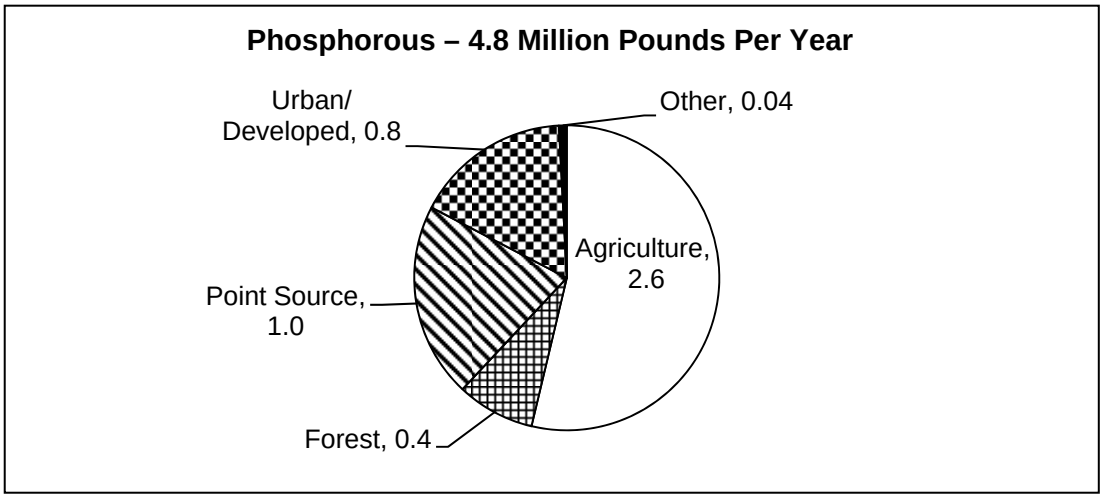
[a] Previously reported as sediment.

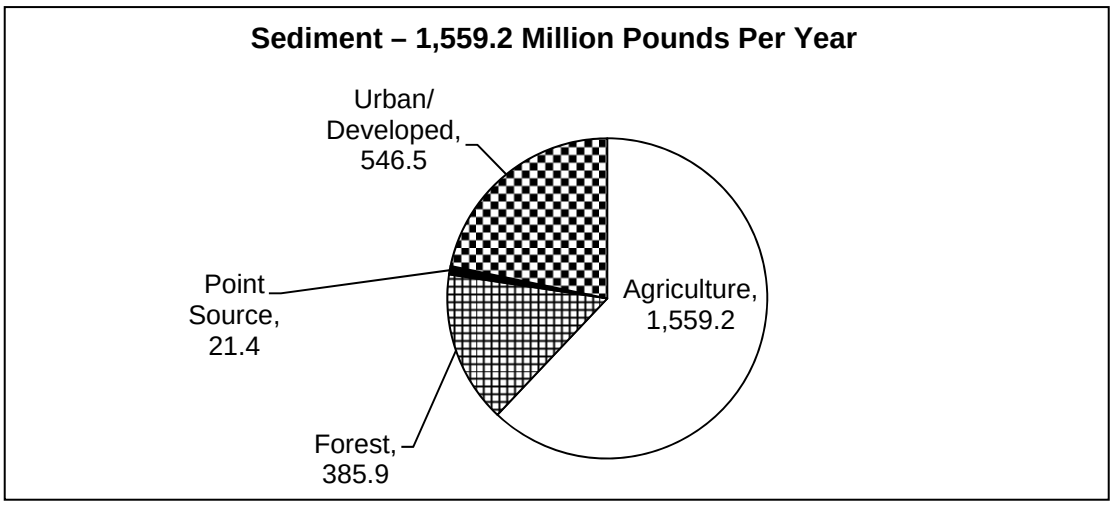
Source: Projected loads as developed through Phase 5.3.2 of the Chesapeake Bay Watershed Model, reported by EPA on 5/12/2012.

Exhibit 1

2011 Model Projected Delivered Nitrogen, Phosphorous, and Sediment by Sector (Pennsylvania)







Source: Loads (2011 progress data reported 4/17/12) as developed through Phase 5.3.2 of the Chesapeake Bay Watershed Model, reported by EPA.

established a federal Total Maximum Daily Load (TMDL) for the Chesapeake Bay. Specifically, the TMDL set bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus, and 6.45 billion pounds of sediment per year. These figures represent a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus, and 20 percent reduction in sediment over 2009 levels. Pennsylvania's share of these reductions (based on Phase 5.3.2 Model updates) is shown in Table 2. States were given until November 2010 to submit their final plans to EPA for how they would achieve their target loads.

Table 2

PA Reduction Targets as Projected by the Phase 5.3.2 Model
(Pounds Per Year)

	Nitrogen	Phosphorous	Sediment[a]
Model-Projected 2011 Progress	112,482,824	4,796,543	2,512,994,737
Phase 2 Planning Target for 2025.....	78,831,975	3,599,323	1,945,000,000
Reductions From 2011 Rates by 2025 .	33,650,849	1,197,220	567,994,737
60 Percent by 2017[b]	93,953,184	4,153,273	2,224,768,925
Reductions From 2011 Rates by 2017 .	18,529,640	643,270	288,225,812

[a] Reported sediment values now reported as total suspended solids by EPA.
[b] Bay jurisdictions are to achieve 60 percent of their 2025 targets (from 2009 baselines) by 2017.

Source: DEP Water Planning Office.

The Tributary Strategy plans to reduce pollution to the Chesapeake Bay have thus been replaced by the state-developed Watershed Implementation Plans (WIPs). DEP submitted Pennsylvania's Phase 1 WIP to the EPA in November 2010. The document outlined the state's plan to address nutrient and sediment loadings that drain to the Chesapeake Bay. DEP submitted its Phase 2 plan, which addresses EPA's revised nutrient and sediment Phase 2 targets, in March 2012.

Pennsylvania's WIP divides the nutrient loads going into the bay watershed from Pennsylvania into various sectors, each of which has its own nutrient load targets (see Table 3). It is important to note, however, that the WIP allows DEP flexibility in how it allocates these reductions among sectors. DEP can change the sector allocations without requiring EPA approval, provided the total reductions remain the same.

In addition to the WIP, every two years, the states are to meet milestone commitments to reduce pollution in the bay. The goal is for the program partners to put all projects in place by 2025. A summary of Pennsylvania's most recent milestone progress report is shown in Exhibit 2.

Table 3

Nutrient and Sediment Loads Delivered to the Chesapeake Bay as Projected by the Phase 5.3.2 Model

2011 Progress and 2025 Target Pounds Per Year

Sector	Model-Projected 2011 Progress Nitrogen	Phase 2 Watershed Implementation Plan 2025 Planning Target Nitrogen	% Difference
Agriculture	59,281,017	35,313,572	-40%
Forest	21,067,076	21,417,135	2
Point Source	11,483,413	9,080,860	-21
Urban/Developed	17,467,177	10,235,505	-41
Septic	2,141,702	1,742,464	-19
Air Deposition to Water	1,042,439	1,042,439	0
Totals	112,482,824	78,831,975	-30

Sector	Phosphorous	Phosphorous	Difference
Agriculture	2,611,189	1,832,756	-30%
Forest	393,689	397,140	1
Point Source	997,916	903,949	-9
Urban/Developed	756,503	428,232	-43
Septic	-	-	-
Air Deposition to Water	37,246	37,246	0
Totals	4,796,543	3,599,323	-25

Sector	Sediment	Total Suspended Solids[a]	Difference
Agriculture	1,559,246,443	1,190,126,459	-24%
Forest	385,909,945	428,739,765	11
Point Source	21,355,580	12,653,777	-41
Urban/Developed	546,482,769	313,479,999	-43
Septic	-	-	-
Air Deposition to Water	-	-	-
Totals	2,512,994,737	1,945,000,000	-23

[a] Note: Previously reported as sediment.

Source: Loads (2011 progress data reported 4/17/12) and Targets (reported 6/27/11) as developed through Phase 5.3.2 of the Chesapeake Bay Watershed Model, reported by EPA.

Exhibit 2

Pennsylvania's 2012-2013 Milestone Commitments to Reduce Nitrogen, Phosphorus and Sediment

Pennsylvania's

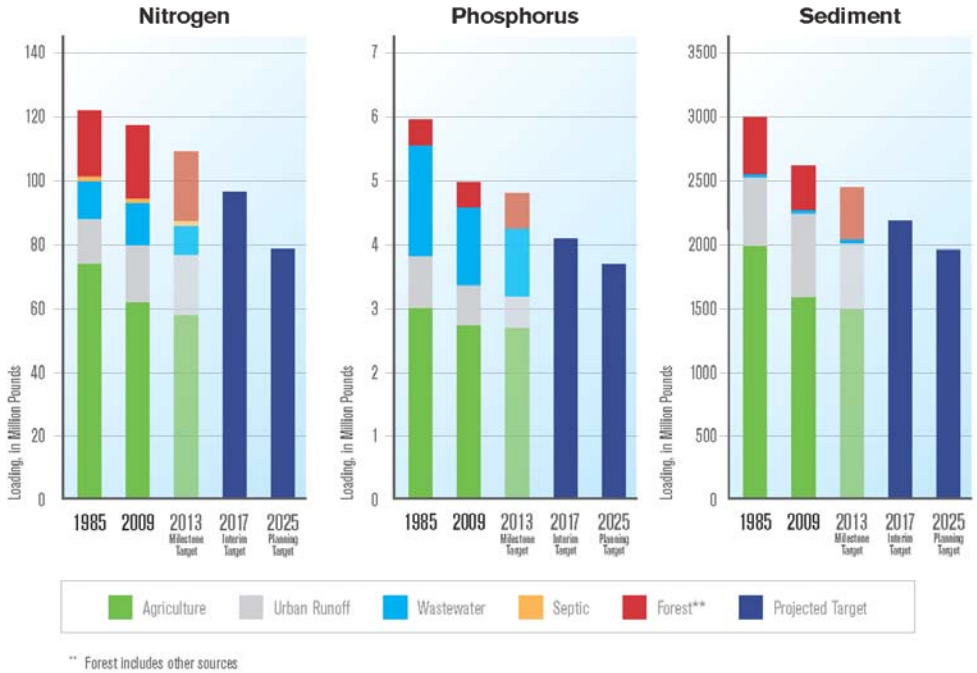
2012–2013 Milestone Commitments to Reduce Nitrogen, Phosphorus and Sediment

Chesapeake Bay Program
A Watershed Partnership

Overview

In 2008 the Chesapeake Executive Council charged the seven jurisdictions to develop a two-year milestone process for reducing their respective nitrogen, phosphorus and sediment contributions to the Chesapeake Bay and to track the pace of those reductions. Two-year milestones provide short-term objectives and have become part of the overall Total Maximum Daily Load (TMDL) accountability framework established in 2010 to assess progress on restoration goals. When fully implemented, the seven Watershed Implementation Plans (WIPs) will ensure that practices are in place by 2017 to reduce the load by 60 percent. By 2025, all practices necessary to meet the target loading levels will be in place. The two-year milestones allow jurisdictions the opportunity to adapt implementation strategies as outlined in their Watershed Implementation Plans as necessary to meet those goals and ultimately achieve applicable water quality standards and restore the Bay. **Pennsylvania's 2012-2013 milestone commitments reduce nitrogen by 6,328,907 pounds, phosphorus by 254,377 pounds, and sediment by 204,112,700 pounds by the end of 2013, compared to the 2009 baseline.**

Pennsylvania's Pollutant Reduction Progress and Future Targets by Source Sector



** Forest includes other sources

For more information, contact Ted Tesler, 717.772.4785, thtesler@pa.gov

Exhibit 2 (Continued)

Pennsylvania's 2012–2013 Milestones to Reduce Nitrogen, Phosphorus and Sediment (continued)

Milestone Highlights:

The foundation of Pennsylvania's Chesapeake Watershed Implementation Plan (WIP) includes milestone implementation and tracking, new technology and nutrient trading, and enhanced compliance. Due to the under-reporting of Best Management Practice (BMP) implementation, there is the appearance that the Pennsylvania 2013 milestones may not be on track to meeting the targets for 2017. Pennsylvania anticipates that implementation of its WIP will improve future reporting of progress.

Pollutant Reduction Controls, Practices and Actions in 2012-2013 Milestone Target Highlights

Pollutant Controls, Practices, and Actions	Progress through 2011	2013 Targets
Agriculture		
Animal Waste Management Systems	644,922 animal units	660,309 animal units
Barnyard Runoff Controls	408 acres	664 acres
Conservation Planning	1,562,980 acres	1,306,621 acres
Conservation Tillage, All Types	633,610 acres/yr	694,546 acres/yr
Forest Buffers	69,180 acres	74,683 acres
Grass Buffers	6,177 acres	7,050 acres
Nutrient Management, All Types	1,388,146 acres	1,450,720 acres
Pasture Grazing Best Management Practices, All Types	94,300 acres	89,390 acres
Stream Restoration	471,670 feet	570,004 feet
Wetland Restoration	4,709 acres	5,720 acres
Wastewater + Combined Sewer Overflow		
Wastewater Facilities Meeting Water Quality Standards in Chesapeake Bay[1] (Cumulative number and percentage of facilities)	47 permits / 22%	135 permits / 63%
Urban Runoff		
Abandoned Mine Reclamation	12,926 acres	13,374 acres
Dirt and Gravel Road Erosion & Sediment Control	3,577,938 feet	3,925,107 feet
Erosion & Sediment Control	0 acres/yr	18,625 acres/yr
Storm Water Management, All Types, Urban/Suburban	698,051 acres	703,610 acres
Urban Tree Planting	0 acres	100 acres

For the full details of Pennsylvania's target implementation milestones, please see http://stat.chesapeakebay.net/milestones2013PA

2012 – 2013 Commitment Highlights

- Develop a Model Ag Compliance Policy for use by Conservation Districts: September 2012
- DEP CBRAP Compliance staff increase agriculture compliance inspections and actions: December 2013
- Update the MS4 Compliance Monitoring Strategy: September 2012
- Develop a tracking system for stormwater BMPs: December 2013
- 135 Significant Sewage facilities are anticipated to comply with cap loads: June 2013
- Development of a Stormwater Management Off-setting Program: December 2013

For the full details of Pennsylvania's programmatic milestones, please see http://www.portal.state.pa.us/portal/server.pt/community/chesapeake_bay_program/10513

[1] based on permits with effluent limits in effect that meet DO and SAV/clarity standards

For more information, contact Ted Tesler, 717.772.4785, thtesler@pa.gov

Source: Pennsylvania Department of Environmental Protection.

In its Chesapeake Bay Tributary Strategy (December 2004), DEP estimated the capital cost to meet the Chesapeake Bay TMDL at $8.2 billion for all sectors, with an additional $665 million in annual costs for operations and maintenance. Agricultural BMPs account for 75 percent of the nitrogen reductions, but only about 7.2 percent of the capital costs ($592 million). Publicly owned treatment works (POTWs) and industrial dischargers are estimated to generate about 11 percent of the nitrogen reductions and account for about 4.6 percent of the estimated capital costs ($376 million). Urban BMPs account for about 9 percent of the nitrogen reductions, but 68.5 percent of the capital costs ($5.6 billion). Finally, septic system denitrification accounts for 2.6 percent of the nitrogen reductions and 19.5 percent of the capital costs ($1.6 billion). [1]

Nutrient Credit Trading

To help meet Pennsylvania's nutrient goals, the 2004 Chesapeake Bay Tributary Strategy and both DEP's Phase 1 and Phase 2 WIPs include nutrient credit trading programs. The goal of credit trading is to utilize market-based principles to allow communities to work together to achieve the desired pollutant reductions through more cost-effective means. For example, the cost to remove a pound of nitrogen or phosphorus through wastewater treatment is often far greater than doing so through agricultural best management practices (BMPs). So rather than invest in expensive bricks-and-mortar upgrades, some wastewater authorities have opted instead to purchase credits created by less-costly nonpoint source projects, such as streambank fencing and riparian buffers installed on farms to reduce pollution.

For example, the Mount Joy Borough Authority investigated costs of upgrading and found that by installing the first level of nitrogen treatment they could reduce nitrogen by about 50 percent for about $8 per pound. However, to reduce nitrogen to their cap load, an additional upgrade would be needed that would increase their costs to about $12 per pound. Instead, the Mount Joy Borough Authority contracted with a local farmer and invested in more than 900 acres of no-till agriculture to meet their permit cap at a cost of only $3.81 for every pound reduced.

Maryland, Virginia, and Pennsylvania all include nutrient credit trading programs as part of their WIPs, although each program differs in its particular policies and practices.

A May 2012 report funded by the Chesapeake Bay Commission[2] concluded that nutrient trading offers the potential to significantly reduce the costs of achieving the TMDL water quality goals for the Chesapeake Bay. The extent of the savings, however, depended largely on the types of sources that are allowed to

[1] The accuracy of these first cost estimates from 2004 have been criticized and are based on early watershed models. They are shown here to make the point that the per-pound cost of nutrient reductions can vary widely from sector to sector. Updated information on the costs for POTWs can be found in our 2008 report entitled *Chesapeake Bay Tributary Strategy Compliance Cost Study*.

[2] *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*, May 2012

participate (e.g., municipal wastewater, agricultural nonpoint, and urban/suburban[3] stormwater sources) and whether trading can occur between watershed basins and/or between states. The more sources that are allowed to participate and the greater the geographic area, the greater the potential savings.

Pennsylvania's nutrient credit trading program started off slowly, with only six trades having occurred between the program's inception and September 2008. Our November 2008 report *Chesapeake Bay Tributary Strategy Compliance Cost Study* found that uncertainties regarding future TMDLs (TMDLs were not established until 2009) and credit certification and verification standards, among other issues, contributed to the reluctance of the municipal wastewater community to embrace nutrient trading.

PENNVEST reports that, as of 2012, the trading program has developed a consistent and growing base of participants, and continued growth in the number of participants is expected as subsequent phases of the Chesapeake Bay Tributary Strategy are implemented. As of November 30, 2012, 38 trades have occurred, with the overall quantities traded being 623,703 pounds of nitrogen and 33,203 pounds of phosphorus. Nitrogen and phosphorus credits traded in auction through PENNVEST have been trading at costs ranging from about $1.25 to $4 per pound. [4]

PENNVEST serves as a clearinghouse in which credit buyers and sellers contract with PENNVEST, which in turn purchases credits from credit generators and aggregators. These transactions occur through periodic credit auctions as well as through bilateral agreements. PENNVEST believes it is likely that participation in trading will continue to increase as the nutrient limits become effective on larger numbers of National Pollutant Discharge Elimination System (NPDES)-permitted facilities.

EPA, however, has expressed concern over certain aspects of Pennsylvania's trading program. In a May 2012 letter to DEP Secretary Michael L. Krancer, EPA indicated it will conduct "enhanced" oversight of Pennsylvania's trading program and may increase enforcement of NPDES permits that rely on trading if EPA's concerns about the program are not fully addressed. As of the end of 2012, negotiations between EPA and DEP regarding these concerns were on-going. DEP believes these negotiations will ultimately result in changes in the methodologies used to calculate and generate credits, which could result in different entities having credits available for sale.

Environmental, Recreational, and Public Health and Safety Benefits

Act 87 directs the study to include a review of the environmental, recreation al, and public health and safety benefits from reductions of nutrients in major watersheds. The Chesapeake Bay Foundation addressed many of these issues in a

[3] Hereafter referred to as simply urban stormwater.
[4] Actual costs for all trades cannot be determined as the cost in private bilateral trades is not fully tracked or available.

May 2012 report entitled *Saving a National Treasure: The Economic Argument for Cleaning Up the Chesapeake Bay and its Rivers.* While many of the direct benefits (fishing, tourism, property values, and shipping activities) accrue primarily to Maryland and Virginia, reducing nutrients in the streams and rivers that flow into the bay also provides benefits. As noted in the report, these include:

- *Recreational fishing.* Nearly two million people go fishing in Pennsylvania each year, contributing over $1.6 billion to the economy. Among the most popular fish for anglers are warmwater species, especially smallmouth bass, and coldwater species, especially native brook trout. On January 1, 2012, the Pennsylvania Fish and Boat Commission enacted a mandate for total catch-and-release of smallmouth bass in certain areas of the Susquehanna River and bans it completely between May 1 and June 15 in parts of the river because of population declines associated with water-quality problems. Degraded stream habitat has restricted the Pennsylvania brook trout to a small fraction of its historical distribution.
- *Wildlife watching.* Roughly eight million wildlife watchers spent $636 million, $960 million, and $1.4 billion in Maryland, Virginia, and Pennsylvania, respectively, in 2006 on trip-related expenses and equipment. These estimates do not include other economic benefits of these expenditures, such as job creation and the multiplier effect on local economies. Improvements to water quality through land preservation, reforestation, and wetlands restoration will increase and enhance wildlife populations.
- *Property values.* A U.S. Environmental Protection Agency study indicated that clean water can increase the value of single family homes up to 4,000 feet from the water's edge by up to 25 percent.
- *Drinking water.* Reducing pollution inputs from pipes and land-based sources can reduce locality costs to treat drinking water sources to safe standards. An EPA study of drinking water source protection efforts concluded that every $1 spent on source-water protection saved an average of $27 in water treatment costs. Similarly, a study by the Brookings Institute suggested that a 1 percent decrease in sediment loading will lead to a 0.05 percent reduction in water treatment costs.
- *Infrastructure savings.* Proactive efforts to lessen stormwater flows today reduce future public costs needed to maintain navigation channels, remediate pollution and hazard flooding, and repair infrastructure and property damage caused by excessive runoff.

A 2001 discussion paper entitled *Benefits of Water Quality Policies: the Chesapeake Bay,* funded by Resources for the Future, had similar findings. The paper identified six categories of benefits: benefits of improved water quality to homeowners who live near the Bay (amenity benefits), recreational benefits to fishers, recreational benefits to swimmers and boaters, commercial fishing benefits, and benefits to people who may never visit the Bay but care about protecting

Chesapeake Bay ecosystems (nonuse benefits). Of all categories of benefits, the paper concluded that those associated with recreational fishing and impacts on property values can be estimated with the greatest confidence. The benefits of improved water quality to swimmers and nonuse values, while important, are more difficult to measure. The paper suggests that the largest categories of benefits are likely to be nonuse benefits, benefits reflected in property values, and benefits to recreational fishers and swimmers.

Meeting Future Interim Milestones and Final Targets

Meeting the milestones and final targets outlined in Pennsylvania's WIP will be challenging. To date, most progress has come from regulated point sources (primarily wastewater treatment plants). Goal attainment related to nonpoint sources, particularly agriculture and urban stormwater, has been less successful (see Exhibit 3 and Appendix C for additional detail).

In recognition of the progress made by Pennsylvania's wastewater treatment plants, in May 2012, the EPA reduced its oversight of the wastewater sector from "enhanced" to "ongoing."[5] The DEP has also noted that the wastewater treatment facilities in Pennsylvania's Chesapeake Bay region are approaching or have already attained their 2017 goals.

In contrast, the EPA is maintaining the higher level of "enhanced" oversight of both the agriculture sector and urban stormwater. The EPA also identified several backstop actions it might take if its urban stormwater concerns are not addressed, including requiring additional reductions from wastewater treatment plants.

A recent analysis by Devereux Environmental Consulting for the EPA highlighted the difficulty confronting the agricultural community in meeting the Chesapeake Bay requirements. Devereux analyzed three different scenarios under which farms could meet Pennsylvania's current "threshold" requirements for nutrient trading.[6] Even when 100 percent compliance with the threshold measures was assumed, the agricultural sector still exceeded the allowable TMDL allocation for nitrogen by at least 41 percent under each scenario. (See Exhibit 4 for additional information on agriculture's baseline and threshold requirements.)

[5] The EPA provides two levels of oversight based on their assessment of a state's progress in meeting its implementation targets: ongoing and enhanced. If the EPA notes particular concerns, it will also develop "backstop" actions to implement if its concerns are not adequately addressed.

[6] The analysis assumed all Pennsylvania's farms were in compliance with applicable nutrient management, erosion and sediment controls, and manure management regulations and implemented either a 35-foot stream buffer or a 20 percent reduction in nutrients below the reductions achieved through regulations, which are "threshold" requirements to generate nutrient trading credits.

Exhibit 3

Assessment of Pennsylvania's Progress on Selected Pollution-Reduction Targets for the 2011 Milestone

Assessment of Pennsylvania's Progress on Selected Pollution-Reduction Targets for the 2011 Milestone

AGRICULTURE	2011 MILESTONE GOAL	MILESTONE PROGRESS	PROGRESS TO 2025 GOAL	LESSONS LEARNED
Continuous No-Till *acres*	86,567	-23%	not able to assess	Uncertainties with the data imply the need to field verify this practice as anecdotal information suggests higher rates of implementation. Need to improve the tracking system for this practice.
Nutrient Management *acres*	129,250	59%	7%	As a regulatory requirement for Pennsylvania farms using manure fertilizer, non-achievement of this milestone is particularly concerning.
Forest Buffers *acres*	19,059	207%	34%	Despite strong reported progress, uncertainties with the data imply the need to field verify this practice as the milestone rate of implementation appears significantly higher than in previous reporting periods.
Total Cover Crops *acres/year*	174,818	37%	10%	Uncertainties with the data imply the need to field verify this practice as anecdotal information suggests higher rates of implementation. Need to improve the tracking system for this practice. Efforts underway to account for the implementation of "non-cost share" practices may help.
Conservation Plans *acres*	327,599	46%	10%	As a regulatory requirement for Pennsylvania farms, non-achievement of this milestone is particularly concerning.
URBAN/ SUBURBAN	2011 MILESTONE GOAL	MILESTONE PROGRESS	PROGRESS TO 2025 GOAL	LESSONS LEARNED
Urban Stream Restoration *feet*	4,400	86%	7%	Uncertainties with the data and the type of restoration techniques suggest we need better verification of the implementation of this practice.
Septic Connections *systems*	7,353	105%	8%	Crediting of connections to treatment plants incentivizes this practice.
Stormwater Management *acres*	8,690	1%	not able to assess	Uncertainties and discrepancies with the data limited analysis and suggest the need for better consistency, accounting, and tracking. Lack of funding and clear requirements limit implementation.
WASTEWATER	2011 MILESTONE GOAL	MILESTONE PROGRESS	PROGRESS TO 2025 GOAL	LESSONS LEARNED
Nitrogen Reduced *pounds*	1,679,000	100% *plus traded lbs.*	48%	Treatment upgrades and nutrient trading contributed to the progress of this practice.
Phosphorus Reduced *pounds*	49,500	255%	100%	Treatment upgrades contributed to the progress of this practice.

Source: EPA Chesapeake Bay Program Office

Goal met or exceeded Goal not met

Conclusion

Overall, Pennsylvania achieved four out of the 10 practices evaluated. While achievements in urban stream restoration, forest buffers, and wastewater are notable, Pennsylvania must redouble its efforts in continuous no-till, conservation plans, nutrient management, and urban stormwater management practices to stay on track to achieve 60 percent implementation by 2017 and full implementation by 2025. In addition, the transparency of the data used to determine progress is of concern.

We thank the Virginia Environmental Endowment and Keith Campbell Foundation for providing funding for this work.

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Source: Chesapeake Bay Foundation, July 2012.

Exhibit 4

Pennsylvania Agricultural Requirements for Baseline and Threshold

The criteria for Pennsylvania's agricultural nonpoint sources take the form of baseline and threshold requirements. All farms (not just those in the Chesapeake Bay watershed) are to meet baseline requirements. Threshold requirements pertain to farms that seek to participate in Pennsylvania's Nutrient Credit Trading Program and therefore only apply to farms in the Chesapeake Bay watershed.

The baseline requirement is that on-site operations must be in compliance with:

- Chapter 102 Erosion & Sedimentation Regulations (i.e., develop and implement an Erosion and Sediment Control Plan). These plans do not have to be submitted for approval but must be kept on the farm and made available upon request.
- Section 91.36 regarding manure management (i.e., develop and implement a Manure Management Plan). There is no reporting or inspection requirement for manure management plans, but the plans must be kept on the farm and made available upon request. DEP and County Conservation Districts have, and continue, to make efforts to inform farmers of the regulatory requirement, including mailings, "door-to-door" visits, and workshops. In 2011 DEP hired four compliance staff positions that, as of June 30, 2012 have completed 368 inspections which resulted in 176 compliance actions that generated $43,591 in fines. Additionally, in September 2012, the State Conservation Commission approved a model compliance policy for agriculture that all CCDs will be required to address by September 2013 or risk losing their CBIG grant funds. These information and compliance efforts also address many of the Chapter 102 (Erosion and Sediment Control Plan) requirements.
- Operations defined as CAOs (Concentrated Animal Operations) or CAFOs (Concentrated Animal Feeding Operations) have additional manure management requirements, known as Nutrient Management Plans. The Nutrient Management Plans for CAOs and CAFOs must be developed and reviewed by certified nutrient management specialists, and the operations are to be inspected, at a minimum, every three years.

Agricultural operations that participate in the Nutrient Credit Trading Program must also meet at least one of three "threshold" requirements:

(1) A 100 foot mechanical setback or equivalent is implemented on-site. It either requires that no surface waters exist within 100 feet of the farm *or* that manure is not mechanically applied within 100 feet of surface water *or* that manure is not applied at all and that commercial fertilizer application rates are below Penn State recommended agronomic rates, or

(2) A 35 foot buffer or equivalent is planted between the field and surface water. The buffer is a swathe of permanent vegetation maintained between the field and surface water. Common types of buffer are riparian forest buffers and riparian grass buffers, or

(3) The farm's overall nutrient balance be reduced by 20% below what is required by the baseline requirement presented above.

Compliance to threshold requirements is determined by a site visit by DEP staff or a DEP-approved entity.

Source: Pennsylvania Departments of Agriculture and Environmental Protection.

III. Restructuring Pennsylvania's Chesapeake Bay Program

Given these uncertainties and high costs some sectors will need to incur to reduce nutrients to compliance levels, Act 2012-87 directed us to conduct "an assessment of the use of competitive bidding for long-term verified nutrient credits rather than sector allocation targets in any watershed implementation plan."[7]

The approach contemplated in Act 87 would involve a change to the Commonwealth's WIP whereby the current sector-allocated nutrient reduction plan for meeting the federal TMDL mandates would be replaced with a program in which the Commonwealth—presumably through PENNVEST—would purchase nutrient credits through a competitive RFP (Request for Proposal) process. The credits would then be applied to the Commonwealth's total reduction requirement, not to the various individual sectors.

The thinking behind this approach is that nutrient loadings stem predominately from agricultural activities, in particular livestock waste. By onsite treatment of such waste, Pennsylvania could potentially meet its nutrient reduction targets at a much lower cost, and with a much higher degree of reliability, than through the approach in DEP's current WIP, which relies heavily on agricultural and urban best management practices (BMPs).

A May 2012 report entitled *Nutrient Credit Trading for the Chesapeake Bay* supports trading as a means of reducing the potentially high cost of compliance with the Chesapeake Bay TMDLs. The report estimates that if Significant Point Sources Discharges, such as municipal and industrial wastewater discharge facilities, were allowed to purchase nutrient credits generated from agricultural sources, potential savings (if allowed on a watershed-wide basis) could approach $200 million, a 49 percent reduction in costs over the "no-trading" scenario.

The potential savings of trading for urban stormwater is even greater. The report estimates that nutrient credit trading for urban stormwater, if done on a watershed basis, could save as much as 82 percent, or about $1.2 billion, when compared to a no-trading scenario.

Nutrient credit trading programs are designed primarily to help point source dischargers (such as wastewater treatment plants) comply with specific nutrient reductions they are required to achieve. The competitive RFP program as outlined in Act 87 is fundamentally different in that the credits would be purchased by the Commonwealth; they would not be traded between sources. The principle, however, is similar: using nutrient credits generated through cost-effective means to replace

[7] As the Commonwealth's current nutrient trading program is also a "competitive bid" program, we use the term "competitive RFP program" to refer to the approach outlined in Act 87.

nutrient reductions that otherwise would have to be generated from high-cost—or at least higher-cost—practices.

Key Features of a Competitive RFP Approach to Nutrient Reductions

The Colorado River Basin Salinity Control Program (CRBSCP) began using a market-based, competitive bidding (auction) model as a strategy to reduce salinity in the Colorado River in 1995. The approach outlined below is based largely on the CRBSCP model,[8] but with a focus on nitrogen, rather than salt, reductions.[9] Key features of the basic program design include:

1. DEP would determine how many additional pounds of nutrients need to be removed to achieve the Chesapeake Bay TMDL requirements for a given one- or two-year period. For example, assuming Pennsylvania met its 2011 target, additional nitrogen reductions of 13.5 million pounds will be needed by 2015. If DEP believes 8 million of the 13.5 million pounds can be achieved through on-going efforts, then the remaining 5.5 million pounds of reductions would be targeted to be achieved through the competitive RFP program.
2. DEP would develop a formula, which would be disclosed to potential bidders, for scoring the proposals they receive. The cost per pound of nitrogen reduction would be the starting point, but the formula would presumably take in other key factors, such as geography, soil conditions, distance from the bay, and other factors that affect the delivery rate of nitrogen entering the bay. Certainty of the project achieving its objectives and the project's impact on local streams TMDLs, particularly any phosphorus or sediment reductions that may accompany the nitrogen reductions, could be other important factors.

   Other considerations, such as flood control, open space, recreational or wildlife benefits, and job creation or economic development potential, could also be included in such a formula. Thus, a project that offers nitrogen reductions at $12 per pound may, depending on how the project scores on other variables, rank higher than a project that offers nitrogen reduction at, for example, $8 per pound but with no other environmental or economic benefits.
3. As part of the RFP process, PENNVEST[10] would need to indicate the contract period for which the reductions are being purchased. As some of the technologies involved in achieving nitrogen reductions can be quite

[8] See also *Priceline for Pollution: Auctions to Allocate Public Pollution Control Dollars*, by Robert W. Adler, Volume 34, Issue 3, *William & Mary Environmental Law and Policy Review.*

[9] As discussed on page 25, the focus is on nitrogen reduction because nitrogen is more readily carried downstream than phosphorous or sediment and thus, from a Chesapeake Bay perspective, is the cost driver.

[10] We assume PENNVEST, which serves as the clearinghouse for the current nutrient trading program, would serve a similar function under the competitive RFP program.

expensive, bidders—and their investors—would need to know the time period over which they could recover their investment. For projects that require significant up-front capital costs, a contract period on the order of 15-20 years might be necessary before investors would be willing to commit to such projects. Longer contract periods lower the risk to investors, who in turn can then lower the bid price of their nutrient reductions. To protect the Commonwealth, PENNVEST would only make payments after the credits were achieved and verified.

4. As the years progress, DEP would have the opportunity to revise the number of new pounds of reductions to place up for bid. DEP would also have the opportunity to revise the formula and contract parameters to adapt to new circumstances.

We discussed such an approach with key agencies and organizations involved in meeting Pennsylvania's Chesapeake Bay goal, including staff at the Department of Environmental Protection, PENNVEST, the Chesapeake Bay Foundation, the Chesapeake Bay Commission, and BION Environmental Technologies, Inc., a private-sector firm with experience in nutrient management. Based on these discussions and our analysis, we identified the following key points:

Both DEP and EPA appear receptive to a competitive RFP program as part of a Chesapeake Bay strategy. In our discussions with DEP, the department expressed interest in a competitive RFP program as "one of the tools in the toolbox" for addressing the Chesapeake Bay goals. DEP believes the WIP as it currently exists should continue to be implemented, but that a competitive RFP program could be an important supplement to the plan. They also believe such a program, if enacted, should be done on a statewide basis (covering all streams and rivers, not just those in the Chesapeake Bay watershed) and cover a variety of pollutants (not just nitrogen).

EPA has also expressed interest in the concept of a competitive RFP program, but noted the specific strategies used to comply with the Chesapeake Bay requirements are the responsibility of the participating states.

DEP cites the importance of advanced technologies in meeting WIP goals. DEP cited "technological innovation" in its 2011 Watershed Improvement Plan as a key element in achieving the Chesapeake Bay goals. The WIP specifically cites technologies such as manure treatment, methane digesters, and electrical co-generation on dairy, poultry, and hog operations. Many of these technologies can produce electricity and marketable soil amendments; reduce methane and ammonia emissions; and generate revenue through renewable energy, nutrient reduction, and carbon credits. Projects of this nature can support the three priorities in the Chesapeake Bay region: maintaining a vibrant farming economy; restoring and protecting the water quality of Pennsylvania streams and the Chesapeake Bay; and

providing crucial economic development benefits to rural businesses and communities.

During the course of this project, LB&FC staff toured two such facilities in south central Pennsylvania, one which processes cow manure and another which processes chicken manure. Both of these facilities see selling nutrient credits, in combination with other revenue streams such as renewable energy and recovering minerals, as key to the success of these projects. Additional information on these two facilities can be found in Appendix A.

A competitive RFP program could dramatically lower overall compliance costs, perhaps by 80 percent or more for nonpoint agriculture and urban runoff. The competitive bidding program implemented by the Colorado River Basin Salinity Control Program serves as a potential target for the level of cost savings that might be achieved by a competitive RFP program enacted for the Chesapeake Bay. According to an article published in the *William and Mary Environmental Law and Policy Review,*

> The BOR [U.S. Bureau of Reclamation] initially expected the average cost-effectiveness of controls under the new program to average $50 per ton. After the initial four years of the program, selected projects averaged just over half of that estimate ($26 per ton), with a range of $11 to $36 per ton, and slightly over a third of the average cost-effectiveness of controls under the previous program ($70 per ton). Moreover, although one might have expected costs to increase after the most cost-effective proposals were funded in the first year or two of the program, cost-effectiveness actually improved over the first four years of the program.

A possible goal of a competitive RFP program for the Chesapeake Bay would be to obtain savings on the same order of the same magnitude (50 percent to 80 percent).

BION, a firm which has implemented a technologically based solution for removing nitrogen and phosphorus from dairy cow manure, estimates the Commonwealth could purchase verifiable nitrogen credits at prices ranging from $8 to $12 per pound. For the purposes of this analysis, we used the mid-point of $10 per pound.

While we cannot attest to the validity of the BION estimates, our 2008 report entitled *Chesapeake Bay Tributary Strategy Compliance Cost Study* found that, as pertains to Pennsylvania's nutrient credit trading program, wastewater treatment plant managers most often cited $9 as their estimate for the likely cost to purchase of a pound of nitrogen credits (the survey was conducted shortly after the trading program began). We also note that under Pennsylvania's current trading program, nitrogen credits are being sold at prices well below $10 per pound (generally, $2 to

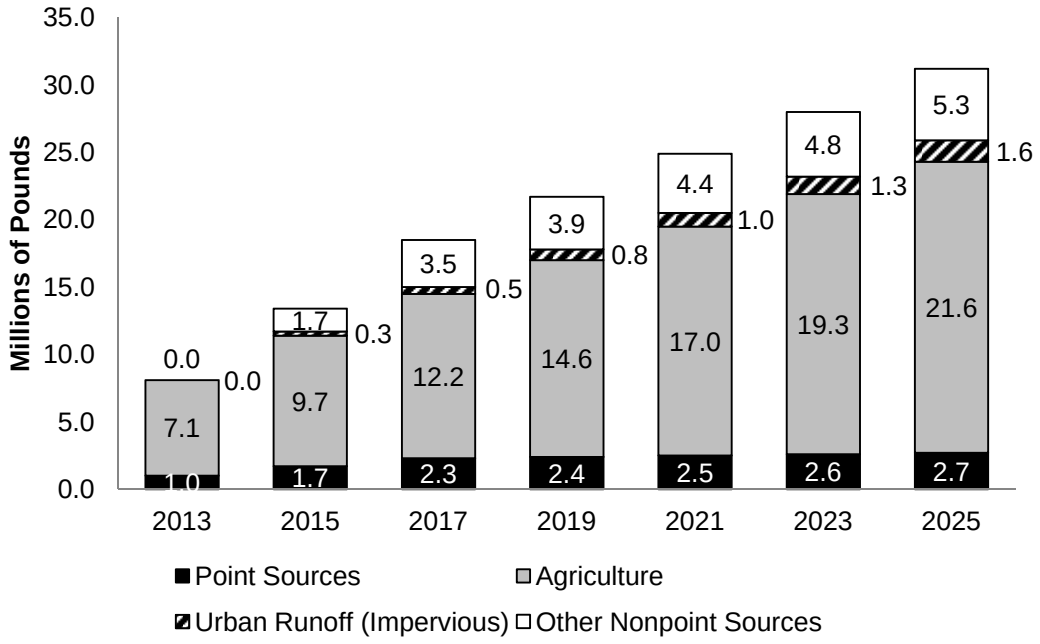
$4 per pound). Finally, EnergyWorks reported its Energy and Nutrient Recovery Facility it could be profitable, when combined with its project's other revenue streams, by selling nitrogen credits at $3 per pound. An estimate of $10 per pound, therefore, appeared to us to be a reasonable, perhaps even conservative, estimate for the purposes of this study.

Additionally, we included a 10 percent transaction cost factor to cover the Commonwealth's administrative costs, with the acknowledgement that for large dollar value contracts, a 10 percent figure might be high, and for small dollar value contracts, a 10 percent transaction cost estimate might be low. The estimate we use for this analysis is, therefore, $11 ($10, plus $1 for transaction costs).

Exhibit 5 shows the targeted amount of nitrogen reductions for point sources (primarily wastewater) and various nonpoint sources (agriculture, excluding CAFOs; urban/developed runoff from impervious surfaces; and all other nonpoint sources.)[11]

Exhibit 5

Pennsylvania's Chesapeake Bay Nitrogen Reduction Targets*



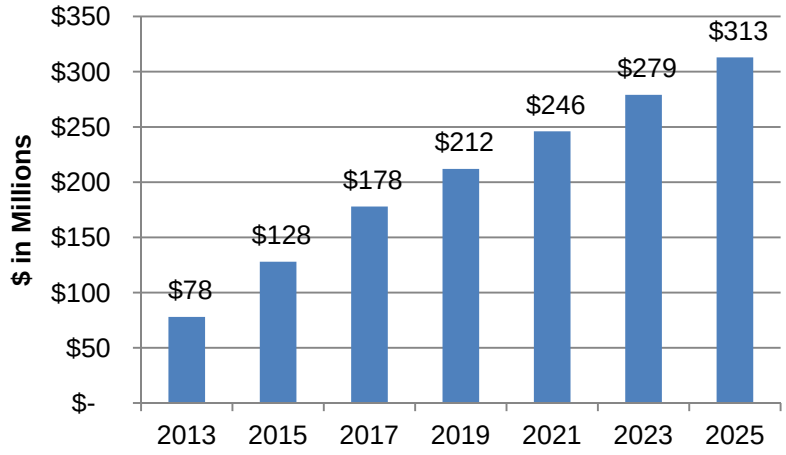
* Assumes 2011 targets are met.
Source: Developed by LB&FC staff from information provided by DEP.

[11] Other nonpoint sources include onsite septic, pervious urban/developed, forest, and nontidal water deposition.

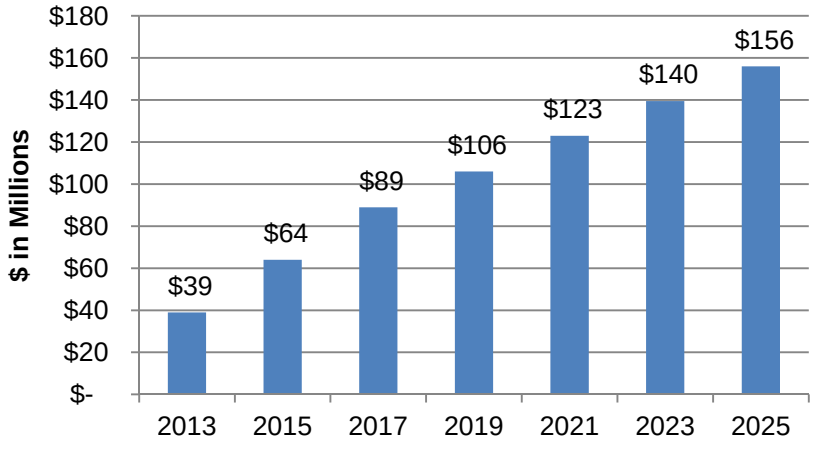
Exhibit 6 shows the estimated annual amount of funds that would be necessary to purchase all the nonpoint source nitrogen reductions required of Pennsylvania under the WIP (agriculture plus all other nonpoint sources).[12]

Exhibit 6

Estimated Cost to Reduce Nitrogen to Pennsylvania's Chesapeake Bay Targets From Nonpoint Sources* Assuming No Additional Nonpoint Source Reductions
(At $11 per pound per year)



Estimated Cost to Reduce Nitrogen to Pennsylvania's Chesapeake Bay Targets From Nonpoint Sources* Assuming 50 Percent of WIP Nonpoint Source Reductions Are Achieved
(At $11 per pound per year)



*Reductions are from 2011 levels (assumes 2011 nitrogen targets have been met). All figures are in 2012 dollars.
Source: Developed by LB&FC staff from the nonpoint source information in Exhibit 5.

[12] Estimates for point sources are not included because DEP believes many point sources (primarily wastewater treatment plants) already have, or are very close to having, achieved their 2017 reduction targets.

As Exhibit 6 shows, under a competitive RFP program, we estimate the revenues needed to meet all additional nonpoint source nitrogen reductions would be approximately $128 million in 2015, increasing to approximately $313 million in 2025, if no additional nonpoint source reductions are achieved.

However, it is reasonable to assume that the on-going efforts to reduce nonpoint source pollution as described in the WIP (e.g., to improve agriculture's regulatory compliance and adopting best management practices and the efforts municipalities are taking to comply with their NPDES stormwater limits) will yield at least some additional reductions. As shown in the lower chart on Exhibit 6, any reductions achieved by on-going efforts—the chart in Exhibit 6 assumes 50 percent of the planned reductions will be achieved—will reduce the cost of an RFP program proportionally.

Exhibits 7 and 8 show the cost per household for these two levels of reductions under two scenarios: if the costs are borne solely by households in the Chesapeake Bay watershed and if the costs are spread out over all Pennsylvania households.

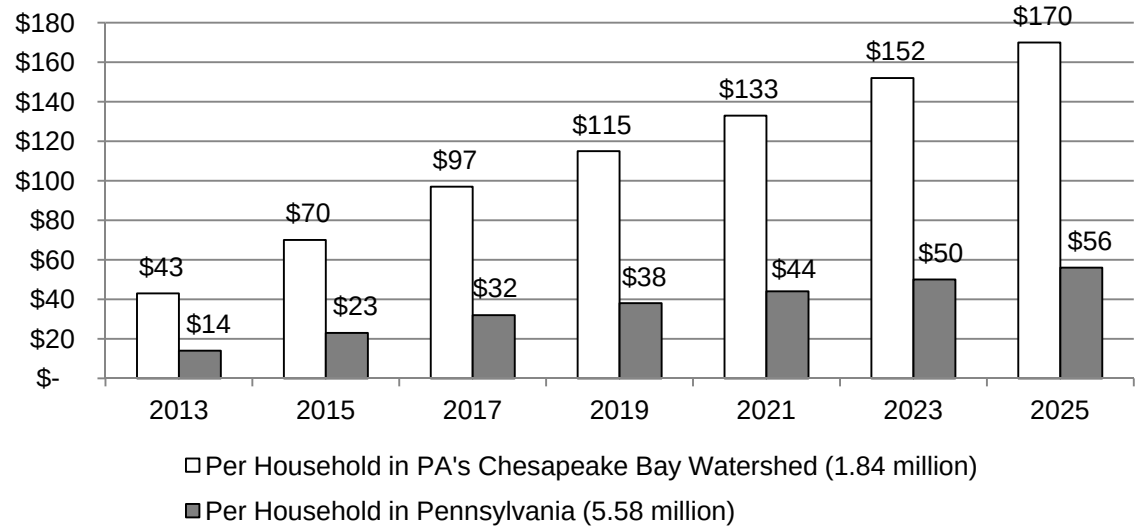
These figures compare to DEP's initial estimate of $693 million in annual operating and maintenance costs (not including annualized capital) for nonpoint source reductions as shown in DEP's 2004 Chesapeake Bay Tributary Strategy. If annualized capital costs are included, annual costs for nonpoint sources would be $1.4 billion, or more than four times higher than the $313 million estimate for the competitive RFP program to meet all the Commonwealth's 2025 nonpoint source nitrogen reduction targets. (DEP's figures include the estimated costs to meet the goals of the 2004 CBTS for removal of nitrogen, phosphorous, and sediment. DEP did not break out the cost of each pollutant separately.)

As a second point of comparison, we also calculated the cost to meet Pennsylvania's nitrogen reductions for two nonpoint sources, agriculture and urban runoff from impervious sources, based on figures presented in the May 2012 report *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*. This report identified the annual cost to reduce a pound of nitrogen for various agricultural and urban stormwater BMPs (see Table 4).[13] We eliminated the two most expense BMPs for both agriculture (off stream watering and precision intensive rotational grazing) and urban stormwater (dry ponds and street sweeping) as they would appear cost prohibitive. We then calculated the mean annual cost to reduce a pound of nitrogen for the remaining practices ($54 for agriculture and $386 for urban stormwater). The annual cost to reduce 9.7 million pounds of nitrogen (the 2015 target for agriculture over 2011 levels) at $54 per pound is $524 million; the annual cost to meet agriculture's 2025 target, a reduction of 21.6 million pounds over 2011 levels, is $1.17 billion.

[13] One-time capital costs for the BMPs were converted to annual terms using a fixed project lifetime and a 7 percent discount rate. The project lifetime varied across BMPs from one year for cover crops to 15 years for conversion of farmland to forestry.

Exhibit 7

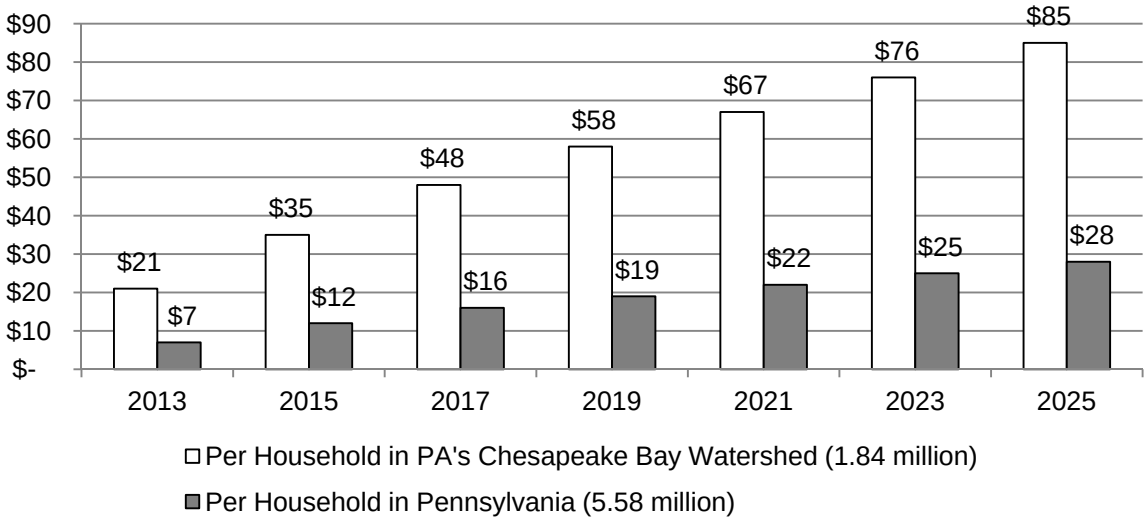
Cost Per Household to Meet PA's Nitrogen Reduction Goals
Assuming No Additional Reductions
(At $11 Per Pound Per Year)



Source: Exhibit 6 and U.S. Census Data.

Exhibit 8

Cost Per Household to Meet PA's Nitrogen Reduction Goals
Assuming 50 Percent of WIP Reductions Are Achieved
(At $11 Per Pound Per Year)



Source: Exhibit 6 and U.S. Census Data.

Table 4

Estimated Cost of Best Management Practices

Agriculture		Urban Storm Water	
Cover Crop Early Drilled Eye	$ 24	Dry Extended Detention Ponds	$ 468
Livestock Exclusion	7	Dry Ponds	4,662
Off Stream Watering	283	Urban Nutrient Management	23
Precision Intensive Rotational Grazing	329	Street Sweeping	4,156
Continuous No-Till	56	Urban Filtering Practices	627
Enhanced Nutrient Management	33	Urban Infiltration Practices	235
Decision Agriculture	117	Urban Infiltration - Sand/Vegetation	538
Grass Buffers	21	Wet Ponds and Wetlands	463
Forest Buffers	37	Urban Forest Buffers	348
Tree Planting	83		
Wetland Restoration	83		
Land Retirement	46		
Upland Prescribed Grazing	86		
Average (mean)[a]	**$54**	**Average (mean)[a]**	**$386**

[a]Excludes the two highest cost BMPS for both sectors. Agricultural BMPs include a 38 percent adjustment factor which, according to RTI (the contractor for the study), is to account for the effects of transaction costs for trades involving agricultural nonpoint sources.

Source: *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*, Chesapeake Bay Commission, May 2012.

For nonpoint source urban runoff from imperious surfaces, the cost to reduce 271,000 pounds of nitrogen (the 2015 target over 2011 levels) at $386 per pound is $105 million; the cost to meet the 2025 target, a reduction of 1.56 million pounds over 2011 levels, is $602 million.[14]

Relying on agricultural and urban stormwater BMPs to meet the TMDL targets for nonpoint source agricultural and urban runoff from impervious surfaces could therefore cost about $628 million in 2015 and $1.77 billion in 2025. This compares to an estimated cost of $110 million in 2015 and $255 million in 2025 for a competitive RFP program to achieve these same levels of reductions, assuming they could be purchased at $11 per pound.[15] This analysis (see Exhibit 9) suggests the competitive RFP program could be on the order of 80-85 percent less costly than

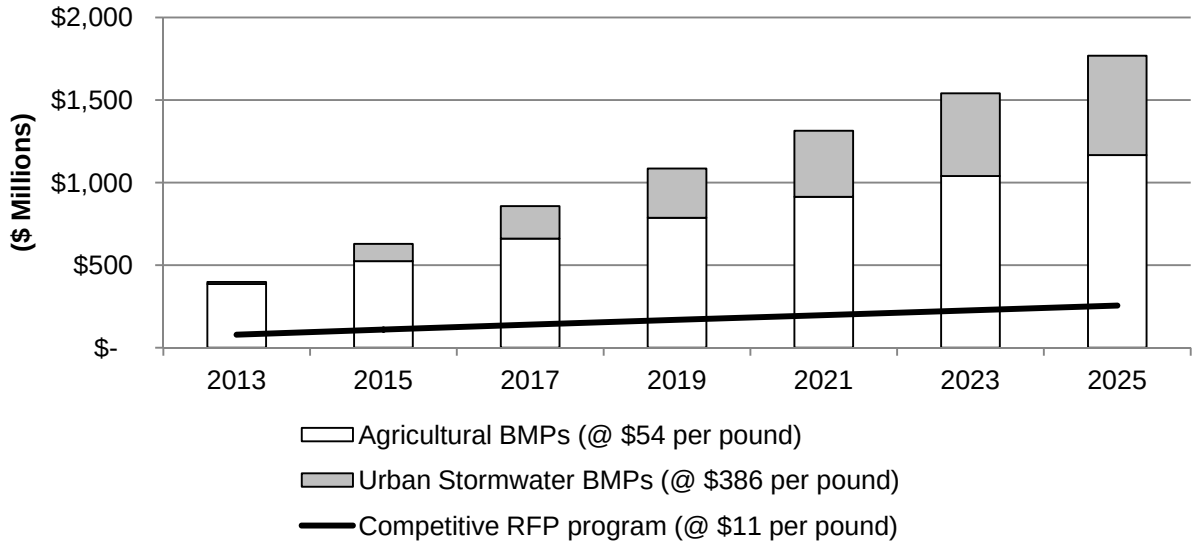
[14] Nitrogen from pervious urban sources, such as golf courses, parks and yards, is also a major contributor to the nitrogen load reaching the Chesapeake Bay. Appendix D contains information on the potential costs of using urban stormwater BMPs to reduce nitrogen loads from urban/developed pervious sources.

[15] These cost figures differ somewhat from those shown in Exhibit 6 because Exhibit 6 includes reductions from all nonpoint sources (including forests, onsite septic, urban/developed pervious, and non-tidal water deposition), not just agriculture and urban runoff from impervious surfaces.

relying on agricultural and urban stormwater BMPs to achieve the same level of reductions.[16]

Exhibit 9

Estimated Costs to Achieve Nitrogen Reduction Targets From Nonpoint Source Agriculture and Urban Runoff From Impervious Surfaces Using Best Management Practices (BMPs) and Under a Competitive RFP Program*/



*/ Information on potential costs to reduce nitrogen from urban/developed pervious surfaces to target levels using urban stormwater BMPs can be found in Appendix D.
Source: Nitrogen reduction targets provided by DEP. BMP cost data is from Table 4.

Nitrogen is easily carried downstream, and is therefore the larger problem with regard to Pennsylvania's pollution of the Chesapeake Bay. As shown in Table 2, Pennsylvania's Chesapeake Bay TMDL requirements are for nitrogen, phosphorus, and sediment. Of the three, however, nitrogen is the most mobile as it can be easily carried downstream. This is primarily because phosphorous binds more tightly with sediment than nitrogen, with 60-80 percent of the phosphorous leaving an agricultural watershed typically being attached to sediment. Nitrogen, on the other hand, leaches through the soil readily, and only about 20-30 percent of this nutrient is typically attached to sediment, with the remainder moving in dissolved form via surface runoff or sub-surface flow. Therefore, sediment control measures are also usually effective at reducing phosphorous levels as well, whereas the same is not always true for nitrogen. As a result, while upstream TMDLs for phosphorous and sediment are also important compliance issues, these problems are primarily local issues, while nitrogen is the primary concern for the Chesapeake Bay.

[16] This analysis assumes that farmers and municipalities would seek to achieve the same poundage reductions from each of the BMPs used to calculate the mean cost ($54 for agriculture and $386 for urban stormwater). In practice, it is likely that greater use would be made of lower cost BMPs, which would thereby lower the overall cost of relying on BMPs.

Long-term financing is essential to technological solutions. Given the high cost of building and maintaining large scale technological solutions such as methane digesters and methane-to-energy projects, which can cost over $30 million for a single project, long-term financing is essential. Obtaining such financing, however, requires being able to demonstrate to investors that the project has sufficient revenue flow to be viable. Long-term contracts (e.g., on the order of 15-20 years) for nutrient credits are therefore necessary for the financial viability of these projects. As noted above (see page 18) the funds for such contracts would not, however, be released until after the credits have been earned and verified.

A source of funding for the competitive RFP program would need to be found. As shown in Table 5, both the Commonwealth and the federal government devote significant resources to Pennsylvania's nonpoint source efforts, at least some of which could possibly be reallocated to a competitive RFP program. We, however, were not able to determine how much of these revenues might be available for such a purpose. Moreover, future federal funding remains uncertain as the complete 2012 U.S. Farm Bill has yet to pass, and pressure to reduce federal spending is expected to continue.

If federal funding is not available, state revenues could conceivably be used to support such a program, either through existing state sources or through a new assessment, such as the Maryland "flush tax." In Maryland, residents and building owners within the Chesapeake Bay watershed[17] are subject to a set of fees that support the Bay Restoration Fund, which was created to upgrade Maryland's wastewater treatment plants (approximately $60 million annually), septic systems ($7 million annually), and to help fund agricultural cover crops ($5 million annually).

The fees are levied on users of wastewater facilities, onsite sewage disposal systems, and holding tanks. The revenue is collected by the billing authorities and remitted to the Comptroller of Maryland.

Each residential dwelling that receives an individual sewer bill and each user of an onsite sewage disposal system or holding tank that receives a water bill is subject to a $5 monthly fee. Users of onsite sewage disposal systems or sewage holding tanks that do not receive a water bill are subject to a $60 annual fee collected through annual property tax bills. The Bay Restoration Fee is separately identified on the customer's bill, along with the corresponding dollar amount. Additional information on the Bay Restoration Fund fees can be found in Appendix E.

A fee of $5 per month ($60 per year) per household would generate approximately $110 million in gross revenue if applied to the 1.84 million Pennsylvania households living in the Chesapeake Bay watershed, and approximately $335 million in gross revenue if applied to all 5.58 million Pennsylvania households.

[17] Maryland residents living outside the Chesapeake Bay watershed pay a reduced fee.

Table 5

Funding Sources for Pennsylvania's Nonpoint Source Management Program

($ Millions)

Local Sources	2010	2009	2008	2007
Conservation District Allocation Program	**-**	**-**	**-**	$ 1.85
Total Local Sources	**-**	**-**	**-**	**$ 1.85**
State Sources (FY)				
PA Department of Environmental Protection				
Conservation District Watershed Specialists	$ 1.96	$ 2.11	$ 2.08	$ 1.96
Conservation Reserve Enhancement Program (CREP)	-	8.00	3.80	6.50
Environment Stewardship and Watershed Protection Projects (Growing Greener I and II):	9.86	20.30	17.85	20.68
Chesapeake Bay Program	3.97	3.97	3.37	2.00
Conservation District Fund Allocation Program	2.91	-	3.60	-
Dirt and Gravel Roads Pollution Prevention Program	3.53	3.01	4.00	-
Nutrient Management Fund	2.04	3.53	-	-
Abandoned Mine Reclamation Program	0.38	2.11	10.80	-
American Recovery and Restoration Act (Chesapeake Bay Watershed Only, approx.)	20.00	-	-	-
PENNVEST	17.15	-	-	-
CzM-Pa Costal Nonpoint Pollution Control	-	0.20	-	-
Other	-	-	2.40	-
DEP Total	**$61.79**	**$ 43.23**	**$ 47.90**	**$31.14**
PA Department of Agriculture				
Nutrient Management Fund/Grant Program	$ 0.71	$ 3.10	$ 3.51	$ 0.30
Conservation District Fund Allocation Program	1.04	1.65	1.66	-
Resource Enhancement and Protection (REAP)	4.50	5.00	10.00	-
Other				0.83
PDA Total	**$ 6.25**	**$ 9.75**	**$ 15.17**	**$ 0.30**
PA Fish and Boat Commission	**-**	**-**	**-**	**$ 0.62**
Total State Sources	**$ 68.04**	**$ 52.98**	**$ 63.07**	**$32.06**
Federal Sources (FFY)				
U.S. Environmental Protection Agency				
Section 319 Nonpoint Source Management Program	$ 5.68	$ 5.70	$ 5.73	$ 5.71
National Fish and Wildlife Foundation	0.95	0.00	-	-
EPA Total	**$ 6.63**	**$ 5.70**	**$ 5.73**	**$ 5.71**
U.S. Department of Agriculture				
Agricultural Management Assistance	$ 0.86	$ 0.67	$ 0.94	-
Chesapeake Bay Watershed Initiative	9.78	9.43	-	-
Environmental Quality Incentive Program	12.89	9.71	14.60	$10.80
Farm and Ranchland Protection Program	6.30	4.03	-	-
Conservation Stewardship Program	3.98	0.00	-	-
Wetlands Reserve Program	4.10	3.78	0.52	1.00
Wildlife Habitat Incentive Program	0.82	0.65	0.88	0.22
Conservation Reserve Enhancement Program	25.95	25.50	4.40	4.40
Biomass Crop Assistance Program	3.69	0.00	-	-
Grassland Reserve Program	0.05	0.83	-	-
Conservation Security Program			2.10	1.80
USDA Total	**$ 68.41**	**$ 54.60**	**$ 23.44**	**$18.22**
U.S. Department of Interior				
U.S. Fish and Wildlife Service/Partnerships	$ 0.00	$ 1.30	-	$ 0.14
Office of Surface Mining	43.81	19.92	$ 20.16	6.07
DOI Total	**$ 43.81**	**$ 21.22**	**$ 20.16**	**$ 6.20**
Total Federal Sources	**$118.85**	**$ 81.51**	**$ 49.33**	**$30.14**
Total Nonpoint Source Funding (All Sources)	**$186.89**	**$134.49**	**$112.40**	**$64.04**

Source: Developed by LB&FC staff from information provided by DEP. Includes funding for all nonpoint sources, not just those located in the Chesapeake Bay region. Local and state funding sources may more accurately reflect calendar years or state fiscal year funding cycles than federal funding cycles. Some funding levels are approximations. Funding sources may be aggregated slightly differently from year to year.

Robert W. Adler, a Professor of Law at the University of Utah who has written extensively on various watershed pollution issues, notes that the flush tax provides no incentive for pollution reduction because the tax is not tied to the amount of pollution caused by each user. Professor Adler has suggested:

> One way in which program funds can be generated in ways that both satisfy the polluter pays concept and that provide additional pollution reduction incentives would be a dedicated tax on agricultural and household fertilizers and any other agricultural, commercial, or industrial products that cause nitrogen and phosphorus to reach the [Chesapeake] Bay. The funding mechanism itself thus would create incentives to use those products more conservatively, and the funds received could be allocated for additional cost-effective pollution controls through the auction process.

Professor Adler does not, however, cite specific products (other than agricultural and household fertilizers) that might be targeted for such a tax.

A decision would need to be made as to how to implement a competitive RFP program. Pennsylvania's nutrient credit trading program was established through the 2004 Chesapeake Bay Tributary Strategy, and subsequently formalized in regulation at 25 PA Code Chapter 96.8. Although a competitive RFP program could conceivably be established in a similar manner, we assume a program of the magnitude envisioned in this report, especially if funded through a dedicated funding source, would need to be established through legislation and, presumably, then embodied in regulation.

Many wastewater treatment plants have already made major capital investments and increased customer fees. Our 2008 report entitled *Chesapeake Bay Tributary Strategy Compliance Cost Study* found that it will cost "significant municipal discharges" approximately $1.4 billion in capital costs to meet the nutrient-related requirements of the Chesapeake Bay Tributary Strategy. This translates to costs of $68 per household equivalent per year ($40 capital related and $28 operation and maintenance related).

Pennsylvania's municipal authorities are therefore concerned that a competitive RFP program may result in their customers, in essence, paying twice for meeting the Chesapeake Bay goals: once in increased fees for their upgraded wastewater treatment plant and a second time to provide funds for the RFP program to purchase additional nutrient credit reductions that, under the current WIP, would primarily be the responsibility of the agricultural sector.

This concern stems, in part, from language in an early draft proposal that would have required sewer authorities (and water authorities whose customers receive water bills but use septic systems) to impose a transfer fee on their customers. Municipalities would be required to impose a similar fee on on-site septic system

permit holders that do not receive a water bill. These fees would then be made available for PENNVEST to use to purchase nutrient credits.

The municipal authorities we spoke to did not believe they should be responsible for collecting additional fees to address nutrient reductions required of non-point sources such as farms, noting that many authorities have already significantly increased fees to their customers to meet Chesapeake Bay requirements. The Scranton Sewer Authority, for example, cited the federal Chesapeake Bay requirements as the reason for a $23 million upgrade to its treatment plant, necessitating a 45 percent increase in rates in 2012. The Waynesboro Borough Authority, citing the costs of upgrades to its facilities to meet the Chesapeake Bay requirements, reportedly enacted a 10 percent increase in rates in 2012, following 15 percent rate increases in both 2010 and 2011. According to the Pennsylvania Municipal Authorities Association, sewage authority increases of this magnitude are common throughout Pennsylvania's Chesapeake Bay tributary regions.

Wastewater treatment facilities that are treating for nutrients over and above what their permits require could, however, benefit from a competitive RFP program by selling credits, the revenue from which could be used to offset a portion of the facility's operating costs. Municipal wastewater authorities could also benefit because the EPA has indicated that if Pennsylvania is not able to achieve the planned reductions in the agriculture and urban stormwater sections of the plan, further reductions may be required of wastewater treatment plants. This next level of reductions, known as enhanced nutrient removal (ENR), can require costly additional upgrades to wastewater treatment plants.

Local streams have their own TMDLs that must also be addressed. If a local stream is identified by DEP as having a nutrient problem, those problems must be addressed even if the state has met its requirements for the Chesapeake Bay. In short, if a local stream is polluted, the problem cannot be offset by buying credits elsewhere. This has led to concerns that, should Commonwealth funds be spent purchasing credits from large-scale technological operations targeted specifically at the Chesapeake Bay, funds would not then be available to help address the water quality problems of local streams.

For most fresh water streams and lakes in Pennsylvania, phosphorous is the "limiting" nutrient (i.e., the nutrient that controls algae growth), whereas nitrogen is typically the limiting nutrient in estuaries such as the Chesapeake Bay. As a result, steps focused solely on reducing the nitrogen flowing to the Bay may do little to address the water quality problems of local streams, which are typically due to excess phosphorus and sediment.

Frequently, however, steps taken to reduce one nutrient, such as nitrogen, also result in the reductions of other pollutants. For example, a recent study of the various control measures implemented by BION at four animal operations in south-central Pennsylvania found these operations will result in significant impacts

to nutrient loads delivered to local streams as well as to the Chesapeake Bay. [18] The study estimated the BION operations, which are primarily targeted toward nitrogen reductions from manure, will also result in adjusted phosphorus load reductions that exceed the TMDL-required reductions in two of three locally impaired creeks (the Quittapahilla and Donegal Creeks) and about 44 percent of the TMDL load in the Chickies Creek.

In addition to addressing phosphorous problems in these local streams, the project is also expected to help mitigate problems caused by elevated nitrate concentrations in groundwater resources that serve as sources of local drinking water supplies. The study noted that Lancaster County has reported that more than 140 water supply systems have had to implement some level of nitrate removal because nitrate concentrations were consistently above the USEPA standard. According to the study, the degree of nitrogen removal expected from BION's treatment activities at the four areas identified would most certainly have a positive impact on groundwater nitrogen concentrations in these areas.

One way to encourage such projects would be to give greater weight (i.e., a higher score) to nutrient credit bids that also address the issues pertaining to impaired local streams. For example, a bid for nitrogen reductions that would also reduce phosphorous in a creek with a serious phosphorous problem could receive a higher score (i.e., the Commonwealth would be willing to pay a higher price per pound of nitrogen reduced) than a bid for nitrogen reductions on a project that does not reduce phosphorous loads into an impaired stream. This is why our outline of a potential competitive RFP program (see page 17) includes DEP developing a formula that would take into consideration phosphorus and other local water quality concerns, such as water-borne pathogens, endocrine disruptors, methane, and nitrates in local drinking water supplies into award decisions.[19]

Credits must be verifiable. One of the potentially most difficult aspects of implementing a nutrient credit trading or credit purchasing program is ensuring that the credits purchased are actually realized, meaning that the proposed project or practice is implemented and yields the planned nutrient reductions. As a general rule, load reductions from nonpoint sources, like agricultural BMPs, are less certain that those from point source control technologies, in part because nonpoint source BMPs are more difficult to monitor and verify.[20] To address this issue, EPA has done significant work to estimate the nutrient removal efficiencies of various BMPs

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[18] *An Overview of Potential Nutrient Load Reductions to Local Streams and the Chesapeake Bay as a Result of Bion's Waste Treatment Activities at Farm Operations in South-Central Pennsylvania*, by Barry M. Evans, Ph.D., Penn State University, October 12, 2012.

[19] This approach has been used in the CRBSCP program, where projects have received additional credit for accompanying reductions in certain other pollutants, such as selenium.

[20] A 2012 report entitled *Improving conservation practices programming to protect water quality in agricultural watersheds: Lessons learned from the National Institute of Food and Agriculture–Conservation Effects Assessment Project* found that farmers tend to discontinue certain types of BMPs, especially practices such as nutrient management. The report attributed these tendencies to generational transfers or changes in land ownership and/or lack of interest in continuation of the practice.

in their Chesapeake Bay Watershed Model, and participating states are required to use those models.[21]

States can further address this uncertainty by building in a "cushion" to protect against overly optimistic estimates in credit exchanges between point and nonpoint sources. Virginia, for example, requires a trading ratio of 2:1 when a new or expanding point source purchases a credit from a nonpoint source. That is, for every credit needed, the point source must purchase two credits from the nonpoint seller. In Maryland, purchasers of agricultural nonpoint credits are also required to purchase a set aside equal to 10 percent of the credit value. Pennsylvania's trading ratio for purchase by a point source from a nonpoint source is 1:1; however, credit calculations must include a 10 percent set aside for the Department's credit reserve.

Pennsylvania also has a process in place to verify that the credits purchased are actually achieved. As part of the certification decision, DEP requires a verification plan that explains how such verification will occur. Verification can take a number of forms, but it must demonstrate that the pollutant reduction activity was implemented as described in the certification and that other requirements, such as those pertaining to baselines and thresholds, have been met. DEP is not typically the primary verifier, but it may conduct verification activities such as monitoring, inspecting sites, and performing compliance audits.

One advantage of using advanced technologies, such as have been employed by BION and EnergyWorks, is that the nutrients are strictly controlled and therefore can be readily measured and verified at various points in the process. This removes much of the uncertainty surrounding the reliability of credits generated through agricultural and urban stormwater BMPs.

Participation by small bidders. PENNVEST has expressed concern that it might be difficult to structure an RFP program in which small farms or entities could compete effectively. One possible solution to promote participation by small bidders could involve "aggregators" who would bundle several small nutrient credit producers into larger units as a way to take advantage of efficiencies of scale. While the costs for nitrogen credits might be higher from such aggregators, the smaller operations may be able to offer other benefits, such as nutrient reductions on impaired local streams, which under the PENNVEST/DEP formula (discussed above) might offset the initially higher costs. Other options for including small bidders include establishing a "set-aside" whereby a certain number of pounds would be allocated for small bidders only or requiring under certain circumstances that large bidders allow smaller operations to participate as part of their bid.

Traditional nutrient removal projects can have important tangential benefits. Concern has also been expressed that, should the Commonwealth implement a nutrient reduction approach that relies heavily on capital-intensive advanced

[21] The EPA has questioned the efficiency of some BMPs, believing they may be overestimated, and may need to be adjusted.

technologies, it would remove much of the impetus provided by the Chesapeake Bay requirements to make needed structural repairs and upgrades in other sectors, particularly urban stormwater systems. Our 2008 report entitled *Chesapeake Bay Tributary Strategy Compliance Cost Study* noted a similar issue; that oftentimes wastewater treatment plants would incorporate other needed or desired capital improvements to their facilities as part of an upgrade to improve nutrient removal.

A similar issue exists with regard to agricultural BMPs. If Commonwealth funds are diverted from existing programs to purchase nutrient credits from advanced technologies, fewer funds may be available to help farmers meet related goals, such as developing and implementing Nutrient Management Plans, Erosion and Sediment Control Plans, and, for farms that include an Animal Concentration Area or that land apply manure, Manure Management Plans.

PENNVEST notes, for example, that it already has a process in place for funding the implementation of BMPs that reduce nutrients without an RFP process. Funding for these projects comes from a combination of state funds approved by voters, federal grants to PENNVEST from the Environmental Protection Agency, and recycled loan repayments from previous PENNVEST funding awards. Examples of recent PENNVEST projects pertaining to the Chesapeake Bay are shown in Appendix F. PENNVEST also notes, however, that its funding is limited, and it receives many more requests for funding that it can accommodate.

If a competitive RFP approach resulted in the Chesapeake Bay TMDLs being achieved at a much reduced overall cost, more funds would be available, at least in the aggregate (meaning public and private sectors together), to address these related infrastructure needs and to target water quality concerns other than nitrogen.

Job creation and economic development potential. Advanced technology projects can not only help the Commonwealth achieve its TMDL loads, but also have the potential to promote economic development and create new jobs in rural communities. A January 2012 report entitled *Manure to Energy*[22] highlighted the triple benefits that manure-to-energy projects can offer; producing renewable domestic energy, sustaining profitable farms, and improving water quality. The report highlights several examples of farms using chicken and cattle manure to generate gas to heat farm buildings, to generate electricity to power the farm and to sell any surplus back to the power grid, to transform raw manure into sterile ash that can be used as an alternative to commercial fertilizer or sold to phosphorous-poor regions of the country,[23] and well as decreasing greenhouse gases and reducing the amount of nutrients and other pollutants delivered to the bay and local waterways. These projects can also produce valuable nutrient, renewable energy, and

[22] *Manure to Energy: Sustainable Solutions for the Chesapeake Bay Region*, January 2012.

[23] As increasing global demand depletes available supplies, renewable phosphorus will become an important factor in achieving sustainable agriculture. Studies are now being completed to demonstrate the safety and efficacy of renewable phosphorus from manure processing as an animal feed ingredient.

carbon offset credits as additional revenue streams. The report contains several recommendations and policy options to encourage these types of projects.

Advanced technologies may also be key to the continued financial viability of small farms. To remain competitive in today's commodity markets, farms need to increase the scale of their operations. Traditional manure management methods involve spreading the manure as fertilizer on farm fields. This means, however, that more land is required to increase the scale of animal feeding operations. By eliminating the need for land application of manure, technology solutions can de-couple this link between land use and the scale of animal operations.

IV. Appendices

APPENDIX A

Advanced Technology Projects at Kreider Farms (BION) and Hillandale Farms (EnergyWorks)

Kreider Farms (BION)

Bion Environmental Technologies, Inc., has executed an agreement with Kreider Farms to install a system at their 2,000-head dairy facility in Lancaster County, Pennsylvania, to reduce ammonia emissions and nitrogen in the effluent. These reductions will qualify for credits under Pennsylvania's Nutrient Credit Trading Program as part of the strategy to comply with Pennsylvania's Chesapeake Bay Tributary Strategy.

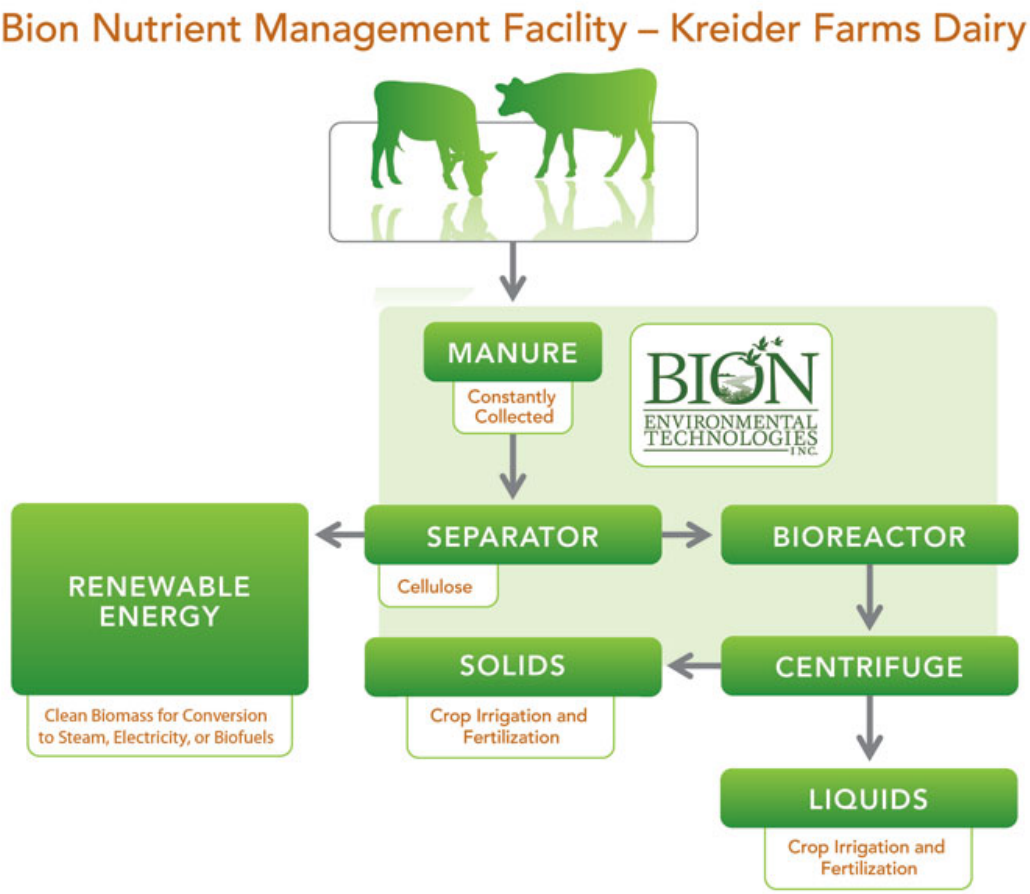
Bion worked extensively with the Pennsylvania Department of Environmental Protection over the past four years to establish a nutrient credit calculation/verification methodology that is appropriate to Bion's technology and recognizes its 'multi-media' (both water and atmospheric) approach to nutrient reductions with respect to the Chesapeake Bay Tributary Strategy. The DEP has approved Bion's protocols for calculating credits for its system's reduction of nitrogen and phosphorus in the liquid effluent, as well as ammonia emissions that have been recognized as a significant contributor of nutrients in the Bay through downwind deposition of nitrogen.

The PENNVEST Board of Directors approved a low-interest loan for Phase I of Bion's Kreider Farms project following Bion's lengthy review process by Penn State University and PA DEP and stakeholder meetings with US EPA, PA DEP, PA Department of Agriculture and others. Bion received approval of its demonstration permit from the DEP in August 2010.

Bion anticipates that Phase 1 of its Kreider Dairy project will initially generate approximately 130,000 nitrogen credits annually from the primary milking herd of 1,200 animals. Phase 1 will also produce approximately 16,250 phosphorus credits. Additional N & P credits can be generated and earned through:

1. actual sampling results (that show improvements from modeling),
2. upcoming studies regarding the bioavailability and denitrification characteristics of the residual fine solids,
3. implementation of the renewable energy facility as outlined for Phase 2 for the combustion of the coarse (cellulosic) solids, and
4. additional manure inputs when the dairy support herd (approximately 800 animals) is brought online

As shown below, Phase 2 will include renewable energy production from the dairy waste coarse solids as well as the waste from Kreider's approximately 5 million chickens. Upon successful completion of Phase 2, which requires PA DEP to approve additional protocols, the project is anticipated to produce a total of 1.5 million credits, potentially more with the treatment of waste from surrounding farms. These are long-term credits (certified for 10 years or more) that can be used to offset the discharges from municipal wastewater treatment facilities and other nitrogen sources in the Susquehanna watershed that face much higher nitrogen remediation costs.



Hillandale Farms (EnergyWorks)

In October 2010, Hillandale Farms Gettysburg and EnergyWorks BioPower, LLC signed agreements to proceed with the construction of an Energy and Nutrient Recovery Facility (the Gettysburg ENRF) on land adjacent to the Hillandale operations in Adams County. The facility will use gasification technology to transform egg layer manure into renewable energy and mineral by-products and will be capable of processing the entire amount of manure produced by 5 million layer hens.

As a nutrient credit generator certified under the Pennsylvania Nutrient Cap and Trade program using gasification technology, the Gettysburg ENRF is the first facility of its kind in the United States. The facility will generate 2.5 megawatts of electricity, recycle over 13,000 tons of mineral byproducts annually, reduce farm ammonia emissions by 50 percent, eliminate over 34,000 tons of CO_2 equivalent greenhouse gases annually, reduce manure storage by 97 percent, eliminate manure application on 23,000 acres of land, and achieve 3.5 percent and 4.4 percent, respectively, of Pennsylvania's 2025 goals for reducing nitrogen and phosphorous loading to the Chesapeake Bay. The project is to become fully operational by the end of 2012.

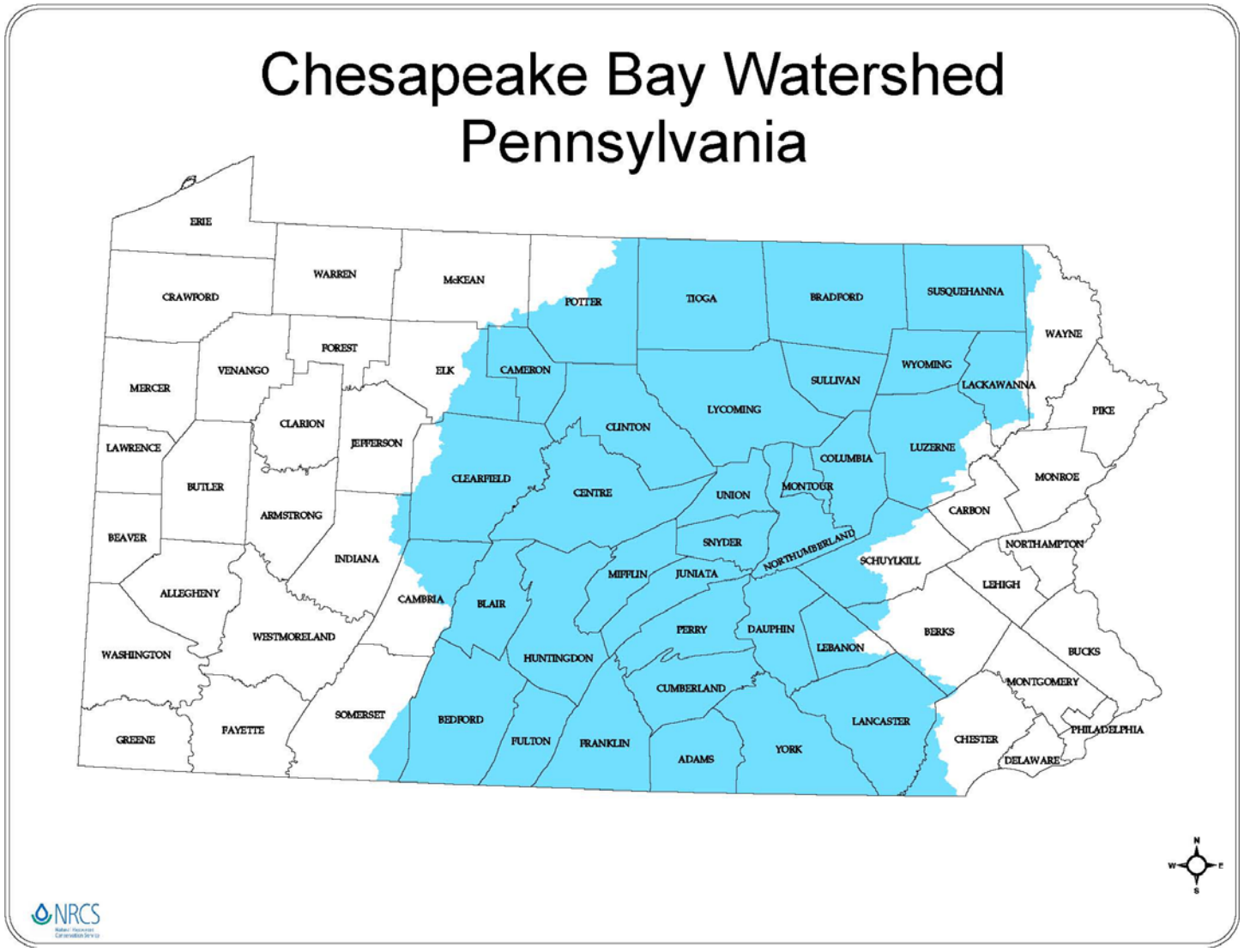
Appendix A (Continued)

The Hillandale Farms egg layer operations north of Gettysburg, currently house approximately 3.5 million layer hens, producing approximately 3 million eggs per day. The farm is expanding its operations to approximately 5 million hens.

EnergyWorks BioPower, LLC, based in Lancaster, will operate the plant and is a subsidiary of EnergyWorks North America headquartered in Annapolis, Maryland.

Gettysburg Plant

APPENDIX B



Source: Pennsylvania Department of Environmental Protection.

APPENDIX C

Pennsylvania

2011 Milestones to Reduce
Nitrogen & Phosphorus - Assessment June 2012
FINAL PROGRESS

Chesapeake Bay Program
A Watershed Partnership

Introduction

During the 2009 Chesapeake Executive Council meeting, the governor of Pennsylvania set short-term goals to reduce pollution to the Bay and dramatically accelerate the pace of restoration. A final assessment of progress follows.

Final Progress

	2009-2011 Commitment	Achievement (7/1/08-6/30/11)	% Achieved (7/1/08- 6/30/11)
Agriculture			
Animal Waste Management Systems (systems)	275	361	131%
Carbon Sequestration/Alternative Crops (acres)	25,740	1,918	7%
Conservation Plans/SCWQP (acres)	327,599	149,932	46%
*Conservation Tillage: continuous no-till and other conservation tillage (acres)	175,491	-96,252	-55%
Cover Crops: late planting (acres)	174,818	65,535	37%
Forest Buffers (acres)	19,059	39,508	207%
Forest Harvesting Practices (acres)	125	9,948	7,959%
Grass Buffers (acres)	1,161	3,389	292%
Land Retirement/Enivironmental Planting (acres)	58,876	153,141	260%
Manure Transport: poultry litter (tons)	58,915	227,671	386%
Mortality Composters (units)	22	21	95%
*Nutrient Management, including enhanced nutrient management (acres)	129,250	76,600	59%
Pasture Grazing BMPs: off-stream watering w/ and w/out fencing and rotational grazing (acres)	34,727	126,840	365%
*Poultry Phytase (pounds P)	19,626	0	0%
Stream Restoration (feet)	215,088	395,347	184%
Tree Planting (acres)	15,065	39,945	265%
Wetland Restoration (acres)	1548	1,872	121%
Urban/Suburban			
Abandoned Mine Reclamation (acres)	2,219	2,157	97%
Dirt & Gravel Road Erosion & Sediment Control (feet)	124,913	583,574	467%
*Erosion & Sediment Control (acres)	7,000	0	0%
Septic Connections (connections)	7,353	7,751	105%
*Stormwater Management (acres)	8,690	-6,440	-74%
Stream Restoration (feet)	4,400	3,765	86%
Wastewater			
Wastewater Nitrogen (pounds reduced)	1,679,000	1,259,348	75%
Wastewater Phosphorus (pounds reduced)	49,500	126,099	255%
Air			
Heavy Truck Anti-Idling Rule	9,780,000	9,780,000	100%

*See background information on reverse.

For more, contact Ted Tesler, ThTesler@pa.gov

Appendix C (Continued)

FINAL PROGRESS - Pennsylvania 2009- 2011 Milestones (Continued)

Chesapeake Bay Program
A Watershed Partnership

Programmatic Accomplishments, 2009-11

	Status
Manure Management Manual	Published 10/29/2011
Agriculture Compliance	Completed
• 1,100 County conservation district staff site visits	12/31/2010
• 38 County conservation district Outreach Plans	11/31/2011
• *"Am I in Compliance"* brochure and barn sheet	1/2011
• *"Basics of Agricultural Erosion and Sedimentation Control Requirements"* barn sheet	7/2011
• *"Basics of Manure Management Requirements* barn sheet	12/2011
• Draft Model Agriculture Compliance Policy	7/2011
• 4 CBRAP regional compliance and inspection staff hired	7-12/2011
Erosion and Sediment Control Regulations	Published 11/19/2010
• Codification of post-construction stormwater requirements	
• Mandatory riparian forest buffers for exceptional value waters	
• Conservation Plan revision to include animal heavy use areas	
Stormwater MS4	Published 09/17/2011
• Approved PAG-13—includes Chesapeake Bay Pollutant Reduction Plan	
Legacy Sediment BMP Development and Implementation	11/02/2011-ongoing
• Targeted Demonstration Site: Big Spring Run Basin of Mill Creek Watershed, Lancaster County. Approx. 5 acres of natural floodplain and riparian wetland restoration and 3,200 linear feet of natural stream restoration	
Phosphate Dishwater Detergent Ban	Effective 7/1/2010
Wastewater Treatment Plant Permits	Status as of 7/2011
• 47 of the 190 significant sewage facilities had cap loads that were effective on or before July 2011. (NOTE: 2009 – 2011 commitment was 40 plants.)	
Nutrient Trading	
• 3 PennVEST Nutrient Trading Auctions	2010 -2011
• 16 WWTP facilities purchased credits to obtain compliance	12/2011

Progress Highlights

- **Dirt & Gravel Road Erosion & Sediment Control: 467%.** PA's milestone was based on early program BMP implementation rates that have shown large increases over the last four years based on steady funding of this program.
- **Forest Harvesting Practices: 7,959%.** PA's milestone was based on historical BMP reporting levels. The PA Department of Conservation and Natural Resources has significantly increased its reporting.
- **Manure Transport: 386%.** A survey of Manure Brokers was completed that more accurately represents manure transport within and out of the Bay watershed.
- **Septic Connections: 105%.** The increase resulted from the first time reporting of septic system hook-ups by PennVest and an increase in hook-ups reported by USDA's Rural Development Program.
- **Wastewater:** PA committed to having 40 Wastewater Treatment Plants (WWTPs) operating under reduced nutrient limit permits by June 2011. 47 of the 190 significant sewage facilities had cap loads that were effective by June 2011.
- **Pasture Grazing BMPs: 365 %.** Increased reporting of pasture grazing BMPs is attributed to the South Central Project Grass administered by the Capital RC&D Area Council. National Fish and Wildlife Funds supplemented existing cost-share programs including EQIP, CREP and DEP CBIG.

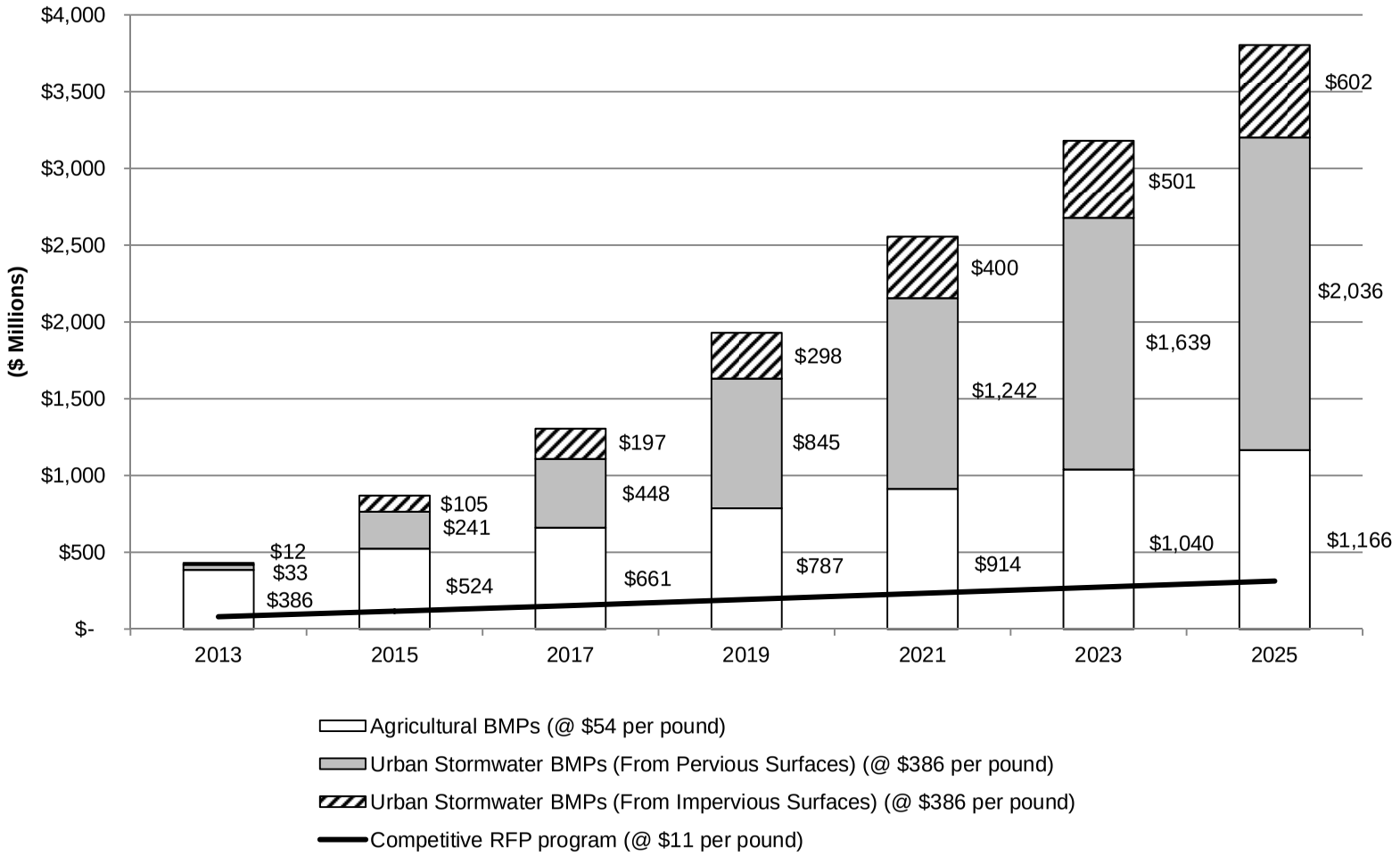
Shortfalls

- **Conservation Tillage: -55%.** USDA/NASS reported that 78% of the tilled land in PA during 2009 used either "No-Till" or other conservation tillage. Efforts are underway to better track voluntary conservation tillage activities including a planned 2012 tillage transect study to better characterize this practice.
- **Erosion & Sediment Control: 0%.** Efforts are underway to better track the implementation of this practice through reporting of data collected from existing state permits.
- **Nutrient Management: 59%.** Evidence in south-central Pennsylvania counties and a recent USDA/CEAP study suggests that implementation levels may range from 50-70%. Efforts are underway to better track voluntary implementation activities.
- **Poultry Phytase: 0%.** No increase in implementation of this practice has been gauged during this milestone period. DEP plans to work with industry groups and stakeholders to characterize the current implementation of phytase feed additive use during the next milestone period.
- **Stormwater Management: -74%.** Ongoing efforts to better track urban BMPs through existing storm water management permits will result in a higher level of implementation than is currently reported.

Source: Chesapeake Bay Program.

APPENDIX D

Estimated Costs to Achieve Nitrogen Reduction Targets From Nonpoint Source Agriculture and Urban Stormwater Sources (Both Pervious and Impervious) Using Best Management Practices (BMPs) and Under a Competitive RFP Program



Source: Developed by LB&FC staff using nitrogen reduction target information provided by DEP. Information on costs of BMPs from *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*, Chesapeake Bay Commission, May 2012.

APPENDIX E

Bay Restoration Fund Facts

COMPTROLLER of MARYLAND
Serving the People

BAY RESTORATION FUND FACTS

July 2012

Comptroller Peter Franchot

This publication offers information about the Bay Restoration Fund. The Comptroller of Maryland administers the billing and collection of fees for the Bay Restoration Fund. The Maryland Department of the Environment (MDE) administers the Bay Restoration Fund.

BACKGROUND

In the 2004 legislative session, the Maryland State Government took a major step to protect our waterways through the enactment of the Bay Restoration Fund (Senate Bill-320). The purpose of the bill was to create a dedicated fund to improve the environment and water quality of the Chesapeake Bay. This fund is used to upgrade wastewater treatment plants, upgrade septic systems in the critical area and implement cover crop on agricultural land through an environmental surcharge fee.

FEES

Residential Home Owners

Water and Sewer Users

A $5.00 monthly surcharge will be collected on residential household water and sewer bills. If you receive a quarterly bill for one household, the fee will be $15.00 (for three months), which cannot be prorated.

Private Wells and Septic Systems

Maryland county governments will be responsible for collecting a septic fee from owners of private wells and septic systems. The annual fee is $60.00.

NOTE: The fee for some users in Garrett County and Ocean City where the wastewater does not drain into the Chesapeake Bay or the Coastal Bay watersheds (surface or ground water) will remain at the existing fee rate of $2.50 for each residential dwelling and $30 per year per septic or holding tank.

Non-Residential Users

Non-Residential water/sewer customers will be charged the Bay Restoration Fee based on the number of equivalent dwelling units (EDUs). The legislation establishes the following fee schedule for non-residential customers.

For properties with or without meters, the Bay Restoration Fee is billed based on the customers' current billing schedule. The number of EDU's is determined by dividing the total average daily water consumption by 250 gallons (or if a system existed prior to January 1, 2004, and used 250 gallons/day or less as a measure for 1 EDU) and multiplying the result times $5.00 per month.

The fee is calculated based on the EDU schedule below and billed based on the customers' billing schedule;

- First 2,000 EDU, the fee is calculated at $5.00 per month per EDU
- Maximum fee for 2,000 EDU or more: $10,000/month for any single user.

NOTE: The fee for some users in Garrett County and Ocean City where the wastewater does not drain into the Chesapeake Bay or the Coastal Bay watersheds surface or ground water) will remain at the existing fee rate of $2.50 for each equivalent dwelling unit not exceeding 2,000.

The Maryland Department of the Environment (MDE) will administer and allocate the funds. For more information on how your fee is calculated, please call MDE at 1-800-633-6101 or visit **www.mde.state.md.us.**

Financial Hardship Exemptions

The law allows, subject to approval by the Maryland Department of the Environment (MDE), the billing authority to establish a program to exempt certain "residential" dwellings that demonstrate substantial financial hardship. The billing authorities may consider the factors below (or other similar financial hardship factors) in developing a program for exempting residential users from paying the Bay Restoration Fee, where the applicant meets at least two of the following conditions:

- Receiving energy assistance subsidy;
- Receiving public assistance – supplemental Social Security income (SSI) or food stamps;
- Receiving Veterans or Social Security disability benefits;
- Meeting the income criteria below:

Household Size	Maximum Monthly Income Standards	Maximum Yearly Income Standards
1	$1,588.12	19,057.50
2	$2,145.20	$25,742.50
3	$2,702.29	$32,427.50
4	$3,259.37	$39,112.50
5	$3,816.45	$45,797.50
6	$4,373.54	$52,482.50
For each additional Person, add	$557.08	$6,685.00

* Source: Maryland Department of Human Resources/Office of Home Energy Programs (www.dhr.state.md.us/meap/index.htm)

The individual exemption should not exceed one year without re-verification of eligibility. The proposed financial hardship exemption plan must be submitted to MDE for approval and should include the following information:

- Proposed financial hardship exemption criteria
- Application procedure and forms
- Required supporting documentations for eligibility determination
- Exemption time-period and process for re-verification of eligibility

Appendix E (Continued)

- Estimated number of residential users that may qualifying for the exemption

The proposed financial hardship exemption plan should be submitted to:

Maryland Department of the Environment
1800 Washington Boulevard, STE 515
Baltimore, MD 21230-1718
Attn: Director, Maryland Water Quality Financing Administration

BILLING AUTHORITIES

Billing Authorities provide water, or sewage services to residential, multi-residential, and/or non-residential users. The Billing Authorities are all Maryland non-exempt local governmental entities, billing authorities and, drinking water and sewage wastewater treatment plant owners.

County governments are responsible for collecting a septic fee from owners of private wells and septic systems.

Due Dates

Billing authorities are required to file a Bay Restoration Fee return (BRF-1) which is due on a quarterly basis. The return is due on the 20th day of the month following the calendar quarter in which Bay Restoration Fees were collected. Preprinted forms will be sent to the Billing Authorities during the first week of the month in which the return is due.

Claim for Credit of Administrative Costs

The BRF Legislation permits local governmental entities and billing authorities for water or wastewater to claim a reimbursement of reasonable administrative costs not to exceed 5 percent of the Bay restoration fees collected. Reasonable administrative costs include only costs which are incremental and verifiable.

A credit for overhead or other costs which would have been incurred in the absence of the Bay Restoration Fee will be disallowed. The amount of reimbursable administrative costs not recovered will be a carry forward for the next quarter. The Comptroller will return the available carry forward amount on the preprinted BRF-1 form sent to billing authorities each quarter.

Mailing Instructions

Please complete and sign the Bay Restoration Fee Return (BRF-1), attach your check and mail payment with this return to:

Comptroller of Maryland
Revenue Administration Division
P.O. Box 1829
Annapolis, MD 21404-1829

FREQUENTLY ASKED QUESTIONS BY BILLING AUTHORITIES

What do I file?
Billing authorities are required to file a Bay Restoration Fee Return (BRF-1) which is due on a quarterly basis.

When do I file it?
The return is due on the 20th day of the month following the calendar quarter in which Bay Restoration Fees were collected.

Where do I get the Bay Restoration Fee Return form?
Preprinted forms will be sent to the Billing Authorities during the first week in the month which the return is due. The preprinted forms will indicate the amount of reimbursable administrative costs carried forward from the previous quarterly period.

Do I have to identify Bay Restoration Fees when I bill?
Yes, when you bill the user you must identify the fee as "Bay Restoration Fee" along with the corresponding dollar amount.

Do I have to maintain a separate account for the Bay Restoration Fees?
Yes, The law requires the billing authorities to establish a "segregated account" for the funds collected for accounting purposes.

As a billing authority for the collection of Bay Restoration Fee, do I deposit the fee on either an "Accrual" or "Cash" basis?
It's your choice. You may pay the fee on either an "Accrual" (based on anticipated payments) or on a "Cash" (based on actual payments received) basis.

Where do I mail my payment?
Make your payment to the Comptroller of Maryland and mail to:

Comptroller of Maryland
Revenue Administration Division
P.O. Box 1829
Annapolis, Maryland 21404-1829

How do I get reimbursed for the costs of setting up the billing and collection system?
The reimbursable administrative costs are reported on the BRF-1 form. Any amount not recovered in that quarter will be a carry forward for the next quarter. The Comptroller will account for the carry forward amount and it will be stated on the preprinted BRF-1 form. Billing Authorities can claim reasonable administrative costs not to exceed 5 percent of the Bay restoration fees collected. Reasonable administrative costs include only costs which are incremental and verifiable. A credit for overhead or other costs which would have been incurred in the absence of the Bay Restoration Fee will be disallowed.

How can I amend?
To file an amended return, contact taxhelp@comp.state.md.us or call 410-260-7980 from Central Maryland or 1-800-MD-Taxes (1-800-638-2937) from elsewhere.

What if I lost my form?
Contact taxhelp@comp.state.md.us or call 410-260-7980 from Central Maryland or 1-800-MD TAXES (1-800-638-2937) from elsewhere.

For more information about the Bay Restoration Fund visit the Maryland Department of the Environment web site at: **www.mde.state.md.us**. For assistance or questions about filing a Bay Restoration Fee Return or filing an amended return, contact taxhelp@comp.state.md.us or call 410-260-7980 from Central Maryland or 1-800-MD-Taxes (1-800-638-2937) from elsewhere.

For the hearing impaired: TTY users call via Maryland Relay at 711 in Maryland. If you need reasonable accommodation for a disability or need this publication in an alternate format, contact us at 410 260-7980 (1-800-638-2937) from Central Maryland or 1-800-MD-Taxes from elsewhere.

Source: Comptroller of Maryland, July 2012.

APPENDIX F

Recent Examples of PENNVEST-funded Projects for Point Source and Nonpoint Source Pollution Reduction to the Chesapeake Bay

2011

- $425,397 grant to construct various manure-control facilities at a dairy and poultry operation in West Lampeter Township that will reduce nutrient runoff into Pequea Creek in Lancaster County.
- $148,802 grant to construct manure-control facilities at a poultry farm in Strasburg Township, where nutrient runoff during wet weather is contaminating Big Beaver Creek in Lancaster County.
- Montour County Conservation District received a $495,000 grant to install manure and animal control facilities at two livestock farms where there is significant nutrient runoff into Mahoning Creek, Beaver Run and ultimately the Chesapeake Bay.
- A $163,213 grant to construct a manure storage facility at a poultry operation in Paradise Township.
- A $573,188 grant to construct a manure storage facility at a farm in Ephrata Township.
- A $176,210 grant to construct a manure storage facility at a farm in Mount Joy Township.
- A $157,534 grant to construct manure litter storage shed at a poultry operation in Strasburg Township.
- A $657,050 grant to construct manure composting facility as well as an infiltration basin at a farm in Drumore Township.
- A $212,056 grant to construct a manure storage facility and make other improvements at a second farm in Strasburg Township.
- Berks County Conservation District received a $764,980 loan to construct a manure solids separation system, a composting facility and a 1.7 million-gallon lagoon and cover at Kurtland Farms to reduce nutrient runoff into a nearby stream. It also received a $300,514 loan to construct a manure storage tank and a steam buffer in order to reduce nutrient runoff into a nearby stream.
- Lancaster County Conservation District received a $518,855 grant to construct manure storage tanks on three farms that will provide enough storage to eliminate the need to apply the manure to fields during the winter, thus reducing nutrient runoff into nearby streams.

2012

- Chester County Conservation District received a $986,671 grant to construct facilities to reduce wastewater runoff from a mushroom farming operation that is contaminating Naaman's Creek with nutrients. They also received a $1,274,595 grant to undertake ten separate projects at various sites in the county. These projects primarily involve the implementation of agricultural best management practices designed to reduce nutrient runoff into local streams and, ultimately, the Chesapeake Bay.

Appendix F (Continued)

- Lancaster County Conservation District received a $620,885 grant to construct a boiler that will burn chicken manure on a poultry farm whose land is saturated with nutrients that are contaminating the local stream and the Chesapeake Bay. They also received a $214,600 grant to construct a riparian buffer on one farm and a manure storage facility and other storm water control facilities on another farm in order to reduce nutrient runoff into local streams and the Chesapeake Bay.
- Berks County Conservation District received a $1,985,032 grant to install manure management and related facilities to reduce nutrient run-off into local streams from four dairy farms, two of which are in the Chesapeake Bay watershed;
- Centre County Conservation District received grants totaling $2,193,581 for construction of manure handling facilities; and
- Lancaster County Conservation District received grants totaling $1,918,475 for construction of manure handling facilities.
- The City of Lebanon received a $576,450 grant to construct a water pervious parking lot and walkways, infiltration basins and swales, and tree plantings.
- York County Rail Trail Authority received a $921,656 grant to construct a 2.5 mile water infiltration system along Codorus Creek and to install an infiltration system in a local parking lot.
- Bucks County Conservation District and the Bucks County Equestrian Initiative received a $157,627 loan and a $122,078 grant to construct a manure storage facility, grassed waterways, animal trails and other improvements to alleviate nutrient runoff into nearby impaired streams and ultimately the Delaware River.
- Lancaster County Conservation District received three separate awards for agricultural projects:
  - A $131,613 grant to construct manure-handling facilities on the Benuel King dairy farm to eliminate nutrient discharges into Calamus Run, a tributary of the Chesapeake Bay.
  - A $470,542 loan to construct manure-handling facilities on the Sam Glick farm to eliminate nutrient discharges into the Octoraro watershed and ultimately the Chesapeake Bay.
  - A $221,905 grant to construct manure-handling facilities on the Sam Miller farm to eliminate nutrient discharges into Little Beaver Creek, a tributary of the Chesapeake Bay.

Source: PENNVEST.