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Nutrient Trading in the Chesapeake Bay Region:

An Analysis of Supply and Demand

PINCHOT INSTITUTE FOR CONSERVATION

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The Pinchot Institute for Conservation specializes in independent and innovative policy, thought, and action to advance sustainable approaches to natural resource conservation. Our program of work provides critical information to decision makers enabling wise and timely responses to ever-changing natural resource conditions.

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CHESAPEAKE BAY TRUST

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Preface

Just as economic capital provides steady financial returns, the natural capital of private farms and forests provides steady environmental, economic, and social returns in the form of ecosystem services. In fact, the public spends millions of dollars on technological replacements for services that these lands provide naturally—to reduce air pollution, minimize the impacts of flooding, and filter pollutants from drinking water and local waterways. As we lose farms and forests, we also lose the ecosystem services that they provide.

Numerous regulatory tools exist to protect the provision of ecosystem services. These tools include the regulation of industrial discharges, restrictions on land use, requirements to protect endangered species, acquisition of land, and a complex but incomplete system of mitigation requirements. However, regulations alone have not delivered the gains needed to restore the Chesapeake ecosystem. Neither have the combined efforts of federal, state, local, and private conservation programs, which lack the capacity to fully reach the large, diverse population of private landowners in the Chesapeake watershed.

Recently, the conservation of ecosystem services is finding new support through innovative market-based approaches like nutrient trading and carbon trading. These emerging markets can offer financial incentives to landowners for their conservation actions and cost-effective tools to permitted facilities for meeting their discharge limits. Yet, private landowners have limited access to these markets due to varying standards, separate markets, difficulty finding buyers, and a general lack of awareness about such markets.

In the Chesapeake region, the Pinchot Institute for Conservation, Sustainable Solutions, LLC, and numerous partners are building Bay Bank—the Chesapeake's conservation marketplace. Bay Bank fills a crucial missing link by connecting farmers and forest landowners to conservation programs and to related markets for ecosystem services such as water quality protection, habitat conservation, carbon sequestration, forest conservation, and wetland conservation. Bay Bank also lowers participation costs by increasing market awareness, aligning buyers and sellers, and ensuring verifiable environmental outcomes.

The Pinchot Institute collaborated with the World Resources Institute to assess the future dynamics of the emerging nutrient trading market in the Chesapeake region, supported by a generous grant from the Chesapeake Bay Trust. The results are presented in this publication, Nutrient Trading in the Chesapeake Bay Region: An Analysis of Supply and Demand, which examines:

- The existing and developing nutrient trading markets in the Chesapeake region
- The potential demand for nutrient credits from point sources
- The potential supply of nutrient credits from both point sources and nonpoint sources, and
- The implications of policy developments on nutrient trading.

Introduction

The Chesapeake Bay is the nation's largest estuary. Its watershed stretches across more than 64,000 square miles, encompassing parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia—and the entire District of Columbia. The Bay's ecosystem is incredibly complex, sustaining sizeable fisheries and recreational interests and providing important habitats for a large number of diverse species. However, most of the Bay and many of its tidal tributaries are impaired, and no longer able to sustain the many species that once thrived in its waters. The overabundance of sediment and nutrients—in the form of nitrogen and phosphorus—has degraded the Bay's water quality. These pollutants enter the Bay from both point sources (primarily wastewater treatment plants) and from nonpoint sources (primarily run-off from agricultural, urban, and suburban lands).

In 2002, five of the seven Chesapeake Bay jurisdictions—Maryland, Virginia, Pennsylvania, West Virginia, and the District of Columbia— joined an effort to restore ecological functions within the Bay watershed by signing the Chesapeake Bay Water Quality Initiative. As part of the Water Quality Initiative, each jurisdiction agreed to develop a Tributary Strategy for its portion of the Bay watershed that would outline steps and goals for achieving agreed-upon pollution allocations for nutrient and sediment loads by 2010.

As a result of nutrient reduction obligations under the Tributary Strategies, the Bay states are now planning for the issuance of National Pollution Discharge Elimination System (NPDES) permits to cap total nitrogen and total phosphorus discharges from point sources regulated under the Clean Water Act—mainly wastewater treatment plants.[1] The nutrient caps on point sources are also motivated by Maryland's adoption of water quality standards for the Bay in 2005. In addition, the Clean Water Act requires states to ensure that they do not prevent the attainment and maintenance of downstream water quality standards.

In order to lower the costs associated with meeting nutrient limits, and to allow for growth under the discharge caps, Virginia, Pennsylvania, Maryland, and West Virginia have developed (or are developing) nutrient trading programs. Nutrient trading is a market-based approach that can help jurisdictions maintain water quality targets more cost-effectively than with regulations and voluntary programs alone.

Nutrient trading systems identify the sources of ecosystem services, quantify their contributions to water quality, and determine financial values. As a result, regulated entities will have new options for offsetting their nutrient discharges. A wastewater treatment plant, for example, could take a conventional route toward reducing nutrients by making on-site improvements to technology—or it could participate in the new market for nutrient trading. Instead of making costly on-site upgrades, the plant could fund equivalent nutrient reductions on lands that provide the same function through ecosystems services. In some cases, a wastewater plant could also purchase nutrient reduction credits from another plant or point source operation with nutrient reduction credits above and beyond their permit requirements.

This emerging nutrient trading market offers landowners additional financial incentives for maintaining farms and forests, as well as for using Best Management Practices (BMPs) and other conservation strategies. It also provides permitted facilities with cost-effective tools for meeting discharge limits and simultaneously supports the regional effort to improve water quality in the Chesapeake Bay and its rivers.

However, even as these trading programs are being established, policies are developing that will affect the way the programs operate, as well as the potential for supply and demand of credits within the watershed. Beginning in 2011, for example, the entire Bay region will be subject to federal pollution limits known as Total Maximum Daily

[1] Sediment reductions called for in the Tributary Strategies are not included in water quality trading programs as currently designed. Wastewater treatment plants do not discharge sediment in large quantities and are thus not regulated for sediment.

Loads (TMDLs). In addition, President Obama issued a 2009 Executive Order that calls for the "next generation of tools and actions to restore water quality" in the Chesapeake Bay and signals increased federal oversight on cleanup efforts. Most recently, a bill proposed by Senator Cardin (D-MD)—the Chesapeake Clean Water and Ecosystem Restoration Act of 2009—seeks to reauthorize section 117 of the Clean Water Act and has provisions for the establishment of an interstate nutrient trading program in the Chesapeake region.

This paper provides an overview of nutrient trading programs as they currently exist in the Bay watershed and examines the potential for supply and demand of credits within those markets. The analysis also considers the likely impacts of a Bay-wide TMDL on nutrient trading—particularly the potential impacts of a TMDL on the agricultural sector's ability to generate credits. It concludes by projecting the balance of supply and demand within trading basins in order to predict places where a short supply of tradable credits could trigger constraints on future growth.

Existing Nutrient Trading Programs in the Chesapeake Region

Four states in the Chesapeake region—Pennsylvania, Virginia, West Virginia, and Maryland—are in various stages of developing and implementing nutrient trading programs as a means of facilitating cost-effective compliance with forthcoming NPDES permits, and as a means of offsetting growth from new and expanding wastewater treatment plants in coming years. In general, the state programs will become active in 2010 or later, once permit requirements for regulated entities become active.

Below is a description of each state's nutrient trading program. Table 1 provides a summary of the permit requirements for regulated sources, and the allocation policy for nutrient discharges of new and expanding sources.

Table 1. Summary of State Nutrient Trading Programs

STATE	Permit / Technology limits	Permit Issuance	Growth Allocations
Maryland	Existing majors (greater than .5 mgd) must upgrade to ENR and operate at concentrations of 4 mg/L N and .3 mg/L P. Existing minors (less than .5 mgd) have no technology requirements.	Technology requirement to upgrade to ENR is in effect.	No allocations for new or expanding facilities of any size.
Pennsylvania	Existing major facilities will be capped at 6 mg/L N at design flow and .8 mg/L P at design flow. Currently, facilities with flow of less than .2 mgd will only be given monitoring requirements, with possibility of caps in the future.	NPDES permits reflecting nutrient limits will become effective in three phases. Phase 1 facilities represent major dischargers: Phase 1: Oct 1, 2010. Phase 2: Oct 1, 2012. Phase 3: Oct 1, 2013. Phase 4: permits will be issued post 2013 for facilities between .2 and .4 mgd	No allocations for new or expanding facilities of any size.for facilities between .2 and .4 mgd
West Virginia[T1] (under development)	Existing major facilities will be capped at 5 mg/L N at design flow and .5 mg/L P at design flow. Minor facilities will have no requirements beyond monitoring.	Permits being issued on rolling basis.	No allocation for new or expanding facilities greater than .05 mgd.
Virginia	Existing major facilities will receive caps for nutrients based on their trading basin. Eastern Shore: 4 mg/L N, .3 mg/L P Potomac AFL: 4 mg/L N, .3 mg/L P Potomac BFL: 3 mg/L N, .3 mg/L P James: 6 mg/L N, .5 mg/L P Rappahannock: 4 mg/L N, .3 mg/L P York: 6 mg/L N, .7 mg/L P	Compliance dates under the General Watershed Permit will vary by river basin, based on ability to achieve compliance.	No allocation for new or expanding facilities greater than .04 mgd.

ENR: Enhanced Nutrient Removal, mg/L: milligrams pre liter, mgd: million gallons per day, N: nitrogen, P; phosphorus

Virginia

Virginia was the first state within the Chesapeake Bay watershed to issue nutrient trading rules. Legislation enacted in 2005 created the Chesapeake Bay Watershed Nutrient Credit Exchange Program and provides wastewater treatment facilities in Virginia's portion of the Bay watershed with the opportunity to meet required nutrient limits through trading. The Virginia program stipulates that existing facilities will have the option of meeting their forthcoming permit requirements using upgrades, reclamation and reuse of wastewater, and/or trades with other point sources. New and expanding plants must obtain offsets from nonpoint sources.

Most waste water treatment plants in Virginia have elected to join the Virginia Nutrient Credit Exchange Association (Exchange) — a trading association that will manage the exchange of credits between point sources. The members of the Exchange plan to comply with upcoming NPDES permit limits through a combination of plant upgrades and credit sales among members. Nonpoint source credits currently cannot be used by the Exchange.

The Virginia Department of Environmental Quality estimates that there are currently 30 to 45 new and expanding wastewater treatment facilities planned within Virginia's Chesapeake Bay watershed area with a capacity of greater than .04 million gallons per day (mgd). These facilities will receive no allocation for the discharge of total nitrogen (TN) or total phosphorus (TP) in their permits.[2] New facilities must be designed to the limit of technology for nutrient removal and obtain offsets for 100 percent of their actual TN and TP discharge. Existing facilities undergoing expansion may have to upgrade technology and must obtain nonpoint source credits to completely offset the increased discharge. If they are unable to locate sufficient nonpoint source credits, they can pay into the state-sanctioned Water Quality Improvement Fund. In turn, the Water Quality Improvement Fund will identify and purchase nonpoint source credits.

Pennsylvania

Pennsylvania was the next state to develop a nutrient trading policy, issuing guidance in 2006. Pennsylvania permit limits for TN and TP are applicable to all facilities with capacities greater than 0.2 mgd, totaling 251 plants. Permits will be issued in five phases beginning in 2010. Pennsylvania has stipulated that new and expanding facilities (regardless of size) will be given no allowances for TN and TP—thus these facilities will need to obtain offsets for all TN and TP they expect to discharge.

Unlike Virginia, existing wastewater treatment facilities have not created a trading association and are not limited to meeting permit requirements through point source credits only. To date, two wastewater treatment facilities (Mt. Joy Borough and Fairview Township) have already brokered trades for the purchase of nonpoint source credits that will come into effect in 2010 when permits are issued. In addition, the Harrisburg wastewater treatment plant has recently issued a request for proposals to provide 150,000 credits annually for five years as part of its compliance plan.

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[2] Personal communication with Allan Brockenbrough of Virginia Department of Environmental Quality.

[3] State negotiations and different Chesapeake 2000 commitments resulted in varying output standards for TN and TP permit limits in each state.

West Virginia

West Virginia recently submitted its final trading guidance for public comment. West Virginia plans to issue permit limits for TN and TP for existing major wastewater treatment plants on a rolling basis (as permits are renewed). Wastewater plants that do not meet permit requirements will have the option of upgrading their facility to meet effluent requirements, performing upgrades on minor plants not subject to the TN and TP limits, obtaining offsets by connecting septic systems to the treatment plant, or purchasing credits from point or nonpoint sources.

No new allocation for TN and TP discharges will be given to new and expanding facilities greater than .05 mgd. New and expanding sources greater than .05 mgd must offset 100 percent of their new nitrogen and phosphorus loads. Offsets can be obtained by performing upgrades on minor wastewater treatment plants not subject to the TN and TP limits, obtaining offsets through septic hook-ups, or purchasing credits from point or nonpoint sources.

Maryland

Maryland is in the process of developing its nonpoint source trading guidance. The state is unique in that it currently has a technology requirement for all major wastewater treatment plants. The 2004 Chesapeake Bay Restoration Act mandated that all major wastewater treatment plants were to upgrade to Enhanced Nutrient Removal (ENR) technology, while at the same time implementing a statewide sewer fee on households to finance the upgrades. The technology requirements cover the 65 major dischargers in Maryland. Facilities cannot trade to meet the technology requirement.

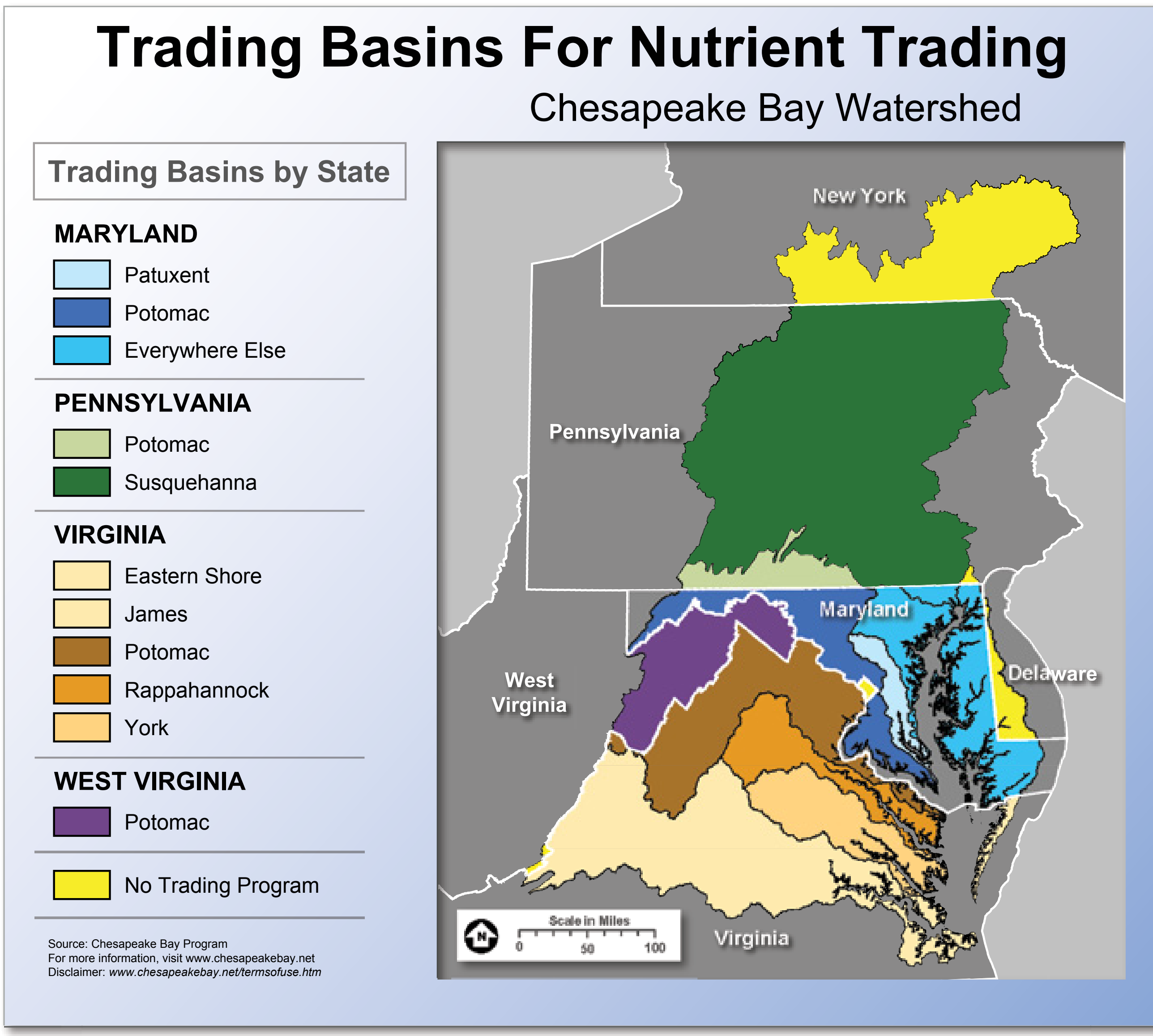
However, Maryland recognized the need to control nutrients from wastewater treatment plants in the face of regional growth and developed an offset program that can be sued for short-term compliance trading by plants that already have upgrades, and also as a source of offsets for new and expanding wastewater treatment facilities. Phase 1 of the policy has been finalized. It describes how facilities can trade for compliance purposes and how new or expanding wastewater plants can acquire offsets by upgrading minor facilities to ENR levels or by connecting residential septic systems to their ENR facilities. Point sources will receive credits for 12.2 pounds of nitrogen per year for every septic hook-up in a critical area; 7.5 pounds of nitrogen for every septic hook-up outside of the Critical Area but within 1,000 feet of perennial surface waters; and 4.6 pounds of nitrogen elsewhere. Septic hook-ups do not generate phosphorus credits. The Phase 2 policy, currently under development, will outline how facilities can purchase credits from nonpoint sources (primarily agriculture). The state is also considering a Phase 3 policy that will describe an offset policy for stormwater.

Trading Basins

Each state has established geographic trading basins that define where trades can occur. The trading basins are based on the major tributaries, except for one portion of Maryland. Maryland combined the Susquehanna, Eastern Shore and Western Shore into a single trading basin labeled "Everywhere Else" (See Figure 1). Trading between basins within states is currently prohibited. However, West Virginia, Maryland, and Pennsylvania have stated that interstate trading within shared river basins will be allowed (e.g., trading between Maryland's Potomac basin and Pennsylvania's Potomac basin). Virginia has also specified that it will allow the Blue Plains wastewater treatment plant, located in the District of Columbia, to trade in Virginia's Potomac basin.

A robust nutrient trading program is dependent upon the geographical boundary of the program having an appropriate balance of credit demand and supply. This analysis examines the potential supply and demand within each of these trading basins.

Figure 1



Demand Analysis

There are generally two scenarios in which regulated entities will require nutrient credits. First, existing regulated entities that are operating above their permit limits will need to acquire credits to remain in compliance with their permits. In many instances, this type of demand will be short term. That is, regulated facilities may acquire credits in order to meet permit requirements in the short term, but ultimately opt for technology upgrades or other types of permanent offset options.

Long-term demand will be driven by population growth—growth will create the need to expand existing wastewater treatment plants or construct new ones. Because most new and expanding plants will not have nutrient discharge allocations under the state regulatory policies, they will need to secure nutrient offsets before receiving a permit to operate.

The following demand estimates focus exclusively on demand from wastewater treatment plants. They do not include possible demand for credits from other regulated entities (such as municipalities) that must comply with stormwater permits.

Short-Term Demand

Pennsylvania, West Virginia, and Virginia are the only states where existing wastewater treatment plants are likely to use credits to meet permit requirements. In Maryland, existing wastewater treatment plants must upgrade to ENR technology and cannot purchase credits in lieu of upgrading. In Virginia, existing point sources have created a Nutrient Credit Exchange Association that develops annual compliance plans to meet permit requirements in each river basin through the trade of point source credits among members. Considering that Maryland does not allow trades in lieu of upgrades for existing facilities, and that Virginia has created an Exchange to ensure compliance with regulatory requirements among members, the analysis of short-term credit demand is limited to Pennsylvania and West Virginia.

The short-term demand from facilities in Pennsylvania and West Virginia was estimated by comparing projected 2010 nutrient loads from permitted facilities within each trading basin to the individual permitted nutrient load requirements expected to be implemented by 2010 or later. Where data indicated that a facility is scheduled to make an upgrade, the analysis assumes that the facility upgrades to meet treatment levels in its permit. For example, in the case of West Virginia the analysis assumes that an upgrading plant would adopt treatment levels equal to 5 mg/L for nitrogen and .5 mg/L for phosphorus.

The short-term demand analysis examines the following:

- The total potential demand within each trading basin;
- The number of potential point source credits that are available within each trading basin; and
- The percentage of total demand that will have to come from nonpoint sources (e.g., agriculture) or other offset options (e.g., septic hook-ups, minor facility upgrades) in lieu of plant upgrades, assuming all point source credits are exhausted.

The analysis shows that all trading basins in West Virginia and Pennsylvania will experience demand from existing regulated facilities that will need to purchase credits for compliance. Furthermore, the potential demand is likely to exceed the available supply of point source credits. Thus, with the exception of the Pennsylvania Potomac trading basin with respect to nitrogen, wastewater treatment plants will need to obtain credits from nonpoint sources or turn to other offset options such as septic hook-ups and facility upgrades.[4]

[4] Facility upgrade schedules were derived from data provided by the Chesapeake Bay Program. This dataset may be underestimating the number of facilities considering upgrades in light of the upcoming permit requirements. Additional facility upgrades would diminish the demand for credits to meet permit requirements in these basins.

In the Pennsylvania Susquehanna trading basin, for instance, existing wastewater treatment plants could potentially supply over 1.5 million pounds of nitrogen per year to facilities needing reductions to meet permit requirements. However, the total demand for nitrogen reductions is near 4 million pounds, so a minimum of 2.2 million pounds of nitrogen from other sources will be needed to meet permit requirements. Similarly, facilities in the West Virginia Potomac trading basin could require up to 90 percent of nitrogen and 100 percent of phosphorus offsets to come from sources other than point sources (Tables 2 and 3).

Table 2. Point Source Supply and Demand for TN to Meet Permit Requirements, 2010[5]

STATE	TRADING BASIN	TN Demand from WWTPs (lbs/year)	TN Supply from WWTPs (lbs/year)	Net TN Supply / Demand (lbs/year)	Percent of Demand NOT Met Through PS Credits
PA	Susquehanna	-3,894,446	1,655,107	-2,239,338	58%
PA	Potomac	-21,048	29,862	8,813	0%
WV	Potomac	-195,432	19,365	-176,067	90%

Table 3. Point Source Supply and Demand for TP to Meet Permit Requirements, 2010

STATE	TRADING BASIN	TP Demand from WWTPs (lbs/year)	TP Supply from WWTPs (lbs/year)	Net TP Supply / Demand (lbs/year)	Percent of Demand NOT Met Through PS Credits
PA	Susquehanna	-272,780	157,378	-266,025	42%
PA	Potomac	-17,843	5,156	-12,687	71%
WV	Potomac	-188,677	0	-137,892	100%

PS: point source, WWTP's: wastewater treatment plants, TP: total phosphorous, TN: total nitrogen

Long-Term Demand

Growth is expected to be the most important driver for nutrient trading in the Chesapeake region. Between 2000 and 2030, the region's population will likely increase by 29 percent, or 4.6 million persons.[6] The related residential and commercial development will create a demand for new or expanded wastewater treatment plants—and, in each of the Bay states, new and expanding wastewater treatment plants of a certain size must offset 100 percent of their nutrient load.

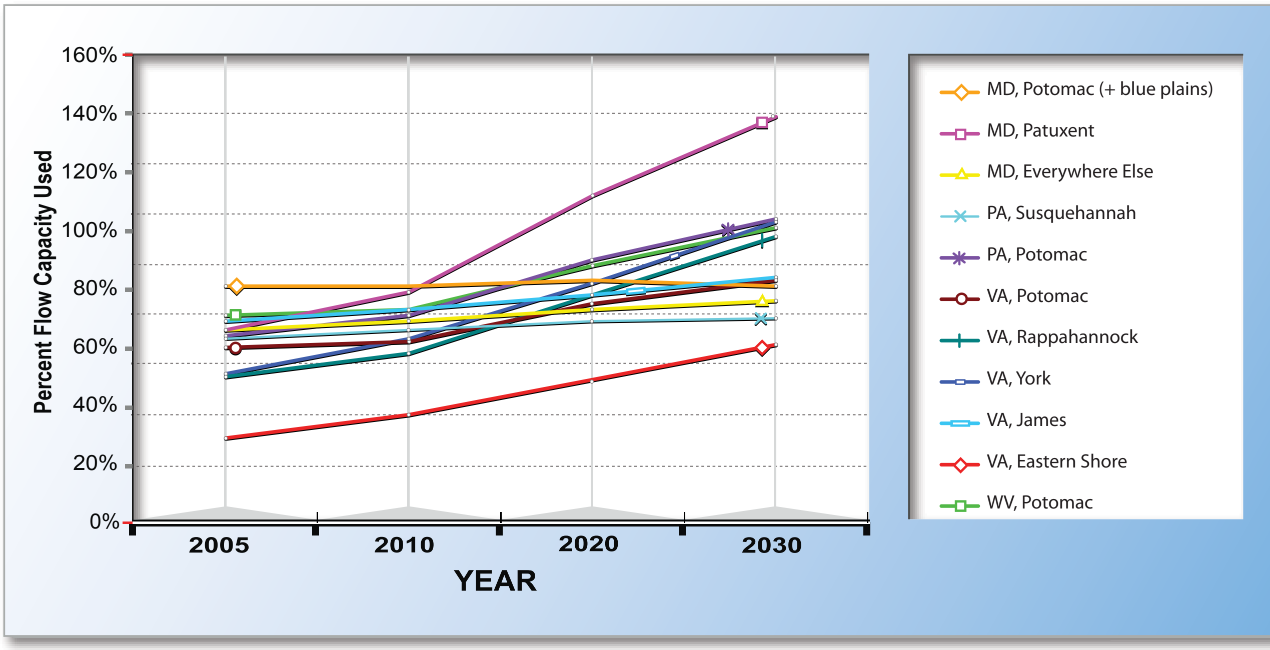
To assess the growth-driven, long-term demand for nutrient credits, this analysis looks at the existing total design flow capacity[7] of wastewater treatment plants in each trading basin. The total basin design flow capacity is then compared to the estimated gross wastewater (or flow) capacity requirements for each trading basin in 2010, 2020, and 2030 (Figure 2). The analysis shows that in 2010, two basins (Maryland's Potomac and Patuxent) are at or near 80 percent capacity. By 2030, all but three basins (Maryland's Everywhere Else, Pennsylvania's Susquehanna, and Virginia's Eastern Shore) are expected to exceed 80 percent of their existing design capacity. Four trading basins will have exceeded 100 percent of total design flow capacity by 2030; these basins include Maryland's Patuxent (39 percent), Pennsylvania's Potomac (4 percent), Virginia's York (3 percent), and West Virginia's Potomac (1 percent).

[5] Nutrient surplus and demand are expressed as pounds of nitrogen and phosphorus delivered to the Bay. According to the Pennsylvania trading policy, wastewater treatment plants must offset their discharges to the Bay, thus the credits they generate, and the credits that they need for compliance are subject to the Chesapeake Bay delivery factor. The delivery factors used to calculate these loads are those used in the respective trading programs for Pennsylvania and West Virginia.

[6] Chesapeake Bay Program population estimates for 2000 and 2030.

[7] The maximum wastewater capacity of a wastewater treatment plant as planned at time of construction.

Figure 2. Projected Flow Capacity Usage by Trading Basin



To estimate total nitrogen and phosphorus offset demand from future flow projections, the analysis assumes that trading basins will begin to add new wastewater flow capacity once the basin flow estimates within each basin reach 80 percent of existing flow capacity, and that all new flow capacity installed within trading basins after 2010 will be built and operated at the limits of technology in order to minimize the need to obtain nutrient offsets.[8] Table 4, below, presents the estimated nitrogen and phosphorus offset demand from long-term growth.

[8] Here, the limit of technology is assumed to be Enhanced Nutrient Removal, which operates at 3 mg/L N and 0.3 mg/L P.

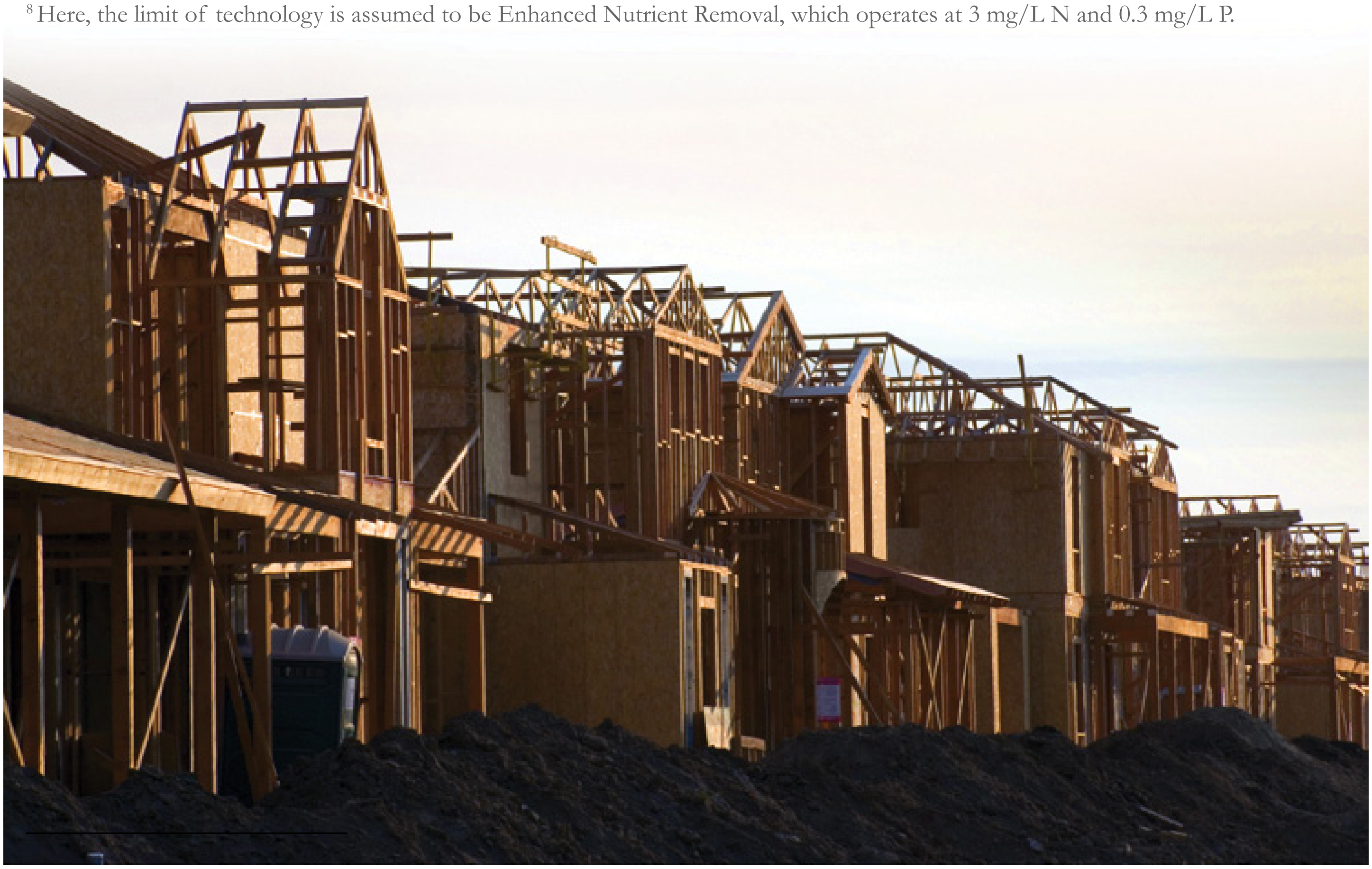


Table 4. Estimated Long-Term Nitrogen and Phosphorus Demand

Trading Basin	Projected Flow to be Offset (mgd)*	Total Nitrogen Offsets (lbs)**	Total Phosphorus Offsets (lbs)**
Patuxent, Maryland	-	-	-
Potomac, Maryland	53	583,614	39,880
Everywhere Else, Maryland	6	64,020	4,802
Potomac, Pennsylvania	4	49,091	6,545
Susquehanna, Pennsylvania	-	-	-
Eastern Shore, Virginia	-	-	-
James, Virginia	19	147,681	28,457
Potomac, Virginia	11	122,363	9,483
Rappahannock, Virginia	8	84,031	7,162
York, Virginia	8	310,752	17,409
Potomac, West Virginia	3	26,723	2,751

*This is projected flow that is in excess of 80 percent of current design capacity. mgd: million gallons per day
** Nitrogen and phosphorus offset demands are expressed in terms of delivered pounds. In order to express delivered pounds, a weighted delivery ratio was created for each trading basin based on the current distribution of wastewater treatment plants within the basin.

Given the localized nature of development, individual facilities within the trading basins will expand existing capacity or new facilities will be built before an individual trading basin reaches the upper limits of its aggregate flow capacity. The demand estimates presented here should be considered only as a rough indication of which trading basins are likely to experience strongest demand for nutrient offsets as a function of growth. Furthermore, it is entirely possible that Virginia's Eastern Shore, Maryland's Everywhere Else, and Pennsylvania's Susquehanna basins—which show no demand for offsets in our aggregate analysis—will in fact experience offsets demand as a function of new development that happens in non-sewered areas, or expanded development that occurs in areas where the existing wastewater treatment plant is at or near capacity.

Supply Analysis

The demand analysis shows that there is likely to be both short-term and long-term demand for credits from point sources, but the timing and extent of this demand will vary by location. While a portion of this demand may be met via credits from other point sources operating below their permit limits, it is likely that the majority of credit supply will be from nonpoint sources (e.g., agricultural operations, forest management), or other offset methods approved by the states (e.g., septic hook-ups, minor facility upgrades).

Supply of nonpoint source credits from agriculture will strongly depend on how the agricultural baseline is determined. The baseline is the level of performance that an operation or individual field must meet before it can generate nutrient reduction credits through additional actions. In the context of a TMDL, agricultural baselines help to ensure that the reductions required by the agricultural sector to meet its load allocation are not traded away as offsets in other sectors; this means that only reductions above and beyond the TMDL requirements can generate credits.

In the various state programs, the agricultural baseline is defined differently (Table 5). In West Virginia and Maryland, the agricultural baseline is set as a numerical load limit that must be met by a farm or operation. In Pennsylvania and Virginia, the agricultural baseline is expressed in terms of the types of practices that must be in place before a farm can generate credits.

The approximate level of performance required by the agricultural baseline also varies by state. In Maryland and Virginia, the baseline is set to the approximate level of reductions that a farm would have to make in order to meet the Tributary Strategies. In Pennsylvania and West Virginia, the baseline is set lower than Tributary Strategies, allowing farmers to generate tradable credits before the operation itself has met the level of reductions called for in the Tributary Strategies.

Table 5. Current State Baseline Requirements for Agriculture

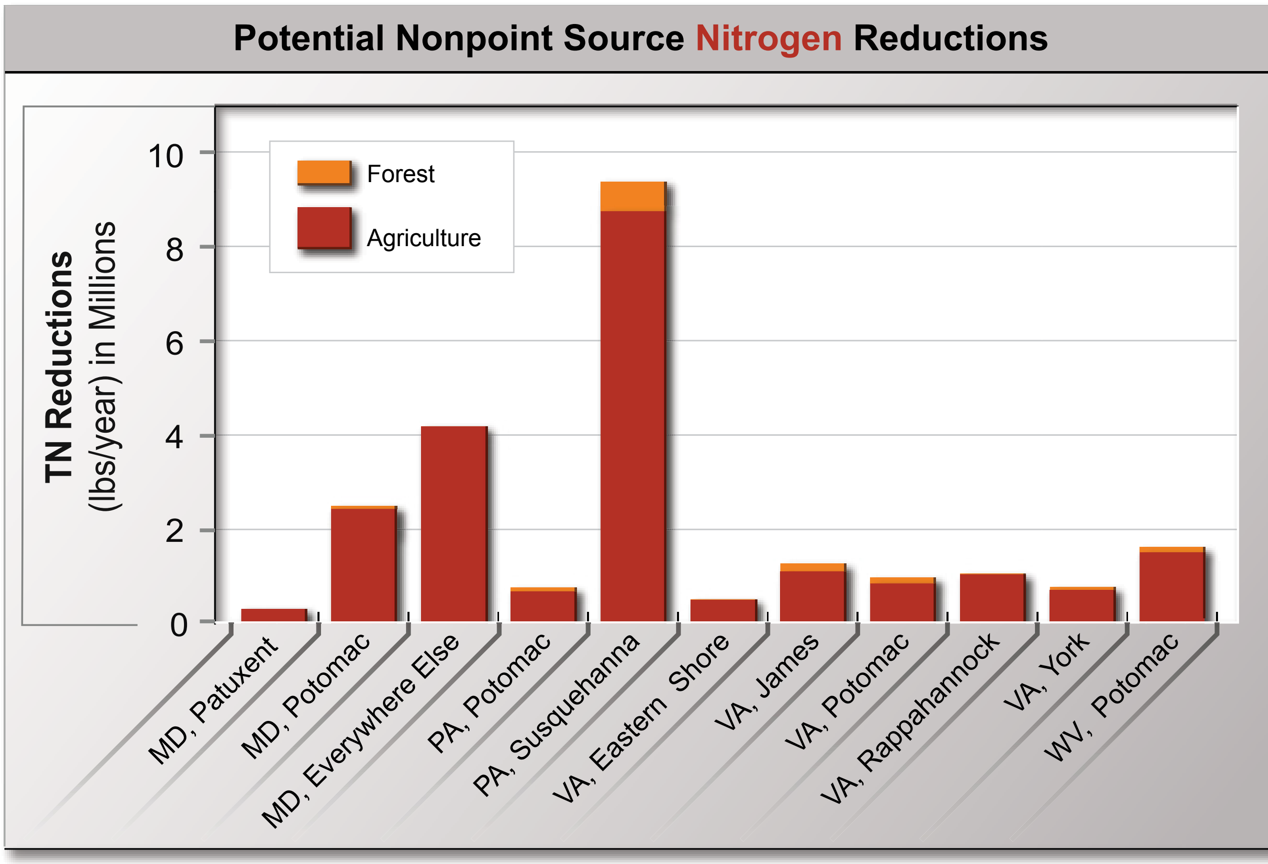
STATE	Agricultural Baseline Requirements
Pennsylvania	**Farmers must have implemented one of the following best management practices:** • 100 Foot setback or equivalent; this is achieved when ONE of the following is met: • Manure is not mechanically applied within 100 feet of surface water; • There are no surface waters on or within 100 feet of the farm; • Farm uses no manure application and applies commercial fertilizer at or below the Penn State recommended agronomic rates. **OR** • 35 Foot buffer or equivalent; this is achieved when all of the following are met: • A minimum of 35 feet of permanent vegetation is established and maintained between the field and surface water. • Area can be grazed or cropped under a specific management plan, and permanent vegetation must be maintained at all times. (Permanent vegetative buffers 50' or greater in width may qualify to generate nutrient reduction credits.) **OR** • 20 % reduction option • A reduction of 20% in the farm's overall nutrient balance beyond baseline compliance.
Virginia	**Farmers must implement the following best management practices that are applicable to their operation:** • soil conservation (i.e., the operation must achieve soil loss tolerance value of T or less), • implemented nutrient management plan, • cover crops (late planting), • stream bank fencing with a minimum 35 foot set-back (pasture only), and • 35 foot vegetated riparian buffers.
Maryland	**Farmers must achieve modeled Tributary Strategy nitrogen and phosphorus load levels for agricultural land. These loads will vary by watershed segments.**
West Virginia (under developement)	**Farmers must achieve modeled 2007 nitrogen and phosphorus load levels for agricultural land. As of the date this paper was published, West Virginia was continuing to review the model year that would be used to set the baseline.**

There is a general consensus that once a Bay-wide TMDL brings increased scrutiny on the progress of all sectors towards meeting water quality goals, states will be obliged to set agricultural baselines at or near those levels called for in the TMDL. Therefore, this analysis examines the potential for nonpoint source credit supplies under a TMDL scenario. Because TMDL allocations have not yet been made, this analysis uses comparable Tributary Strategy sector allocations as a proxy for TMDL sector allocations. The analysis assumes that agricultural operations in each of the state programs must meet the baseline level of reductions called for in the Tributary Strategies before being eligible to generate reductions for nutrient trading markets.

Potential nonpoint source credit supplies are estimated by calculating the difference between the levels of reductions needed to reach Tributary Strategy goals and the maximum level of potential reductions that are possible for any single sector.[9] The maximum level of potential reductions is defined as the estimated nutrient load reductions that could be achieved if the maximum level of controls were applied to all load sources.

The analysis shows that forestry management practices will have very little potential to generate nutrient credits, and the vast majority of nonpoint source credits will come from agricultural operations. The analysis highlights that there are some trading basins with a comparative advantage for generating nitrogen and/or phosphorus credits: the Pennsylvania Susquehanna basin has a high potential supply for nitrogen credits, and the Virginia Potomac and Virginia James basins have a relatively high potential to supply phosphorus credits (Figures 4 and 5).

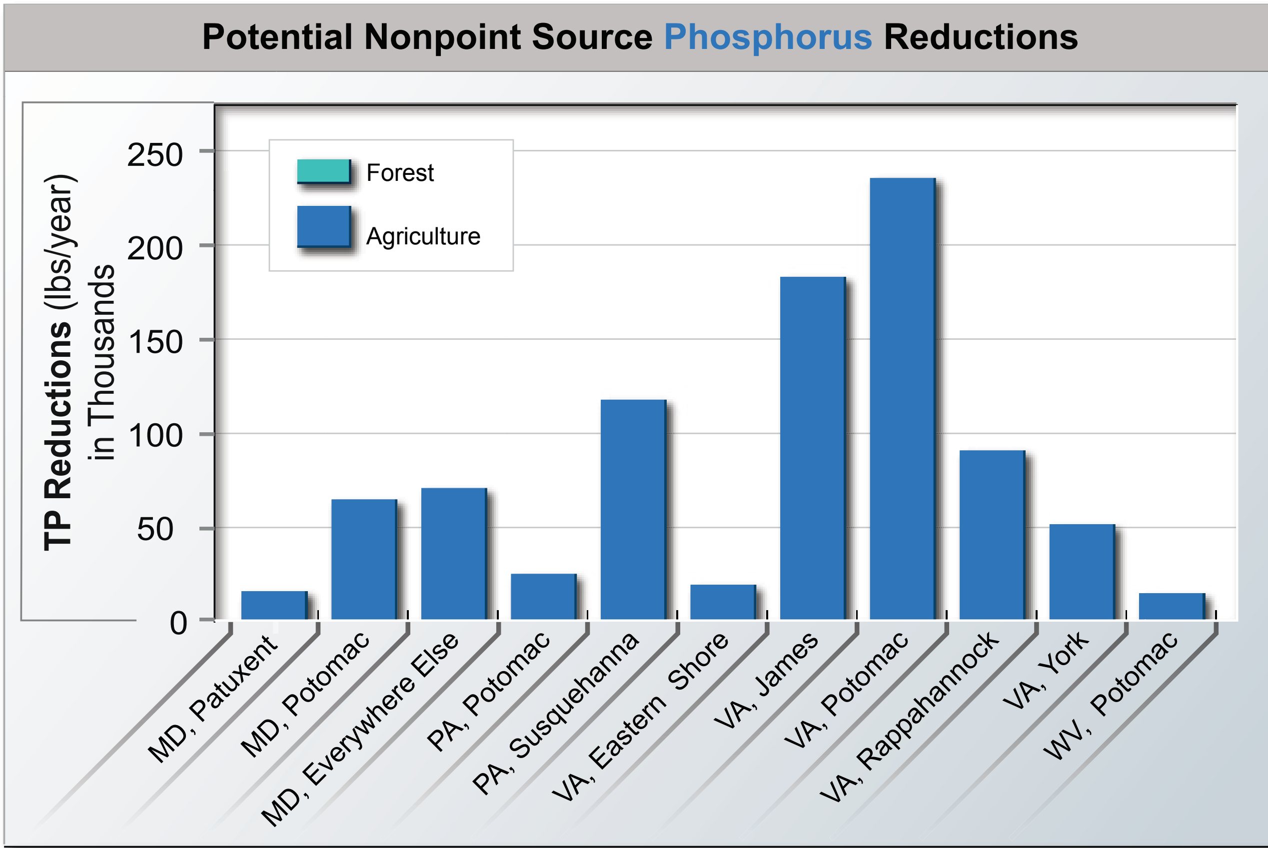
Figure 4.



Source: Chesapeake Bay Watershed Model Phase 5.2

[9] Maximum feasible levels of reduction are based on best management practices that are currently in use in the region and are peer-reviewed and approved by the Chesapeake Bay Program. Innovation in the area of nutrient reduction could achieve a higher maximum feasible level as new practices are implemented and approved.

Figure 5.



Source: Chesapeake Bay Watershed Model Phase 5.2

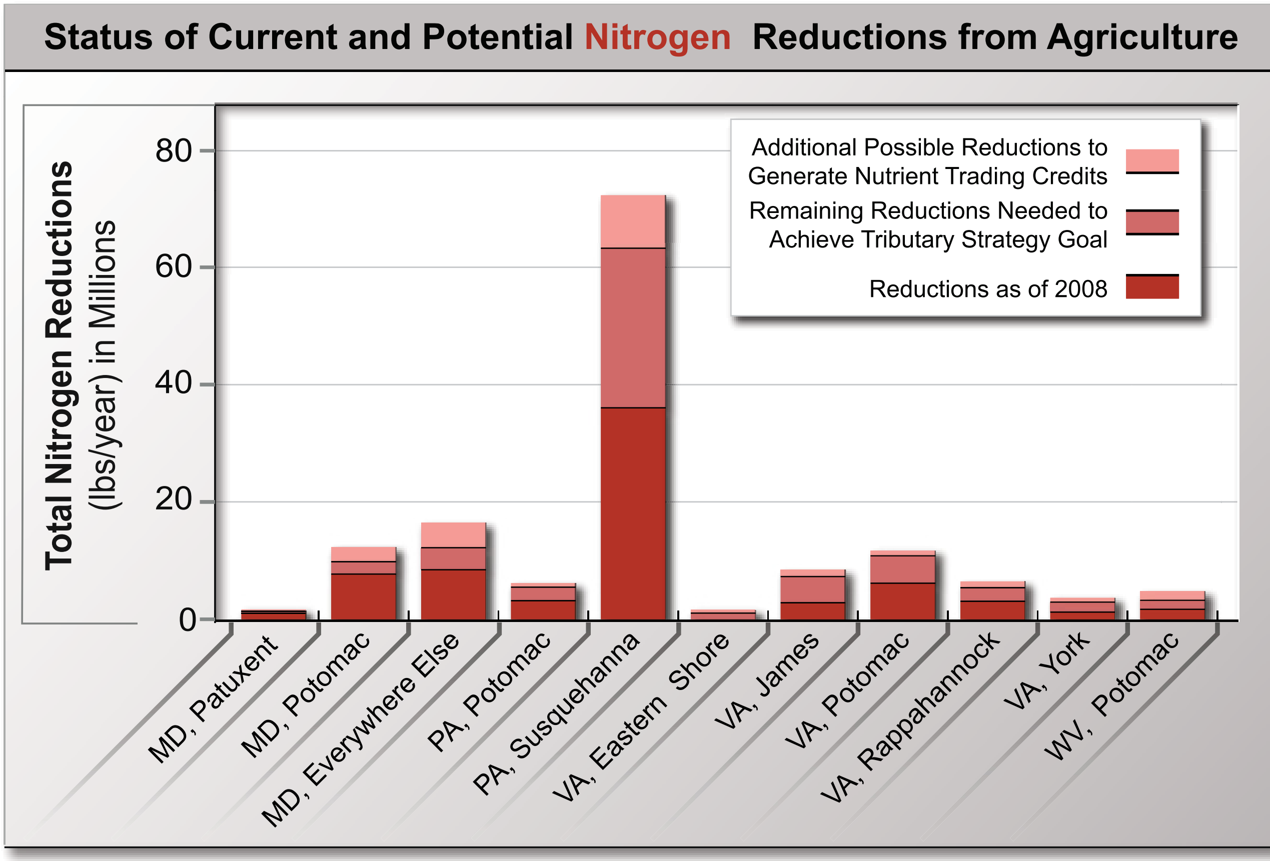
Discussion

Implications for Nonpoint Source Credit Supply under a TMDL

It is a common misconception that nutrient trading can help agriculture meet its obligations under a TMDL. In fact, the agricultural baselines of each program are (or will likely be) set at a level that is equal to the TMDL reduction goals, thus preventing agriculture from trading reductions that are needed to meet the agricultural sector's obligations under the TMDL. However, it is possible that the potential financial returns from a trading market will create the incentives for agricultural operations to implement the practices necessary to meet TMDL goals (to achieve the baseline) and thus be able to participate in the market. In addition, it is hoped that nutrient trading will provide incentives to develop new and innovative practices that will effectively increase the amount of potential nutrient reductions from any single sector.

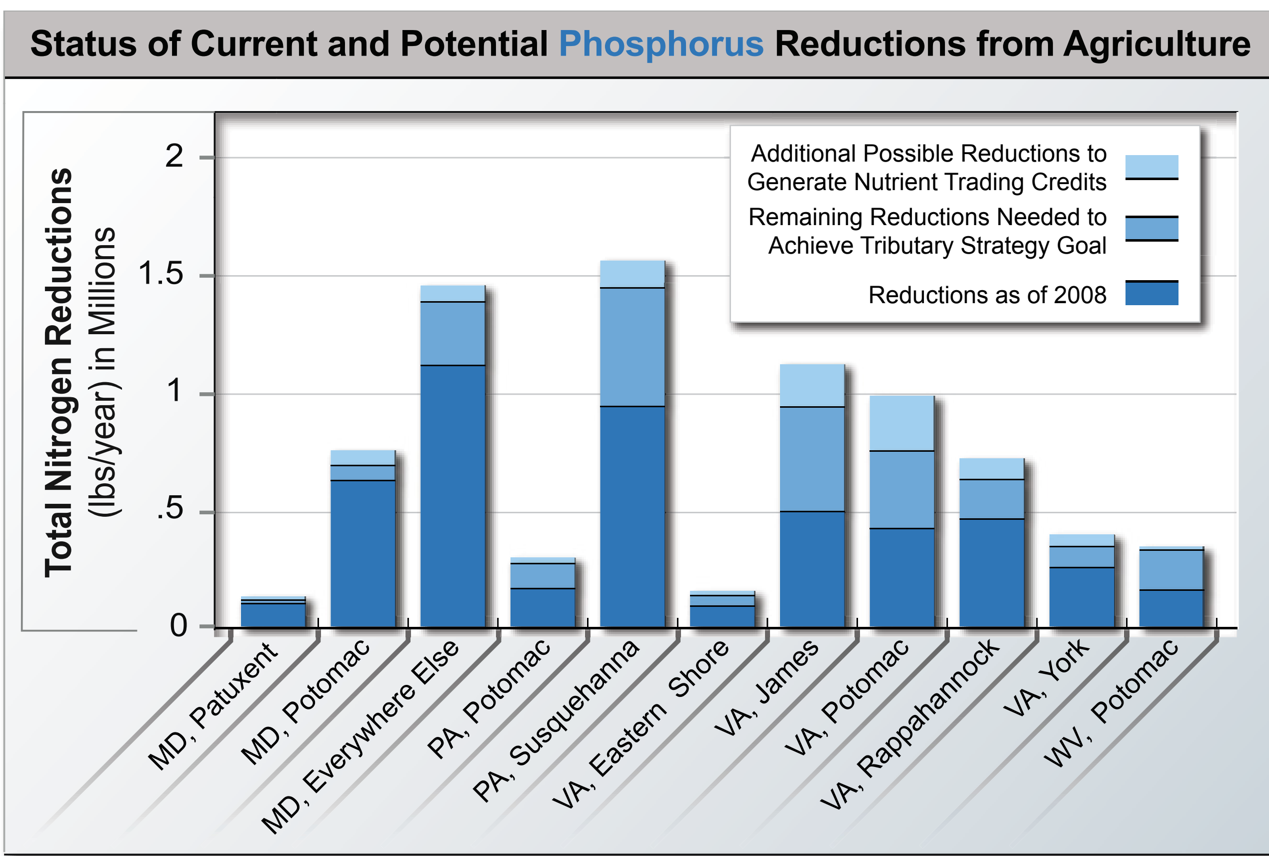
Figures 6 and 7 show the total reductions that recent modeling suggests would be required under the Tributary Strategies. The blue segment shows progress made since 1985 towards the nitrogen and phosphorus goals within each trading basin. The red segment of each bar represents the progress that is yet to be made towards meeting the Tributary Strategy goals. This gap can be made up through the implementation of additional practices financed in part through federal and state cost share programs, private revenue streams, or possibly other markets for ecosystem services. The final segment of each bar represents an estimate of the total nitrogen and phosphorus reductions that can be generated beyond what has been proposed by Tributary Strategies, and are thus eligible to generate credits.

Figure 6.



Source: Chesapeake Bay Watershed Model Phase 5.2

Figure 7.



Source: Chesapeake Bay Watershed Model Phase 5.2

Cost of Agricultural Nonpoint Source Credits

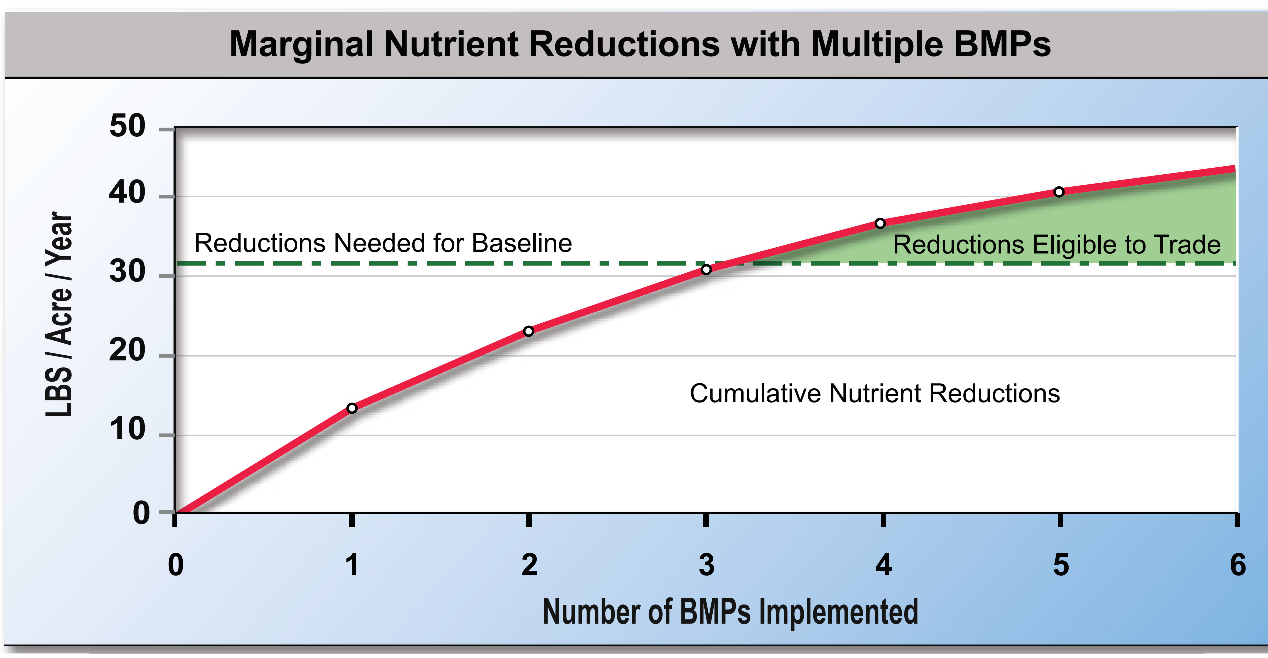
Given that the state nutrient trading programs have (or will have) high baselines for agriculture, it is likely that the most cost-effective agricultural reductions will be in place before a farm becomes eligible for generating credits. Therefore, the reductions that can be achieved beyond TMDL obligations will be more difficult and/or relatively more expensive to attain.

For example, if the average farm on Maryland's Eastern Shore were to install a riparian grass buffer on one acre, the total nitrogen reductions would be approximately 41 lbs/N per year. However, the same buffer would deliver different results on a farm that has already met baseline requirements.[10] In this setting, the buffer would be treating a lower nutrient load, with a smaller amount of remaining possible reductions. Therefore, the total nitrogen reductions resulting from the new buffer would also be lower, at approximately 22.5 lbs/N per year.

Given an annualized installation and maintenance cost of $200 per year for the life of the riparian grass buffer and assuming that costs are equal for both farms, the cost of reducing a pound of nitrogen on the farm with a nitrogen load of 20 lbs/N per acre is nearly $5 lb/N; the cost of reducing a pound of nitrogen on the farm that has met baseline requirements is closer to $9 lb/N. This example illustrates the influence that baseline requirements are likely to have on the costs of generating nitrogen reductions, which may in turn affect credit prices.

Figure 8 shows the hypothetical diminishing marginal nutrient reductions from successive best management practices (BMPs) implemented on the same field. The figure highlights the fact that the marginal nutrient reductions that can be achieved by implementing additional BMPs on agricultural operations that have already reduced their nutrient loads to baseline levels will be small. As a result, we expect that reductions that are eligible to sell in a nutrient trading market are likely to be more costly per pound of nutrient reduced than those reductions that can be achieved below baseline.

Figure 8.

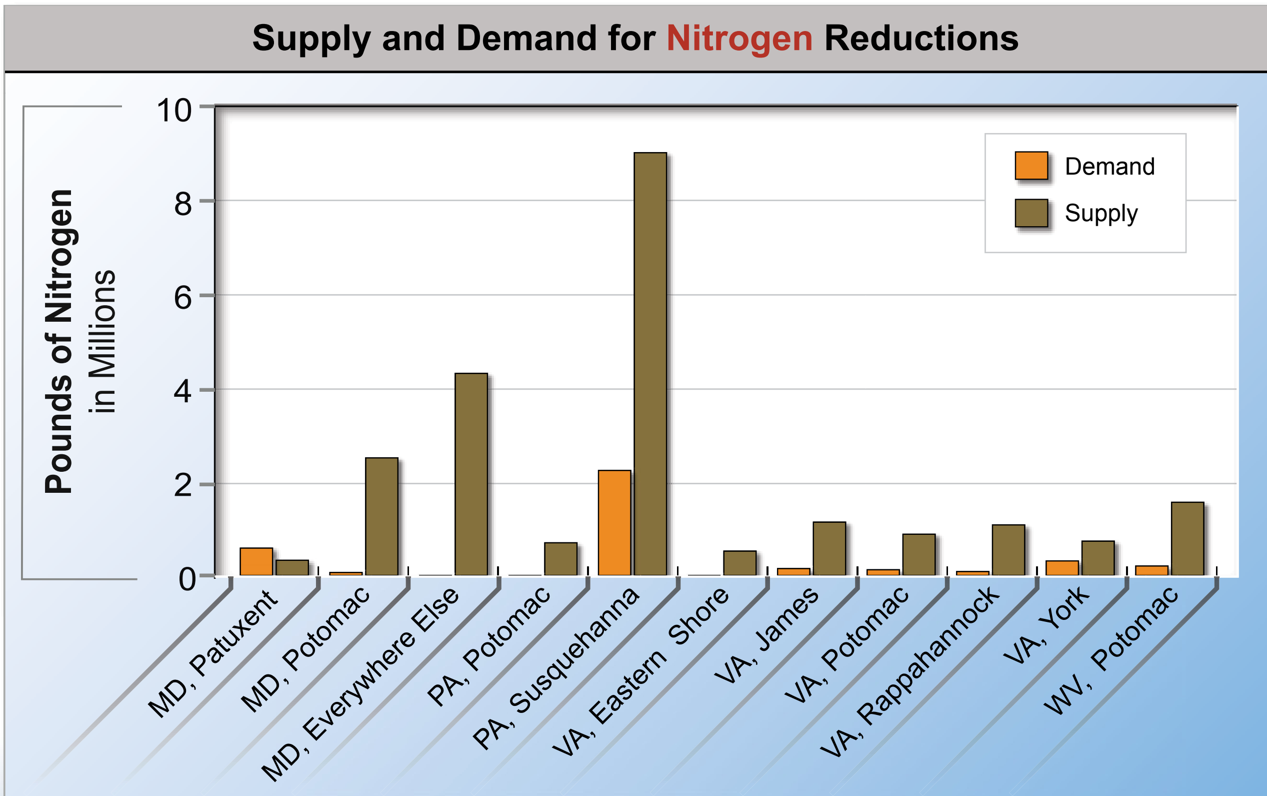


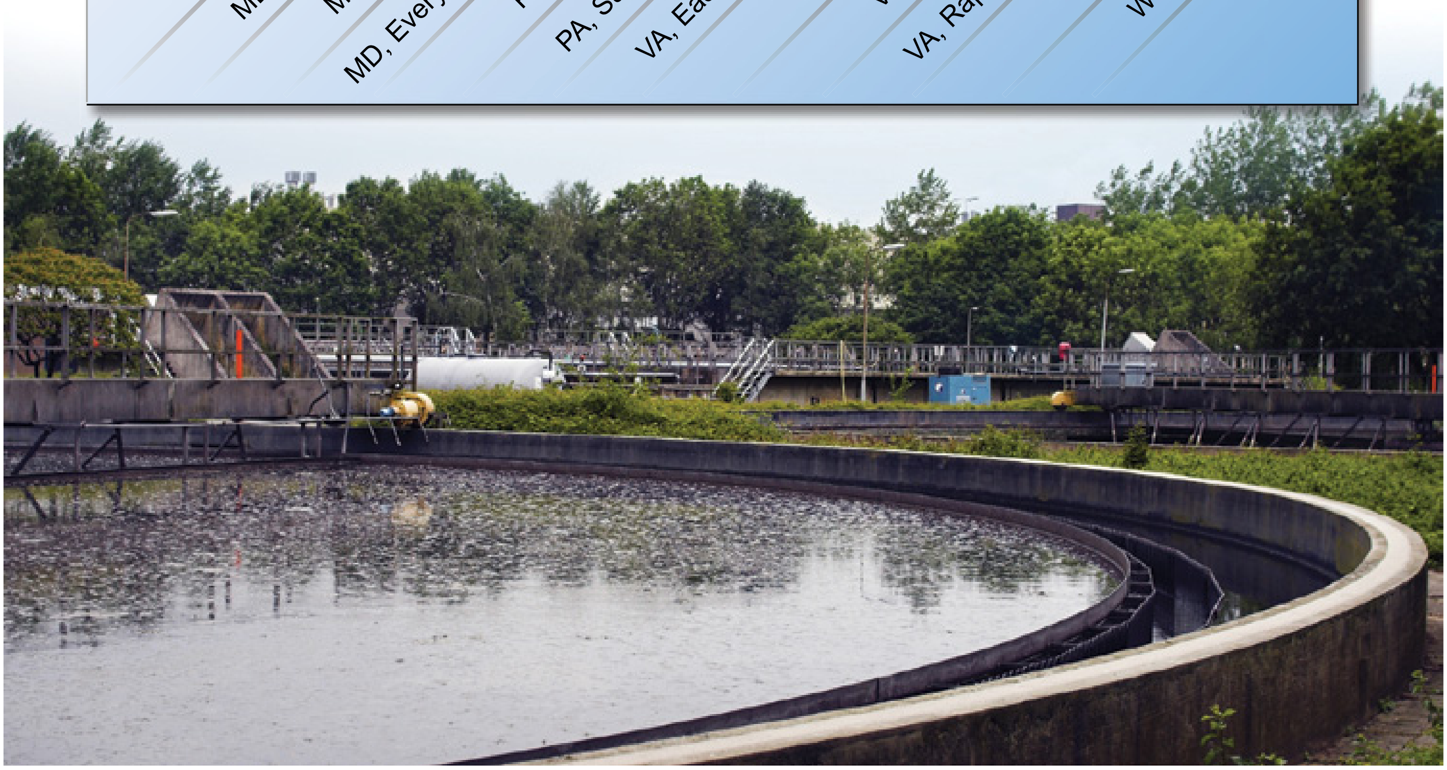
[10] In 2007, the average nitrogen load of a farm on Maryland's Eastern Shore was 20 lbs/N per acre, while a farm that has met baseline requirements would have a total nitrogen load of approximately 11 lbs/N per acre.

Constraints within Basins

According to this analysis, there is likely to be a mismatch between trading basins with high demand and those with high supply of nonpoint source credits, especially in the case of phosphorus. Most basins have adequate supply to meet demand based on a comparison of short-term and long-term demand projections and agricultural supply estimates. However, the estimated nitrogen offset demand in the Maryland Patuxent trading basin exceeds its estimated nitrogen supply, while three basins—Pennsylvania Susquehanna, Maryland Potomac, and Maryland Everywhere Else—have significant opportunities to generate nitrogen credits beyond the estimated demand (Figure 9).

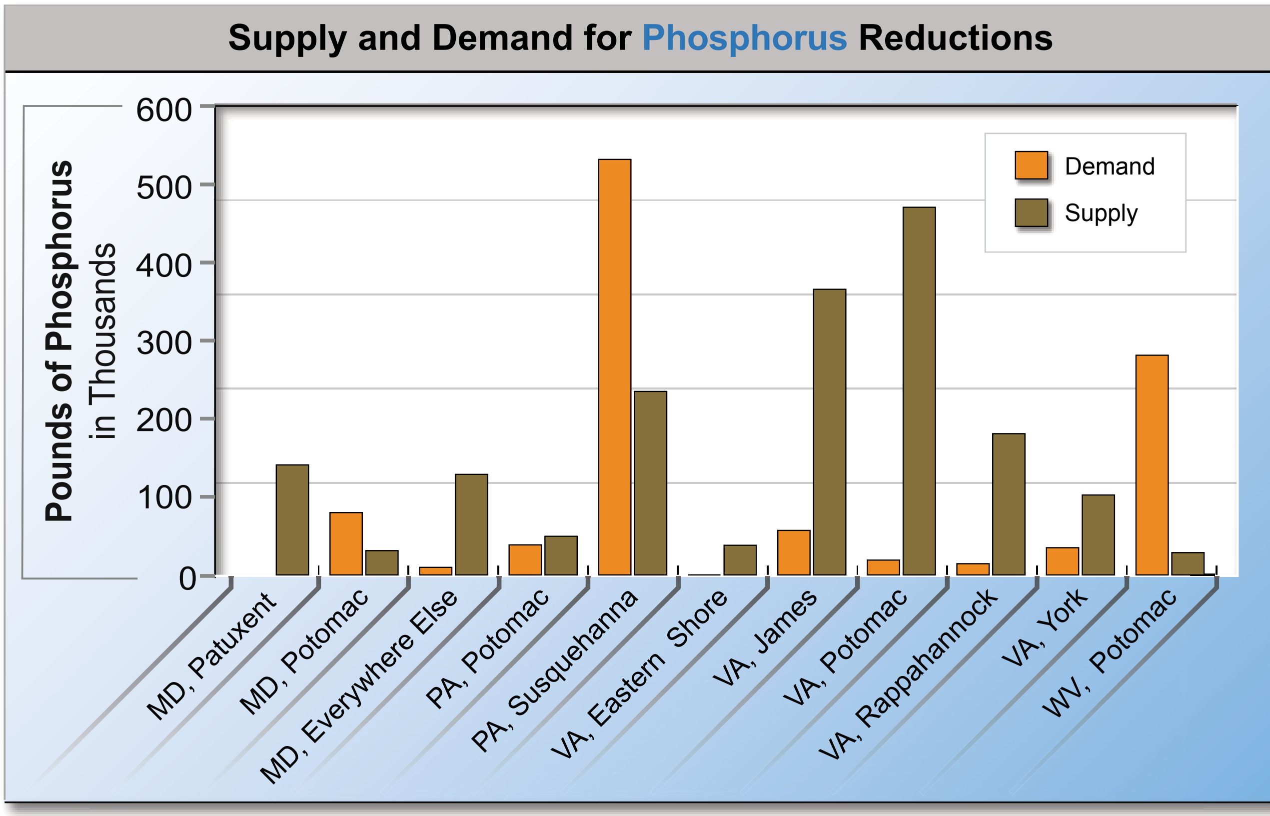
Figure 9.





In the case of phosphorus, three trading basins (Maryland Patuxent, Pennsylvania Susquehanna, and West Virginia Potomac), cannot meet their estimated demand given the current estimates for phosphorus credit supply from agriculture (Figure 10). The Maryland Everywhere Else, Maryland Virginia James, Virginia Potomac, and Virginia Rappahannock basins, on the other hand, have the greatest capacity to generate credits in excess of their estimated demand.

Figure 10.



Credit generating capacity from other nonpoint sources (such as forest management operations) is minimal and was not included in the figures presented above.

This analysis does not consider the supply of nutrient offsets available through other options, such as septic hook-ups, minor facility upgrades, and new technology. Septic hook-ups generate offsets only for nitrogen, and will be limited by location. A market demand for cheap and plentiful nutrient reductions, however, will stimulate investment in the research and development of technologies that can supply additional credits in the future.

Demand estimates presented here are the sum of short-term demand and long-term demand from wastewater treatment plants. In the case of short-term demand, the demand represented is only the portion of demand that remains once all potential point source credits are exhausted. It is important to keep in mind that once a TMDL nutrient cap is in place, there may be demand for nutrient credits from categories other than wastewater treatment plants. For example, municipalities with MS4 stormwater permits may be able to satisfy some of their nutrient reduction obligations and offset growth through the purchase of credits. The additional demand from these types of sources was not included in this analysis.

Credit shortages in a basin may result in restricted growth capacity. Interstate-interbasin trading for the Chesapeake region has recently been proposed under a bill introduced by Senator Cardin of Maryland, and a bill, introduced by Congressman Cummings of Maryland. An interstate-interbasin trading program would allow basins with excess supply to sell to basins with supply shortages and create greater opportunities for growth in basins with limited supplies of nonpoint source credits.

Conclusion and Recommendations

Demand for nutrient offsets will be present in both the short term, to meet regulatory requirements, and in the long term, to accommodate growth in the watershed. Nutrient trading between point sources will not be sufficient to meet these demands; therefore, wastewater facilities will need to secure a significant portion of their offsets through nonpoint source credits and/or other offset options (such as septic hook-ups). While short-term demand might eventually resolve itself as existing plants begin to upgrade, demand for credits to offset new and expanding wastewater treatment plants is expected to increase over time as population within the region grows.

While demand for credits in the Bay states will be relatively strong in the coming years, the implementation of a Bay-wide TMDL is likely to affect the availability and price of credits. To comply with a TMDL, nutrient trading programs must set agricultural baselines at a level that satisfies the agricultural sector’s TMDL allocation. Currently, Maryland and Virginia have agricultural baselines that approximate this level, but West Virginia and Pennsylvania will likely have to revise their agricultural baselines to comply with the forthcoming TMDL. High baselines affect credit supplies in two ways:

- Fewer farmers, at the outset, will qualify to generate credits because only a minority of agricultural operations will initially meet baseline requirements; and

- There are fewer possible reductions to be generated beyond the reductions that are already required to meet baseline.

As a result, we expect the cost of generating agricultural nonpoint source credits to be higher than the cost of achieving the reductions needed to achieve baseline. This analysis does not predict the price of credits and only speaks in relative terms about the cost of producing credits. However, while price can be an important determinant of demand in the short term (i.e., a facility may choose to upgrade instead of purchase credits if credit prices exceed the marginal abatement cost at the facility), facilities facing long-term demand will likely be willing to pay higher prices. In the case of long-term demand, the decision on whether or not to purchase credits will be weighed against the effects of limited growth.

Finally, there is likely to be a geographical mismatch between potential supply of nonpoint source credits and demand for credits within trading basins. Several trading basins, especially in the case of phosphorus, cannot meet predicted demand through nonpoint source agriculture and point source credits alone. Meanwhile, other basins have the capacity to generate nutrient reductions in excess of their estimated demand.

In order to ensure that wastewater treatment plants can cost-effectively meet their permit requirements, and more importantly, that the watersheds are able to sustain growth under a nutrient cap, we recommend the following:

1. ***Facilitate the financing of practices that help farmers meet the agricultural baseline and qualify to participate in nutrient trading.*** Baseline requirements in the Chesapeake region are necessarily stringent and reflect Tributary Strategy implementation levels. State and federal funds are currently used to fund BMPs on farms via programs like the Environmental Quality Incentives Program (EQIP). In addition to traditional conservation programs, several opportunities exist to link farmers and forest landowners to funding streams available through environmental markets. Bay Bank will begin helping farmers and forest landowners navigate these new opportunities in 2010. Leveraging funding effectively to help farmers meet baseline requirements not only facilitates agriculture's meeting of its TMDL obligations, but also creates a greater number of potential credit suppliers in the basin.

2. ***Encourage innovative practices for reducing nutrients.*** The supply of agricultural nonpoint source credits is based on maximum potential implementation of a limited number of agricultural practices. Innovative practices, not previously considered in the Tributary Strategies, can create additional nutrient reduction opportunities that are not presented here. Some practices or technologies that have potential to generate additional nutrient reductions include precision agriculture, algal turf scrubbers, and oyster aquaculture.

3. ***Allow for interstate-interbasin nutrient trading.*** Our analysis shows that in many cases supply and demand are mismatched within trading basins. The proposed Cardin bill that, among other things, proposes to establish an interstate trading program, would allow for basins with greater supplies of credits to sell to basins where credit supplies are low, as long as local water quality standards are upheld. Interstate-interbasin trading may also:

- Provide more certainty to a jurisdiction's ability to accommodate planned growth;
- Help create a level playing field among the states for growth;
- Minimize jurisdictional inequalities due to differing rules and requirements among the states;
- Make the cheapest credits in the Bay watershed available to all buyers, not just those in a restricted geographical area;
- Increase competition among credit sellers, leading to lower credit prices;
- Preclude credit monopolies or artificially restricted supplies;
- Create additional opportunities for generating credits; and
- Produce a more stable and reliable supply of credits.