SAVING THE CHESAPEAKE BAY TMDL:

THE CRITICAL ROLE OF NUTRIENT OFFSETS

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Preface

This report was prepared as part of the environmental policy workshop at the School of Public Policy of the University of Maryland. The environmental policy workshop is a course in the masters degree program of the School. Each masters student devotes a full semester of course work to the study of an important public policy issue. In the spring of 2012 there were five workshop students – Melanie Foley, Jeremy Hanson, Giuliana Kunkel, Fernando Saltiel, and Laura Vykol -- studying policy issues relating to the role of offsets in implementing the Chesapeake Bay TMDL. The combined efforts of these students amounted to more than 700 hours, including review of the literature, meetings with experts, and other methods of study. The environmental policy workshop is supervised by Professor Robert H. Nelson of the environmental policy program of the School of Public Policy.

In addition, also during the spring 2012 semester, two other master students at the School of Public Policy were engaged individually (as part of the "project course" that is also supervised by Professor Nelson) in the intense study of policy issues relating to the Chesapeake Bay cleanup – Nathan Bowen and Mark Smith. Parts of their work were incorporated into this report, including parts of Chapters 2, 3, and 4 that were originally drafted by Mr. Bowen. Yu Zhang and Lindsay Ehrhart worked as research assistants for Professor Nelson and contributed significantly to the finalizing of the report in the fall of 2012.

The Executive Summary presents the principal findings, conclusions and recommendations. The report is available on the web under "professional papers" and "Robert Nelson" at http://www.publicpolicy.umd.edu/nelson/workshop. The contributing students do not necessarily agree with every finding and recommendation of this report.

<u>Contributing School of Public Policy Students</u>

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Executive Summary – A Brief Review of the Argument

The original signees to the 1983 Chesapeake Bay Agreement included Maryland, Virginia, Pennsylvania and the District of Columbia. At the federal level the Environmental Protection Agency was also an original signee. They were joined in 2000 by the headwater states of New York State and Delaware and in 2002 by West Virginia, the other three states within the Bay watershed. The Chesapeake Bay cleanup was a prominent U.S. example of voluntary state and federal participation in achieving an important American environmental protection goal. In this respect, it offered a different approach as compared with the usual federalization of environmental protection responsibilities – with states operating under direct federal oversight – under the Clean Air Act of 1970 and the Clean Water Act of 1972.

In 1987 a further agreement set a target of a 40 percent reduction by 2000 in both nitrogen and phosphorus nutrient flows into the Bay. In the event, reductions of 15 percent in nitrogen flows and 24 percent in phosphorus flows were achieved by 2000. Having fallen short of the 40 percent target, and with greater knowledge concerning the harmful effects of nutrient pollution in the Bay, a new agreement among the states, *Chesapeake 2000*, was signed in 2000. This set new targets for nitrogen flow reductions of 54 percent (162.5 million pound reduction from 1985 levels), phosphorus flow reductions of 68 percent (14.36 million pound reduction from 1985 levels) and sediment flow reduction of 74 percent (1.69 million ton reduction from 1985 levels) to be achieved by 2010. As part of a 1999 court settlement, it had also been agreed that, if the targeted *Chesapeake 2000* reductions were not achieved by 2010, the EPA would itself write a new Bay cleanup plan (formally, a plan to attain "Total Maximum Daily Loads", also known as a "TMDL") under the authority granted to EPA in the Clean Water Act. This would effectively federalize the responsibility for Bay cleanup, bringing it into closer conformity with the typical pollution cleanup methods under the Clean Air Act and Clean Water Act.

As the year 2010 approached, it was clear at least several years in advance that the 2010 targets that had been set in 2000 would not be achieved. EPA began preparing, working with the states within the Bay watershed, for the process of writing a Bay TMDL. This included TMDL planning documents such as *The Next Generation of Tools and Actions to Restore Water Quality in the Chesapeake Bay*, issued by an EPA-led working group in 2009. President Obama issued an executive order setting out federal policies for Bay cleanup in 2009.

Following such guidance, the EPA formally published a Bay TMDL in December 2010. The 2010 Bay TMDL set interim pollution targets for 2017 and final targets for 2025 for nitrogen flows, phosphorus flows, and now sediment flows. As compared with 2010, the interim 2017 targets required at least 60 percent of actions completed, designed to achieve significant reductions of 15 percent for nitrogen, 14percent for phosphorus, and 12 percent for sediment. The final 2025 targets required reductions from 2010 of these pollutant flows of 25 percent, 24 percent, and 20 percent, respectively.

For each pollutant, the overall Bay targets were also disaggregated into 2017 and 2025 pollution targets for each of the six states (and the District of Columbia) in the Bay watershed. The individual states and District then each further disaggregated the TMDL pollution targets among the main sectors from which Bay pollution flows originate: agriculture, sewage treatment plants, stormwater runoff, and septic tanks. (See Chapter 1 for further details on this process. As part of an overall "accountability framework" established for the Bay cleanup by EPA, a new system of two-year milestones was also established to provide for more frequent monitoring of progress towards the 2017 and 2025 targets and sub targets.

The Bay states and the District were also individually charged with further disaggregating their Bay TMDL targets by operating jurisdictions that would implement the actual pollution reductions within each of the states. This was undertaken through the development of Phase 1 and Phase 2 watershed implementation plans (WIPs) in 2011 and 2012. For agriculture, the responsibility for TMDL implementation is assigned to individual soil conservation districts, typically organized along county lines. For other sources of Bay pollution, the on-the-ground implementation responsibilities normally fall on county governments – although in some cases it is a municipal government. Each soil conservation district and county within the Bay watershed receives an overall pollution target for 2017 and 2025, as set by the state government working in consultation with these implementation agencies.

Maryland published its Phase 1 WIP in December 2010, a draft Phase 2 WIP in January 2012, and a final Phase 2 WIP in March 2012. As of the summer of 2012, all the Bay states and the District had completed their final Phase 2 WIPs. The states also included two-year milestones for 2012-2013 that set out specific benchmarks to be achieved by each implementing agency within this timeframe. Further details relating to the workings of this process and the overall Baywide, state-level, and implementation-level planning targets – as further disaggregated by pollution source and WIPs -- are provided in Chapter 1 of this report (as of the summer of 2012).

The ultimate result of the 2010 Bay TMDL is thus literally hundreds of specific pollution reduction targets for 2017 and 2025 for geographic jurisdictions ranging from the entire Bay to the states and finally the local soil conservation districts and the local counties and municipalities. In concept, these targets have the force of a legal requirement, as contained in the language of Section 303 of the Clean Water Act requiring that the federal government or states develop TMDLs for impaired water bodies (such as the Chesapeake Bay) that they must then implement. Since the Chesapeake Bay is a multi-state jurisdiction, the development and implementation of the overall Bay TMDL in this case fell to the EPA.

Despite the large amount of time and effort put into the 2010 Bay TMDL, and the follow up WIP processes at the state and implementation-agency levels, much still remains to be determined. It was well beyond either the intended scope or the capacity of the EPA, states and local implementation-agencies to determine all the actual specific actions that would eventually have to be taken on the ground to achieve the 2017 and 2025 targets.

<u>The Need for Adaptive Management in the Bay TMDL</u>

Officially, every party in the Bay watershed with an assigned set of pollution reduction targets is legally required to undertake the actions necessary to realize these targets. If they do not, as EPA interprets its TMDL responsibilities and authority, these parties would technically be violating the law. While EPA would be very unlikely to seek criminal penalties in the event of a state or local failure to comply with the TMDL targets, it has threatened to impose other sanctions such as the withholding of federal funds or the denial of environmental permitting authority now delegated to the states.[1] EPA also has the authority to use the legal system to seek court directives – and any intentional violation of a court order by a state or local party would significantly raise the level of potential sanctions.

The pollution reduction goals set for 2017 and 2025 thus are treated in the TMDL as legally binding. They are not mere pollution reduction guidelines for states and localities to keep in mind while implementing the various policies and actions that might affect the ability to achieve these goals. This raises a set of difficult issues, however, which the 2010 Bay TMDL did not address. These issues center around questions such as the following – what if the TMDL turns out to contain technical imperfections and even inconsistencies; what if the various local actions specified in the WIPs do not yield the pollution reductions that are expected; what if the necessary funding to implement pollution reductions cannot be obtained; what if strong political resistance in some states slows or even halts some of the planned TMDL implementation measures?

The 2010 Bay TMDL adopted a "top-down" system of planning for Bay pollution goals and necessary reductions. First, overall goals for water quality were set for the Chesapeake Bay. These goals were then converted into specific levels of nitrogen, phosphorus and sediment loadings to the Bay that would sustain their achievement. The necessary levels of total Bay loadings were then disaggregated to state levels and then further disaggregated by types of pollution sources and local implementation agencies. A driving consideration in TMDL planning was that at the most disaggregated level – the "bottom" of the "top-down" system – the disaggregated numbers there must always cumulatively add up to the higher level total targets, including at the very highest level the pollution load goals for the entire Bay. In this sense, accounting considerations relating to acceptable quantities of Bay pollutants were major factors in setting the specific pollution reduction targets at every stage of the TMDL and WIP development processes. Every individual component of the Bay TMDL is interrelated with every other component; change one thing in one area of the TMDL, and everything else is affected to maintain the internal accounting consistency of the overall Bay TMDL.

An alternative TMDL planning system would have been "bottom-up." Each local implementation agency might have been asked to describe the pollution reduction actions that it was already undertaking, those that were already planned, and other potential actions that it regarded as feasible. The sum of all these actions might then have been added from the bottom up to determine currently expected and potentially feasible further total pollution reductions at state levels and finally at the level of the Bay as a whole. Although EPA did consult extensively with the states, including their initial WIP efforts, in the process of TMDL development, it never formally released the results, asked for public comment, or otherwise included such an effort as official EPA policy for public debate and discussion. There was in general a lack of transparency in the setting of TMDL pollution reduction targets by EPA.

If the TMDL process had begun from the bottom, and if all the projected pollution reductions identified were insufficient in total to achieve overall Bay water quality goals, then further policy changes might have been contemplated to induce the bottom levels of the system to take further pollution reduction actions. For example, regulatory changes or financial inducements might have been provided to stimulate more aggressive pollution reduction efforts at local levels, then resulting in cumulatively larger total pollution reductions throughout the Bay watershed.

In an ideal planning process in theory, if the costs of planning and other "transaction costs" were not large considerations, there would be a mix of such top-down and bottom-up calculations. If planning started at the top, the full implications for all the disaggregated local actors would then be worked out (as with the Bay TMDL). But then the localities would indicate their willingness and ability to take such actions, addressing matters such as necessary funding and land use regulatory changes. The total feasible local measures would then be cumulated for states and for the whole Bay. In all likelihood, such new calculations would lead to changes in the higher level goals of the TMDL, given all the new local input. There would follow a repetition of such processes of top-down disaggregation and bottom-up aggregation until an overall acceptable and internally consistent TMDL plan for the Bay was worked out.

In practice, however, the time and resource costs of such a planning process would be much too great for such comprehensive TMDL planning that sought to take everything into account. In any event, large uncertainties would remain relating to the actual real world consequences of pollution reduction actions planned. As a result, most planning theorists today advocate more incremental approaches to planning of large ecological systems such as the Chesapeake Bay, often described as systems of "adaptive management". Under an adaptive management approach, certain actions would be taken based on the best available information in light of the objectives sought. The results of these actions would then later be assessed, and further actions planned, leading to new assessments, all this repeating in cycles of planning, action, assessment, new planning, new actions, new assessments, continuing indefinitely.

The National Academy of Sciences in 2011 issued a comprehensive report on the Bay TMDL and its prospects for success in implementing the Bay cleanup. In its report, the National Academy emphasized the significant uncertainties and the resulting need for systems of adaptive management in the Bay TMDL process. As the National Academy wrote, "Adaptive management arose from the recognition that uncertainty is inherent in natural systems, yet management actions generally cannot be delayed until knowledge is complete and uncertainties resolved. At its heart, adaptive management reflects the understanding that many ecosystem management decisions must be made in scenarios that are characterized by uncertainty," a circumstance clearly characteristic of the Chesapeake Bay ecosystem.[2]

The National Academy found, however, that the general requirements of a TMDL process, as directed by the Clean Water Act, contained rigidities that could pose significant barriers to actually putting adaptive management into practice for the Bay (and elsewhere). Hence, even though the EPA and the Bay states had frequently expressed a commitment to adaptive management in their published documents leading up to and including the 2010 Bay TMDL, the National Academy concluded that it was doubtful that they would succeed in practice. As the National Academy reported, it "did not find convincing evidence that the CBP [Chesapeake Bay Program] partners had incorporated adaptive management principles into their nutrient and sediment reduction programs" as laid out in the 2010 Bay TMDL (and subsequent Phase 1 and Phase 2 WIPs). Part of the problem was that "successful application of adaptive management in the CBP [Chesapeake Bay Program] requires careful assessment of uncertainties relevant to decision making, but the EPA and Bay jurisdictions have not fully analyzed uncertainties inherent in nutrient and sediment reduction efforts and water quality outcomes," and thus have not built into the Bay TMDL a realistic set of adaptive strategies for redirecting TMDL implementation as important new information is obtained and other significant learning takes place.

Given the requirement, for example, that local pollution reductions cumulatively add up to the overall 2017 and 2025 Bay reduction targets, any significant departures from some parts of the original TMDL planned implementation would require that other parts be changed as well. Indeed, as the Bay cleanup strategy is now designed, the entire TMDL would have to be rewritten -- or significantly revised -- periodically to reflect the resolution of at least some of the many significant uncertainties and other critical new information was obtained with growing Bay cleanup experience. Constraints of time and resources, however, would almost certainly preclude any such effort to routinely revise the full Bay

TMDL to adapt it to the learning constantly taking place. What is more likely is that the 2010 Bay TMDL, and the 2012 WIP specific pollution reduction actions planned, will become outdated within a few years and gradually lose their relevance to Bay pollution reduction efforts. Bay policy making and implementation will necessarily then proceed in an ad hoc incremental fashion, and the pollution reductions actually achieved will be similarly determined incrementally through actual experience. As the Yale political scientist Charles Lindblom once famously said, rather than following fully rational plans written in advance, the real world is typically characterized by "the science of 'muddling through.'"[3]

Serious Challenges to the Bay TMDL

The water quality objectives for the Bay and the total Bay loadings necessary to sustain these objectives were determined by EPA and the participating Bay states without much reference to financial considerations. In allocating the Bay totals among the six Bay states and the District of Columbia, the TMDL is not fully transparent but it does not appear that costs were a major factor. No attempt seems to have been made to compare the costs per unit of pollution reduction among the states – say the average costs per unit of nitrogen reduction in Maryland versus the average nitrogen reduction costs in Pennsylvania – as a TMDL basis for allocating the pollution reduction targets among the six states and the District. Similarly, within the states the further disaggregation of pollution reduction targets seems to have proceeded with minimal attention to the costs of actions to reduce pollutant loads. While it was not altogether transparent, the overall approach both Baywide and at the state level seemingly was to determine what is physically feasible and then to temper this by various considerations of social equity – including an equitable distribution of pollution reduction burdens among those jurisdictions with similar physical capacities to make the reductions. All of the above reflected what might be called a "legalistic" as opposed to an "economic" approach to TMDL development and implementation.

It was never likely, however, that the Bay TMDL implementation would ever proceed without reference to costs and other financial factors. Whatever the publicly stated commitments to Bay cleanup made by EPA and state and local officials, these are not financially open ended commitments. Cleaning up the Bay is worth a great deal but there are in practice limits to what levels of spending will be supported by federal and state political leaders and the public – for one thing, spending more on Bay cleanup may require spending less on other important state priorities. While there was little specific knowledge of the magnitudes of economic considerations in the initial Bay TMDL development, this is one of the significant uncertainties that will be resolved with the passage of time and further experience. While management adaptation in response to evolving economic realities was not a part of EPA's TMDL design, a working system of adaptive management for the Bay cleanup would necessarily include changes in the overall Bay TMDL and the state WIPs in response to evolving greater economic knowledge.

As of the summer of 2012, more cost data and other economic information were available than was available in 2010 as the Bay TMDL was being developed. This more recent economic information suggests that the Bay TMDL will face growing challenges in three areas: (1) the large size of total implementation costs; (2) the cost ineffectiveness of TMDL implementation; and (3) challenges to the social equity of the relative costs imposed on different local implementation jurisdictions within the Bay and the Bay states.

High Total Costs – Prior to the development of the Bay TMDL, estimates of the total cost of Chesapeake Bay cleanup were made the Chesapeake Bay Commission (CBC) (2003) and the Blue Ribbon Finance Panel (BRFP)(2004). The 2003 CBC report titled *The Cost of a Clean Bay* estimated the total cost for Maryland, Virginia, and Pennsylvania to meet the various goals of the Chesapeake 2000 agreement. The total estimated cost was $18.7 billion, of which $12.8 billion was considered unfunded at that time. Most of the predicted cost was associated with Goal 3 – Water Quality Protection and Restoration ($11.46 billion estimated cost, with only about $2.16 billion funded), and Goal 4 – Sound Land Use ($4.16 billion cost, $3.05 billion funded). In its 2004 estimates, the Blue Ribbon Panel projected a total cost of $28 billion to meet local water quality standards and the Tributary Strategies associated with the Bay cleanup.

Subsequently, funding on this scale never materialized, one of the main reasons for the failure to meet the nutrient reduction goals for 2010, as originally set in *Chesapeake 2000*. The 2010 Bay TMDL did not provide estimates of the total costs of achieving its 2017 and 2025 pollution reduction targets for nitrogen, phosphorus and sediments. The first such estimates were developed at the state level as part of the development of the state Phase 1 and Phase 2 WIPs (see Chapter 2). Total TMDL implementation costs for the actions laid out in 2012 in Phase 2 of the Maryland WIP are estimated by Maryland officials to be $6.28 billion for the period from 2010 to the interim target date of 2017. Over the period from 2010 to 2025, total TMDL implementation costs for Maryland are estimated to be $14.79 billion. The largest part of Maryland TMDL costs is for meeting new stormwater requirements, equal to $2.5 billion to 2017 and increasing to a total of $7.8 billion by 2025.

For Maryland the total costs of TMDL implementation for agriculture are estimated to be $498 million by 2017 and $928 million by 2025, equal to 8 percent of Maryland's total 2017 TMDL costs and 7 percent of Maryland's total 2025 TMDL costs. Spending of $2.4 billion is projected for waste water treatment plants (WWTPs) prior to 2017 (thus meeting the TMDL wastewater requirements for 2025 as well, so no additional WWTP spending is projected). Total TMDL funding for septic systems in Maryland is estimated to be $978 million by 2017, and $3.7 billion by 2025.

Similar overall estimates were made in 2011 by state officials for Virginia. They estimated that Virginia's total potential costs of meeting the TMDL would range from $13.6 billion to $15.7 billion by 2025. As in Maryland, the largest share of the costs would be arise from stormwater pollution control measures, estimated to range from $9.4 billion to $11.5 billion through 2025. Onsite septic systems are estimated to be the next largest cost category, equal to $1.6 billion in costs through 2025, followed by WWTPs ($1.4 billion) and agriculture ($1.2 billion). As compared with Maryland, these Virginia estimates show higher total costs for stormwater, similar total costs for agriculture, and lower total costs for WWTPs and septic systems.

While similar estimates were not available for Pennsylvania and other Bay states, it is reasonable to assume, based on Pennsylvania's contribution to the total pollution load in the Bay watershed (44 percent of total nitrogen, 24 percent of total phosphorus, and 32 percent of total sediment), that Pennsylvania's total costs of Bay cleanup by 2017 and 2025 will be similar to those of Maryland and Virginia – around $15 billion – that are also responsible for similar pollutant loads. The other three remaining states, Delaware, New York, and West Virginia, together contribute cumulatively around 10 percent of total nitrogen, phosphorus and sediment loads reaching the Bay. Their combined total cleanup costs thus might reasonably be estimated to be around one-third of the costs of Maryland, Virginia and Pennsylvania individually – or $5 billion in total for these three states.

Combining the cost estimates for all six states and the District thus suggests a grand total of around $50 billion by 2025 for the purpose of cleaning up the Bay. Dividing these costs over 15 years from 2010 to 2025, it would amount to about $3.3 billion per year. Individually, Maryland, Virginia and Pennsylvania might each be expected to incur state costs of about $1 billion per year. The states of Delaware, New York and West Virginia might be expected to incur costs in total among the three of about $325 million per year.

The 2010 Bay TMDL and the state and local WIPs subsequently prepared do not indicate where funding of this large magnitude – much of which would have to be new -- might be obtained. In a system of adaptive management, the large funding requirements would be addressed and the potential for funding shortfalls taken into account as they arise. Political resistance is likely to develop in some Bay states when the tradeoffs between spending for Bay cleanup and other state funding needs are examined. (This may be particularly likely for those states that do not directly border on the Bay.) The actual funding that will become available is thus a major uncertainty, depending in part on future political developments at both the federal and state levels. As discussed above, however, the Bay TMDL in practice makes little provision for such uncertainty and for a process of adaptive management to deal with it. It does not examine the significant possibility that sufficient funds might not be forthcoming and that the 2010 Bay TMDL might therefore soon require substantial revisions, including potentially some changes in the 2017 and 2025 reduction targets themselves.

Cost-Ineffective Pollution Reductions – One reason for such high estimated costs of cleaning up the Bay is that the writers of the 2010 Bay TMDL gave little priority to finding the least cost methods of achieving Bay pollution reduction targets. They were more concerned with equity considerations especially as they might influence popular political perceptions. This suggested that required TMDL total pollution reductions should be in rough approximation to the relative pollution loadings coming from different geographic areas within the Bay and from different sources of pollution. The simple physical ability with current technology to make the reductions was also a contributing factor.

Different geographic areas and different sources of pollution, however, can have widely varying costs per unit of pollution reduction achieved (see Chapter 3). The most expensive forms of nitrogen reduction, for example, typically involve the implementation of stormwater nutrient reduction measures. The retrofitting of existing land developments to reduce stormwater flows can be particularly expensive, costing, for example, upwards of $500 per pound of nitrogen load reduction achieved, and sometimes even much more than this. Implementing new stormwater management measures in new development is usually less expensive, on average by some estimates imposing costs of about $100 per pound of nitrogen load reduction. Even these lower-cost stormwater measures are more expensive, however, than upgrades of WWTPs which can range from $15 to $47 per pound of nitrogen reduction.

The most cost-effective nitrogen reduction actions, involving the lowest costs per pound of nitrogen reduction, are typically found in agriculture. Costs of pollution reduction in this sector, in many cases, are below $5 per pound. For example, installation of forest buffers around the edges of cropland can achieve nitrogen reduction at a cost of $1.20 to $3.20 per pound of nitrogen. Conservation tillage and growing of cover crops can cost $3.20 and $4.70, respectively, per pound of nitrogen reduction. A survey of agricultural sources of nitrogen reduction found that for methods using conventional tillage, the lowest cost management practice was strip cropping at $3.94 per pound of nitrogen reduction; for methods using conservation tillage, it was also strip cropping at $10.83 per pound of nitrogen reduction; and for methods based on changed pasture use, it was prescribed grazing practices at $5.23 per pound of nitrogen reduction. (See Chapter 3)

Even within the high cost stormwater sector, some methods cost much more per unit of pollution reduction achieved than other methods. One analyst estimates that achieving stormwater nutrient reductions from bio-retention sandy soils, bio-retention non-sandy soils, installing sand filters, wet ponds, or wetlands could range from $123 per pound to $7,000 per pound of nitrogen. Unconventional means of pollution reduction such as native oyster aquaculture and algal turf scrubbing may also be able to achieve nitrogen reductions in a more cost-effective way than either stormwater measures or upgrades to WWTPs, at around $5 to $10 per pound of nitrogen reduction.

The highest cost methods of nitrogen reduction can thus cost more than 100 times the cost per pound of the lowest cost methods. There are limits to the available application of each reduction method. It may not be possible, therefore, to achieve widespread application of some of the most cost effective measures. It would probably not be possible to achieve the full TMDL load targets for 2025 entirely from the lowest cost agricultural sources of reduction. However, if such methods hypothetically could be employed without limit, it would be possible to drastically reduce the costs of TMDL implementation in Maryland, Virginia, Pennsylvania and other Bay states. Depending on the actual scope for agricultural nitrogen reduction actions, substituting of agriculture for other planned sources of nitrogen reduction, total TMDL implementation costs could reasonably be expected to fall by as much as 90 percent in some areas.

The writers of the 2010 Bay TMDL in effect assumed that the existence of high total cleanup costs for the Bay and the absence of efforts to take full advantage of large potential cost reduction possibilities would carry less weight with political leaders and the general public than the competing equity concerns that they instead emphasized. There is reason, however, to doubt this judgment. In the short run, the TMDL writers may have been correct in putting the emphasis on pollution reduction actions whose burdens would be distributed fairly equally among geographic areas and pollution sources. There was little public recognition at the time of the potential costs because the TMDL did not calculate those costs. In the longer run, however, there could be no escape from much wider recognition of the costs among the political leadership and the general public. This has already begun to happen. The lack of TMDL attention to using more cost-effective methods to reduce costs is thus likely to compound the public concerns with respect to the overall high costs of cleaning up the Bay. This is likely to become a growing challenge to the successful implementation of the Bay TMDL.

Inequitable Economic Burdens in Pollution Reduction – Because of the top-down character of the TMDL disaggregation of pollution reduction targets to states and then to local implementing bodies, it was difficult or impossible to know at the time of the writing in 2010 of the TMDL just what the cost and equity implications among the various Bay implementing jurisdictions would turn out to be. In subsequent writing of WIPs, it fell to the local governing jurisdictions and soil conservation districts to develop more detailed action plans to achieve the specific TMDL targets. As these action were further refined into two-year milestones, only then was it possible to begin to identify with concrete numbers the potential equity consequences of the earlier Bay TMDL load allocations. In the spring of 2012, a preliminary examination for this report of the Phase 2 WIPs for 10 Maryland counties (out of 23 total counties in Maryland) found that the TMDL pollution target allocation process, in fact, had yielded significant inequalities among the local county jurisdictions (see Chapter 4).

In terms of several measures of relative economic burden, the differences among the counties are striking. Recognizing that the figures are not final, and some counties may have overestimated their likely future burdens, total estimated costs for those counties with completed numbers ranged from $138 million in total for Caroline County to $4.3 billion for Frederick County. Calvert County and Frederick County are projected to have by far the highest cost burdens per person, household, assessable tax base, and annual budget expenditures. The costs of implementing the Phase 2 WIP to Calvert County, as estimated by County officials, were $14,900 per capita. This compared with $1,736 per capita for Montgomery County. Relative to the size of the assessable tax base, estimated Calvert County WIP costs were more than ten times as great as for Montgomery County. On per acre basis, only Baltimore City and Frederick County had WIP costs per acre exceeding Calvert County, and in the case of Baltimore City that is due to the City's small size in terms of acreage (51,802 acres compared to Calvert's 136,416 acres). These estimated WIP implementation costs are preliminary but it would not be surprising if large differences in relative economic burdens among Maryland Counties persisted as the numbers were refined. If many Maryland residents perceive that they are being treated unfairly in the allocation of the costs of implementing the Bay TMDL, this is likely to pose a political problem in the future. Similar equity issues are likely to arise in other Bay states.

The Challenge of Future New Development in the Bay Watershed

Besides the major economic uncertainties facing the writers in 2010 of the Bay TMDL -- such as the actual availability of pollution reduction funding on the scale needed -- there were also large uncertainties relating to levels of future new commercial and residential development in the Bay watershed from 2010 to 2025. While projections of future growth are available, they are of uncertain reliability. Substantial growth might easily occur in an area where it is not now expected, while other areas now expected 2010 to grow rapidly might not actually experience such growth in the years to come. This uncertainty significantly complicated the task of disaggregating overall Bay pollution reduction targets to the states and other substate areas for 2017 and 2025.

According to the Maryland Department of Planning (MDP), for example, if current trends continue, it is estimated that Maryland will add another 264,000 households from 2010 to 2020 and 430,000 from 2010 to 2030. MDP further estimates that about 72% of these will be served by WWTPs and 28% by septic systems. The actual distribution that results is important because the pollution load per household from new development on well and septic systems is almost five times as great as new pollution loads from sewered areas. (This is partly due to the operating characteristics of septic systems and partly due to the larger average lot sizes in unsewered areas.) The total nitrogen loads from the new development projected on sewers (both point and nonpoint source) would amount to 727,000 pounds of nitrogen per year (188,000 households) by 2020 and 1.2 million pounds of nitrogen per year by 2030. The TMDL total nitrogen reduction target for 2025 in Maryland is 11.59 million tons. New development will thus work to counteract more than 10 percent of the total Maryland target for nitrogen reductions by 2025. This new development, moreover, will be concentrated in certain geographic areas of Maryland where the counteracting impact will be well above 10 percent.

One approach would be to simply go with the best future growth projections available and to factor these into the Bay TMDL and WIPs. This would then have required larger reductions from existing Bay pollution sources, in order to compensate for the projected increased pollution flows from future new development. The writers of the TMDL, however, did not adopt this approach, partly because of the many uncertainties relating to future growth levels, and also partly because the further increases required of existing sources would have heightened the financial and political costs being imposed on existing pollution sources. In a certain sense, existing development would have been paying the price to create room for additional future development within the overall Bay pollution targets, potentially arousing strong political opposition from the existing sources, including resistance to further growth in the Bay states.

Another possible approach would provide for routinely revisiting the TMDL and the pollution targets as the details of actual growth become known in future years. In effect, a new or revised TMDL would have to be written as uncertainties about growth are being resolved by actual experience. This was also an unappealing prospect, however, in light of the high transactions costs of writing TMDLs, and the new public controversies that might be provoked. The 2010 Bay TMDL therefore also did not adopt this approach. Given the somewhat intractable nature of the problem of dealing with future significant new development, the best the Bay TMDL writers could do was to recommend that future new development be required to obtain "offsets" to the new pollution loads it was generating. An offset would typically be an additional reduction beyond current legal requirements in the pollution loads from an existing source. It could be transferred to a new source of pollution as an alternative to the new source itself making load reductions.

Such offsets might result from direct transactions between individual new developers and existing individual sources of pollutant loads, or they might be bought and sold in an impersonal offset market (which in its more formalized versions is known as a market system of "nutrient credit trading"). Although the writers of the 2010 Bay TMDL recommended a large role for offsets in dealing with the problem of future development in the Bay watershed, they provided few details concerning the design and workings of offset systems. The states were given strong encouragement to incorporate offsets into their future TMDL and WIP planning. Given the lack of more specific Baywide guidance from the 2010 TMDL, each Bay state has tended to pursue its own course in the development of an offset system. Most states expect to have the design of an offset system in place by 2012 or 2013. (See the Appendix to this report for a review of the status of offset development in each of the Bay states and the District of Columbia.) A number of major policy and management issues will have to be resolved in order to put an operating offset system into place in the states (see Part II of this report).

Offsets as Critical Elements in Implementing the Bay TMDL

Offsets would offer major advantages for the Bay cleanup in three further ways besides as a means of achieving pollution reduction targets by offsetting new or increased loads in the Bay watershed due to new development. A first such additional advantage is that a system of offsets will create incentives for new developers themselves to make voluntary nutrient and sediment flow reductions from their own development projects. For example, if a developer has to offset the stormwater nutrient loads from a new subdivision, there will be a significant incentive to minimize the subdivision's stormwater nutrient flows through low-impact development (LID) or other innovative measures (thus reducing the burden of required offset purchases by the developer). Furthermore, if there is an active market for offsets, the developer may seek to generate credits by voluntarily installing a high-performance on-site disposal system (OSDS) that can connect to nearby septic systems and reduce overall nutrient loads. An offset scheme in this way provides incentives to minimize total TMDL implementation costs, further improving the cost-effectiveness and overall efficiency of the Bay cleanup.

In 2012, the Chesapeake Bay Commission estimated that a system of purchasing offsets in a full-fledged Bay nutrient trading market would potentially enable savings of around 80 percent in total Chesapeake Bay wastewater and stormwater implementation costs, as compared with direct action by WWTPs and stormwater districts to reduce their nutrient flows. The total potential cost savings from such a fully operational nutrient credit/offset program would be more than $1 billion per year for all six states combined, or more than $20 billion in long run costs savings within the Bay watershed (applying a 5 percent discount rate). Such potential absolute levels of cost savings are large enough that they could have an observable impact on the overall fiscal circumstances of states in the Bay watershed in the years to come.

The estimated cost savings from a nutrient trading system represent the high end of possible offset cost savings. Buying and selling of offsets can also occur by means of direct transactions between individual nutrient load generators and individual nutrient offset generators within the Bay and its watersheds, analogous to an informal barter system of exchange for ordinary goods and services. The much higher transaction costs associated with such individual barter negotiations for offsets would work, however, to limit the total number of offsets exchanged, resulting in lower offset activity and fewer cost savings than a fully operational nutrient credit trading system. (Imagine the impact if business stocks on Wall Street had to be traded in every case by means of direct transactions between two individual holders of stock certificates, versus the impersonal market mechanisms as actually employed today on Wall Street with such great trading efficiency.)

A second additional advantage to an offset approach is that it is more equitable to the residents and taxpayers of the region. If a specific TMDL allocation for growth is factored into a local existing WIP reduction requirement, it effectively requires current residents to make reductions on behalf of new and increased loads from new development in the future. Existing sources, however, are not themselves responsible for the future development; placing an increased cost burden on existing residents to benefit future residents raises serious equity concerns. If new developers are required, however, to offset their increasing loads as they occur, then the developer and the incoming new residents of the development will bear the added TMDL implementation costs – a more equitable result.

A third additional advantage is that an offset program is a method of adaptive management that is more defensible against political and legal challenges. It involves a simple and easily understandable requirement that those who generate new nutrient loads must offset these loads themselves. If the TMDL planners have to estimate future load increases, and then somehow assign new responsibilities for corresponding load reductions among both existing and future land users, outside parties may be able to successfully challenge the methodology used. EPA and the states may find it difficult to defend their adaptive decisions that directly impose significant new costs on many parties throughout the Bay.

Issues in Implementing an Offset System

For those Bay states that plan to use offsets in their TMDL implementation, they will need to consider various policy issues in setting up an offset system. These issues can be divided into "demand" and "supply" features of offsets. The demand side relates to the allowable circumstances in which an offset somewhere else can be used to substitute for a direct nutrient load reduction by a given pollution generating party. The supply side relates to the allowable circumstances in which pollution reductions at alternative sites will be allowed to count as legitimate offsets that are available to those who have a need for offsets.

Key demand side issues include the following:

1. Who is eligible to substitute an offset for a direct nutrient load reduction?
2. From what types of sources (agriculture, sewage systems, etc.) will such offsets be permissible?
3. How large must an offset be, relative to the alternative of a direct nutrient load reduction at a given site?
4. Where geographically can the offset be located (does it have to be in the same basin, state, anywhere in the Bay watershed, etc.)?
5. What other specific conditions might have to be met by the acquirer of an offset?

On the supply side, key issues include the following:

1. Who is allowed to provide offsets (agriculture, stormwater systems, etc.)?
2. How are "baselines" calculated as part of the level of offset determination?
3. How will the existence of a legally acceptable offset be established and monitored?
4. What will happen if the provider of an offset fails to fulfill the original offset conditions?
5. Can intermediate parties serve as offset banks or other forms of aggregators of offsets?

Polluters and Their Allowed (or Required) Use of Offsets

In concept, a requirement to reduce any form of nutrient load could be "offset" by making the reduction somewhere else. If the offset was fully equivalent to the original pollution load, and if it was less expensive to make the offset, this would be a cost minimizing step. Hence, the greater the flexibility in allowing the use of offsets, the greater will be the potential for holding down the costs of implementing the Bay TMDL. Indeed, as suggested above, it may be necessary to make wide use of offsets in order to sustain the political viability of the Bay TMDL and its 2017 interim and 2025 final pollution load targets. If the use of offsets is unduly constrained, the resulting economic costs to the Bay states could be large.

In practice, given geographic factors, a source of nutrient pollution will seldom be precisely equivalent to an offset that it might obtain. Within a given river basin, if multiple sources of nutrient pollution in close proximity to one another all obtain offsets (thus allowing them all to continue polluting), it may result in the creation of nutrient pollution "hot spots" near their common location in that basin. If the source of the offset is another river basin or water segment, the ability of the first basin to comply with its local TMDL requirement could be adversely affected (by obtaining an offset, the polluter in the first basin would be able to continue polluting at a higher level). In addition to the TMDL for the entire Bay, there are 92 separate TMDL's written for individual water segments within the overall Bay watershed. While TMDL compliance has been achieved in some of these cases, in the majority of river basins it still remains to be achieved.

The use of an offset may be seen by some members of the public as a means of "escape" from a legal requirement to make a direct pollution reduction. A recent policy brief from Center For Progressive Reform (CPR) took sewage treatment plants as an example of "hot spots". If a sewage treatment plant could purchase credits without any limits, it will be able to discharge more sewage. A "hot spot" might be created and its high concentration of pollution could have a negative impact on residents of nearby neighborhoods. If this is seen as morally or otherwise politically offensive, public opposition to the use of offsets may arise, even when the offsets serve to provide needed flexibility and to reduce the overall costs of Bay TMDL implementation. Some potential forms of offsets such as the conversion of agricultural lands to lower polluting nonfarm use may be seen as having other socially undesirable consequences. If the size of the offset is not a multiple of the original nutrient load source being offset, the net benefits of allowing offsets may not be very great in some cases.

One way of potentially increasing the Bay environmental benefits of an offset system is through the use of "trading ratios" of greater than 1:1. The trading ratio sets the number of pollution offsets that have to be obtained in order to compensate for a given pollution load increase somewhere else. For example, if new development was adding pollution load A to the Bay, the developer might be required to obtain load offsets equal to 1.5A or 2.0A as a condition of development regulatory approval. With a trading ratio of greater than 1:1, even increases in pollutant loads to the Bay will cumulatively result in the end in net reductions in the total Bay pollution loads (the new reduction offsets will more than compensate for the original pollution increases). Indeed, requirements for trading ratios of greater than 1:1 would make even the accommodation of new development potentially advantageous to the overall progress of the Bay cleanup. Use of higher trading ratios would have an additional advantage in that it would act as a form of insurance to leave space for any errors that might be created through uncertainties and weaknesses in the implementation of offset policies in practice.

Given the various issues raised, an offset system may not work as well as expected if it is not well-designed and implemented in practice. The policy goal should be to make offsets as widely available as possible, while taking account of any possible negative impacts. In some cases, it may be possible to mitigate these negative impacts (adding extra constraints in the system to the use of offsets). In other cases, the use of offsets may not work at all. Such determinations will have to be made on a case by case basis. (Chapter 6 examines offset issues on the demand side, drawing as appropriate on existing state experiences as discussed there and in previous chapters.)

Issues in the Generation of Offsets

In concept, an offset can be defined as an action that reduces nutrient loads to the Chesapeake Bay and also meets another critical condition: this action would not have been taken in the absence of the creation and transfer of the offset, frequently involving a direct monetary payment for the offset. It is apparent from this definition that the existence of an acceptable offset will not always be self-evident. It requires judgments about what would have happened to Bay nutrient loads in the absence of the offset. Would, for example, the nutrient reducing action have been taken anyway, offset or not? If so, it should not count as an offset for the purposes of Bay nutrient trading or meeting any other Bay offset requirements.

Sometimes this will be easy to determine but other times the circumstances may be less clear. In the language of offset policy, the actions that would be taken in the absence of an offset are said to be the "baseline." The offset is then said to be the additional set of nutrient reductions achieved above and beyond the baseline, stimulated by the possibility of transferring the offset for monetary gain (or some other reason). Government officials may decide that in some sectors or in other particular circumstances the difficulty of defining an offset accurately is too great, and hence offsets should not be permitted in those circumstances. There may be other factors that might lead a Bay state not to allow offsets from a particular nutrient sector. There may be a strong public view, for example, that existing Bay polluters should be required to do everything technically feasible to reduce their nutrient loads to the Bay. If government adopts such strict requirements, there may be no extra room to create further reductions as offsets, because nothing more can be done to reduce nutrient loads and that would therefore qualify as an offset.

Ideally, a baseline would be an accurate projection of what would happen in the absence of any provision for offsets. One important complication is the assessment of the impacts of legal requirements for pollution reductions on baselines. On the one hand, it may be appropriate simply to set the baseline equal to the existing legal requirement. On the other hand, in environmental policy matters, compliance with legal requirements has often been slow and in some cases still remains to be realized long after the legal requirement was established (more than 100 million Americans still live in ozone nonattainment areas 40 years after the Clean Air Act was passed in 1970 requiring attainment of ambient air standards with a short timeframe). A projection of likely outcomes thus might want to take account of the actual likelihood of full legal compliance. If that likelihood is small, there would be significant economic advantages – including in the Bay cleanup -- to altering baselines to reflect the actual most likely future outcomes. For example, the Bay states have set tight legal requirements for farmer changes in management practices to reduce nutrient flows but such changes have been slow in coming and full compliance may not be likely in the immediate future. One option to consider thus is whether agricultural baselines should be set at less than the full legal requirements for agriculture, acknowledging the uncertainty of immediate legal compliance, and thus potentially accelerating the improvement of farmer nutrient management practices (a particularly important goal given the large share of total Bay nutrient loads that originate in agriculture and the low cost of many potential agricultural nutrient reductions).

Where offsets are allowed, it will be necessary to have some formal process by which the offsets are officially measured and accounted for by the government. In order to sell an offset, Bay state governments – working with EPA -- should first formally declare that this proposed specific offset has met the requirements to make it legally acceptable for transfer to another party. The states might do this themselves or they might contract this process to accredited private parties (but would have to maintain close oversight over the actions of such parties). If handled within the government, potential generators of offsets should submit their proposals to a suitable government agency (probably at the state level) that would review the information relating to the manner of implementing the offset and either approve or disapprove the offset (or require further discussions). In a nutrient credit trading system, such approved offsets would be available for sale through normal market methods of exchange. To date, the Bay states have been slow to commit the necessary funds and personnel to facilitate the oversight of a working offset system of any kind. If offsets are to play a large part in the Bay cleanup and TMDL implementation, significantly greater levels of state staffing resources will be necessary in the future. (Chapter 7 provides further details on the calculation of baselines and other issues in the administration of an offset system.)

The Geography of Bay Offsets

Given the specific location of a nutrient polluter that wants (or is required) to obtain an offset, where geographically in the Chesapeake Bay watershed will this party be allowed to obtain its desired offsets. For Maryland, for example, the main possibilities are that the offset could be obtained: (1) anywhere within the same MD-8 digit watershed in Maryland; (2) anywhere within the same TMDL segment shed; (3) anywhere within the boundaries of the same local TMDL implementing jurisdiction, (4) anywhere within the same river basin and also within Maryland, (5) anywhere within the Chesapeake Bay watershed and also in Maryland, (6) anywhere within the same river basin within the Bay watershed (including the possibility of exchanging offsets across state boundaries within the same basin), and (7) finally, and most encompassing of all, anywhere within the entire Chesapeake Bay watershed.

Broadly speaking, the wider the geographic area in which offsets can be obtained, the more options will be available in searching for an offset that can be generated at the lowest possible cost. As a result, the wider the geographic area for obtaining eligible offsets, the more cost effective will be the Bay cleanup as a whole – and the lower will be the total Bay costs of cleanup. This will mean that either more Bay cleanup can be obtained at less total expense, or that fewer funds would have to be spent for a given degree of Bay cleanup. Hence, if the quality of the Bay's waters as a whole were the only concern, a party needing offsets would be permitted to obtain them anywhere in the Bay watershed, including in other states. A Maryland polluter, for example, might obtain offsets in Pennsylvania because they might be less expensive to generate there -- and also because reductions in nutrient loads in the Susquehanna River in Pennsylvania might well have more overall beneficial impact on Bay water quality than say the same level of reduction in nutrient loads to the Potomac River (which enters the Bay in a middle section while the Susquehanna enters at the top and thus its pollutant loads flow down the entire Bay).

This cost saving potential is illustrated in a 2012 study of the economics of Bay cleanup by the Chesapeake Bay Commission (CBC). It was assumed that offsets were required as a result of particular assumed increases in nutrient flows from wastewater treatment plants (WWTPs). The analysis considered four alternatives – (1) allowable offsets had to be generated within the same river basin as the WWTP (and also in the same state); (2) allowable offsets had to be generated in the same state as the WWTP (but could be in any river basin), (3) allowable offsets had to be generated in the same river basin as the WWTP (but in some cases in another state), and (4) offsets could be generated anywhere in the Chesapeake Bay watershed.

Expanding the scope of the allowable offset area has a large impact on the potential Baywide cost savings achievable. As compared with offsets limited to the same river basin and state as the WWTP, expanding the eligible area for offsets to the whole state generated an estimated 31 percent cost savings. Some basins such as the Potomac encompass multiple states. Allowing eligible offsets anywhere in the same river basin (potentially across state boundaries) increased the cost savings to 43 percent. Most impressive of all, allowing offsets to be obtained anywhere in the Chesapeake Bay watershed generated potential costs savings for the Bay cleanup of 87 percent. As these figures suggest, there are large economic advantages from a Baywide perspective to providing a maximum of flexibility in the geographic locations at which offsets can be obtained.

Allowing offsets to be created in other basins may prove objectionable, however, to the local residents of the original basin (containing the party obtaining the offsets), even though it is beneficial for the Bay as a whole. The net effect of the offset acquisition in such circumstances will be to leave the original basin facing increased pollution loads, while reducing them elsewhere where the offset is generated. This may be acceptable, however, if the economic gains are large enough. It may also be more or less acceptable depending on the relative water quality status at present of the two basins involved. Such issues may have to be resolved on a case-by-case basis. (Chapter 8 further examines issues relating to the geographic scope of the transferability of offsets.)

Nitrogen and phosphorus have different physical characteristics that create important differences in their effects on aquatic plant growth in freshwater and saltwater.[4] Nitrogen is more readily dissolvable in water; this means that nitrogen travels faster to the Chesapeake Bay while phosphorus and sediment typically remain longer and move more slowly to the Bay.[5] As a result, phosphorus tends to contribute more than nitrogen to eutrophication of freshwater streams. Excess nitrogen, however, typically creates the greatest problems of algal blooms in coastal waters with higher salt concentrations**.** Indeed, nitrogen is generally the primary limiting nutrient in the seaward portions of estuarine systems while in freshwater lakes, ponds, reservoirs and streams, phosphorus is the nutrient that has the most influence on plant growth and other nutrient pollution problems.

These different physical characteristics of nitrogen and phosphorus have potentially important implications for the geography of Bay offsets. For nitrogen, the potential for hot spots in individual river basins is significantly less than for phosphorus. The largest negative impacts of nitrogen pollution are felt in the Bay itself. This suggests that future Bay offset policies might allow acceptable exchanges for nitrogen over wider geographic areas, potentially even the whole Bay watershed. For example, cross state nitrogen trading between Maryland and Pennsylvania might be permitted, while similar cross state trading for phosphorus might create different tradeoffs and be more difficult to implement.

Innovative Sources of Offsets

In its review of the Phase II WIPs, EPA encouraged the states to pursue more innovative options for reducing loads. The various proposed and existing offset systems in the Bay area focus on maintaining or reducing nutrient loads by preventing their direct release into the watershed at the source. However, as the focus of trading and offsets may shift to find the most cost effective means of restoring water quality, more attention should be given to enhancing natural nutrient assimilation processes. In some cases it may be cheaper to mitigate the effect of a pound of nutrient than to prevent its release at the source. Offsets could be generated, for example, by harvesting plant biomass or by restoring former floodplain wetlands, which would increase the nutrient assimilative capacity of the aquatic ecosystem. There are three main ways in which nutrient assimilation services (NAS) can be created or enhanced: chemical transformation, nutrient harvest, and nutrient storage.

Chemical transformation refers to the processes that convert nitrogen into biologically unacceptable forms. This prevents consumption of the nitrogen by organisms such as algae, and therefore the harmful resulting environmental impacts. This transformation occurs naturally in wetlands, creating the potential for offset generation. Nutrient harvest involves the removal of nutrient-saturated organisms, which prevents nutrient release in their decomposition or consumption. Organisms capable of sequestering Bay pollutants include algae, oysters, and other shellfish. Nutrient storage is similar to nutrient harvest, but the sequestration occurs in sediment rather than in biomass.

Summary of Key Recommendations

1. Offsets should play a central role in the implementation of the Bay TMDL, as a means of lowering total costs, increasing cost effectiveness and achieving more equitable outcomes.
2. The Bay states need to commit significantly greater resources to the design of an offset system.
3. A single state agency should be designated to oversee the design and implementation of an offset system as an urgent state need.
4. A top priority in offset system development should be the putting in place by state governments of rules and procedures for defining and certifying acceptable offsets.
5. Use of offsets should be allowable in most circumstances, unless there would be clear localized pollution problems created.
6. Trading ratios should be greater than 1:1, perhaps typically 1:5 or 2:1, but may vary according to the circumstances of the specific use of offsets. Trading ratios should also take into account the level of uncertainty relating to the ultimate full realization of offset plans and targets.
7. Baseline calculations should take account of the actual outcomes most likely to be achieved in practice, as well as strict compliance with legal requirements (that may be less likely to occur in practice). Alternatively, the legal requirements should themselves be altered to improve the likelihood of actual compliance in practice.
8. Interbasin and interstate use of offsets should be allowable in principle, and the permissible extent should be resolved on a case-by-case basis. Offset policies should take account of the different chemical and TMDL legal circumstances of nitrogen and phosphorus, potentially establishing separate rules for interbasin and interstate use of nitrogen and phosphorus offsets.
9. As the agency responsible for Baywide outcomes, EPA should set rules for interstate use of offsets.
10. EPA should support research and development of innovative new sources of Bay offsets such as oyster farms or algae nutrient reduction systems.

SAVING THE CHESAPEAKE BAY TMDL:

THE CRITICAL ROLE OF NUTRIENT OFFSETS

Introduction – What Are Nutrient "Offsets" And Why Are They So Important?

In December 2010, complying with a legal requirement dating to 1999, the Environmental Protection Agency (EPA) released a federal plan for cleaning up the Chesapeake Bay. This plan established "total maximum daily loads" (TMDLs) of nitrogen, phosphorus and sediments that would be compatible with achieving and maintaining a healthy Bay environment capable of fully supporting fishing, boating, swimming, and other designated Bay uses. In the language of federal water pollution control, the plan is itself considered as "the TMDL" for the Bay. For each of the states in the Chesapeake Bay watershed, it sets target levels for annual flows of nutrient and sediment pollution to be achieved by 2025, with interim targets to be achieved by 2017. The 2025 TMDL targets represent a reduction in nitrogen, phosphorus and sediment flows from 2010 levels of 25 percent, 24 percent, and 20 percent, respectively.

The Bay TMDL is the latest stage in a cleanup effort that officially began in 1987 with an agreement among Maryland, Virginia, Pennsylvania, the District of Columbia and EPA to reduce nitrogen and phosphorus levels by 40 percent by 2000. Between 2000 and 2010, these parties, now joined by Delaware, New York and West Virginia, sought further significant reductions in Bay nutrient levels. However, despite federal and state regulations and substantial expenditures of funds, these goals in nutrient reduction were not achieved. EPA therefore stepped in to orchestrate a new federal strategy for Bay cleanup in the form of the December 2010 TMDL.

According to the TMDL, "offsets" will be an important tool in the Bay cleanup. Indeed, as this report argues, if there is to be a realistic possibility of achieving the pollution reduction goals set out in the Bay TMDL, offsets will likely have to play a significant role in its implementation. First, without effective provision for the ample use of offsets, the total costs of implementing the Bay TMDL are likely to exceed the levels of funding available. Offsets provide a workable means of increasing the cost effectiveness of actions taken to clean up the Bay, and thereby of reducing total Bay cleanup costs significantly. Offsets also provide a workable means of addressing potentially significant inequalities in the TMDL allocation of nutrient reduction burdens. Finally, a Bay approach based heavily on offsets may not be subject to the same legal challenges that face the current top-down TMDL strategy under which EPA assigns states specific pollution reduction targets that they are required to meet as a matter of law.

<u>What are "Offsets"?</u>

The concept of offsets was first developed as an implementation strategy under the Clean Air Act. Enacted in 1970, the Clean Air Act (CAA) required EPA to set national ambient air quality standards and to designate those parts of the United States that were in "nonattainment" of these standards. New sources of air pollution that located in nonattainment areas would exacerbate the existing problem of pollution, yet it was politically unacceptable for EPA simply to declare that new sources of air pollution would be prohibited across the wide sections of the United States that were in nonattainment of the air quality standards.

The solution developed by EPA was to allow new sources of air pollution but to require these sources to generate an "offset" to their own additional pollution. Offsets would be generated by actions that reduced pollutant loads somewhere else – for example, actions taken by an existing polluter to reduce pollution flows. Indeed, new sources of pollution would often be required to generate more than a one-to-one offset. In this manner, new sources of pollution could actually contribute to improved air quality in nonattainment areas, since the pollution "offsets" generated would be greater than the additional pollution created by the new source.

While required offsets could be developed in various ways, in general, the majority of offsets were developed as a compensatory mechanism, such as a reduction in pollution from an existing source in the nonattainment area. The party obtaining the offset might well pay for the costs of achieving this reduction (plus potentially an additional bonus to compensate for the transaction costs associated with making the pollution reduction). In short, if a new business A wanted to add 100 units of air pollution in a nonattainment area, it would be responsible for finding an existing pollution source B that would reduce its emissions by more than 100 units (depending on the "offset trading ratio"). In addition, before relying on such offsets, the new source A would be required to adopt the most effective pollution abatement technology currently available, thus minimizing its new levels of emissions.

Introducing offsets into environmental regulatory system introduces a potentially valuable element of flexibility into the system. If a polluter is allowed to offset its emissions reduction requirement from another source, it may be able to satisfy the emissions reduction requirement at significantly less cost than reducing its own emissions. If such offsets are widely used, the total costs of the environmental regulatory system may themselves be significantly reduced. The added flexibility introduced by offsets may also serve social equity purposes. For example, direct emission reductions may require unfairly large expenses for a particular industry, causing a loss of production and jobs. The option to obtain an offset instead may reduce or eliminate this problem. As is argued in this report, the current Chesapeake Bay TMDL may involve prohibitive total costs and equity concerns that could raise significant doubts as to its political viability. The availability of offsets may therefore be an essential part of a successful implementation of the Bay TMDL.

Offsets and Emissions Trading Systems

The experience with offsets under the CAA – when combined with the pro-market sentiment of the 1980s and 1990s and the encouragement from the developing field of "environmental and natural resource economics" – set the stage for the tradable permit market established for the pollutants nitrogen oxides (NO_x) and sulfur dioxide (SO_2) under the 1990 Clean Air Act Amendments.[6] Since the 1990 law was enacted, SO_2 emissions fell by 6.8 million tons as of 2007 (a 43 percent reduction).[7] This has sharply reduced the frequency and severity of acid rain, helping to improve water quality and also producing significant benefits to human health. The emissions trading market established by the 1990 Amendments is widely regarded as a major success and as a sound model for the broader use of market forces to achieve environmental goals at reduced cost.

Indeed, "environmental markets" now cover a wide range of environmental media, such as greenhouse gases, wetlands, toxic air emissions, and water pollutants. Most prominently, the efforts of the European Union (EU) to reduce greenhouse gas emissions rely heavily on the creation of an EU-wide greenhouse gas emissions trading system which commenced operations in 2005. Globally, billions of US dollars are exchanged through various environmental markets every year, as the estimates in Table i.1 indicate below.

Table i.1 Asset Value of Environmental Markets Globally

Environmental Market	**Market Value (2008)**
Regulated Carbon	$117,600,000,000
Water Quality	$9,250,000,000
Biodiversity	$2,900,000,000
Voluntary Carbon	$705,000,000
Forest Carbon	$37,100,000

Source: Tracy Stanton et al. 2010

An offset system is sometimes regarded as identical to an emissions credit trading system. Some discussions of trading markets in fact refer to "credits" and "offsets" interchangeably. It is thus important to clarify the precise meaning of each term. An "offset" is a more general term while an emissions trading system is more specific and thus narrowly defined, referring to one particular way by which an offset might be generated. In an emissions trading system, polluter A enters into an actual "credit" market to purchase an offset to its pollution. The credit is supplied by some polluter B of whom polluter A may have no specific knowledge. Rather, B makes a reduction in pollution and thus generates an emissions credit that it makes available for sale in the emissions trading market through some impersonal exchange mechanism (as company stocks, for example, are impersonally traded on the New York and other stock exchanges).

There can be many other ways, however, by which offsets might be created. Polluter A may simply pay or otherwise directly engage with some other polluter C to make offsetting reductions in the levels of pollution from C. Unlike the pricing and other impersonal market features of a full scale emissions credit trading system, such a personal transaction among two parties might be compared with a barter exchange. Additionally, if polluter A has multiple sources of pollution within its scope of company operations, it might be able to generate needed offsets within the same firm itself – by reducing its pollution levels at one source to compensate for increased pollution at another source. Purchasing an emissions trading "credit," in short, is merely one specific way among a number of alternative possibilities for generating an emissions "offset."

Use of Offsets in the Chesapeake Bay Cleanup

Given the importance of emissions trading and other forms of offset systems in other areas of environmental policy, the use of a system of "offsets" to increased nutrient pollution loads, in some cases resulting from increased population and new land development, has already become an important part of the policy discussions relating to the Chesapeake Bay cleanup. The 2009 EPA report *The Next Generation of Tools and Actions to Restore Water Quality in the Chesapeake Bay* states that in dealing with "new or expanded sources of nutrient and/or sediment pollution," EPA would "consider the use of offsets in the context of the Chesapeake Bay TMDL, scheduled for publication in December 2010. The implementation of this rule in coordination with the point source WLAs and nonpoint source load allocations in the Bay TMDL will be important as EPA and its partner states pursue Bay-wide management and lasting reductions of pollutants into the Bay."[8]

The 2011 report of the National Academy of Sciences *Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay, An Evaluation of Program Strategies and Implementation* states that, in dealing with "stormwater, [residential] growth and development, and residential fertilizer use," Bay jurisdictions may have to "adopt regulations to restrict land-use changes that would increase nutrient loads from stormwater runoff or cap wastewater treatment plant discharges at current levels." In that case, rather than shutting off new growth, following the precedent of the use of offsets under the Clean Air Act, it would also be important to have the flexibility to require "offsets for any future increases" in nutrient loads from such growth.[9]

As published by EPA in December 2010, the overall Chesapeake Bay TMDL adopted the use of offsets as official EPA policy. Appendix S to the Bay TMDL states that:

> As an assumption of the Chesapeake Bay total maximum daily load (TMDL), U.S. Environmental Protection Agency (EPA) expects Chesapeake Bay jurisdictions to account for and manage new or increased loadings of nitrogen, phosphorus, and sediment.
>
> As explained in Section 10.1, where the TMDL does not provide a specific allocation to accommodate new or increased loadings of nitrogen, phosphorus, or sediment, a jurisdiction may accommodate such new or increased loadings only through a mechanism allowing for quantifiable and accountable offsets of the new or increased load in an amount necessary to implement the TMDL and applicable water quality standards (WQS) in the Chesapeake Bay and its tidal tributaries.
>
> Therefore, the Chesapeake Bay TMDL assumes and EPA expects that the jurisdictions will accommodate any new or increased loadings of nitrogen, phosphorus, or sediment that lack a specific allocation in the TMDL with appropriate offsets supported by credible and transparent offset programs subject to EPA and independent oversight. This appendix provides details of common elements from which EPA expects the jurisdictions to develop and implement offset programs.

In essence, EPA is now planning to use much the same approach first adopted in the 1970s for the use of offsets to new sources of air pollution in nonattainment areas. Where a new land use in the future would threaten the achievement of 2017 and 2025 water quality goals for the Chesapeake Bay, this land use will either be required to substantially or entirely mitigate its nutrient pollution impacts on the Bay, or to purchase a nutrient offset to any unavoidable impacts. The Bay states are still in the process of developing the detailed policies by which the use of offsets policy will be implemented. This report examines the status of Bay implementation efforts as of Summer 2012 (see the Appendix) and the future offset policy issues that the states will eventually have to resolve (see Part II).

Some Notes on the Report

It is important to note that a comprehensive review of each state in the Chesapeake Bay Watershed is beyond the scope of this report. Therefore, this report mainly focuses on Maryland, Virginia, and Pennsylvania as the largest contributors of pollution to the Bay as well as Delaware and the District of Columbia in certain cases due to their proximity to the Bay. A detailed description of each of these jurisdiction's plans and progress is in the development of an offset system provided in the Appendices.

Part I -- An Endangered Chesapeake Bay TMDL

Introduction to Part I

The 2010 Chesapeake Bay TMDL and follow-up Phase 1 and Phase 2 Watershed Implementation Plans of each of the Bay states are a product of a 1999 legal agreement that required the writing of a TMDL if Bay nutrient reduction goals had not been met by 2010 (see Chapter 1). A government plan of the scope of the Chesapeake Bay TMDL, however, is not simply an exercise in legal compliance. In putting the TMDL into practice, it amounts to a plan for a significant rearrangement of important parts of the land use and indeed the economy in the Chesapeake Bay region. In writing such a plan, the impacts will ultimately be felt by hundreds of thousands of people. It is impossible for the writers of as comprehensive a plan as the Bay TMDL to anticipate how all these many impacts will work out (and in this case, they did not have the time or resources even to try).

Hence, there are likely to be many surprises. Results that were anticipated as consequences of TMDL implementation may not in fact be achieved. Some aspects of the TMDL, like many comprehensive planning efforts in the past, may even prove at some point to be counterproductive or even internally contradictory. Indeed, there has been a wide recognition in recent years that "adaptive" planning and management is required to address many important social and economic problems and the associated large uncertainties. The 2011 National Academy of Sciences report on the Chesapeake Bay cleanup states that "Since 2008, the CBP [Chesapeake Bay Program] has advocated for the use of adaptive management at both the state and federal levels as a way to enhance overall management of the program and to strengthen scientific support for decision making" (ES-7).

That is to say, it is misleading to regard the Bay TMDL as a legal document that will necessarily be implemented as written. Many political and economic events will affect the future course of Bay TMDL implementation. Whatever the TMDL may say, there is no guarantee that the load reduction targets for 2017 and 2025 will be realized. The actual load reductions achieved will depend on many factors that cannot be known at present with any degree of certainty. It is possible, however, to assess in more general terms the likelihood that the TMDL will in fact be implemented approximately as written in 2010.

Part I of this report develops such an assessment. The conclusion is that the successful implementation of the Bay TMDL is in doubt as of this moment – that it is an "endangered TMDL." The principal reasons, as will be explored in Part I, are its very high costs (Chapter 2), its cost-ineffectiveness (Chapter 3), and equity concerns raised by the relative burdens imposed on different jurisdictions by TMDL implementation (Chapter 4). As will also be discussed, provision for the wide use of offsets offers an important means of addressing these areas of potential concern about the viability of the Bay TMDL (Chapter 5).

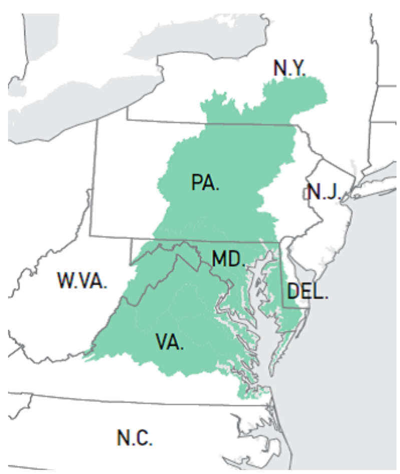
Chapter 1 – Bay State TMDL Watershed Implementation Plans (WIPs)

The Chesapeake Bay Watershed extends over six Mid-Atlantic states: Maryland, Virginia, Pennsylvania, New York, West Virginia, and Delaware, also including the District of Columbia (Figure 1.1). As stated earlier, EPA established the Chesapeake Bay TMDL to coordinate cleanup efforts among these six states and the District of Columbia. The TMDL identifies the necessary pollution reductions from sources of nitrogen, phosphorus, and sediment and divides the overall reductions between the states. The TMDL requires total reductions be met by 2025, with an interim target of 60 percent of reductions by 2017.

To meet these pollution allocations, the states, working with EPA and with the local jurisdictions and soil conservation districts, the states then disaggregated their allocation into target nutrient reductions for local watersheds within the state, resulting in a "Watershed Implementation Plan" (WIP). Each WIP sets specific targets for reductions in nitrogen, phosphorus, and sediment as well as identifies the sources from which these reductions need to be made and strategies for how to achieve the targets. The first generation of Phase I WIPs was issued by the states in 2010 in conjunction with EPA's publication of the overall Bay TMDL. A second generation of Phase II WIPs was issued in draft form in January 2012 and, after receipt of EPA and other comments, was published in final form in the spring of 2012. The cumulative reductions across all the states set in the local WIPs and state reductions must match the TMDL target set for overall Bay reductions in nutrient flows to be achieved by 2017 and then 2025.

This chapter details various state WIPs, in particular those of Maryland, Virginia, and Pennsylvania. This chapter also serves as a background on nutrient pollutants, providing a review of pollution levels and their sources of origin. As is shown in the rest of the chapter, states such as Maryland, Virginia, and Pennsylvania contribute the majority of nutrient loads to the Bay from various source sectors and as such, have significant target load reductions compared to other states in the watershed. While each state has complied with EPA in creating a WIP and outlining various strategies, the approach and willingness to implement these strategies varies among the watershed states.

Figure 1.1 Chesapeake Bay Watershed



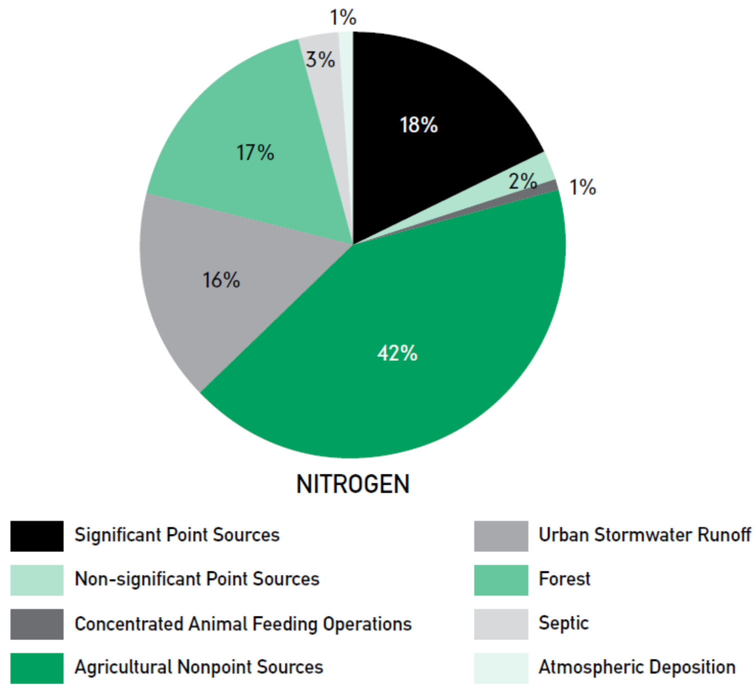
Source: U.S. Environmental Protection Agency

Existing Sources of Pollution in the Chesapeake Bay Watershed

Excess amounts of the nutrients nitrogen and phosphorus are the leading factor in the impaired health of the Bay. Each state in the watershed contributes nutrients to the Bay and its tributaries from a variety of sources, including point sources such as wastewater treatment plants (WWTPs) and nonpoint sources such as runoff from the land or air pollution. The following section reviews these sources and their points of origin.

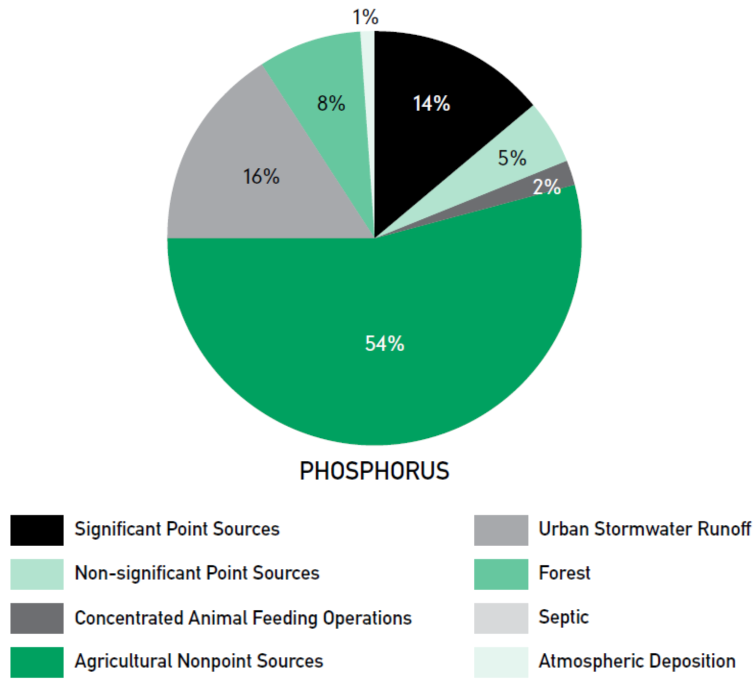
The leading sources of nitrogen in the overall Chesapeake Bay watershed are shown in Figure 1.2. The leading sources of phosphorus are shown in Figure 1.3. Agriculture in both cases is the most important contributor, creating 42 percent of the total nitrogen flows into the Bay and 54 percent of the total phosphorus flows. Other major contributors of both nitrogen and phosphorus include WWTPs, urban stormwater, and forests.

Figure 1.2 Sources of Nitrogen Loads to the Chesapeake Bay



Source: EPA Chesapeake Bay Program

Figure 1.3 Sources of Phosphorus Loads to the Chesapeake Bay



Source: EPA Chesapeake Bay Program

Table 1.1 shows how the distribution of nutrient flows into at the Chesapeake Bay is distributed among the originating six states in the Bay watershed (only two of these states, Maryland and Virginia, directly border on the Bay). Fully 44 percent of nitrogen arriving in the Bay originates in Pennsylvania, mainly coming from the Susquehanna River which enters the Bay at its northernmost point in Maryland. After Pennsylvania, Virginia (27 percent) and Maryland (20 percent) are the other two large contributors of nitrogen flows. These three states alone contribute more than 90 percent of the total nitrogen flows reaching the Bay. For phosphorus, Virginia is the leading source of nutrient flows (44 percent), followed by Pennsylvania (24 percent) and Maryland (20 percent). These three states alone contribute 88 percent of the total phosphorus flows to the Bay.

Table 1.1 Comparison of 2009 Nutrient and Sediment Loads by Jurisdiction

State	Nitrogen (lbs/yr)	Percent
Pennsylvania	106,413,000	44%
Virginia	65,303,000	27%
Maryland	49,421,000	20%
New York	10,541,000	4%
West Virginia	5,774,000	2%
Delaware	4,180,000	2%
District of Columbia	2,853,000	1%
Totals	244,485,000	
State	Phosphorous (lbs/yr)	Percent
Virginia	7,168,000	44%
Pennsylvania	3,965,000	24%
Maryland	3,304,000	20%
West Virginia	833,000	5%
New York	801,000	5%
Delaware	316,000	2%
District of Columbia	86,400	1%
Totals	16,473,400	
State	Sediment (tons/yr)	Percent
Virginia	1,616,000	40%
Pennsylvania	1,283,000	32%
Maryland	693,000	17%
West Virginia	188,000	5%
New York	164,000	4%
Delaware	32,300	1%
District of Columbia	15,900	0%
Totals	3,992,200	

Source: EPA Phase 5.3 Watershed Model

Sources of pollution are also broken down into the sector of origin, including for example, agriculture or stormwater runoff. Table 1.2 shows both the state and the source sector from which nitrogen originates. Pennsylvania contributes a large percentage of each source sector, including 46 percent of forest nitrogen flows, 33 percent of stormwater flows, and 25 percent of flows from WWTPs. Importantly, the state contributes more than half (55 percent) of the total agricultural nitrogen loads. Maryland and Virginia are also significant nitrogen contributors in each source sector. Maryland is the leading contributor of flows of septic system nitrogen flows at 36 percent, while Virginia is the leading contributor of WWTPs flows at 39 percent.

Table 1.2 Percentage of Total Nitrogen Delivered to the Bay from Each Jurisdiction by Pollutant Source Sector

Jurisdiction	Agriculture	Forest	Stormwater runoff	Point Source	Septic	Nontidal deposition
Delaware	3%	1%	1%	0%	2%	1%
District of Columbia	0%	0%	1%	5%	0%	0%
Maryland	16%	14%	28%	27%	36%	27%
New York	4%	7%	3%	3%	5%	5%
Pennsylvania	55%	46%	33%	25%	30%	42%
Virginia	20%	27%	33%	39%	24%	25%
West Virginia	3%	4%	2%	1%	2%	1%
Total	100%	100%	100%	100%	100%	100%

Source: Phase 5.3 Chesapeake Bay Watershed Model 2009 Scenario
Note: Nontidal deposition refers to atmospheric deposition direct to nontidal surface waters.

Similar figures are shown in Table 1.3 for phosphorus flows into the Bay. In this case, Virginia is the leading contributor, sending 42 percent of the total phosphorus from agriculture into the Bay, 45 percent of the total forest flows, 50 percent of the total stormwater flows and 42 percent of the total WWTP flows. Significant shares of total phosphorus flows from stormwater runoff also come from Maryland (28 percent) and of WWTP flows from Pennsylvania (28 percent). Similar to nitrogen, Delaware, the District of Columbia, New York and West Virginia contribute much less to Bay nutrient pollution, as compared with Pennsylvania, Maryland and Virginia.

Table 1.3 Percentage of Total Phosphorus Delivered to the Bay from Each Jurisdiction by Pollutant Source Sector

Jurisdiction	Agriculture	Forest	Stormwater runoff	Point Source	Septic	Nontidal deposition
Delaware	4%	1%	1%	0%	0%	0%
District of Columbia	0%	0%	1%	2%	0%	0%
Maryland	19%	14%	28%	21%	0%	27%
New York	5%	7%	3%	5%	0%	5%
Pennsylvania	24%	25%	16%	28%	0%	27%
Virginia	42%	45%	50%	42%	0%	38%
West Virginia	6%	7%	2%	3%	0%	2%
Total	100%	100%	100%	100%	100%	100%

Source: Phase 5.3 Chesapeake Bay Watershed Model 2009 Scenario
Note: Nontidal desposition refers to atmospheric deposition direct to nontidal surface waters. Although the percentage contribution of phosphorus from nontidal deposition is provided here, the overall amount of phosphorus contributed from nontidal deposition is considered to be insignificant.

Total TMDL Targets and Reductions

Reflecting the leading role of agriculture as a source of Bay nutrient pollution, as shown in Table 1.4, the Bay TMDL also assigns the agricultural sector the largest role in making reductions of total nutrient flows to the Bay, seeking a 38 percent reduction by 2025 from the agricultural level of 2009. Overall, agriculture is designated to make 65 percent of the total nitrogen reductions to the Bay over the period from 2009 to 2025. The next largest sector contributing to total Bay nitrogen reductions is waste water treatment plants (22 percent of total reductions) and urban stormwater (8 percent). Forests see a small increase in total nitrogen flows, reflecting the TMDL policy goal to increase the total area of forest buffers and otherwise to convert existing lands to less nutrient intensive forests.

Table 1.4 Nitrogen Loads, 2025 Targets, and Reductions by Sector

Source sector	Sector load, 2009	Sector load, as % of total load, all sectors (2009)	2025 Target	Sector load, as % of total load, all sectors (2025)	Net reduction, as % of sector load in 2009	Net reduction	Net reduction, as % of total net reductions, all sectors
Agriculture	111,077,096	41.66	68,772,550	34.22	38.09	42,304,545	65.11
Forest	50,483,189	18.94	50,868,510	25.31	-0.76	-385,321	-0.59
Non-Tidal Water Deposition	2,770,062	1.04	2,552,512	1.27	7.85	217,550.37	0.33
Onsite	11,036,905	4.14	8,403,381	4.18	23.86	2,633,524	4.05
Tidal Atmospheric Deposition	17,339,288	6.5	15,700,000	7.81	9.45	1,639,288	2.52
Wastewater (w/ CSO)	53,286,282	19.99	39,076,501	19.44	26.67	14,209,781	21.87
Total urban/ stormwater	20,609,238	7.73	15,593,579	7.76	24.34	5,015,659	7.72
LA reserve	-	-	664,371	-	-	-	-
Total	**266,602,060**	**-**	**201,631,405**	**-**	**24.37**	**64,970,655**	**-**

Source: U.S. EPA Chesapeake Bay TMDL Tracking and Accounting System (BayTAS)

WIPs and TMDL Status by State

Maryland's TMDL Status

The Chesapeake Bay plays a larger role in the economy and in general in the life of Maryland than any other state in the Bay watershed. It is thus not surprising that Maryland has long been a strong supporter of aggressive efforts to restore the water quality of the Chesapeake Bay. Since 1985, Maryland has reduced its nitrogen pollution by 33 percent and its phosphorus pollution by 38 percent. These reductions were achieved even while population in the state increased by 29 percent (1.28 million people) from 1985 to 2009. Maryland was the first Bay state to require nutrient management plans on all farms and to commit to major upgrades on each of the State's 69 largest wastewater treatment plants (WWTPs). Following EPA's December 2010 issuance of the Bay TMDL, Maryland has made a firm commitment to reaching the 2025 targets. It will be actively measuring progress based on success in completing each two-year set of milestone increments. Maryland has developed BayStat to measure and make easily available to the public the record of progress in the Bay's recovery.

In October 2010, the Maryland Department of the Environment (MDE), the Department of Natural Resources (DNR), The Maryland Department of Agriculture (MDA), and the Maryland Department of Planning (MDP) released the Draft Phase 1 WIP for public review. Following consideration of hundreds of public comments, Maryland submitted its Final Phase 1 WIP to EPA on December 3, 2010.[10] The Phase 1 WIP includes a series of proposed strategies to meet the interim 2017 target of 60 percent of the final 2025 reductions in nitrogen and phosphorus nutrients and in sediments.

The EPA provided Maryland and other Bay jurisdictions with their Phase II WIP target loads for the whole state in August 2011. The loads were based on the most recent Chesapeake Bay Program model of the Bay and were then reallocated among each of the five major tidal basins in the state: the Potomac River basin, Eastern Shore, Western Shore, the Patuxent River basin, and Maryland's portion of the Susquehanna River basin (see Figure 1.4). Maryland was tasked with further allocating these basin targets by local governing jurisdiction and into source sectors, including WWTPs, agricultural sources, forests, stormwater, and septic systems. Loads were also allocated to atmospheric sources, but state and federal programs are addressing these sources and local governments are not tasked with managing these sources.

Figure 1.4 Major Tidal Basins in Maryland

Source: Maryland Department of the Environment

As shown in Table 1.5, the Maryland TMDL prescribes total statewide reductions in nitrogen, phosphorus and sediments by 2025 of 22.0 percent, 14.9 percent, and 1.9 percent, respectively. As is the case for the Bay watershed as a whole, the largest absolute load reductions in the Maryland TMDL are projected to come from agriculture. On a percentage basis, however, the largest reductions for nitrogen (38 percent of existing nitrogen loads from this sector) are projected to come from septic systems (they are not considered a source of phosphorus at all). Achieving these reductions from existing sources of pollution would be difficult enough in itself. As a further complication, the reductions will have to be achieved over a period in which Maryland is experiencing significant new development and increases in population, creating brand new sources of nitrogen and phosphorus pollution. Since the levels of new development between now and 2025 cannot be predicted accurately at this time, they were not principal factors in the development of the Maryland TMDL and WIPs (or the TMDLs and WIPs of other Bay states).

Table 1.5 Maryland TMDL Load allocations and Percentage Reductions, by Source

Total Nitrogen (million lbs/yr)			
Source Sector	2010 Progress	Final Target Load	% Reduction from 2010
Agriculture	19.95	15.22	23.7
Stormwater	9.55	7.59	20.4
Septic	3	1.85	38.2
Forest	5.29	5.31	-0.2
Wastewater	14.31	10.54	26.3
Non-tidal Air Dep	0.66	0.66	0
Total	52.76	41.17	22%
Total Phorphorus (million lbs/yr)			
Source Sector	2010 Progress	Final Target Load	% Reduction from 2010
Agriculture	1.64	1.45	11.5
Stormwater	0.73	0.51	30.2
Forest	0.15	0.15	-0.1
Wastewater	0.74	0.66	11
Non-tidal Air Dep	0.04	0.04	0
Total	3.3	2.81	14.90%
Total Suspended Solids (million lbs/yr)			
Source Sector	2010 Progress	Final Target Load	% Reduction from 2010
Agriculture	696	-	-
Stormwater	545	-	-
Forest	126	-	-
Wastewater	9	-	-
Total	1,376	1,350	1.90%

Source: Maryland Phase II Watershed Implementation Plan

Note: a. Non-tidal Air Dep is only direct deposition to non-tidal waters, a very small component of the total air deposition and is included solely for completeness. Since the larger overall deposition of atmospheric nitrogen will be reduced by national program, EPA did not allocate or assign that to the States.b. Maryland did not set individual sector targets for sediment.

Within each tidal basin, Maryland, as part of its Stage II statewide WIP, further subdivided the nutrient allocations by local governing jurisdictions, which are the administrative bodies that will ultimately be responsible for directly making a large part of the actual nutrient reductions. Table 1.6 displays the Maryland TMDL target loads as broken down by local governing jurisdiction and by sector for nitrogen, the form of nutrient pollution that has received the most emphasis in watershed strategies and planning. Overall, for nitrogen the largest TMDL reductions from 2009 to 2012 are designed to come from Baltimore County and Baltimore City (treated as a county for TMDL development purposes), equal to 2.1 million tons and 1.5 million tons, respectively. Most of the reductions in these two jurisdictions are to come from upgrades to WWTPs, which were already in the works before the TMDL was finalized. The suburban counties of Anne Arundel (928 thousand tons) and Montgomery (553 thousand tons) are also assigned large TMDL reductions to be achieved mostly from WWTPs, stormwater and septic systems. Other Maryland counties assigned by the TMDL to make large nitrogen reductions, including Kent (733 thousand tons), Caroline (615 thousand), Queen Anne's (608 thousand), Talbot (501 thousand), Frederick (450 thousand tons), Washington (332 thousand), and Dorchester (322 thousand) and are expected to achieve their targets largely through reductions in the agricultural sector. In most counties, the agricultural sector is not the direct responsibility of the county government, but is being handled on a state-level by the Maryland Department of Agriculture and on a local-level by U.S. Department of Agriculture soil conservation districts that normally correspond to county boundaries.

Table 1.6 Maryland TMDL Nitrogen Load Reduction, by County and Sector (tons of nitrogen)

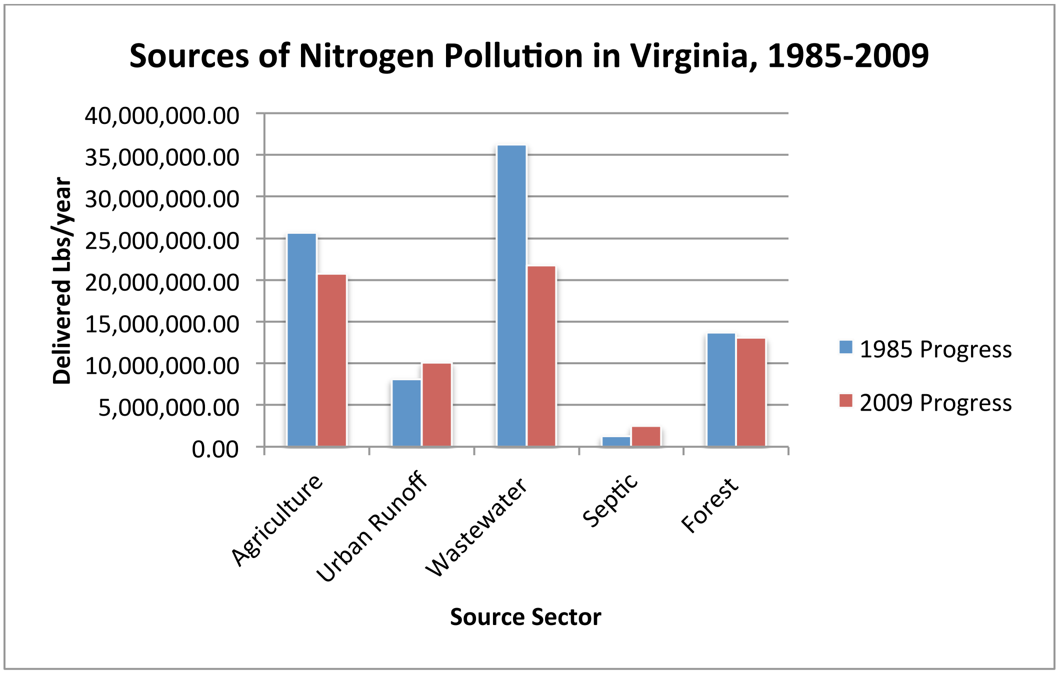
Jurisdiction	County Total 2009 Load	Agriculture Reduction 2009-2025	Urban Reduction 2009-2025	Septic Reduction 2009-2025	Forest Reduction 2009-2025	Wastewater Reduction 2009-2025	County Total Change 2009-2025
Allegany	553,290	-1,349	10,635	1,334	-5,199	39,799	45,220
Anne Arundel	3,072,884	68,581	279,100	236,794	2,274	341,696	928,445
Baltimore City	3,937,710	0	115,877	40	-23	1,424,602	1,540,496
Baltimore County	4,700,791	103,796	250,621	60,148	311	1,702,831	2,117,707
Calvert	822,420	56,153	59,141	120,419	-366	-2,420	232,927
Caroline	2,182,210	524,428	43,677	29,550	-1,314	18,627	614,968
Carroll	1,108,957	88,855	16,727	6,288	-91	11,842	123,621
Cecil	2,138,173	392,187	102,507	81,755	1,153	33,619	611,221
Charles	1,160,412	64,580	10,963	58,453	-4,772	-128,113	1,111
Dorchester	1,744,775	317,242	33,825	31,121	-3,497	-57,177	321,514
Frederick	4,508,668	355,546	86,391	35,572	-8,733	-19,203	449,573
Garrett	49,337	1,683	893	73	-610	-31	2,008
Harford	2,548,204	339,882	189,104	71,458	-2,995	32,547	629,996
Howard	1,524,557	7,968	49,353	19,085	619	437,870	514,895
Kent	1,861,232	689,709	42,767	18,995	-701	-17,423	733,347
Montgomery	4,328,998	176,656	161,700	32,695	3,126	178,953	553,130
Prince George's	2,994,972	47,919	203,423	30,536	1,392	-4,017	279,253
Queen Anne's	1,967,693	517,041	60,999	52,196	-1,172	-20,783	608,281
Somerset	1,540,947	64,404	37,326	21,277	-3,123	-10,708	109,176
St. Mary's	1,152,622	132,303	18,985	85,812	-3,250	1,169	235,019
Talbot	1,634,136	381,564	60,988	37,050	-775	22,037	500,864
Washington	3,158,427	248,935	27,748	21,387	-10,867	34,981	322,184
Wicomico	1,924,818	42,540	52,315	62,239	-3,405	136,743	290,432
Worcester	859,368	-107,946	6,658	5,408	-3,019	21,534	-77,365
Maryland Total	**51,475,601**	**4,512,677**	**1,921,723**	**1,119,685**	**-45,037**	**4,178,975**	**11,688,023**

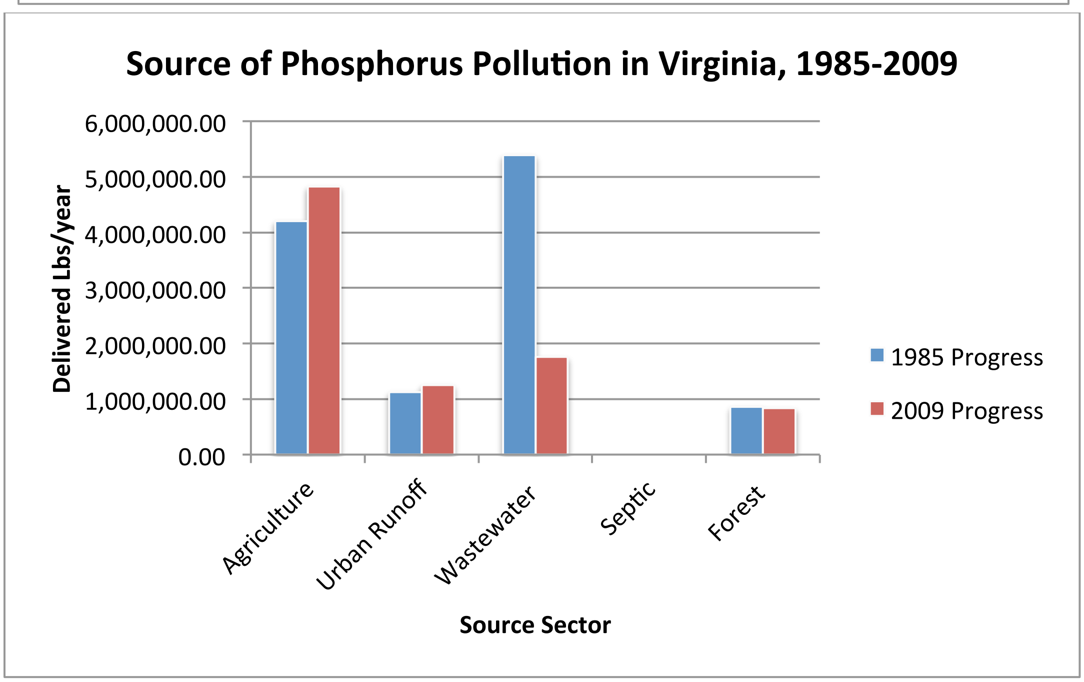
Source: Maryland Phase 1 Watershed Implementation Plan (from Watershed Model Phase 5.3.0)

Virginia's TMDL Status

From 1985 to 2009, driven in part by the goals set out in the Chesapeake 2000 Agreement, Virginia made significant progress in reducing the flows of nitrogen and phosphorus to the Chesapeake Bay from agriculture and from WWTPs. As shown in Figure 1.5 for nitrogen, however, Virginia was less successful in other areas such as stormwater ("urban runoff") and septic systems, both of which increased significantly over that period. This highlights the strong need in the Virginia TMDL both to develop new policies for stormwater and septic systems as well as to continue to achieve reductions in agriculture and WWTPs, if the 2017 and 2025 Virginia TMDL targets are to be met.

Figure 1.5 Sources of Nitrogen and Phosphorus Pollution in Virginia, 1985 to 2009





Source: U.S. EPA Chesapeake Bay TMDL Tracking and Accounting System (BayTAS)

In November 2010, Virginia issued its Phase I WIP that established a state-wide general strategy for meeting the TMDL load reduction goals for 2025. Table 1.7 provides details concerning the relative and absolute WIP reductions in both nitrogen and phosphorous for various forms of specific economic activities in Virginia. On average, reductions of 17 percent will be required in nitrogen loads, and of 24 percent in phosphorus loads for Virginia as a whole. For some activities, however, the required reductions will be much greater, for example, a 73 percent reduction in nitrogen loads coming from concentrated animal feeding operations (CAFOs), which are labeled as "animal operations."

Table 1.7 Relative and Absolute Nitrogen and Phosphorus Reductions Compared to 2009 Baseline Levels

Subsource	LU/LC (acres)	2009 Nitrogen Load	2025 Nitrogen Goal Load	Nitrogen Reduction Goal	Nitrogen Reduction %	2009 Phosphorus Load	2025 Phosphorus Goal Load	Phosphorus Reduction Goal	Phosphorus Reduction %
Animal Operations	6,395	9,284,062	2,501,318	(6,782,744)	-73%	540,056	141,806	(398,250)	-74%
Crop	716,576	19,278,828	13,434,764	(5,944,064)	-30%	1,835,530	1,408,260	(427,270)	-23%
Hay	719,584	12,362,786	10,394,455	(1,968,331)	-15%	216,221	394,742	178,521	83%
Pasture	1,164,723	13,071,413	11,154,367	(1,917,046)	-15%	2,153,923	1,446,349	(707,574)	-33%
Nurseries	215	67,259	19,334	(47,925)	-71%	31,376	9,013	(22,363)	-71%
MS4Urban	665,395	5,509,928	5,200,511	(309,417)	-6%	729,711	664,944	(64,767)	-9%
NonMS4Urban	495,727	5,647,472	4,305,996	(1,341,476)	-24%	867,158	540,085	(327,073)	-38%
Construction	13,967	376,303	280,609	(95,694)	-25%	125,900	75,753	(50,147)	-40%
CSS	18,945	-	-	-	0%	-	-	-	0%
Septic	-	4,861,654	4,356,752	(504,902)	-10%	-	-	-	0%
Surface Mine	35,148	478,420	24,295	(454,125)	-95%	184,630	9,373	(175,257)	-95%
Unmanaged Grass	201,272	1,217,627	2,181,818	964,191	79%	6,588	11,957	5,369	81%
Forest	9,804,958	30,346,571	30,838,750	492,179	2%	1,629,000	1,649,136	20,136	1%
Grand Total	13,842,906	102,502,323	84,692,969	17,809,354	-17%	8,320,093	6,351,418	(1,968,675)	-24%

Source: Virginia Department of Conservation and Recreation

Tables 1.8 and 1.9 show the Phase 1 WIP nitrogen and phosphorous target loads for 2025 for each of the five river basins (Potomac, Rappahannock, York, James, and Eastern Shore) in Virginia. The Virginia TMDL projects the various sources of pollution to 2025. The James River Basin and the Potomac River Basin are projected to be largest contributors of nutrient pollution. For example, the James River Basin is projected to be the source of the largest nutrient flows from WWTPs, including 69 percent of the total nitrogen loads and 65 percent of the phosphorus loads in the state, as well as the largest contributor of phosphorus from stormwater flows. The Potomac River basin is projected to be the largest contributor of nutrient flows from agriculture by 2025, equal to 41 percent of Virginia's agricultural nitrogen load and 32 percent of its agricultural phosphorus load, as well as the largest contributor of nitrogen from stormwater sources. The three other river basins in Virginia -- the Rappahannock, York, and Eastern Shore – are all projected to contribute a much smaller share of nutrient loads in 2025, equal to 10 percent, 10 percent, and 2 percent, respectively, of the Virginia total for nitrogen from all sources, and equal to 16 percent, 10 percent, and 3 percent, respectively, of the Virginia total for phosphorus from all sources.

Table 1.8. Virginia 2025 Target Loads for Nitrogen

Source Sector	**Potomac**	**Rappahannock**	**York**	**James**	**Eastern Shore**	**Virginia Total**
Agriculture	6.359	2.515	1.404	4.253	0.890	15.421
Urban Runoff	2.635	0.403	0.445	2.534	0.050	6.067
Wastewater	3.743	0.640	1.201	12.491	0.087	18.162
On-site	0.597	0.322	0.487	0.923	0.076	2.405
Forest	4.197	1.886	1.782	6.048	0.162	14.076
Non-tidal	0.103	0.073	0.089	0.320	0.032	0.617
Dep Total	17.634	5.839	5.409	26.569	1.297	56.748
Basin Allocations	17.634	5.840	5.410	23.480	1.297	53.662

Source: Virginia Phase I Watershed Implementation Plan

Table 1.9 Virginia 2025 Target Loads for Phosphorus

Source Sector	**Potomac**	**Rappahannock**	**York**	**James**	**Eastern Shore**	**Virginia Total**
Agriculture	0.674	0.533	0.157	0.622	0.111	2.097
Urban Runoff	0.273	0.094	0.090	0.528	0.009	0.994
Wastewater	0.278	0.079	0.155	0.967	0.008	1.487
On-site	0	0	0	0	0	0
Forest	0.205	0.183	0.126	0.543	0.015	1.072
Non-tidal	0.008	0.007	0.009	0.030	0.002	0.056
Dep Total	1.438	0.896	0.538	2.690	0.145	5.707
Basin Allocations	1.439	0.900	0.540	2.340	0.145	5.357

Source: Virginia Phase I Watershed Implementation Plan

The TMDL timeline set by the EPA required Virginia to submit its draft phase 2 WIP by late 2011. The EPA did not raise any major concerns about the Phase 1 WIP submitted by the state (except in requiring Virginia to slightly adjust its nutrient allocations). As a result, the Phase 2 WIP focused on facilitating implementation of the Bay TMDL by dividing the overall TMDL allocations into local area targets for governing jurisdiction, working with local governing jurisdictions on their needed actions to achieve these targets.

While Virginia submitted the final Phase 2 WIP to EPA on March 30, 2012, public comments were accepted until the end of May. EPA had previously had some positive comments with respect to Virginia's WIP strategy. For example, the Agency praised Virginia's inclusion of agricultural initiatives for CAFOs and expansion of the nutrient trading system. However, EPA in 2012 expressed a concern that the WIP 2 Plan lacked enough detail at the local level. The EPA also commented that the state had not relied on local land use data. Virginia responded that the state had not had enough time to consult with local governing bodies. Virginia has also stated that it had found anomalies in the model used for developing the nutrient management plans and has thus asked for a necessary correction of this model. In general, perhaps reflecting in part the election of a new Republican governor who took office in 2009, there have been increasing tensions recently between EPA and the Virginia government concerning the implementation of the Bay TMDL.

Pennsylvania's TMDL Status

Since 1985, Pennsylvania has achieved 27 percent of the total nitrogen reductions, 31 percent of the phosphorus reductions, and 50 percent of the sediment reductions that will eventually be needed to reach its 2025 TMDL targets. The Susquehanna River, originating in New York State and traveling through Pennsylvania, is the Chesapeake Bay's largest tributary and supplier of over 50 percent of its freshwater.[11] As shown in Figure 1.6, the majority of the state of Pennsylvania lies within the watershed of the Susquehanna River which accounts for 92 percent of the state's Bay drainage area. The portion of the Potomac River watershed found in Pennsylvania accounts for 7 percent and three other Pennsylvania watersheds contribute one percent in total.

Figure 1.6 Pennsylvania's Major Watersheds

Source: Pennsylvania Department of Environmental Protection

Pennsylvania issued its draft Phase 1 WIP on September 1, 2010, and following a series of revisions, the final version on January 11, 2011. The Phase I WIP was written by the Pennsylvania Department of Environmental Protection (PADEP), with input from the Watershed Implementation Plan Management Team and stakeholders including WWTP managers, legislators, agricultural representatives, and environmental leaders.

The Phase I WIP is intended to inform EPA of the state's schedule for reducing nutrient and sediment loads by sector and basin. As shown in Table 1.10, EPA has determined that by 2025 Pennsylvania must reduce its nitrogen loads to 78.83 million pounds per year, its phosphorous loads to 3.6 million lbs/yr and total sediment loads to 1,945 million lbs/yr.

Table 1.10 Pennsylvania Nitrogen, Phosphorus, and Sediment Delivered Loads in Millions of Pounds per Year

	Nitrogen	**Phosphorous**	**Sediment**
2011	112.48	4.8	2,513
Planning Targets (Year 2025)	78.83	3.6	1,945
Remaining Reductions	33.65	1.2	568

Source: EPA Phase 3.5.3 Watershed Model

In the Phase 1 WIP, Pennsylvania subdivided the basin load allocations to major load-generating sectors, including agriculture, forest, wastewater treatment facilities ("point sources"), stormwater ("urban/developed"), septic systems, and air deposition to water. In its Draft Phase 1 WIP, PADEP first allocated to point sources as much as possible, then allocated to all other sectors based on their percentage of nutrient and sediment pollution (available in the table below). However, following EPA's comments, the Final Phase I WIP followed a different protocol. The allocations now reflect to a greater degree implementation of cost-effective best management practices and available technology. This is a more realistic, common sense approach. However, difficulties remain for reducing loads from sectors such as air deposition, and forest runoff. Table 1.11 indicates the sector-specific loads.

Table 1.11 Pennsylvania Target Load Reduction, 2011 to 2025

	Nitrogen			Phosphorus			Sediment		
	2011 Data	**2025 Goal**	**% Reduction from 2011**	**2011 Data**	**2025 Goal**	**% Reduction from 2011**	**2011 Data**	**2025 Goal**	**% Reduction from 2011**
Agriculture	59,281,017	35,313,572	40.43%	2,611,189	1,832,756	29.81%	1,559,246,443	1,190,126,458	23.67%
Urban Runoff	17,467,177	10,235,505	41.40%	756,503	428,232	43.39%	546,482,769	313,479,999	42.64%
Waste Water & CSO	11,483,413	9,080,860	20.92%	997,916	903,949	9.42%	21,355,580	12,653,777	40.75%
Septic	2,141,702	1,742,464	18.64%	-	-	-	-	-	-
Forest	21,067,076	21,417,135	-1.66%	393,689	397,140	-0.88%	385,909,945	428,739,765	-11.10%
Air Deposition	1,042,439	1,042,439	0.00%	37,246	37,246	0.00%	-	-	-
Total Pounds:	112,482,824	78,831,975	29.92%	4,796,543	3,599,322	24.96%	2,512,994,737	1,945,000,000	22.60%

Source: Pennsylvania Chesapeake Watershed Implementation Plan Phase 2

As shown in the table above, agriculture is responsible for the largest part of Pennsylvania's nutrient and sediment loads. For non-point sources, agriculture is the cause of 50 percent of phosphorous runoff and 52 percent of nitrogen runoff.

There has been greater tension between state officials in Pennsylvania and the EPA, as compared with most other Bay states (there has also been considerable tension with New York State, also partly due to the distance of New York from the Bay itself). The state's Phase I WIP devotes considerable space alleging that their reductions are not adequately represented in EPA's model. As a state with less direct benefit from a healthy Chesapeake Bay, and a heavy investment in agriculture, Pennsylvania may be more reluctant in its support for the Bay cleanup. In Pennsylvania's Phase 2 WIP in the March 2012, the state protests potential EPA enforcement of the TMDL as "wholly unjustified and arbitrary and capricious." The state may be laying the foundation for a judicial challenge. The document also includes dozens of pages of stakeholder complaints, especially that BMPs are under-reported.

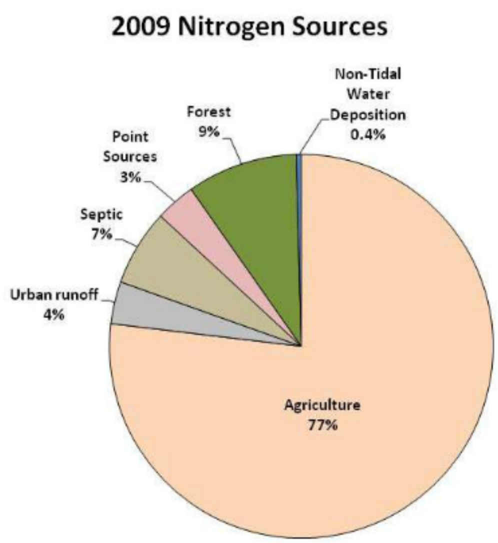
In its oft-cited October 5, 2011 letter, EPA succumbed to pressure and allowed Bay jurisdictions to subdivide allocations by basin, instead of by county, in the Phase II WIP. Pennsylvania has interpreted this letter as an admission of the model's flaws and overreach of EPA authority. Pennsylvania argues that EPA's model should be used as a guide, and not as a regulatory tool. The reluctant Commonwealth from the Phase I WIP is now increasingly an opponent in the Phase II WIP.

The Chesapeake Bay Foundation, with a coalition of dozens of other environmental groups, released a September 2012 review of actions to achieve TMDL milestones. Pennsylvania fared worse than other states, meeting or exceeding its goals for four practices and falling short on six. The state did well in reducing pollution from wastewater and septics, and doubled its goal of forest buffers. However, stormwater management saw little progress, and other areas of agricultural BMPs (such as no-till land and cover crops) fell far short of their targets.[12]

Delaware's TMDL Status

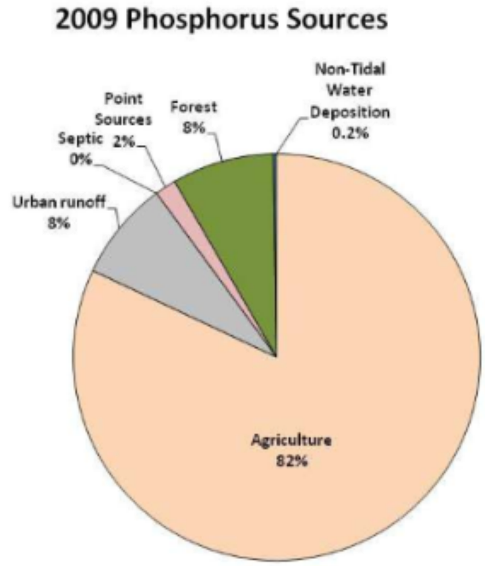
Delaware's portion of the Chesapeake Bay Watershed is 769 square miles and makes up only 1 percent of the total land area within the Bay watershed.[13] Portions of New Castle County, Kent County, and Sussex County lie within the watershed. The counties contribute only 2 percent of the total nitrogen, 2 percent of the total phosphorus, and 0.8 percent of the total sediment arriving at the Chesapeake Bay. Figures 1.7 and 1.8 show the sources of nitrogen and phosphorus from Delaware in 2009. Delaware's contribution to Bay nutrient loads comes predominately from agriculture, accounting in 2009 for 77 percent of Delaware total nitrogen loads and 82 percent of total phosphorus loads. The focus of Delaware's TMDL is therefore on the agricultural sector.

Figure 1.7 2009 Delaware Nitrogen Sources



Source: Delaware Chesapeake Bay Watershed Implementation Plan - Phase I

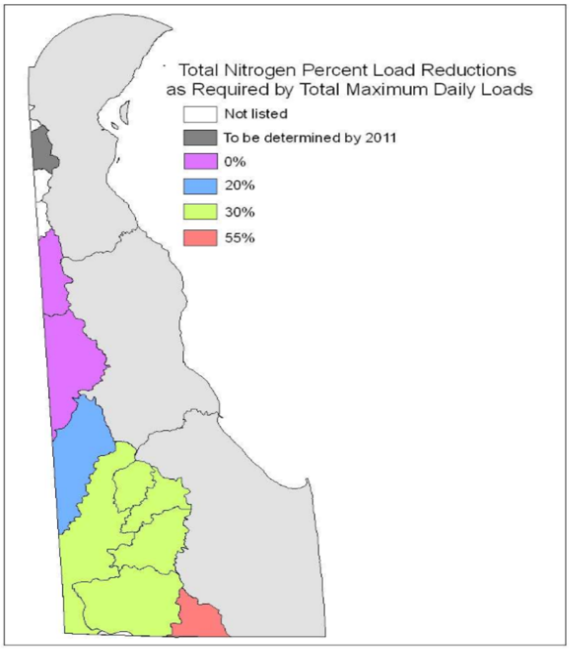
Figure 1.8 2009 Phosphorus Sources



Source: Delaware Chesapeake Bay Watershed Implementation Plan - Phase I

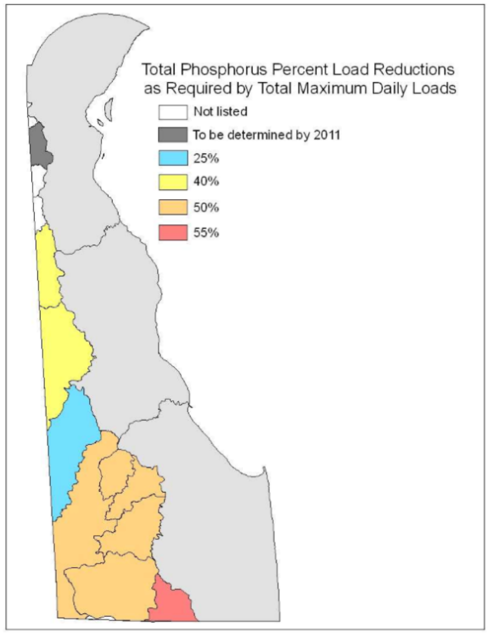
Figures 1.9 and 1.10 show nitrogen and phosphorus reductions required by the Delaware TMDL in the Chesapeake Bay Watershed. For nitrogen, the largest TMDL reductions (30 percent or more) will be in the southern part of Delaware, mainly Sussex County. For phosphorus, the largest reductions (50 percent of more) will again be mainly in Sussex County but significant reductions (25 percent or more) will also be required by the TMDL in Kent County.

Figure 1.9 Nitrogen Reduction Required by the Delaware TMDL in Chesapeake Bay Watershed



Source: Delaware Chesapeake Bay Watershed Implementation Plan - Phase I

Figure 1.10 Phosphorus Required by the Delaware TMDL in Chesapeake Bay Watershed

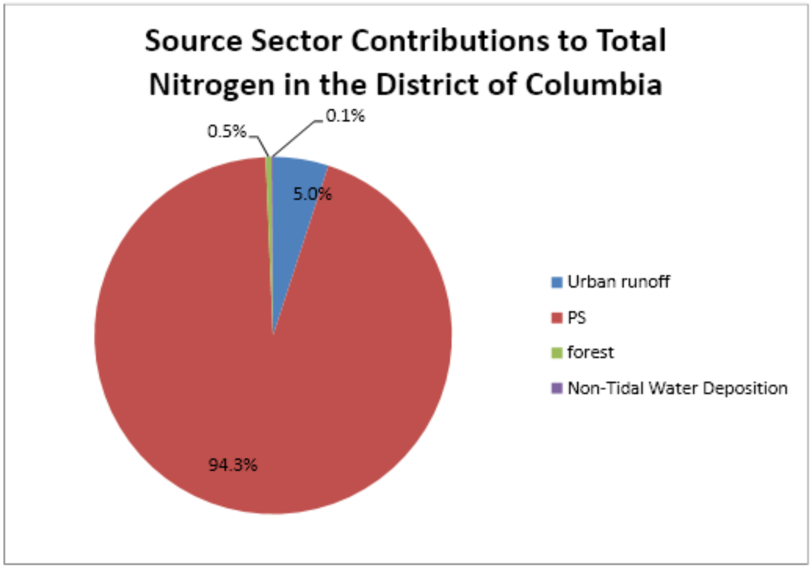


Source: Delaware Chesapeake Bay Watershed Implementation Plan - Phase I

The District of Columbia's TMDL Status

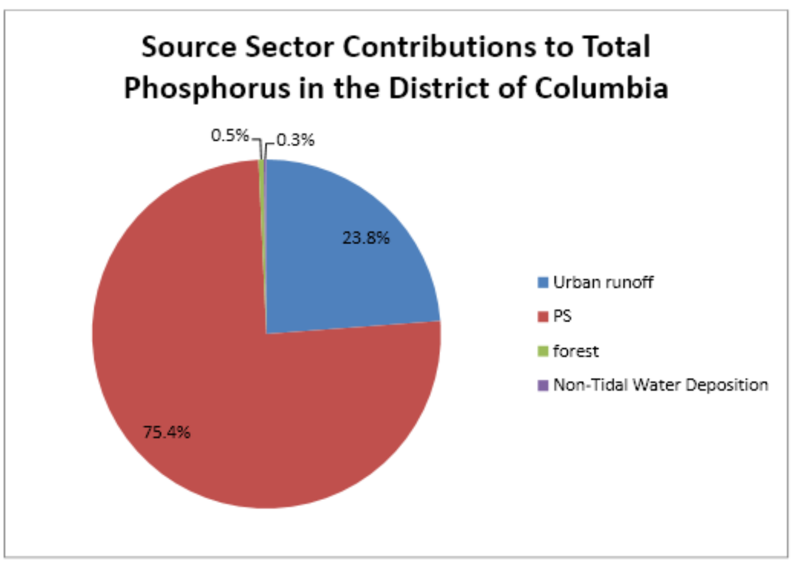
The District of Columbia (D.C. or the District) covers 69 square miles and is distinct from other Chesapeake Bay jurisdictions in meeting baselines and TMDL requirements because 80 percent of the District is developed, 20 percent is open space, parks, or water and no land within the District is classified as agriculture[14]. As shown in Figure 1.11, point sources thus contribute 94.3 percent of nitrogen, 75.4 percent of phosphorus, and 61.6 percent of the sediment of the District's Bay loads. Urban stormwater runoff contributes 5 percent of nitrogen, 23.8 percent of phosphorus, and 36% of the sediment from the District. As with agriculture, forests and non-tidal water deposition make a very small contribution.

Figure 1.11 Source Sector Contribution to Total Nitrogen in the District of Columbia



Source: Phase I District of Columbia Watershed Implementation Plan

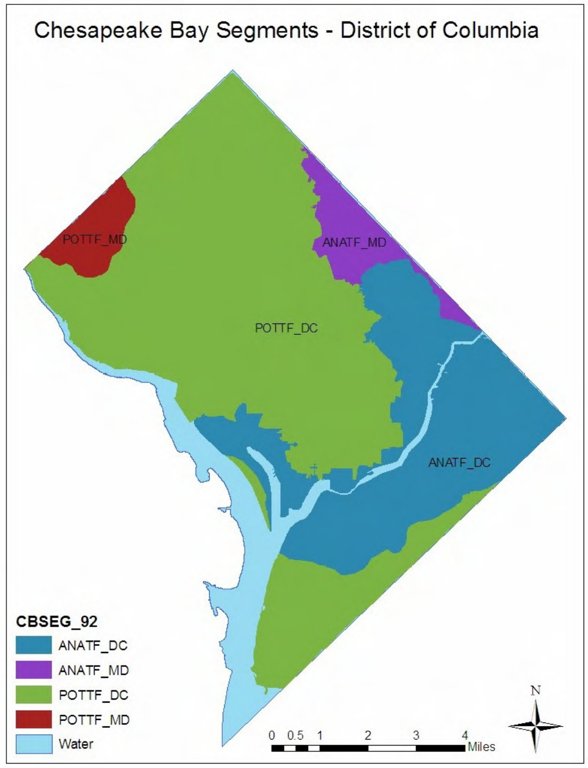
Figure 1.12 Source Sector Contributions to Total Phosphorus in the District of Columbia



Source: Phase I District of Columbia Watershed Implementation Plan

D.C. has portions of four of the 92 impaired segments listed in the Chesapeake Bay Watershed TMDL. These segments include portions of the Upper Potomac River and the Anacostia River. Figure 1.13 identifies these segments. The District will not be relying on voluntary or incentive-based programs to reach target loads since most reductions will occur through municipal separate storm sewer system (MS4) permits and other mandated requirements.[15] The new MS4 requirements establish a 1.2 inch (1.2") retention standard, requiring new development and redevelopment in the District to retain at least 1.2” of stormwater runoff caused by any redevelopment activity that disturbs up to 5,000 square feet of land.[16]

Figure 1.13 Chesapeake Bay Segments – District of Columbia



Source: Phase I District of Columbia Watershed Implementation Plan

Conclusion

Under the instructions and guidance of EPA, a TMDL for the Chesapeake Bay was issued in December 2010 that would achieve interim targets in 2017 and final targets in 2025. Parts of Maryland, Virginia, Pennsylvania, West Virginia, Delaware and New York State fall within the Chesapeake Bay watershed. EPA has set statewide targets for each of these states and is requiring the states to development watershed implementation plans (WIPs) to achieve the targets. These WIPs were issued by the states in 2012, including the disaggregation of the statewide targets by water basins and local government jurisdictions (and corresponding soil conservation districts for agriculture). The states have established two year milestones including specific actions from the various sources of Bay pollution to be taken by each implementing jurisdiction. The TMDL process has thus reached a stage where much of the long range planning has been completed and the detailed implementation is now beginning.

As will be discussed in Chapters 2, 3, and 4, many large hurdles remain to the successful implementation of the Bay TMDL, including the large state and local costs and equity concerns relating to the varying distributional burdens imposed by the TMDLs of each state. Policies for nutrient offsets will probably play an important – indeed essential – role, if these hurdles are to be overcome.

Chapter 2 – Unaffordable TMDL Costs

As described in the previous chapter, EPA and the states divided the total load targets among the six states and still further into local implementing jurisdictions and soil conservation districts. While the states may have informally taken some economic factors into account on the local level, the load allocations themselves were never intended at any stage to be the direct result of a set of economic calculations. Indeed, the basis for the TMDL was the legal requirement of the Clean Water Act, largely independent of costs, that certain levels of water quality must be achieved. Thus, as the total costs were never calculated, neither was an explicit cost-effectiveness or benefit-cost analysis undertaken by EPA as part of the TMDL development process (EPA is now preparing a comprehensive benefit-cost analysis after the fact of the publication of the TMDL in December 2010). Instead, it was assumed that, since the TMDL was legally binding, the costs would somehow be covered by the states and other involved parties, whatever the magnitude of the costs. No attempt was made as part of TMDL development to explain where the funds to cover the costs would specifically come from. It was left to later stages of TMDL implementation to work out such funding details.

Recognizing this, some of the Bay states have begun to estimate the costs of the implementation of their share of the TMDL. These costs turn out to be surprisingly large. Spending at these levels for the Bay cleanup may encounter significant political resistance in the Bay states. Moreover, it is questionable whether the states can be legally obligated to provide the full funding necessary to implement the Bay TMDL. As the U.S. Supreme Court in June 2012 affirmed in *National Federation of Independent Business v. Sebelius* with respect to the Medicaid provisions of the Affordable Care Act, there are constitutional limits to the ability of the federal government to impose new programmatic and spending requirements on state governments. Even if the federal government turns out to have the legal authority, another question is whether it will have the necessary political will.

The rest of the chapter attempts to roughly estimate the costs of TMDL implementation, particularly the cost to Maryland, Virginia, and Pennsylvania, which as the largest contributors to Bay pollution, should bear a larger proportion of the total cost. Given the high estimated costs, the likely political willingness of the state governments and taxpayers is also considered.

<u>Estimating TMDL Costs</u>

Previous estimates of the total cost of Chesapeake Bay cleanup were made the Chesapeake Bay Commission (CBC) (2003) and the Blue Ribbon Finance Panel (BRFP)(2004). The CBC report titled *The Cost of a Clean Bay* estimated the total cost for Maryland, Virginia, and Pennsylvania to meet the various goals of the Chesapeake 2000 agreement. The total project cost was $18.7 billion, of which $12.8 billion was unfunded at that time. Most of the predicted cost was associated with Goal 3 – Water Quality Protection and Restoration ($11.46 billion estimated cost, with only about $2.16 billion funded), and Goal 4 – Sound Land Use ($4.16 billion cost, $3.05 billion funded).[17] In its estimate, the Blue Ribbon Panel predicted a total cost of $28 billion to meet local water quality standards and the Tributary Strategies associated with the Bay cleanup to achieve the pollution reductions set out in the *Chesapeake 2000* agreement among the Bay states.[18]

As stated earlier, as of the summer of 2012, the EPA had not provided an estimate of the full total costs of Bay TMDL implementation. While it is beyond the scope of this report to develop a comprehensive estimate of total TMDL costs, a rough estimate using various state estimates follows. Table 2.1 provides a breakdown of the TMDL reduction targets for existing sources by 2025. Available cost estimates (per-pound total nitrogen removed) are divided into three scenarios (low, mid, and high), which yields an approximate range of values. The table illustrates how widely cost estimates vary, given the relatively large uncertainties for agricultural, urban, and septic costs. The low-end estimate is not practical, since it implies that all reductions are met through implementation of only the lowest cost BMPs and projects, an unlikely outcome. The total cost most likely falls somewhere between the mid- and high-end estimates, though the total TMDL costs ultimately depend on the policies adopted by state and local officials, and the actions taken by private landowners. Since the cost estimates are based on the total reductions for all existing sources, the costs include both public and private expenses. Furthermore, it is important to remember the costs are spread over many years.

Table 2.1 Estimated Costs of Total Nitrogen Reductions, by Source

	Total N reductions, 2009-2025	Est. cost per lb. N (low)	Est. cost per lb. N (mid)	Est. cost per lb. N (high)	Total est. cost (low)	Total est. cost (mid)	Total est. cost (high)
Agriculture	42,304,545.49	$50	$100	$195[*]	$ 2,115,227,274	$ 4,230,454,549	$ 8,249,386,370
Onsite/septic	2,633,523.53	$500	$3,237[*]	$4,629[#]	$ 1,316,761,765	$ 8,524,715,666	$ 12,190,580,419
Total urban	5,015,659.30	$400	$4,000[*]	$10,000[#]	$ 2,006,263,719	$ 20,062,637,185	$ 50,156,592,963
Wastewater	14,209,780.78	$100	$200	$625[*]	$ 1,420,978,078	$ 2,841,956,155	$ 8,881,112,986
					$ 6,859,230,835	$ 35,659,763,555	$ 79,477,672,737

[*] This unit cost approximates the overall unit cost for this sector, based on Maryland's Phase II WIP
[#] This unit cost approximates the overall unit cost for this sector, based on Virginia's cost estimates

Given potential Bay TMDL costs that could turn out to be in the range of $35 billion to $80 billion for the whole Bay, the future full implementation of the Bay TMDL is thus a question mark. The funds may simply not be available in the necessary amounts, which could raise further complications as the various elements of the TMDL are highly interdependent. The high costs are a main reason that the future of the Bay TMDL is endangered. Use of nutrient offsets may become particularly important as one possible means of addressing potential future deficits in TMDL funding.

<u>TMDL Costs by State</u>

Maryland TMDL Costs

As shown in Table 2.2, total TMDL implementation costs for the actions laid out in 2012 in Stage II of the Maryland WIP are estimated by Maryland officials to be $6.28 billion for the period from 2010 to the interim target date of 2017. Over the period from 2010 to 2025, total TMDL implementation costs for Maryland are estimated to be $14.79 billion. The largest part of Maryland TMDL costs is for meeting new stormwater requirements, equal to $2.5 billion to 2017 and increasing to $7.8 billion by 2025. Spending of $2.4 billion will be required for WWTPs prior to 2017 (this will also meet the TMDL wastewater requirements for 2025). Total TMDL funding for septic systems in Maryland is estimated to be $978 million by 2017, and $3.7 billion by 2025.

The total costs of TMDL implementation for agriculture are estimated to be $498 million by 2017 and $928 million by 2025, equal to 8 percent of Maryland's total 2017 TMDL costs and 7 percent of Maryland's total 2025 TMDL costs. Since agriculture contributes 39 percent of Maryland's total nitrogen load, and 50 percent of its total phosphorus load, it is apparent that agriculture would bear a disproportionately much lower share of the costs than its contribution to nutrient loadings. If costs of implementation in agriculture were in direct proportion to its nutrient loads, the TMDL costs for agriculture would be more than $2.5 billion by 2017 and more than $5.76 billion by 2025. Such levels of costs might well have driven many farmers out of business, perhaps an implicit if not an explicit consideration in the Maryland process of TMDL development. Use of nutrient offsets, however, may provide a means by which agriculture in Maryland may make larger nutrient reductions without farmers having to bear the full cost burden themselves.

Table 2.2 Maryland Costs of TMDL Implementation, by Source (in $ millions)

Source Sector	Cost of 2017 Strategy 2010 - 2017 (Millions)	Cost of 2025 Strategy[a] 2010 - 2025 (Millions)
Agriculture	**$498**	**$928**
Municipal Wastewater	**$2,368**	**$2,368**
Major Municipal Plants	$2,306	$2,306
Minor Municipal Plants	$62	$62
Stormwater	**$2,546**	**$7,388**
MDOT[c]	$467	$1,500
Local Government	$2,079	$5,888
Septic Systems	**$824**	**$3,719**
Septic System Upgrades	$562	$2,358
Septic System Connections	$237	$1,273
Septic System Pumping	$25	$88
TOTAL	**$6,236**	**$14,403**

a. Cumulative total.
b. Costs are in 2011 dollars unless otherwise noted in Appendix C.
c. Maryland Department of Transportation (MDOT) costs are segregated from other stormwater costs due to their non-standard cost structure. Cost estimates were provided by MDOT.

Source: Maryland Phase II Watershed Implementation Plan

According to Maryland's Stage II WIP, total spending in the state will be about $1 billion per year through 2025 in implementing the Bay TMDL. The population of Maryland in 2011 was 5.83 million. Thus, Maryland TMDL spending from 2010 to 2025 will be about $172 per person per year. Perhaps more relevant, Maryland had 1.98 million households in 2011. On a per household basis, Maryland TMDL spending will be about $505 per household per year through 2025. For a typical household of three, the poverty level is $19,090 per household. For such a household, Maryland TMDL costs would equal about 2.6 percent of their income, if they bore a proportionate household share of the TMDL costs.

Another basis for assessing the total TMDL cost burden is to compare it with other areas of government spending in Maryland (recognizing that a significant part of the TMDL costs may be privately borne by Maryland farmers, homeowners in stormwater districts, and other private parties). In 2010 total state spending for the prison system was $836.2 million, less than the estimated annual costs through 2025 of Bay TMDL spending in Maryland. Total Maryland spending on public schools is $11.8 billion per year, 48 percent funded by state sources, 46 percent funded by local sources, and 6 percent funded by federal sources. The total costs per year of the Bay TMDL to Maryland would thus be about 8.5 percent of its total annual spending on public schools. In comparison to the total annual budget of the University of Maryland, College Park ($1.6 billion in 2011), the Maryland annual costs of Bay TMDL implementation through 2025 would be about 60 percent of this figure.

It remains to be seen whether TMDL spending of this magnitude will be politically acceptable in Maryland, especially in a time of fiscal austerity for states throughout the nation, including Maryland. A further consideration is that the benefits of the Bay cleanup will be unevenly distributed geographically among the state residents -- to a greater extent than the other spending categories above -- being the largest for those Marylanders who live in the closest physical proximity to the Bay.

Virginia TMDL Costs

Recent estimates of the total costs of the Bay TMDL for Virginia, based on the Phase I WIP presented to the Senate Finance Committee of the state legislature in 2011, are similar to the total cost estimates for Maryland. As shown in Table 2.3, these estimates suggest that Virginia's total potential costs of meeting the TMDL would range from $13.6 billion to $15.7 billion by 2025. As in Maryland, the largest share of the costs would be borne by stormwater sources, estimated to range from $9.4 billion to $11.5 billion through 2025. Onsite septic systems are the next largest cost category, equal to $1.6 billion in costs through 2025, followed by WWTPs ($1.4 billion) and agriculture ($1.2 billion). As compared with Maryland, these Virginia estimates show higher total costs for stormwater, similar total costs for agriculture, and lower total costs for WWTPs and septic systems.

The population of Virginia, however, was 8.1 million in 2011, about a third greater than the population of Maryland. Total TMDL spending in Virginia is thus correspondingly less on a per capita basis for the state (ranging from $112 to $129 per year) or on a per household basis (ranging from $336 to $388 per year). On the other hand, much of Virginia lies outside the Bay watershed, while all of Maryland is in the watershed. Thus, many residents of Virginia may end up contributing funds for Bay cleanup for which they receive fewer direct benefits, as compared with people actually living within the Bay watershed. Those Virginia residents who live in close physical proximity to the Bay, like similar residents in Maryland, may receive particularly large benefits per person, as compared with other residents of the state living far from the Bay.

Table 2.3 Virginia Costs of TMDL Implementation, by Source

	Projected Total Cost ($ in billions)	Who Pays	Potential State Costs ($ in billions)	Potential Sources of Funding
Wastewater (including CSOs)	$1.4	State Govt./Local Govt./Rate-payers	$0.3 (plus $78 million for CSOs?)	WQIF, State GF, Bonds /Local GF, Bonds/Tax Assessments, Sewer Rates
Agriculture	$1.2+	State Govt./ Farmers	$0.8+	WQIF, State GF/ Agribusinesses
Stormwater	$9.4 to $11.5 (including VDOT)	Local Govt./ Property Owners/ VDOT	$2.1 (VDOT Share)	Local GF, Bonds/Utility Fees, Assessments/ Transportation Trust Fund
Onsite/ Septic Systems	$1.6	Property Owners	Unknown What Role State May Play	"Betterment loans", Potential for Tax Credits or Grants
Bay TMDL Total	**$13.6 to $15.7**	**Potential State Total**	**$3.2+**	

Source: Senate of Virginia Senate Finance Committee report November 18, 2011, Accessed here: *http://sfc.virginia.gov/pdf/retreat/2011%20Retreat/Presentation_Final%20PDF%20for%20Website/5.Chesapeake%20Bay%20TMDL%20FINAL.pdf*

An important further consideration is the allocation of the total TMDL cost burdens, in particular the funding that would be obtained privately versus the commitments of public funds. Higher private funding levels raise the possibility of greater political resistance among those who would be most directly affected. Higher public funding levels distribute the costs more widely but would bring TMDL funding direction into competition with other Virginia budgetary priorities. Table 2.4 shows the estimated costs by year for planned agricultural best management plans (BMPs) in Virginia. From 2012 to 2018, the total agricultural costs in Virginia are estimated to be $487 million. The state would pay $351 million as its share of these costs (72 percent), while farmers would contribute a $137 million share (38 percent). Thus, the public sector even for a private activity such as farming would bear the largest part of the TMDL funding burdens.

Table 2.4: Distribution of Costs of agricultural BMPs in Virginia, 2012-2018

Fiscal Year	State Share	Farmer's Share *	Total
2012	$36.9**	$14.4	$52.3
2013	$39.8	$15.4	$55.3
2014	$42.4	$16.5	$58.9
2015	$47.5	$18.4	$65.9
2016	$58.3	$22.6	$80.9
2017	$60.2	$23.4	$83.6
2018***	$65.8	$25.5	$91.3
Total	$350.9	$136.5	$487.4

Source: Senate of Virginia Senate Finance Committee report November 18, 2011, Accessed here: *http://sfc.virginia.gov/pdf/retreat/2011%20Retreat/Presentation_Final%20PDF%20for%20Website/5.Chesapeake%20Bay%20TMDL%20FINAL.pdf*

TMDL implementation costs of the magnitude suggested above may challenge the fiscal capacities of Virginia and its localities to find the necessary funding. The Virginia TMDL for the Bay only prescribes load reductions for geographic areas of the state and by type of source. It does not explain how or where the necessary funding will be obtained. The development of funding sources is considered to be part of the continuing process of implementing the TMDL, not a task that is itself part of the Bay TMDL. Given that the largest part of the funding is expected to be borne by private owners and by state and local governments, it would have been difficult if not impossible for EPA to develop a well defined budget plan for implementing the TMDL in Virginia and other Bay states. In the case of state and local governments, it would have been particularly difficult.

It will be a large challenge to meet the ambitious TMDL goals for Virginia in the timeframes set out in the WIPs. Indeed, some experts have been skeptical about the feasibility of achieving such large Virginia reductions in nutrient discharges at an acceptable cost to the State. In comments to EPA, Virginia has itself expressed its concerns about the short timelines, the burdensome costs, and the accuracy of the computer model used by EPA to determine nutrient loads. In the cover letter to the Phase I WIP Plan, Virginia stated that "we must reiterate Virginia's concerns about the process, cost, legality, allocations, and compressed timing in the development of this plan." Virginia complained that the Bay TMDL worked as "another federal unfunded mandate on the state, localities, private industries, and homeowners." For its part, EPA has been concerned about the degree of Virginia commitment to full TMDL implementation, as manifested in its Phase 1 and Phase 2 WIPs. Such tensions may grow over time as the TMDL implementation proceeds further and requires actual large commitments of funds, potentially endangering the achievement of the 2017 and 2025 nutrient load targets in Virginia.

Pennsylvania TMDL Costs

Pennsylvania may pose the greatest test for the Bay TMDL in terms of the willingness of the state to bear the significant costs involved. Because Pennsylvania is such a large contributor to Bay pollutant loads, its share of the TMDL implementation costs will be correspondingly large. However, as compared with Maryland and Virginia, the other two states with the largest cost burdens, Pennsylvania does not directly border on the Bay. Indeed, many parts of Pennsylvania are several hours driving time away from the nearest parts of the Bay.

Pennsylvania has nevertheless historically cooperated closely with Maryland and Virginia in seeking to play its part in the Bay cleanup (other Bay states were not part of the Bay cleanup agreement until 2000). Until EPA's release of the Bay TMDL in 2010, however, Pennsylvania was taking these actions on a voluntary basis, as part of overall Bay cleanup agreements reaching back to 1987. With the release of the Bay TMDL in 2010, the EPA is now asserting a federal authority to require Pennsylvania to take numerous Bay cleanup actions and to incur the corresponding expenses within the State. EPA has threatened to cut federal spending in Pennsylvania and to impose other penalties if Pennsylvania does not comply with the requirements of the Bay TMDL. This has already led to rising tensions between state officials in Pennsylvania and the EPA. The state's Phase I WIP complains that Pennsylvania was not given adequate credit for the state's past reductions in EPA's model and TMDL development process.

The high degree of concern over costs being expressed in Pennsylvania is rarely supported with hard numbers. Data on the total cost of TMDL compliance is much more difficult to find than individual estimates of cost savings. For example, the Harrisburg Authority estimates that nutrient credits will save them $28 million over the next 20 years, and save ratepayers an estimated $48 per year on sewer service charges Pennsylvania's total contributions to pollution loads in the Chesapeake Bay are similar to Maryland and Virginia. It would be reasonable to expect that the costs of implementing the Bay TMDL might be broadly similar in all three states. Based on such an assumption, and given the cost estimates shown above for Maryland and Virginia, one can estimate total TMDL implementation costs for Pennsylvania of around $15 billion from 2010 to 2025, or about $1 billion per year. These costs would be borne in part by private and in part by public sources.

<u>The Funding Gap: How Much More is Needed?</u>

It is difficult to say where revenues to cover projected current funding shortfalls might be obtained. At a time when federal, state, and local budgets are under extreme pressure, it can be difficult for lawmakers to dedicate funds for stormwater retrofits or agricultural conservation programs. Indeed, the latest Farm Bill includes large cuts and consolidates the Chesapeake Bay Watershed Initiative (CBWI) with other regional programs. Previously, the CBWI provided $188 million to the farmers in the Bay region, in addition to conservation spending already in the area. The debate over Farm Bill conservation spending raises important concerns, including the respective burdens on public vs. private funds and the role of federal and state grants to private farmers for TMDL conservation purposes.

The most expensive portion of nutrient and sediment controls falls in the public sector. Publicly owned treatment works (POTWs) and storm sewers are capital assets managed by public utilities and governments. Furthermore, the various levels of government own large amounts of land within the Bay watershed, thus burdening them further as they must account for stormwater and wastewater from their own properties.

The remaining cost burdens fall mainly on private landowners, businesses, and residents. Granted, these individuals also pay taxes, but it would be unreasonable to expect the government to assume the stormwater and wastewater cost burdens for everyone in the watershed. The long-term success of the TMDL, and environmental efforts in general, depends greatly on the role to be played by private businesses and individuals. Bay governments have a variety of tools at their disposal to accomplish two kinds of funding actions: (1) fund projects with public money, and (2) spur private spending on desired TMDL implementation projects. "Projects" could be stormwater retrofits, low impact development, WWTP upgrades, connection of septic systems to the sewer grid, installation of high-treatment community "package" systems, or agricultural BMPs, etc. Through fees, taxes, standards, and other policies, the government can both *push* and *pull* actions and investments that promote clean water and the full realization by 2025 of the TMDL pollution load targets.

Conclusion

When the figures for each of the six Bay states are included, the likely total costs associated with implementing the Bay TMDL could well be around $50 billion between 2010 and 2025. This is not the absolute cost, it should be emphasized, of having a quality of Bay water at the levels projected in the TMDL for 2025. Rather, it is the cost of the incremental improvements in Bay water quality by 2025 that will result from implementing the Bay TMDL itself, representing improvements in water quality above what had already been achieved as of 2010. It is difficult not to conclude that the political willingness of the Bay watershed states to incur such large additional TMDL costs in order to achieve incremental improvements in Bay water quality will be a significant future uncertainty.

By far, the largest portion of the designed total TMDL cost burdens is incurred in the stormwater sector over the next 15 years. By comparison, the TMDL costs in the agricultural sector are around an order of magnitude less. In terms of contribution to Bay nutrient loads, however, agriculture (42 percent and 54 percent of Bay nitrogen and phosphorus loads, respectively) substantially exceeds stormwater (16 percent and 16 percent, respectively). This suggests the possibility of redirecting spending from less cost-effective stormwater projects to more cost-effective agricultural projects as a way to reduce total Bay TMDL costs. Use of nutrient offsets for stormwater sources could help to facilitate the funding of such cost-effective efforts in the agricultural sector without overburdening farmers with the direct costs of making agricultural nutrient reductions at their own expense.

Chapter 3 – Cost-Ineffective TMDLs

Just as the total cost of implementation was not taken into explicit account in the development of the TMDL, neither was the cost-effectiveness of various pollution reduction strategies. Cost-effective analysis, in economic terms, compares the relative costs of policy alternatives for achieving a given outcome. For example, if the cost of one unit of pollution reduction from source A equals $100 and $50 from source B, it is more economical to concentrate reductions on source B. Every dollar spent on source B produces twice as much total pollution reduction as the same dollar spent on source A. As a result, instead of recommending the most cost-effective solutions, the Bay TMDL prescribes cleanup actions with widely varying costs per unit of nutrient reduction achieved, which has driven up cost estimates, as seen in the previous chapter.

Cost-effectiveness, of course, is not the only objective of public policy. Presumably, the writers of the Bay TMDL were willing to make some sacrifices in terms of cost-effectiveness in order to achieve other policy objectives. Since they did not systematically develop cost-effectiveness calculations, they may not have realized, however, the full magnitude of the tradeoffs involved. As suggested below, it is possible that the same 2025 pollution targets of the TMDL could have been achieved for half -- or even less than that -- total expenditure, if the spending was done in a more cost-effective way. Given some states' current objections to the high cost of implementation, the failure to take cost-effectiveness into greater account is another factor that could endanger the future prospects for success of the Bay TMDL.

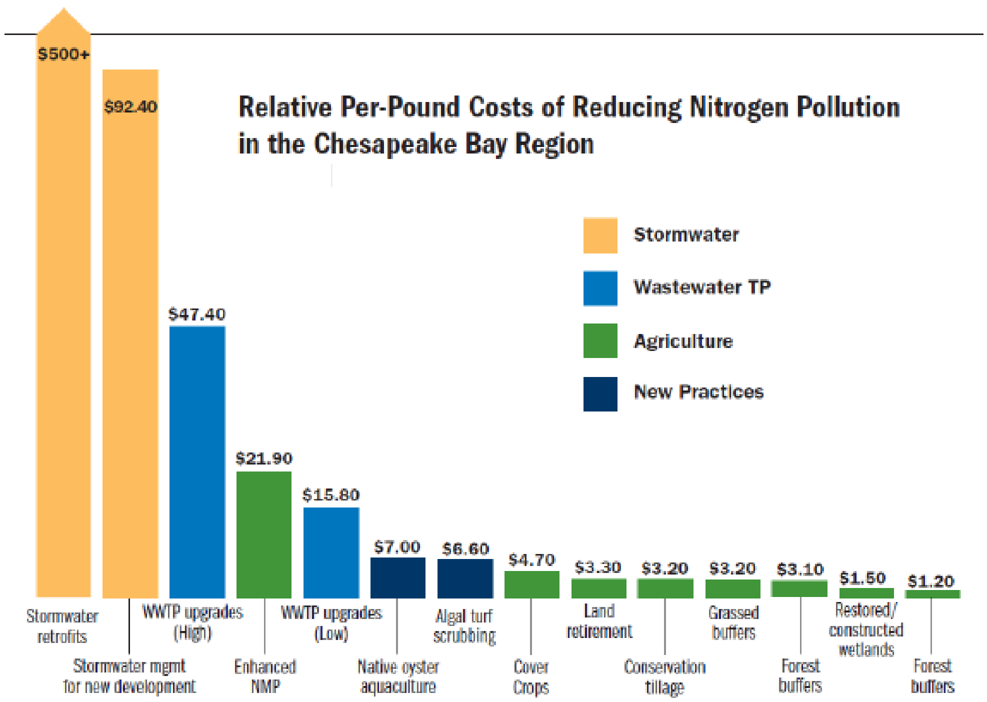
<u>Relative Cost-Effectiveness of Alternative Nutrient Reduction Actions</u>

While the Chesapeake Bay TMDL gives little explicit weight to considerations of cost-effectiveness, other analysts have been more concerned. Figure 3.1 shows one estimate of the cost-effectiveness of alternative methods of reducing nitrogen loads in the Bay. As with other such studies, the most expensive forms of nitrogen reduction involve the implementation of stormwater measures. According to this analysis, retrofitting of existing land developments to reduce stormwater flows can be particularly expensive, costing upwards of $500 per pound of nitrogen load achieved. Retrofitting can be so expensive because it commonly involves modifying existing infrastructure (although some inexpensive retrofits such as installing rain barrels may also be available). Implementing stormwater management measures in new development is usually less expensive, on average costs of about $90 per pound of nitrogen load reduction. Even these lower cost stormwater measures are more expensive, however, than upgrades of WWTPs which can range from $15 to $47 per pound of nitrogen reduction.

The most cost-effective nitrogen reduction actions, involving the lowest costs per pound of nitrogen reduction, are typically found in agriculture. Costs of pollution reduction in this sector, in many cases, fall below $5 per pound. For example, installation of forest buffers around the edges of cropland can achieve nitrogen reduction at a cost of $1.20 to $3.20 per pound. Conservation tillage and growing of cover crops can cost $3.20 and $4.70, respectively, per pound of nitrogen reduction. Unconventional means of pollution reduction such as native oyster aquaculture and algal turf scrubbing may also be able to achieve nitrogen reductions in a much more cost-effective way than either stormwater measures or upgrades to WWTPs, at around $5 to $10 per pound.

The highest cost methods of nitrogen reduction can thus cost more than 100 times the cost per pound of the lowest cost methods. There are limits to the available application of each reduction method. It may not be possible, therefore, to achieve widespread application of some of the most cost effective measures. It would probably not be possible to achieve the full TMDL load targets for 2025 entirely from low cost agricultural sources of nutrient reduction. However, if such methods hypothetically could be employed without limit, it would be possible to drastically reduce the costs of TMDL implementation in Maryland, Virginia, Pennsylvania and other Bay states. Depending on the actual scope for agricultural nitrogen reduction actions, substituting of agriculture for other planned sources of nitrogen reduction, total TMDL implementation costs could reasonably be expected to be less than 25 percent of those now being estimated.

Figure 3.1 Mitigating Impact with Cost-Effective Methods

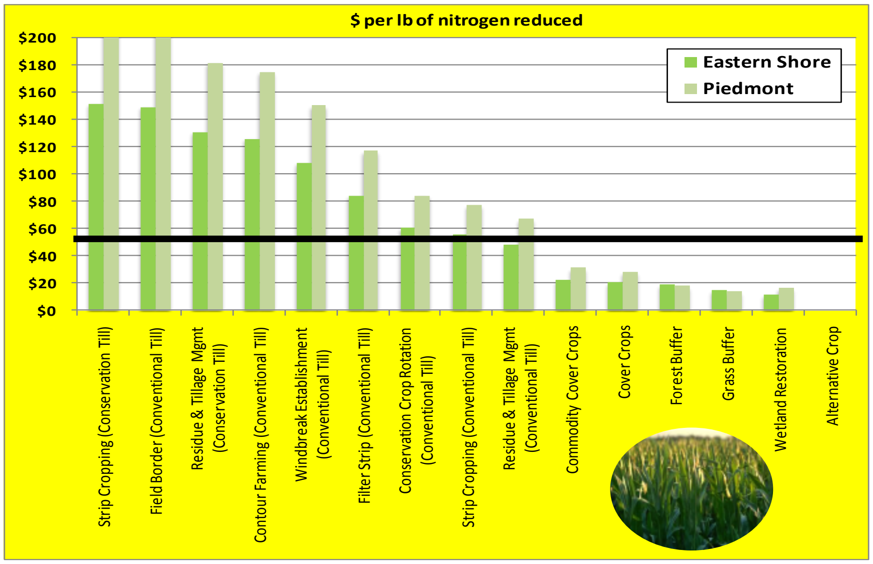


Source: World Resources Institute, 2010

Case Study: Nitrogen Reduction Cost-Effectiveness of Agricultural Measures in Maryland

Cost savings potentially can be achieved by shifting to more cost-effective methods of nutrient reduction within the same sector as well as across different sectors. A master's student in the conservation biology program at the University of Maryland, Nicole Angeli, presented the results of her cost-effectiveness study of Maryland agriculture at a seminar at the School of Public Policy in April 2012. As shown in Figure 3.2, there are a wide range of costs per pound of nitrogen reduction achieved for crop farming measures in Maryland agriculture. On the Eastern Shore of Maryland and in the Piedmont section of the Potomac basin, the cost per pound is less than $50 per pound for cover crops, forest buffers, grass buffers and wetland restoration, and alternative crop substitution. With conventional tillage, conservation crop rotation, strip cropping and residue and tillage management can cost less than around $100 per pound of nitrogen reduction.

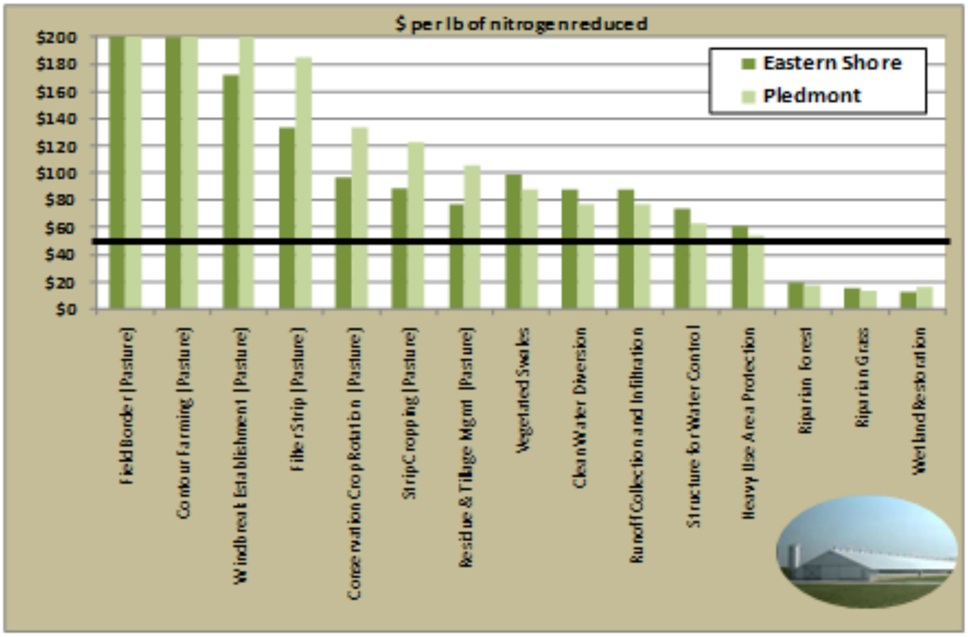
Figure 3.2 Crop Farming: Best Management Practices Feasible



Source: Nicole Angeli, Michael Nakamoto, Sameer Vaswani. May 2011. "Creating Opportunity for Farmers: Nutrient Trading in Maryland." Sustainable Development and Conservation Biology and Smith School of Business, University of Maryland. Prepared for Maryland Department of Agriculture and Potomac Conservancy.

As shown in Figure 3.3, Angeli also examined various methods of nitrogen reduction for poultry farming. Here again various poultry farm management practices such as vegetated swales, clean water diversion, runoff collection and infiltration, structures for water control, and heavy use area protection involved costs of nitrogen reduction of less than $100 per pound. At the lowest end, riparian forests, riparian grass and wetland restoration involved costs of less than $20 per pound. This was not an exhaustive analysis of all agriculture options but of selective alternatives that Angeli chose to examine.

Figure 3.3 Poultry Farming: Best Management Practices Not Feasible



Source: Nicole Angeli, Michael Nakamoto, Sameer Vaswani. May 2011. "Creating Opportunity for Farmers: Nutrient Trading in Maryland." Sustainable Development and Conservation Biology and Smith School of Business, University of Maryland. Prepared for Maryland Department of Agriculture and Potomac Conservancy.

Summing up her findings, Angeli provided a list of the most cost-effective agricultural practices, as shown in Table 3.1. These practices were organized according to whether they applied to conventional tillage, conservation tillage, or pasture use. For conventional tillage, the lowest cost management practice was strip cropping at $3.94 per pound of nitrogen reduction; for conservation tillage, it was also strip cropping at $10.83 per pound of nitrogen reduction; and for pasture use, it was prescribed grazing practices at $5.23 per pound of nitrogen reduction. As compared with a stormwater retrofit that cost more than $500 per pound of nitrogen reduction, the substitution of strip cropping on land being conventionally tilled thus could generate nitrogen reductions more than 100 times greater, for the same amount of money being spent. Most relevant for the purposes of this report, if stormwater sources were able to offset nitrogen loads by making nitrogen reductions in the agricultural sector, similar cost savings for Maryland could be achieved on a widespread basis.

Table 3.1 Priority Best Management Practices to Reach Baseline in the Eastern Shore ($ per lb/acre of Nitrogen Reduced)

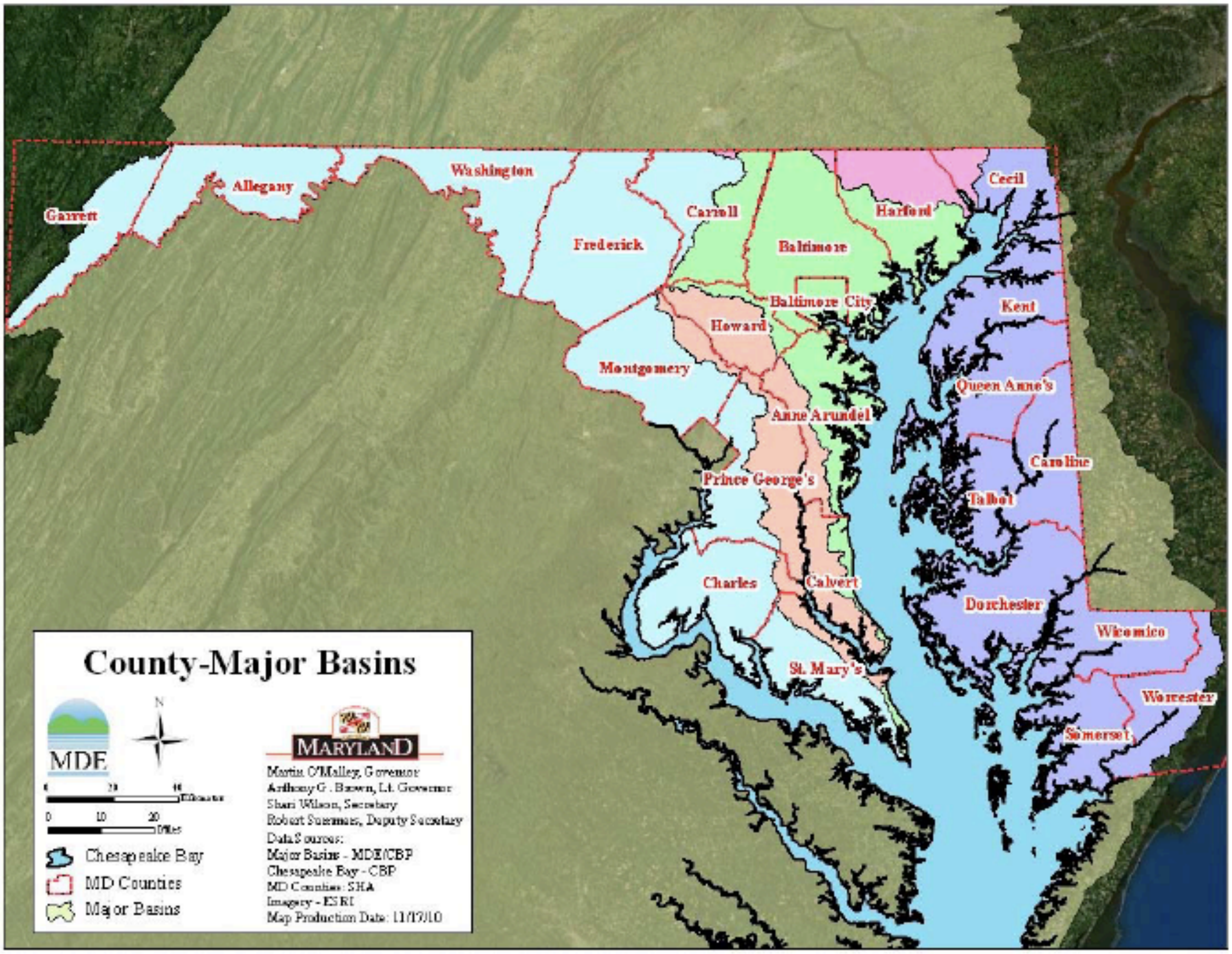
#	For Conventional Till	For Conservation Till	For Pasture
1	Strip Cropping - $3.94	Strip Cropping - $10.83	Prescribed Grazing - $5.23
2	Filter Strip - $5.2	Filter Strip - $14.10	Filter Strip - $8.23
3	Residue & Tillage Mgmt - $6.75	Residue & Tillage Mgmt - $18.33	Water Control Structure - $12.98
4	Conserve Crop Rotation - $8.10	Conserve Crop Rotation - $21.98	Field Border - $14.75
5	Contour Farming - $8.29	Contour Farming - $22.51	Conservation Cover - $15.01
6	Field Border - $9.32	Commodity Cover Crops - $6.40	Nutrient Management - $15.75
7	Conservation Cover - $9.48	Cover Crops - $3.27	Windbreak Establishment - $18.90
8	Windbreak Establishment - $11.94	Riparian Forest Buffer - $1.11	Spring Development - $21.28
9	Conservation Cover Crops - $6.40	Riparian Grass Buffer - $0.92	Riparian Forest Buffer - $1.11
10	Cover Crops - $3.27	Wetland Restoration - $0.77	Riparian Grass Buffer - $0.92
11	Riparian Forest Buffer - $1.11		Wetland Restoration - $0.77
12	Riparian Grass Buffer - $0.92		
13	Wetland Restoration - $0.77		

Source: Nicole Angeli, Michael Nakamoto, Sameer Vaswani. May 2011. "Creating Opportunity for Farmers: Nutrient Trading in Maryland." Sustainable Development and Conservation Biology and Smith School of Business, University of Maryland. Prepared for Maryland Department of Agriculture and Potomac Conservancy.

Cost-Effectiveness of TMDL Allocations in Maryland

There are significant costs for local governing jurisdictions associated with Maryland WIP implementation. As with other Maryland spending, it is in the best interest of the State and its citizens that the money is spent as efficiently as possible. Such cost-effectiveness reduces the total cost burden and increases the fiscal likelihood of TMDL success and the public/political support necessary for this success. The actual responsibility for implementing the TMDL in Maryland will fall mainly to county governments and soil conservation districts (for agricultural nutrient reductions). Figure 3.4 shows the 23 counties in Maryland and the five River Basins in which they are in whole or in part located.

Figure 3.4 Major Basins in Maryland by County



Source: Maryland Department of the Environment

Another master's student at the University of Maryland, Nathan Bowen (a graduate of the School of Public Policy in May 2012) prepared a detailed illustrative analysis in the spring of 2012 of the cost-effectiveness of Maryland's Phase II WIP as the State proposes to implement it, focusing on one Maryland county, Calvert County. Bowen also analyzed the relative cost effectiveness of the Maryland TMDL in terms of the nutrient reductions required of the various counties in Maryland.[19]

As Bowen found, in their sub-allocation process by local governing jurisdiction and by type of source, Maryland officials in the Phase II WIP used a methodology that they had already developed for the Phase I WIP. First, a portion of the load was assigned to WWTPs based on what is "generally considered the limit of technology."[20] The loading assigned to forests is a constant, as they have the lowest loading rate among sources, and the overall forest target load grows somewhat as forested buffers are planted to decrease urban loads and forest acreage is increased. The remaining nonpoint sectors (urban, agriculture, and septic systems) were allocated nutrient and sediment loads in the Maryland TMDL based on the following process and principles:

- Equity among sources: A “reducible load” was calculated for each nonpoint source sector as the difference between no action and all technically feasible reductions (note that economic feasibility was not considered). This overall reducible load was compared to necessary reductions under the TMDL and the results were divided evenly among sectors (urban, septic, forest, and agriculture) within each land-river segment.
- Consideration of geographic effectiveness: Loads resulting from the first step were adjusted for relative effectiveness largely based on geographic proximity (areas closer to the Bay have more impact).
- Credit for existing actions: Adjustments were made to account for reductions achieved to date by local jurisdictions and sectors.

In cases where local team strategies were not submitted, or fell short of the Final Target, Maryland supplemented the local plans. In addition, some elements of the WIP reflect existing state policies that will be implemented through permitting processes. Such policies include reductions from various industrial point sources and the long-standing upgrades of major municipal WWTPs using enhanced nutrient removal (ENR) technology (decisions that were made in many cases well before the development of the current WIPs). Also, the state has established standard stormwater management strategies for federal and state facilities, as well as a number of small municipalities, that are covered by federal NPDES stormwater permits. These generic plans are subject to refinement in the future.[21] It is of particular importance to note that Maryland did not give much if any consideration to cost-effectiveness in developing its WIPs as part of the implementation process for the Bay TMDL.

Stormwater Nitrogen Reduction in Maryland: Cost-Effectiveness Across Counties?

In his analysis of TMDL costs to counties, Bowen found that while Calvert County itself generally chose cost-effective alternatives in terms of stormwater management within its jurisdiction, there are large differences among Maryland counties in the costs per unit of stormwater nitrogen reduction. The Calvert County WIP reports that the stormwater BMPs needed to achieve Maryland’s required WIP reductions will cost the County approximately $1.092 billion through 2025. When a simple analysis is performed comparing the resulting cost per pound of urban stormwater nitrogen reduced in nine different Maryland counties (plus the City of Baltimore), based on the costs reported in their WIPs (Table 3.2), Calvert County’s costs stand out as unusually high. According to these figures, it costs $18,466 per pound of nitrogen reduction in Calvert County (Calvert County staff may want to reexamine their calculations to determine why exactly the cost per pound reduced are so high). This compares with much nitrogen reduction costs in other counties such as Anne Arundel at $3,563 per pound of nitrogen reduction or even lower in Caroline County at $674 per pound. As a result of these disparities, it is evident that the nitrogen reductions mandated by the Maryland TMDL among the counties in the state are extremely cost-ineffective. That is to say, if TMDL stormwater nitrogen reductions were reallocated among the counties, the same degree of total stormwater nitrogen reduction could be achieved at a far lower cost than the current TMDL.

There are also differences – if not as large -- among the Maryland Counties in terms of the costs per unit of nitrogen reduction for septic system upgrades and WWTP improvements. Again, this means that the overall costs to Maryland of TMDL implementation could be reduced by reallocating mandated reductions away from the higher cost counties and towards the lower cost counties within the TMDL statewide planning for septic systems and WWTPs.

Table 3.2 Comparison Cost per Pound of Nitrogen Reduced by County Strategies

Jurisdiction	Urban	Septic	Wastewater	TOTAL
	Cost/Pound	Cost/Pound	Cost/Pound	Cost/Pound
Anne Arundel County	$3,563	$3,205	$790	$2,179
Baltimore City[1]	$1,425	N/A	$206	$423
Calvert County	$18,466	$1,745	($8,264)	$5,676
Caroline County[2]	$674	$928	$2,676	$226
Cecil County	N/A	N/A	N/A	$982
Dorchester County	$813	$1,406	($219)	$261
Frederick County[3]	N/A	N/A	N/A	$9,565
Montgomery County	$10,433	N/A	N/A	$3,050
Prince George's County	$3,834	N/A	N/A	$2,793
Somerset County	N/A	$2,181	N/A	$425

Sources: Unless otherwise noted, WIP costs from County Plans or presentations

Note: Caroline County's WIP also includes estimates for agriculture costs, so the Projected WIP cost is higher than the listed total of urban, septic, and wastewater. Also, some values are negative because those sources are actually permitted to grow through 2025 (i.e. wastewater treatment plants).

[1]WIP cost ($250 million) for Baltimore City excluded WWTP upgrades. These numbers came from the BRF Advisory Committee 2011 Annual Report and the Bay Daily article "State Report: MD's "Flush Fee" Needs To Be Doubled To Cover $530 Million Shortfall". Also, WIP's $250 million was only through 2017. This analysis extrapolated a total number through 2025 by multiplying the anticipated cost/pound by the required pounds reduced.

[2]Caroline County's WIP did not include cost estimates through 2025 (full WIP implementation). This analysis extrapolated the County's calculated costs/load for each sector through 2025 by multiplying their numbers by the required load reduction in each sector.

[3]Frederick plan contained no total - from article http://fredericknewsflash.typepad.com/blog/2011/12/officials-say-high-costs-make-cleaning-up-chesapeake-bay-impossible-for-frederick.html

TMDL Cost-Effectiveness Across Maryland Counties, By Sector

Another issue is whether the Counties and their WIPs are allocating nutrient reductions among the different sources of pollution in a cost effective manner within the same County. For example, would it save money to make larger reductions in agriculture and smaller reductions in the stormwater sector within a given Maryland county? Several past studies have analyzed what sources of reducing pollution into the Bay are the most cost-effective. Most notably, in 2004, the Chesapeake Bay Commission produced the report *Cost-Effective Strategies for the Bay; 6 Smart Investments for Nutrient and Sediment Reduction*. The authors of the study evaluated 34 existing practices used to reduce nutrient and sediment loads into the Bay, including those associated with WWTPs, agriculture, urban stormwater, land preservation, forestry, and air pollution. They ranked these measures based primarily on cost-effectiveness and type of nutrient reduction, with priority given to those measures that prevented nutrients from entering the environment in the first place, and also considered "reliability of the practice, sensitivity to different conditions, consistency of success in nutrient and sediment reduction, political reality and the likelihood of a reliable source of financing over time."[22] They then chose the top six strategies which were the most cost-effective and, if deployed to the "maximum feasible" extent, could account for a majority of the 2000 Bay Agreement goals for 2010. These top six strategies were WWTP upgrades, diet and feed adjustments for poultry and livestock, traditional nutrient management plans (NMPs) for agricultural land, enhanced nutrient management for farms, conservation tillage, and cover crops. Table 3.3 displays the costs per pound of nutrient reduction for each of these six practices, as calculated by the Chesapeake Bay Commission.

Table 3.3 Six Most Cost-Effective Strategies for Bay Restoration

Strategy	Nitrogen $/lb	Phosphorus $/lb
Wastewater Treatment Upgrades	**$8.56**	**$74**
Diet and Feed Changes	**N/A**	**0**
Nutrient Management	**$1.66**	**$28.26**
Enhanced Nutrient Management	**$4.41**	**$95.79**
Conservation Tillage	**$1.57**	**No Additional $**
Cover Crops	**$3.13**	**No Additional $**

Source: Chesapeake Bay Commission. 2004. "Cost-Effective Strategies for the Bay: 6 Smart Investments for Nutrient and Sediment Reduction." Annapolis, MD: CBC.

Noticeably, these six strategies cover only two sources: agriculture and point sources. In 2005, the Maryland School of Public Policy Environmental Policy Analysis Workshop produced the report, *A Bigger Bang for the Buck: Offsets and Other Cost-Effective Strategies for Nitrogen Reductions for the Chesapeake Bay*, which also analyzed the most cost-effective ways in which jurisdictions could reduce their loads.[23] They produced a similar analysis, highlighting the 26 most cost-effective practices to reduce nutrient loads. Twenty-four of these were associated with agriculture, and the remaining two were WWTP upgrades and federal air pollution regulations. Significantly, they found that: "By implementing eighteen of the most common agricultural best management practices in Maryland, Pennsylvania, and Virginia, close to half of the nitrogen goal (45 million of 103 million pounds) could be achieved for $110 million per year. None of these BMPs cost greater than $5 per pound of nitrogen reduced. Free nitrogen reductions in terms of TMDL costs (11 million pounds per year) would result from reduced airborne deposition as the Clean Air Act nitrogen control program was implemented, bringing total reduction to 56 million pounds per year for the same $110 million per year. The projected point source nitrogen reductions from upgrades of sewage treatment plants in Maryland, Pennsylvania, and Virginia reduce 35 million additional pounds of nitrogen per year for an average of approximately $8.50 per pound at an expense of about $300 million per year. Thus, employing these three approaches could reduce 91 million pounds of nitrogen per year for about $400 million per year, only 12 million pounds short of the goal for 2010, at far lower costs than were then projected for Chesapeake Bay cleanup.[24]

In the case of Calvert County at present, there appear to be large departures from a cost-effective WIP strategy. Calvert County is currently required to reduce its nutrient and sediment loadings by managing urban stormwater and septic systems, the two most expensive and least cost-effective sources to manage. Combined, these two sources make up over 75 percent of the total nitrogen load reductions Calvert County has been asked to make under Maryland's WIP allocations. Since the remaining 25 percent is agricultural pollution which is not under the Calvert County WIP's jurisdiction, 100 percent of the County's reduced load for the WIP is allocated to the most costly sources to manage (note that their WWTP load, as the only source which accounts for population growth, is actually permitted to increase for nitrogen).

Other Maryland counties might be able to trade off internally among their sources to lower costs of implementation, such as by reducing point source pollution using cost-effective strategies and taking some of the burden off of costlier sources such as stormwater. However, Calvert County's WWTPs either have or will have implemented the best available technology for reducing their nutrient loads by the end of 2012. Also, a survey of farmers by MDA in 2011 indicated that there is limited interest in the agricultural community in trading nutrient reductions to other sources.[25] This leaves the County no other option but to employ very expensive pollution reduction strategies that are very cost-ineffective.

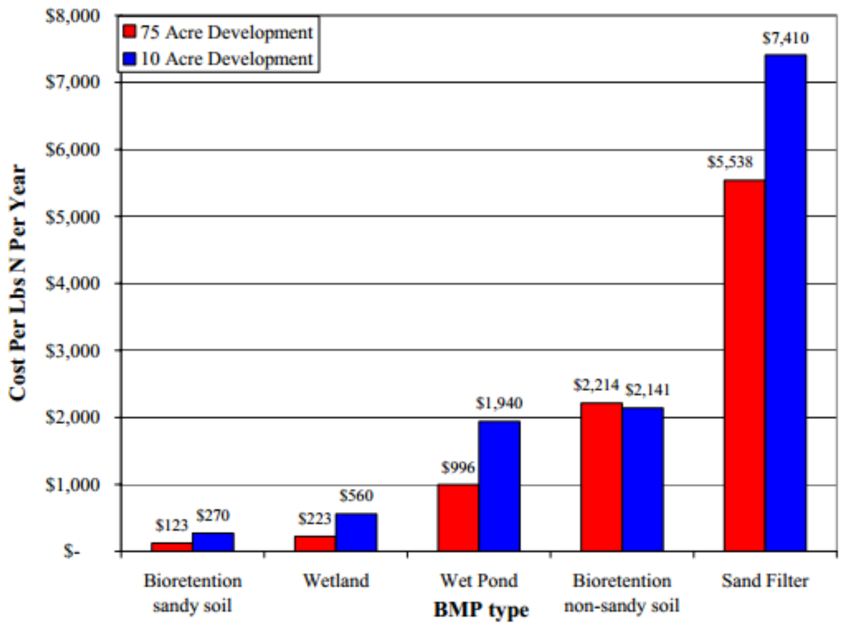
It should be noted that in their WIP Phase II, Maryland explicitly states that their load allocation was based on the concept of equity/fairness rather than of cost-effectiveness and least funding burden. On page 44 of the plan, it says "it is well established that reducing a pound of nitrogen from a septic system costs more than reducing a pound from the agricultural sector. However, it would not be fair for the restoration strategy to place most of the restoration burden on the farming community and little or no responsibility on those who own septic systems." Rather than setting allocations based on the criterion of minimizing cost, Maryland emphasized the principle that polluters should pay (and perhaps a trading system would eventually be set up to allow market forces to drive down the total costs using an offset approach).

Nonetheless, it remains to be seen whether such trading and other uses of offsets will occur. Also, even if the government fully funded the costs of the most cost-effective agricultural BMPs rather than passing those costs onto farmers, total WIP costs would likely be significantly less than the current equitable approach. Since agricultural practices mostly cost less than $200 per pound of nitrogen reduced[26] if one multiplied that number by the total 232,927 pound reduction required in Calvert's load allocation the resulting total cost would be approximately $45.6 million. This number is far lower than the current anticipated cost of Calvert's WIP implementation of more than $1 billion. Taxpayers might find this cheaper approach to actually be fairer, as a purpose of governmental regulation is to provide the greatest societal benefit at the least cost.

Two Cost-Effectiveness Analyses in Virginia

Similar to the Bowen analysis for Maryland, University of Minnesota economist Stephen Aultman has estimated per pound costs for reducing nutrient discharges from different sectors in Virginia. Figure 3.5 shows his estimates of the costs of reducing nitrogen discharges associated with different types of non-point source offsets in Virginia. While these estimates are derived from computer models, they show that achieving nutrient reductions from bio-retention sandy soils, bio-retention non-sandy soils, installing sand filters, wet ponds, or wetlands could range from $123 to $7,000 per pound of nitrogen. This very wide range emphasizes the importance of flexibility in the place and manner designated by Virginia for obtaining TMDL nitrogen reductions, if the full costs to the state are to be minimized.

Figure 3.5 Cost Estimates of Nitrogen Discharge Reductions, by Source



Source: Stephen Aultman. 2007. "Analyzing Cost Implications of Water Quality Trading Provisions: Lessons from the Virginia Nutrient Credit Exchange Act." Blacksburg, VA: Virginia Tech.

Kurt Stephenson et al also provide estimates of potential costs of obtaining offsets from three types of nonpoint sources. These estimates reflect the requirements for creating offsets in the Nutrient Credit Exchange, such as the 2:1 requirement for offsets generated by nonpoint sources. Table 3.4 shows the estimated costs of generating one pound of offset from each type of agricultural nonpoint sources in four Virginia river basins. Table 3.5 shows the number of acres that would be required to create agricultural offsets in this manner to offset a 1 million of gallons per day (MGD) expansion in wastewater flows.

Table 3.4 Cost of Agricultural Nonpoint Offsets

Offset Options	Annual Cost of Nitrogen Offset			
	Shenandoah/ Potomac	Rappahannock	York	James
Early Cover Crops	$26 to $107	$40 to $404	$31 to $2,800	$30 to $210
15% N Reduction	$8 to $23	$12 to $29	$8 to $54	$9 to $34
Continuous No-till	NA	NA	NA	NA
15% N Reduction+Cont No-till	NA	NA	NA	NA
Crop to Forest Conversion	$66 to $189	$117 to $487	$87 to $556	$82 to $376

Source: K. Stephenson et al. 2010. "An evaluation of nutrient nonpoint offset trading in Virginia: A role for agricultural nonpoint sources?" Water Resources Research 46.

Table 3.5 Acres Required for Agricultural Nonpoint Offsets

Offset Options	Acres Required for a 1 MGD Offset							
	Shenandoah/ Potomac		Rappahannock		York		James	
	West	East	West	East	West	East	West	East
Early Cover Crops	17,143	16,364	64,286	26,741	450,000	20,690	33,333	19,780
15% N Reduction	6,923	4,276	8,696	6,667	16,216	4,369	10,286	4,865
Continuous No-till	10,056	13,636	19,355	20,930	25,352	16,667	17,143	15,929
15% N Reduct+Cont No-till	4,489	3,529	6,691	5,488	10,909	3,766	5,488	7,115
Crop to Forest Conversion	1,650	1,554	4,245	2,765	4,852	2,057	3,284	1,927
Total Corn Acres Available in Each Region	*126,870*		*74,920*		*82,170*		*79,935*	

Source: K. Stephenson et al. 2010. "An evaluation of nutrient nonpoint offset trading in Virginia: A role for agricultural nonpoint sources?" Water Resources Research 46.

The tables and figures in this chapter show that allowing for agricultural nonpoint source offsets can reduce costs compared to a system limited to offsets generated from point sources. However, it is not clear from the analysis if there is enough available agriculture land to substitute for a significant share of stormwater or other more costly nutrient pollution reductions through the use of agricultural offsets in Virginia.

<u>A Cost-Effectiveness Analysis of Delaware's TMDL</u>

Although currently Delaware is not pursuing cross-sector nutrient trading, there are cost-effectiveness analyses that indicate trading between the sectors could be beneficial if done appropriately. The Delaware Department of Natural Resources and Environmental Control Watershed Assessment estimates that 1 acre of cover crop reduction will reduce nitrogen flows by 12.4 pounds per acre per year (lbs/ac/yr) in Delaware's Inland Bays watershed, which is approximately the same treatment capacity of a bio-retention facility for 1 acre of impervious area generating stormwater flows.[27] The cost of a cover crop BMP would be approximately $90/ac while some cost estimates of urban retrofit to address legacy stormwater could amount to $93,765 per acre of impervious surface. According to DNREC's analysis, if stormwater sources could purchase cover crops as offsets in place of meeting nitrogen reduction requirements on-site, $140 million could provide 77,777 acres of cover crops for 20 years, resulting in total nitrogen load reductions of 964,435 lbs/ac/yr. This amounts to more than 50 times the nitrogen load reduction that would be achieved with simply spending the same amount of money on stormwater retrofits. Of course, there is a question of whether farmers will be willing to take enough land out of rotation for 20 years, especially when considering high food prices, and it could come down to whether or not the price is right. At present, Delaware favors targeting more opportunistic urban areas for stormwater retrofits as projects and funding become available.

Conclusion

As shown in various cases discussed in this chapter, there is a great potential for expanded adoption of new management plans in agriculture that would result in nutrient load reductions. If the 2010 Bay TMDL had been developed on the basis of minimizing costs for the total load reductions achieved, a significantly larger part of the reduction responsibility would have been assigned to agriculture and a smaller part to stormwater and other more costly reductions. Indeed, there might have been few if any assigned stormwater reductions that required the retrofitting of existing development.

The EPA guidance and the state assignment of planned load reductions by source, however, was not done on the basis of criteria of cost-effectiveness. Rather, while they were not fully transparent, it appears that the states estimated technically feasible nutrient load reductions (without paying much attention to relative costs) for each source and then assigned "appropriate" shares to each source. The manner of determining "appropriate" amounts remains somewhat opaque but EPA and the states took into account equity of the funding burden and other factors that worked against an overall cost-effective outcome. It would have been difficult, for example, to assign most of the reduction burden to the agricultural sector, as might have been the result of a load allocation based exclusively on cost-effectiveness criteria. The financial resources of land developers to contribute to TMDL implementation, moreover, greatly exceed those of farmers. While the federal Department of Agriculture has a number of programs that could be used to fund nutrient reductions by farmers, these programs are unlikely to be sufficient to fund many cost-effective changes in agricultural practice – and even past levels of Farm bill funding are now in doubt with the current fiscal problems of the federal government.

The Bay TMDL is a legal more than an economic document. It is designed to assure that total nutrient reductions in the six states of the Chesapeake Bay watershed result in a total level of nutrient loadings in 2025 that is compatible with water quality standards. Considerations of equity factored more heavily into the Bay TMDL allocations than economic cost-effectiveness. This was partly motivated by a sense that political feasibility was more a consequence of perceived equity of the TMDL allocations than the economic rationality of those allocations. This was perhaps true in the initial public presentation of the TMDL and in its refinement in Phase 1 and Phase 2 of the WIP process. As TMDL implementation moves further down the road, however, closer analysis of the cost-effectiveness of the TMDL will inevitably arise. This is especially the case given the high estimated costs – perhaps $50 billion for the full TMDL process across the six Bay states from 2010 to 2025, as suggested in Chapter 2 – of TMDL implementation.

It seems likely that further adaptive management steps will have to be taken in the near future to improve the cost-effectiveness of the Bay TMDL and the implementation processes in each of the six states. Policies allowing for wider use of offsets may be the most practical means of achieving this objective.

Chapter 4 – Inequitable TMDL Cost Burdens

As discussed above, the process of developing the Chesapeake Bay TMDL worked in a top-down fashion. EPA first determined the total nutrient loads entering the Bay that would be compatible with achieving a level of water quality necessary to support human uses and ecological functions of the Bay. These loads were then allocated by EPA among the six states in the overall Bay watershed. The states then individually further divided their own loads among the river basins within each state. Working with local officials, the total basin allocations were then distributed by the states among the local governments (and soil conservation districts) that would be responsible for actual implementation measures on the ground.

This process was completed in an essentially improvised manner. EPA and the states have never spelled out clearly the TMDL criteria and other bases for making all these load reallocations. EPA and several states have said that equity was an important consideration but have not clarified just how equity was actually taken into account. For example, on page 53 of Maryland's Draft Phase 2 WIP, it simply states that "allocations are based on the 'polluter pays' principle in which everyone contributing to the problem must contribute to the solution." As noted in Chapter 3, partly because of equity concerns, the Bay states have explicitly disavowed a strong emphasis on cost-effectiveness and cost minimization in making their load reallocations.

However, because of the informal nature of this process, it was difficult or impossible to know just what the cost and equity implications would be. It fell to the local governing jurisdictions and soil conservation districts, working with the states, to develop a detailed action plan to achieve the specific targets. As these actions were further refined into two-year milestones, only then was it possible to identify with concrete numbers the potential equity consequences to the earlier TMDL load allocations. This chapter provides further details of Nathan Bowen's analysis of the Maryland Phase 2 WIP. Bowen found that despite the repeated statements of a commitment to equity, the load allocation process, in fact, yielded significant inequalities among the local jurisdictions.

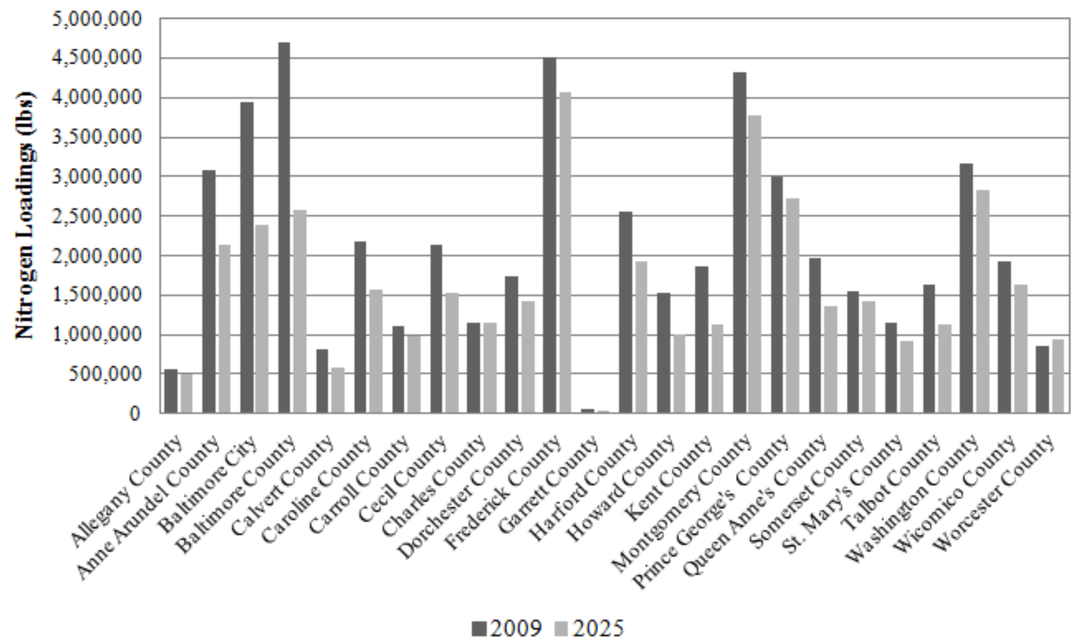
<u>WIP Distributional Burdens in Maryland</u>

Local counties in Maryland first formulated a set of specific TMDL actions in late 2011 and early 2012, included as main elements of the Phase II WIP finalized in the spring of 2012. Nathan Bowen, then a master's student at the School of Public Policy of the University of Maryland, worked in conjunction with Calvert County officials to examine the likely costs of TMDL implementation for Calvert County, and for selected other counties in the state as well. As this analysis showed, there were significant disparities in the cost burdens likely to be incurred by Maryland counties. Bowen concluded that the Maryland TMDL load allocations and resulting necessary implementation actions raised large equity concerns in terms of the differential treatment of various Maryland counties in the TMDL process.

As calculated by Bowen, Figures 4.1 and 4.2 display the non-federal land nitrogen reduction allocation for each Maryland local jurisdiction under the WIP, expressed in loadings (pounds) and total percentage reductions. The results vary widely, from Baltimore County's required reduction of 45.1 percent to Worcester County being permitted to actually grow 9 percent in its nitrogen load. Calvert County's percent reduction, for example, is greater than the other three Southern Maryland counties which are also located in the Patuxent River Basin (St.

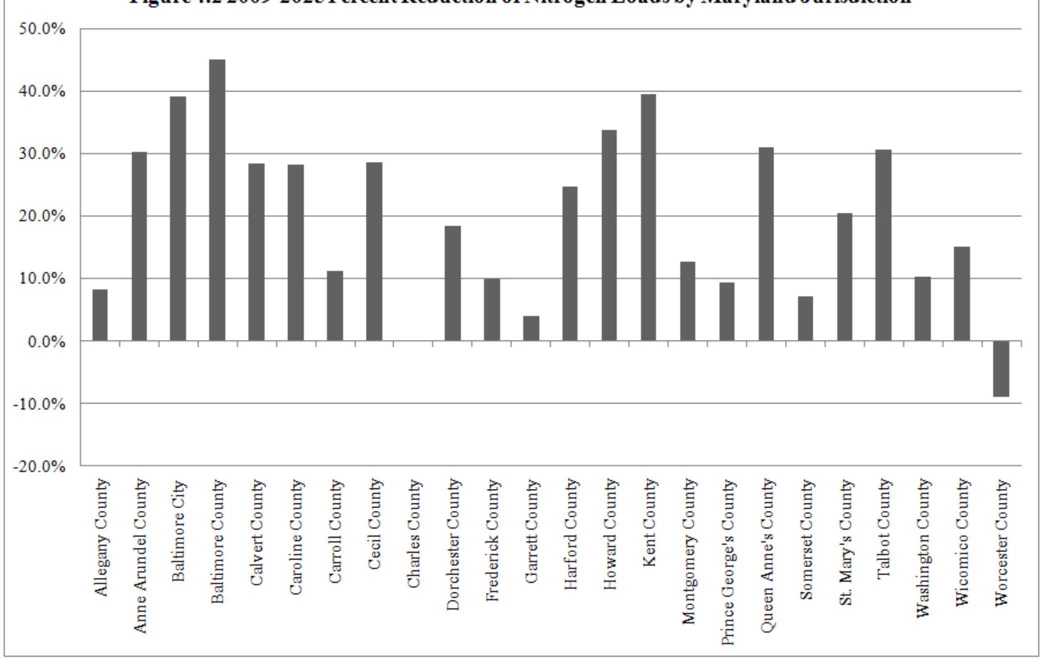
Mary's, Charles, and Prince George's). The load reduction number in pounds is nearly that of Prince George's County despite the fact that Prince George's 2009 load was more than three times Calvert's 2009 load. Also, Calvert County's required nitrogen reduction is 28.3 percent of its loadings while the average for the state is 22.7 percent.

Figure 4.1 Nitrogen Loadings Reduction per County under Maryland WIP



Source: MDE, Maryland WIP Phase II Target Load Summaries, 2011

Figure 4.2 2009-2025 Percent Reduction of Nitrogen Loads by Maryland Jurisdiction



Source: MDE, Maryland WIP Phase II Target Load Summaries, 2011

It may be helpful to explain what appear to be surprising numbers from Baltimore County's reductions shown in Figure 4.1. The County contributes to the sewage input of two major WWTPs: the Back River and Patapsco facilities.[28] Both plants are scheduled for upgrade to Enhanced Nutrient Removal (ENR) by 2015, which accounts for almost all of their required reduction. Garrett County's numbers appear unusually low because the western two-thirds of the county drain not into the Bay but instead to the Gulf of Mexico via the Monongahela-Ohio-Mississippi River system.[29]

Table 4.1 takes another view on the comparison of load allocations, showing instead a comparison of (a) what percentage of total 2009 Maryland nitrogen loadings each jurisdiction represented to (b) the percentage of total loading reductions for the state from 2009 through 2025 for which each jurisdiction is being asked to account in the Maryland TMDL. The last column displays each local government's nitrogen load reductions from 2009 to 2025 as a percent of Maryland's total nitrogen reductions over this period. If the equity standard is that the polluter pays, one might expect that jurisdictions would show similar percentage reductions. The numbers are closer here than they were in the preceding figures, but a certain degree of inequity is displayed in this comparison. The eleven jurisdictions with bolded numbers in the second column are those whose percent of the total state nitrogen reductions is larger than their 2009 percent of total state nitrogen load. Calvert County is in this group, as it represents 1.6 percent of the 2009 state load but has been asked to reduce 2 percent of the state load going forward to 2025. While a 0.4 percent difference may seem small, when the massive size of the total state reduction is taken into consideration, an additional 0.4 percent is a large burden for a small county such as Calvert to handle. The other three Southern Maryland counties are all being asked to play a smaller percentage role in the future state reductions than is represented by their current nutrient loads.

Table 4.1 Comparison of Jurisdiction Percentage of 2009 Total Maryland Nitrogen Loads to Percentage of Maryland Nitrogen Reductions 2009-2025

Jurisdiction	% of 2009 Maryland Nitrogen Loadings*	% of Maryland Nitrogen Loadings 2009-2025
Allegany County	1.1%	0.4%
Garrett County	0.1%	0.0%
Calvert County	**1.6%**	2.0%
Worcester County	1.7%	-0.7%
Carroll County	2.2%	1.1%
St. Mary's County	2.2%	2.0%
Charles County	2.3%	0.0%
Howard County	**3.0%**	4.4%
Somerset County	3.0%	0.9%
Talbot County	**3.2%**	4.3%
Dorchester County	3.4%	2.8%
Kent County	**3.6%**	6.3%
Wicomico County	3.7%	2.5%
Queen Anne's County	**3.8%**	5.2%
Cecil County	**4.2%**	5.2%
Caroline County	**4.2%**	5.3%
Harford County	**5.0%**	5.4%
Prince George's County	5.8%	2.4%
Anne Arundel County	**6.0%**	7.9%
Washington County	6.1%	2.8%
Baltimore City	**7.6%**	13.2%
Montgomery County	8.4%	4.7%
Frederick County	8.8%	3.8%
Baltimore County	**9.1%**	18.1%
Maryland Total	**100.0%**	**100.0%**

*Bolded numbers indicate that counties play a larger part in reductions than they do in current emissions.

Source: MDE, Maryland WIP Phase II Target Load Summaries, 2011

Another factor in the Maryland load allocation process is important to note. The tables in this section include point (WWTP) loads in their calculations, while the State of Maryland separated out WWTP loads before it began the portion of its allocation that considered equity. The idea is that WWTP load reductions are largely required by law and the state funds most of the involved upgrades. However, not including these numbers in consideration of reductions that are supposed to be equitable does not make sense. This is in essence excluding a large portion of a jurisdiction's load from their total considered nutrient load in certain counties that happen to have more public sewer and less septic. The pollution these facilities create should be accounted for in an analysis of the total pollution problem. The fact that state funding is going towards these facilities in particular makes the exclusion of WWTP loads even less equitable, since the local polluters are not in truth paying for the reductions. Therefore, to ensure that the "polluter pays", it is reasonable to leave WWTP load amounts in this section's calculations.

From these tables and figures it becomes apparent that, while there may be some aggregate equity in terms of sources state-wide, an allocation process that was ostensibly based on equity and "fairness" resulted in inequitable loadings for local jurisdictions in Maryland. Counties that pollute more are not necessarily being asked to contribute more to the solution. As the next section shows, this combined with a lack of consideration for cost-effectiveness has resulted in significantly unequal WIP costs between counties.

Inequality of Resulting WIP Costs Among Maryland Jurisdictions

Table 4.2 displays an analysis of the resulting WIP costs by jurisdiction. The third through seventh columns quantify the actual burden of the WIPs, taking into account varying county capacities to pay for WIP strategies depending on their population, budget, and taxable assessable base. Note than only 10 of the 23 jurisdictions have projected costs for their strategies, and of these, four have not considered total costs (those labeled with an asterisk). However, it is unlikely that the comparison will change drastically when costs are finalized since (1) the Dorchester number represents septic and urban sources which, as was discussed above, tend to be the most expensive for a jurisdiction, (2) Montgomery County's number represents urban sources which are 43 percent of WIP strategy reduction, the remainder of the reduction is mostly from WWTP loads which are highly cost-effective, and Montgomery County has a very large population, budget, and assessable base, and (3) Prince George's County's costs are for urban strategies which account for a vast majority of loading reductions. The only county whose numbers may change dramatically is Somerset. For Somerset, urban strategies are not included and urban source reductions account for even more of total reductions than the septic systems whose costs are displayed.

Table 4.2 shows that the differences among the jurisdictions are striking within each category. Total WIP Phase 2 costs for those with complete numbers range from $138 million for Caroline County to $4.3 billion for Frederick County. Calvert County and Frederick County are projected to have by far the highest cost burdens per person, household, assessable base, and annual budget expenditures. Per household, for example, Calvert Couny is facing WIP costs of $44, 467 per household compared with $6,279 in Dorchester County, $4,903 in Montgomery County, and $2,618 in Prince Georges County. Similar large differences in relative burden exist on the basis of a comparison with the assessable tax base and annual county budget expenditures. Of course, agricultural costs are not included in WIP plans and therefore in these cost estimates. However, since agricultural BMPs are among the least costly strategies to implement, it is unlikely their inclusion would drastically change the distribution.

Table 4.2 Analysis of Maryland Jurisdiction WIP Phase II Implementation Cost Burdens

Jurisdiction	**Projected WIP II Cost**	**Cost Comparison**				
		Per Person	**Per Household**	**Per Acre**	**Cost/Taxable Assessable Base**	**Cost/ Budget FY12**
Anne Arundel County	$2,023,300,000	$3,763	$10,632	$7,620	$0.03	1.66
Baltimore City[1]	$651,042,246	$1,048	$2,738	$12,568	$0.02	0.39
Calvert County	$1,322,195,177	$14,900	$44,467	$9,692	$0.11	5.7
Caroline County[2]	$138,696,658	$4,195	$11,583	$678	$0.05	3.33
Cecil County	$600,000,000	$5,934	$16,726	$2,707	$0.06	3.58
*Dorchester County[3]	$83,774,500	$2,568	$6,294	$242	$0.03	1.72
Frederick County[4]	$4,300,000,000	$18,424	$52,907	$10,177	$0.16	9.57
*Montgomery County[5]	$1,687,000,000	$1,736	$4,903	$5,366	$0.01	0.39
*Prince George's County[6]	$780,000,000	$903	$2,618	$2,525	$0.01	0.29
*Somerset County[7]	$46,400,000	$1,753	$5,563	$227	$0.03	1.28
Maryland Total	**$11,632,408,581**	**$2,015**	**$5,559**	**$1,872**	**$0.02**	**1.07**

* Not a total cost estimate.

[1] *WIP cost ($250 million) for Baltimore City excluded WWTP upgrades. These numbers came from the BRF Advisory Committee 2011 Annual Report and the Bay Daily article "State Report: MD's "Flush Fee" Needs To Be Doubled To Cover $530 Million Shortfall". Also, WIP's $250 million was only through 2017. This analysis extrapolated a total number through 2025 by multiplying the anticipated cost/pound by the required pounds reduced.*

[2] *Caroline County's WIP did not include cost estimates through 2025 (full WIP implementation). This analysis extrapolated the County's calculated costs/load for each sector through 2025 by multiplying their numbers by the required load reduction in each sector.*

[3] *Dorchester draft plan contained no total - this is a composite of their estimated totals of septic and urban projects.*

[4] *Frederick plan contained no total - from statement made by County representative in article http://fredericknewsflash.typepad.com/blog/2011/12/officials-say-high-costs-make-cleaning-up-chesapeake-bay-impossible-for-frederick.html*

[5] *Montgomery County plan contained no cost estimate - from draft Countywide plan just for MS4 permits.*

[6] *Stormwater costs only.*

[7] *Septic costs only.*

Sources: Unless otherwise noted, WIP costs from County Plans or presentations; U.S. Census Bureau. State Department of Assessments and Taxation July 1, 2011; Budget FY12 from Maryland local government

Why are there such large variances in relative WIP cost burdens among the counties? As was shown in Chapter 3 relating to cost-effectiveness, the manner in which the TMDL allocates load reductions among the sources in a jurisdiction plays a large role in the resulting total costs of implementation for the jurisdiction. Table 4.3 displays a comparison of how each jurisdiction's load reductions are distributed between sectors and the resulting cost-effectiveness and overall cost implications of this distribution.

The third through seventh columns i Table 4.3 show how the nitrogen load reductions for each jurisdiction are allocated under Maryland's WIPs. The last two columns analyze what percentage of these reductions are to come from (a) sources that are cost-effective to manage including agricultural and wastewater plant reductions and (b) sources that are more costly to manage per pound of nitrogen including stormwater and septic sources of reductions. Note that some values are negative or exceed 100 percent because certain sectors "make up" loading gains from other growing sectors. The most extreme case is Charles County where, because the wastewater sector is permitted to grow significantly, other sectors are required to cover the increase. In this case, the total reduction for the County is so small (1,111 pounds), and each sector is measured in percentage relative to this small reduction, that the WIP reductions for agriculture, urban, and septic sectors appear huge in percentage terms and the growth under wastewater appears even larger (when in reality they are small absolutely).

The results from the table indicate why Calvert's WIP cost burdens are so high in relation to the other nine Maryland counties with available cost estimates. Seventy-seven percent of the nitrogen load reduction for Calvert County is required to come from sources that are less cost-effective. The only other county in Table 4.3 with a similarly high percentage of reduction coming from less cost-effective sources is Prince George's County (at 84 percent), and it is a larger county with a much greater budgetary capacity. Even when the number of counties is expanded to include all those in Table 4.3, Calvert and Prince George's still top the list in terms of the percentage of reductions expected to come from less cost-effective septic and urban sources.

Table 4.3 Percentage of Total County WIP Nitrogen Loading Reductions by Source and Comparison of Cost-Effectiveness

Jurisdiction	Total Reduction 2009-2025	Percent of County Loading Reductions 2009-2025[1]					Cost-Effectiveness: % of Total Reductions from Different Sources [2]	
		Agriculture	**Urban**	**Septic**	**Forest**	**Wastewater**	**Cost-Effective[3]**	**Less Cost-Effective[4]**
Allegany County	45,220	-3.00%	23.50%	3.00%	-11.50%	88.00%	85.00%	26.50%
Anne Arundel County	928,445	7.40%	30.10%	25.50%	0.20%	36.80%	44.20%	55.60%
Baltimore City	1,540,496	0.00%	7.50%	0.00%	0.00%	92.50%	92.50%	7.50%
Baltimore County	2,117,707	4.90%	11.80%	2.80%	0.00%	80.40%	85.30%	14.70%
Calvert County	232,927	24.10%	25.40%	51.70%	-0.20%	-1.00%	23.10%	77.10%
Caroline County	614,968	85.30%	7.10%	4.80%	-0.20%	3.00%	88.30%	11.90%
Carroll County	123,621	71.90%	13.50%	5.10%	-0.10%	9.60%	81.50%	18.60%
Cecil County	611,221	64.20%	16.80%	13.40%	0.20%	5.50%	69.70%	30.10%
Charles County	1,111	5812.80%	986.80 %	5261.30%	- 429.50%	-11531.30%	-5718.50%	6248.10%
Dorchester County	321,514	98.70%	10.50%	9.70%	-1.10%	-17.80%	80.90%	20.20%
Frederick County	449,573	79.10%	19.20%	7.90%	-1.90%	-4.30%	74.80%	27.10%
Garrett County	2,008	83.80%	44.50%	3.60%	-30.40%	-1.50%	82.30%	48.10%
Harford County	629,996	53.90%	30.00%	11.30%	-0.50%	5.20%	59.10%	41.40%
Howard County	514,895	1.50%	9.60%	3.70%	0.10%	85.00%	86.60%	13.30%
Kent County	733,347	94.00%	5.80%	2.60%	-0.10%	-2.40%	91.70%	8.40%
Montgomery County	553,130	31.90%	29.20%	5.90%	0.60%	32.40%	64.30%	35.10%
Prince George's County	279,253	17.20%	72.80%	10.90%	0.50%	-1.40%	15.70%	83.80%
Queen Anne's County	608,281	85.00%	10.00%	8.60%	-0.20%	-3.40%	81.60%	18.60%
Somerset County	109,176	59.00%	34.20%	19.50%	-2.90%	-9.80%	49.20%	53.70%
St. Mary's County	235,019	56.30%	8.10%	36.50%	-1.40%	0.50%	56.80%	44.60%
Talbot County	500,864	76.20%	12.20%	7.40%	-0.20%	4.40%	80.60%	19.60%
Washington County	322,184	77.30%	8.60%	6.60%	-3.40%	10.90%	88.10%	15.30%
Wicomico County	290,432	14.60%	18.00%	21.40%	-1.20%	47.10%	61.70%	39.40%
Worcester County	-77,365	139.50%	-8.60%	-7.00%	3.90%	-27.80%	111.70%	-15.60%
Maryland Total	**11,688,023**	**38.60%**	**16.40%**	**9.60%**	**-0.40%**	**35.80%**	**74.40%**	**26.00%**

[1] Some values are negative or exceed 100%. See the text on the previous page for an explanation.
[2] Forest sources are excluded and, since in most cases forest loads represent a net increase, totals may not equal 100% and will likely exceed 100%.
[3] Per discussion in Section 4.1, sources that are cost-effective to manage include agriculture and wastewater.
[4] Per discussion in Section 4.1, sources that are less cost-effective to manage include urban and septic.

Source: MDE, Maryland WIP Phase II Target Load Summaries, 2011

The heart of the matter lies in jurisdictional land use. Jurisdictions with highly developed urban areas, such as Baltimore City, Baltimore County, and Montgomery County, are able to rely to a greater degree on cost-effective WWTP upgrades for their TMDL required load reductions. Other counties with low levels of urban development and more agriculture, such as the Eastern Shore counties of Queen Anne's, Talbot, Dorchester, and Caroline, are able to rely on cost-effective agricultural BMPs for their TMDL required reductions. However, Calvert County has a moderate amount of development, much of it low density, and only 14 percent of its land is in agriculture. Calvert has neither sufficient urban areas nor agricultural areas to bear the loads of nutrient reductions, and must instead rely on costly stormwater and septic system upgrades.

One additional factor is important to take into consideration: how the load allocation between sources impacts how costs are distributed within a jurisdiction's population. Different strategies have diverging funding sources which affect the finances of local governments and their citizens in varied ways. For example, WWTP upgrades have a dedicated state funding source in the Bay Restoration Fund (BRF) which covers much of the associated costs, as well as state loan guarantees for the remainder of the costs. Also, the costs to local governments for these upgrades are spread evenly over a jurisdiction's population through property taxes and other revenue sources. Similarly, there is dedicated federal and state funding for agricultural BMPs such as cover crops. In the State of Maryland, one analysis estimated that local governments would only bear one third of total point source management costs and farmers would only pay for about half of agricultural BMP costs.[30]

However, there is less dedicated state and federal funding for the other types of nutrient sources for which counties must make reductions by 2017 and 2025. While grants and funding are available for stormwater BMPs, dedicated funding is not assured for these and funding to date would not come close to covering a substantial portion of the anticipated costs for needed stormwater upgrades. The remainder of the costs will be borne by local governments and their taxpayers. For septic systems, more than half of upgrade costs are anticipated to come directly from individual homeowners and another quarter from local governments.

These factors combined mean that in jurisdictions that must rely more on stormwater and septic sources for nutrient load reductions, these costs burdens will be placed on the shoulders of the local county government and individual home owners to a greater degree than in jurisdictions that can rely on WWTP upgrades and agricultural BMPs. Additionally, the total costs to these jurisdictions will be greater due to the low cost-effectiveness of stormwater BMPs and septic system upgrades. This discussion is particularly applicable to Calvert County, where nearly 52 percent of reductions are to come from septic system upgrades, the one source whose cost of making nutrient reductions most directly affects individual citizens financially.

Conclusion

Bowen's analysis of the Maryland Phase II WIP shows that, despite the stated concerns of state officials to achieve an equitable TMDL result, the actual results of their efforts have nevertheless yielded significant inequalities. It was difficult for Maryland officials to know this in advance because the top-down TMDL process required load allocations to be distributed among Maryland jurisdictions without detailed knowledge of the actions on the ground that would have to be taken to achieve these load targets. The actual distributional burden of costs was thus uncertain at the time of the TMDL allocation process among counties and other parties. Whatever their equity intentions – which were vague to begin with – Maryland TMDL planners did not have the information and resources to design an equitable TMDL set of load allocations. This shows up in the significant disparities among Maryland counties in the cost burdens of implementing their WIPs.

No similar analysis is available for the five other states of the Bay watershed but they worked within the same TMDL framework as Maryland and it is reasonable to expect that the TMDL load allocations and the resulting WIPs in these states may show similar inequities, once the allocations are translated into specific actions of local jurisdictions and the resulting cost burdens can be more fully identified. Further analysis will be necessary to make such equity assessments.

One way of addressing the equity concerns of the Maryland TMDL is to make wider use of offsets. If counties that now face high costs are allowed to obtain offsets from other more cost-effective nutrient sources, they may be able to significantly reduce the cost burdens they are now being required to incur. The alternative to such use of offsets would be to revisit the Maryland TMDL and to develop a new set of load allocations that are in fact more equitable. This would have to be done in a more bottom up way than the initial Maryland TMDL load allocations. Any such effort would inevitably be controversial and time consuming, probably impossible to complete in less than a years time, and perhaps requiring a considerably longer period.

Chapter 5 – Offsets as a Bay TMDL Solution

In most watersheds across the country, the Clean Water Act's TMDL process consists of formulating a written plan in order to achieve TMDL target acceptable pollutant loads. This results in little more than allowing the states to decide what load allocations will be and where they will come from. It typically has few teeth for actual enforcement with respect to non-point sources – often key to implementing the TMDL. In the Chesapeake Bay Watershed, however, EPA has assigned load allocations to Bay states and has declared its intent to guide the process with a firmer hand. For instance, in New York, EPA withheld more than $300,000 in grant money because of the state's tardiness in delivering a draft of their Phase I WIP. It has further made statements about other enforcement tools that EPA will use if states do not follow through with their TMDL plans including:

- Expanding coverage of NPDES permits to sources that are currently unregulated.
- Increasing oversight of state-issued NPDES permits.
- Requiring additional pollution reductions from federally regulated sources.
- Increasing federal enforcement and compliance.
- Prohibiting new or expanded pollution discharges.
- Redirecting EPA grants.
- Revising water quality standards to better protect local and downstream waters.
- Discounting nitrogen, phosphorus and sediment reduction progress if jurisdiction cannot verify proper installation and management of controls.[31]

EPA thus proposes to go well beyond its usual enforcement methods in the Chesapeake Bay Watershed. According to EPA's website on the Chesapeake Bay TMDL, "EPA has full discretion to determine whether federal actions are appropriate based on the degree to which reduction goals are missed, the reasons why, and additional actions that jurisdictions are taking to ensure that load reductions will remain on track to meet the Partnership's goal of all practices in place by 2025 to meet applicable water quality standards. EPA has already demonstrated this discretionary authority when deciding whether to establish backstop allocations and adjustments in the Chesapeake Bay TMDL."

The Chesapeake Bay TMDL is also unusual because of the extensive measures EPA and the jurisdictions have adopted to ensure accountability for reducing pollution and meeting deadlines for progress. The TMDL will be implemented using an accountability framework that includes state and local WIPs, two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal contingency actions, listed above, if the jurisdictions do not meet their commitments. EPA states that, "This accountability framework is being established in part to provide demonstration of the reasonable assurance provisions of the Chesapeake Bay TMDL pursuant to both the Clean Water Act and the Chesapeake Bay Executive Order" issued by President Obama in 2009.

Unlike many other TMDLs across the nation, moreover, EPA has been intensely monitoring the Chesapeake Bay Watershed implementation, conducting ongoing oversight of all state programs to assure they are on track to meet the WIPs released up over the past year and the associated milestones. More specifically, EPA will use the Chesapeake Bay TMDL Tracking and Accounting System (BayTAS) to monitor and verify progress in meeting cleanup commitments under the Chesapeake Bay TMDL, using the two-year milestones to track progress toward reaching the interim 2017 target and the ultimate 2025 goal.

This intense scrutiny, threat of action, and close monitoring by EPA has already drawn considerable attention from the agriculture community, and more specifically, pro-agriculture politicians. For instance, Virginia Republican, Bob Goodlatte sponsored the Chesapeake Bay Program Reauthorization and Improvement Act (H.R. 4153) on April 5, 2012, that proposed to remove most of the EPA's authority over nutrient and sediment reduction efforts, while giving states and the U.S. Department of Agriculture more clout. If passed, the bill would further call into question EPA's authority to require states to regulate non-point source pollutants in such a direct way.

The Chesapeake Bay TMDL process has also triggered backlash from agricultural trade organizations, city leaders and developers in the region who are fearful of costly new rules and regulations that could occur under the TMDL. A coalition, made up mostly of agribusiness groups such as the American Farm Bureau Federation, has challenged the Bay TMDL in court.[32] With current Republican governors in Virginia and Pennsylvania, these states may be more willing to challenge the Obama administration. The political opposition that already exists to the Chesapeake Bay TMDL could increase as greater public awareness develops of the large total cost burdens of TMDL implementation for the six Bay states (and in particular Maryland, Virginia and Pennsylvania), of the cost-ineffectiveness and lack of concern for minimizing total costs reflected in the TMDL load allocation process and WIP development, and of the inequalities that these TMDL load allocations and WIPs have created. Indeed, it is fair to say that, in light of such considerations, as described in Chapters 2, 3, and 4, the future of the Bay TMDL is in doubt; it is an "endangered Bay TMDL" at present.

Use of Offsets to Address Bay TMDL Concerns

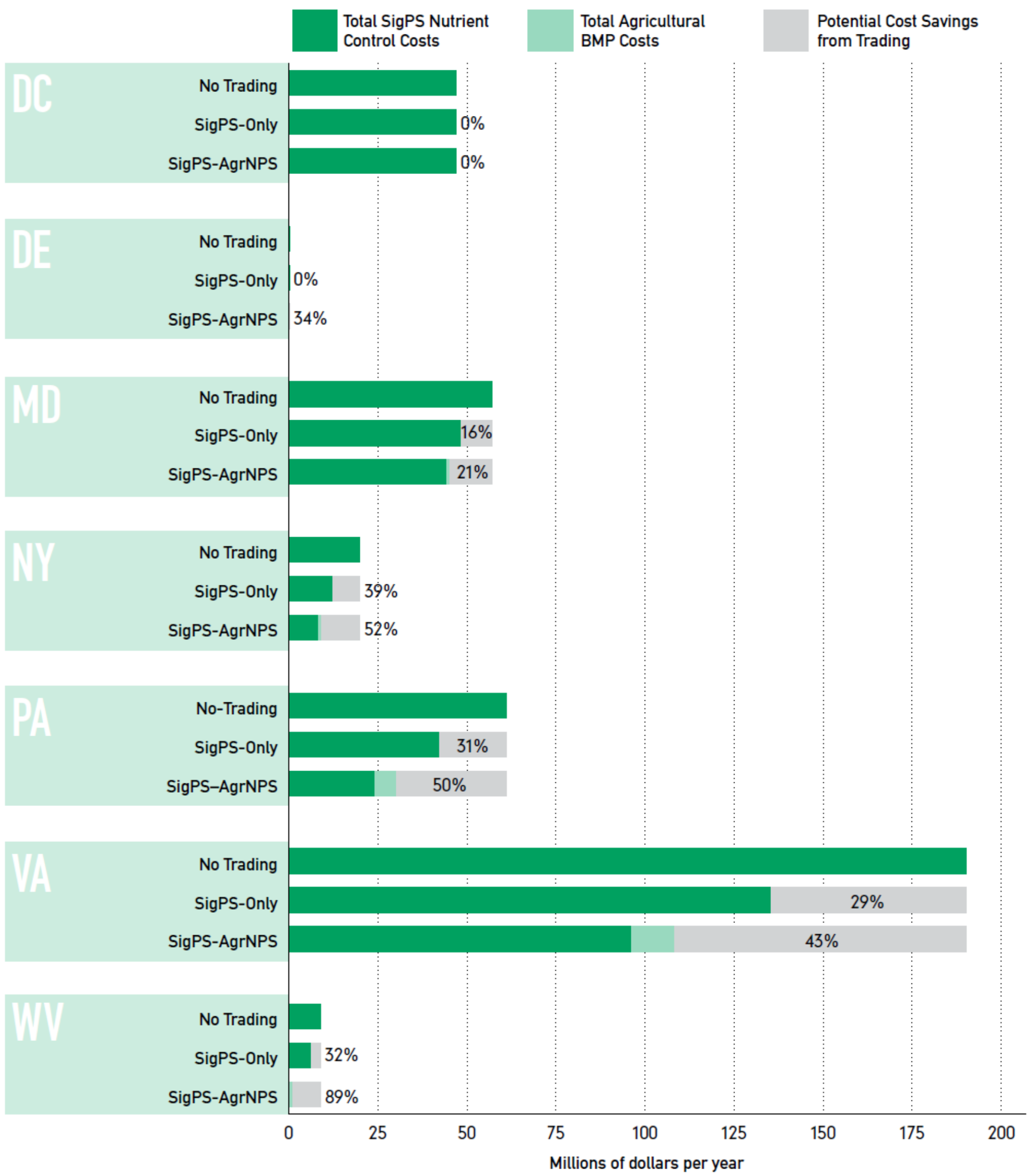
As this report examines, there is an available policy alternative that may well be able to successfully address the above issues. Instead of mandating costly load reductions across key sources, it may be preferable to allow those who generate nutrient flows to purchase "offsets" from less expensive measures. For example, instead of mandating stormwater reductions, polluters could purchase offsets from agricultural sources, which would similarly reduce nutrient impact on the Bay, but bring the total costs of TMDL implementation down. If the required "offset trading ratio" is greater than one, a system of offsets may even generate larger reductions in nutrient flows to the Bay than would have been achieved from requiring stormwater sources to make the reductions directly by themselves.

Provision for stormwater and other offsets, in short, offers a possibility of greater reductions in nutrient flows at less overall cost and greater equity among involved Bay parties. Given the high overall funding burdens associated with Bay TMDL implementation, ways of reducing costs may be important to the future political viability of the TMDL process. Putting an offset system in place would in practice raise various policy issues and would require institutional innovation for its administration, as will be discussed further in Part II of this report.

The most formal and developed form of an offset system is a nutrient trading system in which offsets are bought and sold in the specific form of nutrient trading credits. A nutrient trading market operating in a region could in particular allow for more cost-effective reductions of non-point source pollution. Nutrient trading would give sources of pollution various ways to reduce their total nutrient loads, either directly or indirectly by purchasing offsets. A nutrient trading system is also the form of offset generation and transfer than has thus far received the most scholarly and other policy attention.

The Chesapeake Bay Commission (CBC) in 2012 estimated the economic gains from the use of a market system of trading in nutrient credits in implementing the Bay TMDL. Figure 5.1 shows the cost savings that would be potentially achievable if WWTPs were allowed to avoid installing expensive treatments by purchasing offsetting nutrient credits from some other source. Two scenarios are shown. In the "SigPS-Only" scenario, WWTPs can only purchase nutrient credits from some other WWTPs (which generate saleable credits by making nutrient reductions greater than otherwise required of them). In the "SigPS-AgrNPS" scenario, WWTPs are also allowed to purchase credits from farmers in the agricultural sector who modify their management practices in order to created increased nutrient load reductions.

Figure 5.1 – Potential Cost Savings from an Offset System for Waste Water Treatment Plants, by State

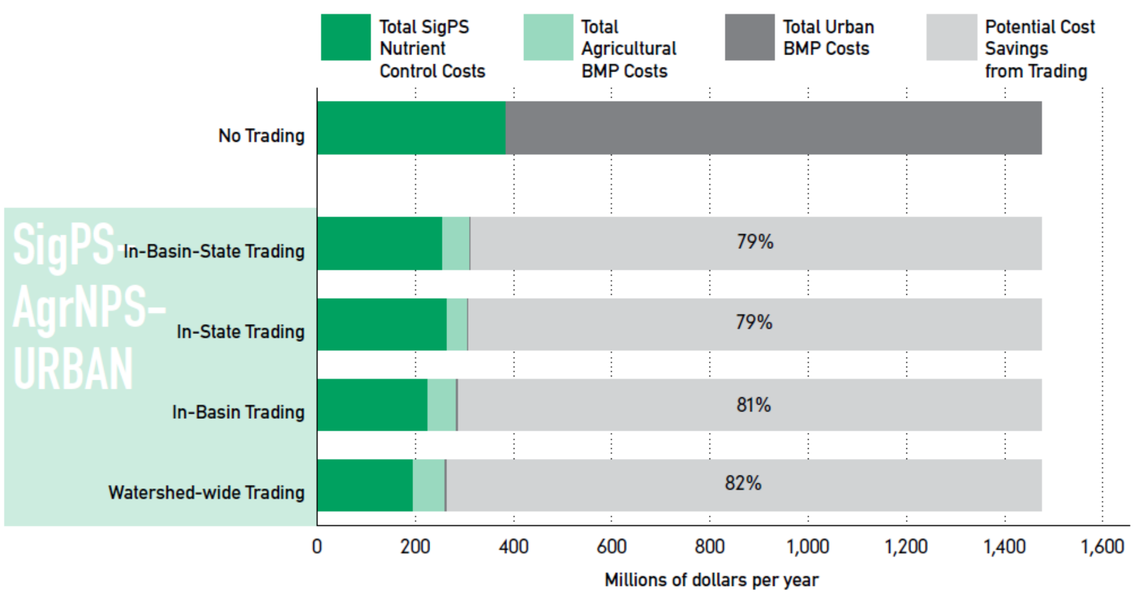


Source: Chesapeake Bay Commission, May 2012, "Nutrient Credit Trading for the Chesapeake Bay: An Economic Study," Annapolis, MD: CBC.

As shown in Figure 5.1, the potential for cost savings from a nutrient trading system of purchasing offsets to WWTP loads varies significantly according to the specific circumstances of each jurisdiction. In the District of Columbia, there would not be any credits available – there is no farmland in the District to generate credits, for example – and thus no potential cost savings. Maryland also has modest levels of savings available from a system of nutrient trading to offset wastewater loads, potentially a cost reduction of 21 percent in the second scenario where offsets can be purchased from agriculture. In New York, Pennsylvania, and Virginia, however, the potential cost savings are larger, 52 percent, 50 percent and 43 percent, respectively. In West Virginia, cost savings as large as 89 percent might result from a market system of trading in nutrient credits to offset wastewater loads.

If purchases of credits in a nutrient trading market are also allowed to offset stormwater nutrient reductions, the potential cost savings for TMDL implementation become much larger, reflecting the especially high costs of achieving stormwater nutrient reductions, and the large economic gains from using nutrient offsets elsewhere to avoid the necessity of making such expensive stormwater reductions. Figure 5.2 shows the potential total cost savings for all the Bay watershed states where both WWTPs and stormwater districts are allowed to purchase nutrient credits as a way of offsetting increased nutrient flows (instead of reducing the flows directly) from stormwater. The level of cost savings depends to some degree on the allowable degree of geographic flexibility in finding eligible credits to purchase as offsets – the wider the range of eligible areas, the more credit/offset options will be available, and the larger the potential cost savings.

Figure 5.2 – Potential Total Cost Savings from Offsets for Wastewater Treatment Plants and Stormwater Districts, All Chesapeake Bay Watershed States, by Eligible Offset Areas



Source: Chesapeake Bay Commission, May 2012, "Nutrient Credit Trading for the Chesapeake Bay: An Economic Study," Annapolis, MD: CBC.

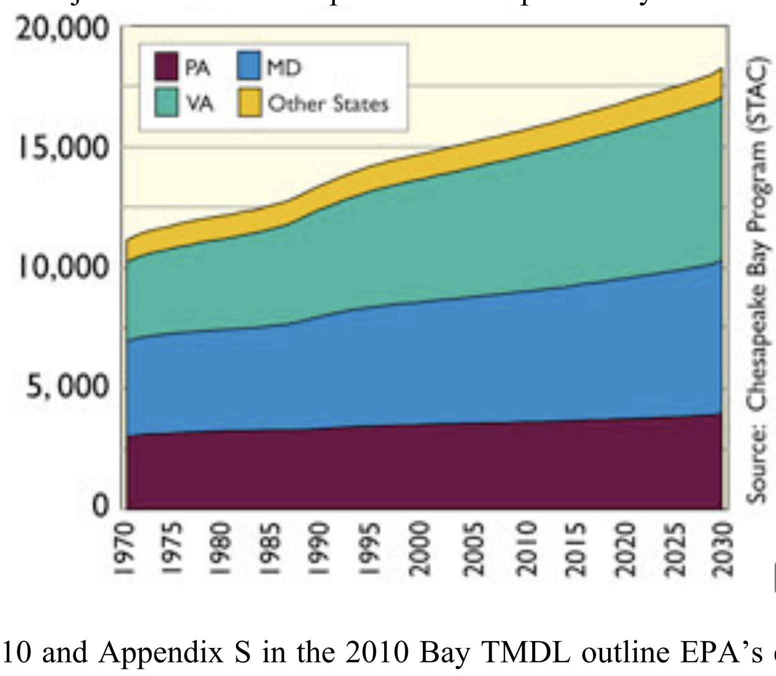
As shown in Figure 5.2, a system of purchasing offsets in a nutrient trading market would potentially enable cost savings of around 80 percent in Chesapeake Bay wastewater and stormwater implementation, as compared with direct action by WWTPs and stormwater districts to reduce their own nutrient flows. The total potential cost savings from such a nutrient credit/offset program would be more than $1 billion per year for all six states combined, or more than $20 billion in long run cost savings within the Bay watershed as a whole (applying a 5 percent discount rate). Such potential absolute levels of cost savings are large enough that they could have an observable impact on the overall fiscal circumstances of states in the Bay watershed in the years to come.

The estimated cost savings from a nutrient trading system represent the high end of possible cost savings. Nutrient credit trading can also occur in a more informal way through a barter system of direct exchanges between individual parties. The higher transaction costs associated with direct barter negotiations work to limit the number of offsets obtained, resulting in lower activity and less cost savings than a full market system.

Offsets to Future Population Growth in the Bay Watershed

As the Bay TMDL is implemented, it will be necessary to consider new development and economic growth. As shown in Figure 5.3, significant increases in population are expected in the Bay states from 2010 to 2030.[33] New neighborhoods or shopping centers create additional nitrogen, phosphorus, and sediment loads through stormwater runoff and sewage treatment – on-site or at a WWTP. If local and state decision-makers fail to take account of such new pollutant loads, total nutrient flows into the Bay will increase. In essence, state and local officials are aiming for a moving target: as they reduce current loads to their target allocations under the TMDL, they must also deal with the arrival of new sources of pollution. The TMDL assumes that Bay state jurisdictions will account for, and manage, any new or increased loads of nutrients or sediment; EPA expects the jurisdictions to do so.

Figure 5.3 Projected Growth in Population Chesapeake Bay Watershed, 1970-2030



Section 10 and Appendix S in the 2010 Bay TMDL outline EPA's expectations for how state and local officials must account for new or increased loads from growth and development.

To accommodate new or increased loads, state and local officials have two basic options under the TMDL: either (1) provide a specific (built-in) higher allocation to include new or increased loadings of nitrogen, phosphorous, and sediment in their plans, or (2) accommodate new or increased loads through "a mechanism allowing for quantifiable and accountable offsets" in an amount necessary to achieve and maintain water quality standards. Thus far, the Bay states say they will depend heavily on the latter option, although the details of a system of offset implementation are still being worked out (see the Appendix to this report for details on the individual states).

An offset approach to the accommodation of new or increased loads in the Bay watershed has three primary advantages relative to the use of specific, built-in allocations. First, an offset-based approach more effectively accounts for new development as it occurs. If state and local officials build in a specific growth allocation, it will make a difficult WIP process even more burdensome. Some jurisdictions have enough difficulty getting to their TMDL targets with reductions from existing sources, and the incorporation of significant further required reductions to existing loads might make their task nearly impossible in some cases. Furthermore, any growth allocation would necessarily be based on future projections and best-guesses. Frequent revisions to the growth allocation – for example, under an adaptive management framework – would require even more time and effort from TMDL officials and planners, and the end result would remain uncertain. Alternatively, if each new development source of nutrient loads is required to offset its nutrient and phosphorous loads, then officials only need to worry at present about achieving reductions from existing loads.

A second advantage is that offsets make nutrient and sediment reductions more cost-effective and efficient. For example, if a developer has to offset the stormwater loads from a new subdivision, they will have a significant incentive to minimize the subdivision's impact through low-impact development (LID) or other innovative measures. Furthermore, if there is an active market for offsets, the developer may seek to generate credits by installing a high-performance on-site disposal system (OSDS) that can connect nearby septic systems and reduce overall nutrient loads. An offset scheme provides private incentives to minimize total TMDL implementation costs.

A third advantage is that an offset approach is more equitable to the residents and taxpayers of the region. If a specific allocation for growth is factored into a local WIP, it effectively requires current residents to make reductions on behalf of new and increased loads in the future. However, existing sources are not responsible for the future development, so placing an increased cost burden on current residents easily raises concerns over equity. If current residents have to bear much of the pollution reduction cost to accommodate new development, strong local forces are likely to arise to resist such development, potentially altering local growth patterns for the worse. If developers are required to offset their new loads as they occur, then the burden is more equitably distributed.

A fourth advantage is that an offset program is more defensible against political and legal challenges than the alternatives. It involves a simple and easily understandable requirement that those who generate new nutrient loads must offset these loads. If the TMDL has to estimate future load increases, and then assign new responsibilities for corresponding load allocations, outside parties may be able to successful challenge the methodology used. EPA and the states may find it difficult to defend their decisions that directly impose significant costs on many parties who are not directly involved in the development process.

Conclusion

In concept, an offset system offers the possibility of achieving Bay TMDL nutrient reductions in a much less expensive fashion, as compared with a system that simply requires all WWTPs and stormwater districts to comply with the regulatory mandates imposed by EPA and the states. Given the magnitude of direct stormwater nutrient reduction costs, it is questionable whether the large financial resources necessary for direct implementation would actually become available to achieve the load reductions assigned to stormwater in the Bay TMDL. Thus, in many cases a system of offsets may be the only way that stormwater districts will be able to take on the responsibility of generating nutrient reductions to the Bay.

An offset system is also a viable option for states dealing with significant projected growth. A principal concern of states is to ensure that continuing population growth and other new sources of Bay pollution do not undermine the state's ability to achieve its 2017 and 2025 TMDL pollution reduction targets. This can be accomplished by requiring that increases in nutrient pollution loads owing to new housing and other land development be "offset" by reductions in pollution loads somewhere else.

Part II -- OFFSET POLICY ISSUES FOR THE CHESAPEAKE BAY STATES

Introduction to Part II

For those Chesapeake Bay states that plan to use offsets in their TMDL and WIP implementation, they will need to consider various policy issues in setting up an offset system. These issues can be divided into "demand" and "supply" elements of offsets. The demand side relates to the allowable circumstances in which an offset somewhere else can be used to substitute for a direct nutrient load reduction at a given polluting site. The supply side relates to the allowable circumstances in which such an offset can be created at an alternative location.

Key demand side issues include the following:

1. Who is eligible to substitute an offset for a direct nutrient load reduction?
2. From what types of sources (agriculture, sewage systems, etc.) will offsets be permissible?
3. How large must an offset be, relative to the alternative of a direct nutrient load reduction at a given polluting site (allowable offsets may have to multiples of this direct reduction)?
4. Where geographically can the offset be located (does it have to be in the same basin, state, etc.)?
5. What other specific conditions must be met by the user of an offset?

On the supply side, key issues include the following:

1. Who is allowed to provide offsets (agriculture, stormwater systems, septic systems, etc.)?
2. How are baselines calculated as part of the level of offset determination?
3. How will be the existence of a legally acceptable offset be established and monitored?
4. What will happen if the provider of an offset fails to fulfill the offset conditions?
5. Can intermediate parties serve as offset banks or other forms of aggregators of offsets?

Part II will address these and other questions concerning the establishment of a system of offsets in a Bay state. Chapter 6 will examine several policy issues relating to the demand side. Chapter 7 will examine issues relating to the supply side. Chapter 8 will examine the role that geographic location might play in making use of and providing offsets. Finally, Chapter 9 will explore innovative ways (such as oyster aquaculture) by which offsets might be created. Examples of current practices and thinking of the individual Bay states will be offered, drawing in part upon the discussions of offset policy development by individual Bay states, as contained in the Appendix.

Chapter 6 – Polluter Reduction Requirements and the Allowed Use of Offsets

In concept, a requirement to reduce any form of nutrient pollution load reaching the Chesapeake Bay could be "offset" by making the reduction somewhere else. If the offset was fully equivalent to the original pollution load, and if it was less expensive to make the offset, this would be a cost minimizing step for the overall Bay cleanup. Hence, the greater the flexibility in allowing the use of offsets, the greater will be the potential for holding down the costs of implementing the Bay cleanup. Indeed, as suggested above, it may prove to be necessary to make wide use of offsets in order to sustain the political viability of the Bay TMDL and its 2017 interim and 2025 final pollution load targets.

In practice, a source of nutrient pollution will seldom be precisely equivalent to an offset that it might obtain. If an offset of a pollutant load in one river basin is obtained from a different basin, there will be differential impacts on the two basins, even if the Bay itself is not affected. Some forms of potential offsets such as the conversion of agricultural lands to nonfarm use may also be seen as having other socially undesirable consequences. If the size of the offset is not a multiple of the original nutrient load source being offset, the net benefits of allowing offsets may not be very great in some cases. The use of an offset may be seen by some members of the public as a means of "escape" from a legal requirement to make a direct pollution reduction.

If multiple sources of nutrient pollution in close proximity to one another all obtain offsets (thus allowing them to continue polluting together), it may result in the creation of nutrient pollution "hot spots" near their common location. A recent policy brief from Center For Progressive Reform (CPR) took sewage treatment plants as an example of potential "hot spots". If one or two sewage treatment plants could purchase offsets without any limits, they might discharge much more nutrient flow themselves. A "hot spot" could be created and the high concentration of pollution could have a negative impact on residents of nearby neighborhoods.[34] In such circumstances, public opposition to the use of offsets might arise, even when the offsets serve to reduce the overall costs of Bay TMDL implementation.

Given the problems mentioned above, offsets may not work as hoped if the system is not well-designed and implemented in practice. Chapter 6 considers some of these issues from the demand side, drawing as appropriate on existing state experiences as discussed in previous chapters and the Appendix.

1. **Who is eligible to substitute an offset for an otherwise direct nutrient load reduction at a given site?**

To answer the question, this section describes three cases (Virginia, Maryland and Pennsylvania) that are representative of other Bay states as well.

Virginia

Among the six Bay states and the District of Columbia, Virginia has gone the farthest in identifying the circumstances in which the use of an offset will be acceptable (for further details see Appendix B). It became the first state in the Bay area to give a working role to nutrient credits and offsets as part of its overall nutrient pollution reduction strategy. Authorized by the legislature in 2005, and beginning operations in 2007, the Virginia Exchange Program allows for trading to help point source dischargers in meeting their individual Wasteload Allocations (WLAs). Wastewater treatment plants are allowed to purchase nutrient "credits" (one form of an offset) from other point sources to meet their WLAs. Virginia law sets the required credits as the amount by which the total annual nutrient discharge from a treatment plant exceeds the WLA. Sources that are not meeting their WLA requirements are required to purchase credits. The credits can only be exchanged if they are generated in the same calendar year as the purchaser's yearly WLA. In the event that not enough credits are generated by point sources, the Virginia program allows the treatment plan dischargers to pay a fee into the Water Quality Improvement Fund, which would direct the resulting revenues to be used to purchase non-point source credits. The Exchange Program also allows for the acquisition of non-point source load allocations through the use of best management practices (BMPs) within the same basin as the discharger.

The most recent WLAs for significant facilities were set in Virginia in 2010 at levels which seek to allow for future growth into the foreseeable future. The WLAs for non-significant facilities with individual VPDES permits are based upon the 2005 permitted design capacity. In case these facilities exceed a design flow of 1,000 gpd, however, they would then be required to offset their entire extra load and register the offsets under the watershed general permit.

Virginia is currently experiencing a decrease in agricultural land use, which is being converted to other uses. Therefore, there is no net expected growth in agricultural pollution due to new sources built into the WIP planning. The Phase I WIP mentions, however, that a few sub-sectors, such as sod farms, nurseries, vineyards and biofuel feedstock, are expected to show growth in acreage over the next few years. As a result, the state has decided to require implementing new BMPs for these activities. Few if any offsets are expected to be obtained by agricultural sources.

For stormwater, Virginia's strategy for dealing with potentially significant growth in nutrient loads in the stormwater sector (associated with housing and business development) has changed since the publication of the Phase 1 WIP. The State originally planned to account for growth by requiring each new development project to meet its pre-development loads through a combination of site planning, BMPs and, if necessary, offsets. The Phase 1 WIP called for the use of offsets in the event that adequate on-site practices were not undertaken, but it did not give the details of how the required number of offsets would be obtained and determined.

Since the Phase 1 WIP, the Virginia DEQ has taken further steps to a plan for incorporating offsets into the stormwater sector management of growth. The statutory basis was enacted as SB 1099 law in 2011. This law establishes that any locality that has adopted a local stormwater management program is allowed to consider offset options elsewhere as long as "the applicant demonstrates that alternative site designs have been considered that may accommodate on-site BMPs, on-site BMPs have been considered in alternative site designs to the maximum extent practicable, and post-development nonpoint nutrient runoff compliance requirements cannot be met on site. If the applicant demonstrates on-site control of at least 75% of the required phosphorous reductions, the applicant [will then be allowed to purchase offsets]". The offsets must have already been constructed and available prior to development of the site. Furthermore, the offsets must be available in the same tributary as the development activity and within allowable hydrologic unit codes.

If the use of offsets would contribute to local water impairment, the stormwater applicant would not be allowed to purchase offsets and is required instead to achieve the reductions entirely on-site. Virginia will rely on the established system through the existing nutrient trading exchange which already allows for non-point sources to generate offsets. Once these nitrogen and phosphorous offsets are generated, developers will be allowed to purchase them as stormwater offsets.

For septic systems, the Virginia Department of Health in December 2011 established regulations for alternative systems, which require a minimum 50% reduction in delivered nitrogen for all new small (<1000gpd) on-site systems in the Bay. The Phase II WIP proposed additional alternatives, such as establishing five year pump-out requirements for septic tanks, or establishing tax credits for upgrade/replacement of existing conventional systems with nitrogen-reducing systems, but no action has been taken on these proposals yet. There is no well defined policy as of yet on use of offsets as an alternative to improvements in the workings of septic systems – or of using septic system improvements as offsets to increased nutrient load flows from stormwater systems.

Maryland

Maryland regards its offset policy as a key to dealing with future business and housing development in the state. According to the Phase I WIP, "Maryland is proposing to designate target loads for some new or increased sources and establish offset requirements for others in light of these factors that determine the nature of development and its post development loading rates." As noted in Appendix A, areas within each jurisdiction will be classified into Low, Moderate and High Per Capita loading categories" (areas having low, moderate and high nutrient flows relative to the total populations in the areas).[35] As proposed under Phase 1 of the Maryland WIP, some of the offset policies will be designed to encourage location of new development in areas with existing sewer and other infrastructure. At the same time, development in areas with little infrastructure will be discouraged by the imposition of tighter offset requirements.

It is likely that that Maryland's final offset policy will include distinctions among new development, redevelopment, and point and non-point sources. As explained in the Phase 2 WIP, "new development will need to meet all applicable Maryland law and regulations and offset post-development nonpoint source loads. Redevelopment as defined in States Stormwater Management Regulations, regardless of the Offset Category, will have to satisfy applicable stormwater regulations, but will not be required to offset the post-development septic load. New point source loads, and increased loads from existing point sources above their WLA will have to be offset according to the procedures established in Maryland's nutrient trading policies."[36]

Maryland's current proposed offset policies include the following:

- Existing development in Low Per Capita loading areas and Moderate Per Capita loading areas – areas that have lower nutrient flows relative to population-- will not be required to offset increased point source loads from wastewater.
- Redevelopment within Low Per Capita loading areas will be required to meet established stormwater management requirements (relating to impervious cover, Environmental Site Design (ESD) to the maximum extent practicable (MEP), or watershed management plans as provided in the approved local ordinance. Redevelopment projects in these areas will not be required to offset post-development non-point source loads.
- New (or greenfield) development within Low Per Capita Loading areas will be required to satisfy stormwater management regulations and offset post-development non-point source loads above the standard forest loading rate established by MDE.

- All new development in Moderate Per Capita loading areas will be required to offset increased point and post-development nonpoint source loads (including septic system loads) in excess of the standard forest loading rate established by MDE.
- High Per Capita loading areas may be subject to greater offset requirements, i.e., development may be required to offset point and post-development nonpoint source loads in excess of the standard forest loading rate established by MDE, at a ratio that is higher than that required in Low and Moderate Per Capita Loading areas.

In Maryland, nonpoint source nutrient trading policy supports trading between point sources and nonpoint sources, primarily from the agricultural sector. This nonpoint source framework allows trades to offset permitted point source loads and trades for other purposes, for example, environmental advocacy organizations purchasing loads to retire credits. Offsets only can be generated once a farm has met certain baseline levels of conservation treatment and related load reductions.[37]

Pennsylvania

Pennsylvania and Virginia are the Bay states furthest along in the development of a nutrient credit trading system; however, that is not to say that the State is necessarily a role model for the others. The state's Nutrient Credit Trading Program (NCT), administered by the Pennsylvania Department of Environmental Protection (PADEP), is a voluntary program for National Pollutant Discharge Elimination System (NPDES) permit holders to reduce pollution in a cost-effective manner. As the Pennsylvania Department of Environmental Protection states, "point source growth may be addressed by the purchase of nutrient credits, by the use of offsets from the elimination of less efficient sewage treatment facilities, or by another non discharge alternative such as employing recycle and re-use technology or land application." Pennsylvania predicts no increase in loads from expanded agricultural production. Pennsylvania offset policy allows much broader demand of offsets in point, non-point, new or renew pollution sources.

2. **From what types of sources (agriculture, sewage systems, etc.) will offsets be permissible?**

In Virginia, offsets have largely been used by wastewater treatment plants, obtained from other wastewater treatment plants that were operating below their allowed nutrient flows under the Virginia WLA standards. Maryland has put in place a system to provide offsets – expected to be mainly from agriculture – through a nutrient trading system. As of the spring of 2012, however, no offsets had actually been provided by this system. It is worth pointing out that an upgrade of major WWTPs is mandatory in Maryland, where trading is not available as a substitute for these upgrades. Both Virginia and Maryland have been moving to make greater use of offsets from agriculture, stormwater and other non-point sources.

Along with Virginia, Pennsylvania has thus far focused much of its offset policy development on the use of nutrient trading systems. Although only a limited amount of trading has occurred, Pennsylvania has made greater use of non-point source offsets than Virginia or other Bay states.

Delaware does not believe that significant nutrient credit trading will be necessary. It is in fact pursuing two linked offset tracks to meet TMDL requirements, including an offset program for stormwater and an offset program for all land use changes based on watershed-wide regulations. The intention is to use a single process for both programs to ease the workload on the regulated community.[38] Delaware is considering allowing offsets to occur outside a sub-watershed but within a designated local basin. A credit registry will be used for the statewide nutrient offset program and will keep track of credit exchange, but it will not result in a full-blown trading program that includes the aggregation of BMPs into tradable credits.

In the District of Columbia, land redevelopers will be allowed to offset their stormwater flows from other stormwater improvements in the District or payment of fees-in-lieu of retention on-site. Buying and selling stormwater offsets -- "Stormwater Retention Credits" (SRCs) -- through a private market or paying fees-in-lieu to DDOE would give developers the flexibility to meet stormwater retention standards by not forcing all retention to be accomplished on-site[39].

3. How large must the offset be, relative to the alternative of a direct nutrient load reduction at the site?

Even if there were to be no net future growth entering the states in the Bay watershed, there are still high existing pollution levels for which an offset policy could be the most effective approach. An offset system could seek affirmatively to reduce existing pollution levels by requiring "trading ratios" of greater than 1 – perhaps 1.5 or even 2.0 or 3.0. The acquirer of an offset would not only offset the additional pollution they were responsible for, but a multiple of this figure would have to be obtained. Such a higher trading ratio could work as a benefit in two ways. First, it would act as a form of insurance to leave space for any implementation failings in practice of offset policies. Also, requiring offsets to be obtained at a higher ratio than 1:1 would also work to reduce the pollution levels that already exist in the Bay watershed. In that case, the higher ratio could help the states to reach TMDL nutrient targets at an even faster and in a more cost-effective way. If developers must pay for the offsets, it may also be more politically feasible to have the incoming homeowners bear more of the financial responsibility for making pollution reductions from existing development, as a higher trading ratio would accomplish.

Political backlash to higher offset ratios from developers adding growth to the watershed might result, since there is an equity issue to putting the main burden on new nutrient generators to fund reductions created from existing sources. University of Maryland analyst Dan Nees agrees that it's possible some states may require developers to go beyond the 1:1 ratio, but "that's essentially a tax and would bring economic development to a halt, so it's not very likely"[40]. For any higher trading ratios to work, a watershed-wide accreditation process will probably be needed to make trading easier.

Pennsylvania sets the trading ratio for its nutrient credit trading system effectively at 1.1 to 1, since trades require a 10% credit reserve for unforeseen losses to future reductions. However, in the event that these credit reserves must be applied, the ratio would drop down to 1 to 1. EPA is concerned that Pennsylvania not overestimate nutrient load reductions by counting reserves that are designed to safeguard against the unforeseeable.

Current upgrades that have taken place for WWTPs under the Bay Restoration Fund in Maryland have accounted for future growth and development that will use the WWTPs. Therefore, these facilities still have the capacity to be able to handle increased loads. Still, more development does mean that there will still be increased nutrient loads that will flow into the Bay's waters, despite having been handled in the WWTPs with the Best Available Technology (BAT).

Does this mean then that as the WWTPs get closer to capacity that developers should have to acquire more offsets so that more funds may be directed to upgrade other nearby WWTPs? Another issue is if a WWTP has reached its load capacity, and there are no other WWTPs in a specific area that may be able to service future development, should it be required to purchase offsets. Alternatively, perhaps there should then be a moratorium placed on development in the area.

An offset policy for septic systems might need to be created as well. The amount of offsets required might depend on how advanced the septic system is that the developer installs. By installing septic systems that have the BAT, developers might not have to acquire as many offsets as for the less expensive septic systems that are not as effective in nitrogen removal. Through this offset approach, it is possible that developers would be more likely to keep development closer to areas that are serviced by WWTPs, which could work to limit urban sprawl. MDE estimated in the Phase 1 WIP the ways in which future growth would affect the Bay if houses that were developed relied upon WWTPs, versus relying on septic systems, and the differences were large, as was discussed in Chapter 5.

4. Where geographically can an offset be located (does it have to be in the same basin, state, etc.)?

This issue will be discussed in detail in Chapter 8. In Pennsylvania, nutrient credit trades may only occur within the same water basin unless PADEP grants special permission. Currently, trading is only allowed within the Susquehanna and Potomac watersheds. Pennsylvania and Maryland have agreed to allow trades across their borders within the Potomac watershed. In 2010, a trade was approved for the Jefferson County Public Service District in West Virginia to purchase credits from the Red Barn Trading Company in Pennsylvania. With no available certified credits in West Virginia, the district somewhat reluctantly purchased the Pennsylvania credits to meet an impending NPDES requirement.[41]

5. What other specific conditions must be met by the user of an offset?

Each state will have various requirements for defining and accrediting offsets. Acquirers of offsets will have to comply with such requirements on a state by state basis.

Conclusion

The offset systems thus far developed by the Bay states vary significantly in the allowable circumstances for the use of offsets. Virginia has pioneered in the use and exchange of offsets among wastewater treatment plants. Since 2007, the Virginia Nutrient Exchange Program has allowed for trading among WWTPs to help them in meeting their individual WLAs. WWTPs operating above their WLA are allowed to purchase nutrient “credits” (in effect offsets) from other WWTPs that are operating below their WLAs -- and which thus have available credits to sell or exchange.

Pennsylvania has experimented with nutrient credit trading on a limited basis, including provision for point sources to obtain offsets from agricultural non-point sources. Maryland is still in the design stage of its nutrient credit system and of any other mechanisms that allow for the use of offsets. The District of Columbia is now introducing a new offset system within the stormwater sector. Land redevelopers in the District who exceed stormwater flow requirements will be able to purchase offsets from other existing stormwater sources. Given their diverse approaches and experiences, the Bay states might benefit from greater coordination and sharing of information relating to these efforts. EPA might play a useful role in facilitating such a process.

Chapter 7 – Generating and Accounting for Offsets

In concept, an offset can be defined as an action that reduces nutrient loads to the Chesapeake Bay and also meets another critical condition: this action would not have been taken in the absence of the creation and transfer of the offset, frequently involving a direct monetary payment for the offset. It is apparent from this definition that the existence of an acceptable offset will not always be self-evident. It requires judgments about what would have happened to Bay nutrient loads in the absence of the offset. Would, for example, the nutrient reducing action been taken anyway, offset or not. If so, it should not count as an offset for the purposes of Bay nutrient credit trading or meeting any other Bay offset requirements.

Sometimes this will be easy to determine but other times the circumstances may be less clear. In the language of offset policy, the actions that would be taken in the absence of an offset are said to be the "baseline." The offset is then said to be the additional set of nutrient reductions achieved above and beyond the baseline, stimulated by the possibility of transferring the offset for monetary or other gain. Government officials may decide that in some sectors or in other particular circumstances the difficulty of defining an offset reasonably accurately is too great, and hence offsets should not be permitted in those circumstances. There may be other reasons as well why a Bay state might not chose to allow offsets from a particular nutrient sector. There may be a strong public view, for example, that Bay polluters should be required to do everything technically feasible to reduce their nutrient loads to the Bay. If government adopts such strict requirements, there will be no room to create offsets, because nothing further can be done to reduce nutrient loads that would therefore qualify as an offset.

This might be seen as not only a legal concern but a moral issue – that pollution is an offense against society and that polluters should therefore limit pollution – either voluntarily or through government regulation -- to the maximum extent feasible. Minimizing pollution should not be a matter of being compensated monetarily or otherwise privately benefited for taking actions to reduce nutrient loads – by the transfer of an offset or any other means of compensation. In this way of thinking, pollution is not a suitable matter for making benefit and cost calculations. Such views, held by at least some members of the public, would preclude the development of an offset system if they became official government policy.

Where offsets are allowed, it will be necessary to have some formal process by which the offsets are officially measured and accounted for by the government. In the Appendix S of the Chesapeake Bay TMDL, the EPA set out guidelines for dealing with an offset/credit process. The EPA requires states to "validate that proposed activities to create reductions (e.g. BMP installation) are expected to generate the credits …", as well as "verifying that the credit was and continues to be generated, via monitoring, inspection, or reporting." Appendix S also requires establishing an appropriate baseline for credit generation. On the "supply side" of an offset system, the key policy issues to be resolved include the following:

1. What sectors are allowed to provide offsets (agriculture, stormwater, septic systems, wastewater treatment plants, etc.)?

Maryland's Phase 1 WIP advises that Maryland should "work in concert with the nutrient trading policy; take advantage of the ability of market forces to find innovative solutions to the problems involved; and incorporate the essential role of outreach and delivery of assistance to the farm community."[42] Nutrient trading is included in Phase 2 of Maryland's WIP, including nonpoint to nonpoint source trading. Agriculture is expected to be a major source of non point source credits, in many cases (as discussed in Chapter 3 above) it will be the lowest cost source per unit of nutrient reduction. Under Maryland policy, farmers must first meet baseline requirements before generating any nutrient trading credits (or other forms of offset). Farm operations thus will first have to meet the level of nutrient reduction that is called for in the TMDL strategy for their basin, as shown in the relevant WIP for the basin.[43] Thus, any farm BMP measure or practice that is used for an offset cannot be an action that would have been required under existing laws, regulations, statutes, or permits. For example, the restoration of a wetland required as mitigation for a non-tidal wetland impact cannot also be used as an offset. Similarly, a reforestation effort required under the Maryland Forest Conservation Act cannot be used as an offset.

The Maryland Department of Planning (MDP) identifies three categories of non-point credit generating practices potentially going beyond baseline requirements that can be used as offsets in nutrient trading: (1) BMPs with approved load reductions such as no till riparian forest buffers and grass buffers, wetland restoration, tree planting, cover crops, and animal management systems; (2) BMPs requiring technical review such as dairy feeding, precision agriculture, conservation tillage precision grazing, water control structure, stream restoration, cropland conversion, and ammonia emission reduction; and (3) other BMP practices or innovative approaches such as algal turf scrubbers, oyster aquaculture, manure incorporation, and phosphorus-absorbing materials.[44]

Other guidelines for the nutrient trading program include a requirement that credits must be used in the year in which they were generated and cannot be banked for sale or used in future years. Also, the full annual credit produced by the practice will not be certified until the year following the year of installation. In addition to the previously mentioned principle that generators of agricultural non-point source credits must demonstrate that they have met the baseline water quality requirements for nitrogen and phosphorus levels in their watershed (**Key Principle #1**), there are several other key principles that have been officially promulgated by the Maryland Department of Planning in dealing with generation of nutrient offsets involving agriculture:

Key Principle #2: Agricultural generators have to be incompliance with all local, state, federal laws, regulations and programs. The person who purchases the credits cannot cause or contribute to adverse water quality effects locally, downstream, or Bay wide.

Key Principle #3: Agricultural BMPs funded by federal or state cost-shares can not be used to generate credits during their contract life. They can, however, be used to generate credits after the contracted funding lifespan for the BMP actions has expired.

Key Principle #4: Nutrient trading involving agriculture should not accelerate the loss of productive farmland, so credits will not be generated for the purchase and idling of whole or substantial portions of farms.

Key Principle #5: Trades must result in a net decrease in nutrient loads.

Key Principle #6: An agricultural practice can only generate credits once it is installed and verified or placed in operation.[45]

Given the high costs of stormwater nutrient management, it is likely that stormwater sources will most often be in a position of purchasing offsets. There may be some situations; however, where stormwater actions can themselves generate new offsets – as long as the generation of these offsets can be done at a low enough cost that they will be attractive for purchase. Some stormwater offset opportunities might include creation of detention ponds and flood control structures in existing development. Another potential stormwater offset would be to add stormwater drain modifications so as to lower nutrient runoffs.

In considering stormwater policy, any activity or practice that is required under existing statutes, permits, NPDES stormwater requirements or regulations could not be used in Maryland as an offset. For example, a developer is not able to take credit for constructing a BMP in a newly developed area that is already subject to the water quality provisions of the Maryland Stormwater Law. A local government would not be able to collect offset credits for constructing a regional BMP that is primarily intended to control runoff from new or planned development activities. Some other practices that would be unacceptable in Maryland for creating offsets include required mitigation of wetland impacts and required 100-foot buffer plantings.

The Delaware Nutrient Management Relocation Program (DNMRP) encourages eligible farmers, brokers and truckers to transport litter and manure from one location to another in an effort to prevent excess nutrient runoff to the Chesapeake Bay. Such efforts could be supported directly with state funds or by making them eligible for offsets. The manure is carried throughout Delaware or across state boundaries to Maryland, New Jersey, or Virginia. Eighty-percent of relocated manure from Delaware's Chesapeake watershed is sent outside of the Chesapeake Bay watershed or to alternative uses. There are currently three approved alternative uses: the Perdue AgriRecycle facility, mushroom facilities, and manure for steam generation process. There are currently 48,757 tons of manure in Delaware's relocation program but there is room to increase the program, as eligibility for offsets might serve to stimulate.[46]

Delaware will meet stormwater load allocations by requiring the installation of BMPs to minimize runoff.[47] BMPs such as bioretention, buffers, conservation site designs, filter strips, source area disconnection, biofiltration swales and infiltration trenches will be used to intercept stormwater and redirect it to vegetated areas for better absorption. Based on the revisions to DSSR, all new projects will need to reduce stormwater runoff to the "equivalent 0% effective imperviousness" and redevelopment projects would be required to reduce to the equivalence of 50% of existing effective imperviousness.[48] These new standards will act in place of requiring expensive retrofits for all development to address legacy stormwater. According to the Center for Watershed Protection, the median cost to retrofit a development project with bioretention in accordance with Delaware's design criteria would be $93,765 per acre of impervious surface.

Development activity that cannot meet all the requirements on-site will need to compensate for their loads by acquiring offsets off-site. Given the high costs of most stormwater reductions in nutrient flows, however, it is less likely that new stormwater controls will serve as a source of future offsets. Indeed, stormwater control systems may be the principle source of demand for offsets in Delaware, as stormwater districts seek to avoid potentially very high levels of expenditures by obtaining offsets instead.

Ninety-five percent of Delaware's Chesapeake Bay Drainage basin is served by septic systems and there is a potential for thousands more to be developed.[49] Delaware predicts that septic systems will increase fairly steadily because of the current and predicted residential development, where it is not possible for central sewer lines to reach all new development. Based on Delaware's strategies, it is predicted that several thousand septic systems will be eliminated by 2025 and that 70% of system elimination will occur by 2017.[50] A statewide Pump Out and Inspection Program will be effective in 2013 and will cause reductions to increase over time. Regulations are pending to require failing on-site treatment systems with proximity to tidal waters and wetlands to replace old systems with advanced treatment; this regulation will cause further reductions in the future. Septic systems could potentially serve as both the generators of new offsets and as the purchasers of offsets, according to the specific circumstance. Policy in Delaware concerning such matters is still evolving.

Since land use within Delaware's Chesapeake Drainage area is predominantly rural, it is understandable that agriculture is the leading source of nutrients and sediment[51]. Delaware uses tax incentives, regulations, state funding and intergovernmental coordination to create agriculture preservation districts, which prevent agriculture land from being converted into development by designating it for "continued agricultural use."[52] While this may reduce urban sprawl, stormwater runoff and new septic tanks, this still leaves a lot of agricultural land contributing nutrient and sediment loads. This may be another important Delaware source of offsets, once baseline levels of agricultural nutrient runoff have already been met.

In Virginia, the Phase 1 WIP also provided developers with an opportunity to create additional stormwater reductions beyond those required, and to market them to other developers as offsets through the Nutrient Credit Exchange Program. In Pennsylvania, only municipal or industrial permit holders may purchase credits or offsets; however, its policy is that credit generators need not be permit holders, and may be point or non-point sources. Nitrogen, phosphorous, and sediment reductions are all eligible for credit generation, although no trades in sediment have occurred to date. The Pennsylvania nutrient trading system follows many of the program guidelines enumerated in the EPA Final Bay TMDL Appendix S, for example, potential credit generators must first meet baseline requirements.[53]

2. How are baselines calculated as part of the level of offset determination?

Establishing tradable offsets from agriculture raises the issue of farm baselines and how they should be calculated in determining the number of offsets that will be accredited. Virginia's 47 Soil and Conservation districts are in charge of collecting, verifying data entry for agricultural BMPs which then get inputted into the Agriculture Cost Share Program Tracking Database. BMPs that are state-funded are subject to field spot checks during their lifetimes, and the Department of Conservation and Recreation (DCR) monitors the implementation of installed BMPs by randomly selecting five percent of installed practices within a year. As with other states, VA is likely underreporting non-cost-shared agricultural BMPs given there is no easy method for tracking them. For agricultural sources to generate nonpoint source credits they are first required to establish a certain level of best management practices as required by existing Virginia legislation. The farms that have met the required BMP enhancements are said to have met the "baseline." They are allowed to use cost share dollars from federal and state programs to implement the BMPs required to achieve the baseline requirements. At present farmers in Virginia must implement the following BMP actions in order to meet their baseline requirements:

- Soil conservation plan, which is to be developed to the USDA specifications to achieve a soil loss tolerance value of T (which indicates the maximum amount of soil loss in tons per acre hat can be tolerated while allowing for a high level of sustained crop productivity) or less for all cropland, hay, or pasture.
- Nutrient management plans, which have to be written by a certified nutrient management planner that meets a set of standards set forth by the Department of Conservation and Recreation (DCR) for all cropland, hay or pasture.

- Cover cropping, which requires planting cereal cover crops in all land where summer crops are grown (such as vegetable crops or corn for grain) if the crop received more than 50 pounds of nitrogen application.
- Riparian buffer installation, which requires maintaining a minimum width vegetative buffer of at least 35 feet.
- Livestock stream exclusion, which requires establishing exclusionary fencing that restricts livestock from reaching streams, rivers, ponds, or lakes, with a riparian buffer, having a minimum width of 35 feet.

Once a farm has achieved its baseline, it will be allowed to generate and sell nutrient trading credits and other types of offsets. However, farmers are not allowed to generate offsets from activities for which they have received state or federal cost-share payments. Offsets can be generated in Virginia by installing further BMP enhancements beyond the baseline, among which are included:

- Early Planted Cover Crops, which requires establishing vegetative cover on cropland with the goal of protecting it from erosion and reducing nutrient losses to groundwater by planting cover crops. The activity is to be done in the early fall within optimum planting times in order to maximize nutrient trapping capability. The nutrient reductions achieved by early planted cover crops are attributed to the calendar year before spring planting.
- 15 percent nitrogen reduction on corn, which requires applying nitrogen at 85% of less of the recommended rate in a nutrient management plan to reduce the loss of nutrients to levels under those determined in the plan (including legume credits, fertilizer applications, mineralization of past applications of manure, etc.). Those pursuing this enhancement are also encouraged to maximize application efficiency and the use of nitrogen.
- Continuous no-till, implementing a no-till system and nutrient management technologies which result in reduced pollution to state waters from nutrients and sediments. This BMP enhancement must be implemented on January 1 of the calendar year and has to be maintained for a period of at least 5 years only in double crop cash grain or cotton rotations.
- Even though the list of BMP enhancements seems to be presently limited, DEQ and DCR predict that as more reductions from other sources are adequately quantified (given that DEQ can evaluate proposals on a case-by-case basis) they could be added to the list of eligible practices.

While these BMP enhancements beyond the baseline will mostly generate offsets on a yearly basis, farmers are also allowed to implement land conversion practices, which have the potential to generate permanent offsets. Land conversion is allowed to create an offset only if it occurred after July 2005. In addition, the land conversion must convert land to a use with a lesser nutrient load for a large or small portion of land. For example, a tract of land that was previously fallow and then converted to forest could generate a certain number of permanent offsets.

Given that achieving nutrient reductions from nonpoint sources involves more uncertainty than from point sources, generating offsets from agricultural nonpoint sources in Virginia requires a 2:1 nutrient reduction ratio. As a result, two pounds of nutrient reductions generated through either agricultural BMP enhancements or land conversion will only create a one pound offset for a point source. Finally, any actual transfer of offsets will only be recognized after the seller has generated the offsets for the relevant calendar year. The offsets must be certified by February 1st of the calendar year by DEQ.

Under existing Maryland policy, as noted above, any generation of offset credits will require bringing nutrient loads below the current baseline numbers. The baseline is determined by existing state regulatory requirements for farmer adoption of "best management practices" (BMPs), and the related requirements included in the Phase 2 WIPs for the agricultural sector. There is no assurance, however, that most farmers will achieve their baselines at any time soon. EPA authority to regulate non-point sources of pollution such as agriculture is uncertain. State governments have been reluctant to enforce BMP requirements aggressively where farmers have resisted. If they have not met their baseline as defined in current Maryland policy, many farmers may therefore be precluded from participating in the nutrient trading program. The total supply of offsets from Maryland agriculture might prove to be limited under existing policies.

There might be a case therefore for a less restrictive approach to establishing farmer baseline requirements. Given that full farmer compliance with state BMP requirements may be more of a theoretical ideal than a practical reality in the near future, it may be desirable to encourage farmers to take nutrient reducing actions even when they have not yet fully met all state BMP regulatory requirements. The inducements from being able to create saleable offsets are potentially an important means of encouraging farmers to become more aggressive in making nutrient reductions beyond the status quo. If farmers otherwise would not make these nutrient reductions, such a policy could lead in practice to an overall long run decrease in total nutrient loads to the Bay. While it raises equity concerns, it may therefore be worth considering the establishment of a new Maryland baseline policy in which offsets can be generated without full compliance with BMP requirements. In the most aggressive nutrient reduction strategy, the current farm status quo could be treated as the effective baseline for generating new offsets.

Such a policy may not be necessary, however, in many cases. According to former University of Maryland conservation biology student Nicole Angeli -- who worked with many of the local soil conservation offices in Maryland -- there are already many farms that are below the nitrogen baseline. This means that these farmers, if participating in an offset policy, would be able to make money by generating offsets right away without making further changes or instituting any new BMP actions. Essentially, in such cases farmers would be paid for creating new offsets without first having to make any additional changes to their current manner of operating the farm.

In addressing the equity issues raised by baselines issues and farming offsets, another consideration is the free rider problem that potentially could arise if a specific basin is meeting its TMDL yet there still are farmers that are not fully compliant with state BMP requirements. What would be the justification for further regulation of farms in basins already in full TMDL water quality compliance? Would those specific farmers who are not meeting the TMDL requirements in such basins be able to ride the coattails of other farmers who have already taken actions towards meeting the TMDL, or should there be effective ways to regulate them as well? Who would ensure that full enforcement of BMP requirements would occur among all farmers, once the TMDL targets for a river basin have been achieved?

As stated above, farmers would not be able to generate offsets from actions taken with the support of federal Farm Bill or other grants. This still leaves, however, the issue of how to approach federal money that may be eliminated due to budget cuts. Should farmers in a river basin then become eligible to create offsets so that they are able to maintain the nutrient loads achieved when federal funds were more easily available? Otherwise, in the absence of federal support, farmers might abandon practices that have resulted in significant nutrient load reductions.

A nutrient credit generator in Pennsylvania, like those above, must first meet their baseline, "the legal requirements that apply to that person" according to the PA Nutrient Trading Program. The Pennsylvania Code defines baseline as:

> (i) The compliance activities and performance standards that must be implemented to meet current environmental laws and regulations related to the pollutant for which credits or offsets are generated.
>
> (ii) The term includes allocations established under this chapter, in a TMDL or in a similar allocation, for the pollutant.[54]

This differs from the Maryland baseline, which requires credit generators to be below their TMDL allocation. Pennsylvania's baseline, like Virginia's, embraces a "good actor" philosophy that rewards generators for enacting certain basic practices. One Pennsylvania law known as Chapter 102 requires farmers and other "persons proposing or conducting earth disturbance activities" to employ an erosion and sediment control plan. Two other laws require animal operations to employ manure management plans for storage and application. Additionally, eligible animal operations must obtain CAFO NPDES permits.[55]

In addition to meeting the baseline (complying with the above laws), Pennsylvania law requires farmers to meet at least one "threshold" to be eligible for credit generation:

> (A) Manure is not mechanically applied within 100 feet of a perennial or intermittent stream with a defined bed or bank, a lake or a pond. This threshold can be met through one of the following:
>
> (I) There is not a perennial or intermittent stream with a defined bed or bank, a lake or a pond on or within 100 feet of the agricultural operation.
>
> (II) The agricultural operation does not mechanically apply manure, and applies commercial fertilizer at or below agronomic rates contained in the current Penn State University Agronomy Guide published by Pennsylvania State University.
>
> (B) A minimum of 35 feet of permanent vegetation is established and maintained between the field and any perennial or intermittent stream with a defined bed or bank, a lake or a pond. The area may be grazed or cropped under a specific management plan provided that permanent vegetation is maintained at all times and there is no mechanical application of manure within the buffer area.
>
> (C) The applicant applies an adjustment of at least 20% to the overall amount of the pollutant reduction generated by the pollutant reduction activity the person is submitting for certification.[56]

A common complaint in Pennsylvania, as elsewhere, is that best management practices are underreported. The state's WIP Un-reported/Under-reported BMP Initiative seeks to remedy this problem through outreach, site visits, surveys, and other innovative approaches. This is in keeping with the first key element of the state's WIP: Milestone Implementation and Tracking (the others being Advanced Technologies and Nutrient Trading, and Enhancing Compliance Efforts).

3. How will the existence of acceptable offsets be established administratively and then monitored by state and local governments?

The Maryland Department of Environment (MDE) collects monthly WWTP discharges, and it also tracks the installation of septic upgrades for N removal through the local health department's reports. For stormwater, local government agencies submit BMPs which are then compiled in Maryland's urban BMP database. The stormwater retrofits and urban water quality improvement projects are reported in BayStat. MDE also requires regular inspection of stormwater BMPs, at least once every three years.

The Maryland Department of Agriculture (MDA) is in charge of tracking agricultural BMPs, which are also reported to BayStat. MDA conducts field checks for 10% of all implemented BMPs, though the current staff size has only been enough to sustain a 7-8% annual rate. For cover crop programs, Soil Conservation Districts inspect all the participants in the fall, and then 10% are randomly checked in the spring. Ten percent of manure transport programs are also checked. The MDA also seeks to complete around 400 inspections of randomly selected fields every year, which focuses on reviewing the field's nutrient management plans, as well as up to 100 site inspections for CAFO operations. In general, for agricultural BMPs without state funding, the Soil and Conservation District staff has recently been allowed to track these BMPs and report them to the Conservation Tracker database. Finally, the state of Maryland, mainly through MDE, has undertaken careful measures to protect against double-counting of credits, by, for example, specifically analyzing, editing and verifying data before inputting it into the databases.

Currently in Maryland, there are staff members in each county soil conservation district office who are tasked with using the Nutrient Net computer system which is able to determine, using different farming BMPs, how many nutrient trading credits could be generated by a farm for sale through the nutrient trading program. It is possible that a similar program should be used in analyzing other forms of offsets besides agriculture. While overall policies would be developed at the state level, there might be a local office in each county with a staff member that could assess all forms of potential offset generation, using a computerized system that would be similar to Nutrient Net?

A local jurisdiction would need to have clear and concise criteria specifying how its offset program works and which agencies take the lead responsibilities. The jurisdiction would need to specify how offsets located on properties owned by the local government or a private individual would be maintained. For example, if a local government allows a riparian buffer as an offset, this would preclude the trees being removed at a later date to accommodate a land development project.

Another issue that would be critical to discuss is how to establish public financing mechanisms for public sector offset programs. The collection of offset fees may allow a developer to pay a local jurisdiction to finance public sector implementation of an offset program. Yet another issue to discuss in designing an offset policy is the tracking system. This would be needed in all local offset programs, for determining with reasonable accuracy that the offsets claimed are in fact being realized. Local jurisdictions should keep a detailed and accurate record of the pollutant loadings associated with specific projects, of the fees collected, and of the fees expended on the measures.

One question is whether, in designing a strategy and a policy for offsets, there should be a consistent set of rules that the entire Bay watershed should adhere to? If this were to be the case, would it then be best for the EPA to design an overarching offset implementation strategy? Or, because each state works differently, should each state have its own basic offset policies? Going even further, would the best approach be for officials within each water basin or in each county to develop their own offset implementation policy that they would then have to submit to the state for approval.

Virginia offers an example of how the generation of nutrient offsets might be overseen. In Virginia, the Nutrient Credit Exchange coordinates and facilitates participation in the nutrient exchange program by the dischargers and the credit/offset providers. The Exchange is required to develop a standard form of agreement for certifying nitrogen and phosphorous credits, helping establish the market for buyers and sellers, and coordinating planning to help ensure that sufficient credits became available each year. In 2008, the Nutrient Credit Exchange helped facilitate Virginia's first non-point source nutrient bank: the Chesapeake Bay Nutrient Land Trust, LLC. After the Watershed General Permit (WGP) – providing the WLAs to the wastewater treatment plant dischargers – was established in 2007, 2011 was the first year for compliance under the WGP.

The Exchange Association is required to compile, on a yearly basis, the "Exchange Compliance Plan", which is then submitted to the Virginia Department of Environmental Quality (DEQ). The Compliance Plan focuses on identifying which facilities plan to introduce nutrient removal technology upgrades in order to comply with the phosphorous and nitrogen WLAs. Furthermore, the Plan also serves as a "comprehensive document" for planning and implementing nutrient credit trading in each basin, which is regulated through the Exchange.

The trading of credits takes place through the Exchange, which is in charge of clearing the market by purchasing all nutrient trading Credits generated by participants as provided. Therefore, the class A seller price is different than the Class A purchase price since there is a difference between the volume of credits supplied and purchased. Given that the volume of Class A credits supplied is currently larger than those purchased; the price of the former is lower. On the other hand, given that Class B credits just reflect a surplus to provide flexibility to facilities for the June 1st deadline, they are sold at a much lower price; for example, in the Upper James Basin recently at $0.14/credit.

Although most credits are exchanged formally through the Exchange, WWTP facilities in Virginia also allowed to undertake bilateral private trades. However, only a few facilities have conducted these trades so far -- among them, facilities in the following areas: Spotsylvania County and Town of Washington (Rappahannock/Phosphorus); RockTenn and White Birch-Bear Island (York/Phosphorus); Honeywell-Hopewell and Hopewell RWTF (James/Nitrogen); Chesterfield County and Dominion-Chesterfield (James/Phosphorus).

For point sources, the District of Columbia collects monthly wastewater discharge reports, which are generated from the DC Water and Sewer Authority. In terms of nonpoint sources, the main focus is on stormwater discharges for which the District Department of the Environment (DDOE) tracks and inspects construction sites larger than 5,000 square feet and compiles the data in a DDOE database. The Watershed Protection Division, Inspection and Enforcement Branch is in charge of conducting compliance inspections (two times a year) during and post-construction to ensure the completion and maintenance of the stormwater management facilities. Finally, voluntary practices are installed through DDOE's River Smart program, which meets DDOE specifications.

The District also uses the Plan Review Database which streamlines stormwater control measures, with the goal in mind of protecting against double-counting as well as ensuring that supposedly new practices did not exist previously. A report by the National Academy of Sciences (NAS) suggests that underreporting might not be as large a concern in the District as in other states and that it has done a good job in streamlining the tracking process by having just one agency (DDOE) handle the process. On the other hand, the BMP data is, at this point, based on the approved stormwater plans, but not on what is actually installed.

To be eligible for trading in Pennsylvania, credits must be certified, verified, and registered. Certification typically occurs before a reduction activity is conducted. The potential credit generator submits an application to the Pennsylvania Department of Environmental Protection (PADEP) for that activity to be certified. PADEP will then publish the request in the Pennsylvania Bulletin for a 30 day public comment period, during which time the request is reviewed for "technical acceptability and consistency with program requirements." PADEP certification determines the amount of credits an activity may generate. Once an activity is certified, PADEP publishes a notice in the Pennsylvania Bulletin for a 30 day appeal period.

Verification can take many forms, but must demonstrate compliance with baseline and other requirements. PADEP may conduct monitoring, site inspections, and compliance audits, but typically is not the primary verifier. The following entities have verified credits in compliance year 2011: Berwick Area Joint Sewer Authority, Chesapeake Nutrient Management, Cumberland County Conservation District- Ickes Operation, Dauphin County Conservation District- Lapp Operation, ElectroCell, Elizabethtown Borough Authority, Lancaster Area Sewer Authority, Lycoming County Conservation District, Northeastern York County Sewer Authority, Northwestern Lancaster County Authority, Red Barn Trading Company, and Wyoming Valley Sanitary Authority.

Once a credit is certified, verified, and set for purchase in a valid contract, PADEP registers the credit in the *Pennsylvania Bulletin*. Registration allows PADEP to track verified credits for use in NPDES permits.

PADEP is in charge of tracking monthly WWTP discharges from point sources. It does track stormwater BMPs, but there is no existing database for analyzing the BMP data. PADEP collects information from various programs focused on agricultural BMPs, such as the "Growing Greener Grant Program" or the "Abandoned Mined Land Reclamation Program", but the state is not involved in the verification and quality assurance of agricultural BMPs.

Pennsylvania has not yet developed a strategy for protecting against double-counting, but it does track practices by funding sources, which, according to the NAS report, should help reduce double counting. The NAS report also finds that agricultural BMP practices are likely to be underreported in Pennsylvania given the lack of a streamlined tracking system.

The New York State Department of Environmental Conservation is in charge of collecting monthly WWTP discharges, while the Upper Susquehanna Coalition focuses on nonpoint source implementation (largely focused on agriculture and wetlands). The state has not provided much further information on their tracking and accounting practices; however the NAS report notes that urban and septic practices are usually not reported due to severe staff shortages.

The West Virginia Department of Environmental Protection (DEP) tracks point source facilities that discharge more than 0.4 MGD. The WVDEP is also in charge of collecting information for septic and stormwater discharges (though the state does not have a system to verify whether post-construction stormwater BMPs were in fact put in place) and for tracking nutrient management plan. West Virginia has not yet established verification protocols for CAFOs, or non-cost-share agricultural BMPs, however.

Further Baywide Tracking and Accounting Issues

While the Bay jurisdictions have made progress in improving their monitoring systems, there is still potential for improvement. Admittedly, a number of the existing issues are driven by Federal policy and thus cannot be addressed at the state level. For example, a large portion of the information on point/nonpoint source nutrient reduction activities is held by the USDA, but the 2008 Farm Bill included privacy requirements (in Section 1619) which make it challenging to accurately track agricultural BMPs. Nevertheless, as the NAS report notes, a recent project between the FSA, the NRCS and the US Geological Survey has allowed states to better track the BMP location in the Watershed Model before submitting the data to the CBP.

Dealing with non-cost-shared BMPs has been a larger problem, however. While a number of the agricultural (and other) BMPs have been achieved as part of a cost-share (Federal or state) program, many BMPs are voluntarily implemented because of their private economic benefits to the farmers. However, while the projects being currently funded under cost-share programs must be reported to the CBP, the voluntary BMPs are not similarly required, which leads to the underreporting of these practices. For example, Pennsylvania recently conducted a study in Bradford County which showed that up to 88 percent of the nutrient-control practices that were in place were not reported to the CBP because they were not funded through a cost-share program. While Maryland launched the Conservation Tracker database in 2009 to track both types of BMPs, by 2010 it was only being used to track cost-shared ones. The NAS report argues that if the current programs are unable to account for non-cost-shared BMPs, the states will have to rely on the existing information on cost-shared practices. Nevertheless, the report also states the when the EPA stated its expectations for non-cost-shared BMP data, it required states to include provisions for reducing double-counting, for updating datasets, and for allowing for field verification, which implies that states will have to improve upon their existing strategies for reporting on non-cost-shared BMP practices.

The extent of field verification of urban and agricultural BMPs varies across the states. Field verification is necessary in order to certify that the BMPs are in fact being carried out, thereby leading to the expected nutrient and sediment reductions across the Chesapeake Bay. However, the actual process of verifying BMPs in the field requires a large staff as well as the necessary budget to cover for the travel costs. As a result, it is unlikely that any state will be able to implement field verification for every landowner, focusing instead on reaching a pre-determined percentage of field verifications. Currently, a few of the states seek to verify eight to ten percent of agricultural BMPs per year, which the NAS report argues would be a reasonable goal for all the states. Furthermore, the report also suggests considering the possibility of developing surveys that could be mailed to those producing the BMPs to confirm if they are maintaining those practices as long as the surveys are coupled with random visits to the BMP locations. Finally, further improving the geo-referencing systems could lead to a cheap alternative for verifying certain practices.

A further issue is that the guidelines for BMPs are currently not updated over time. For example, Virginia currently states the practices which are eligible as a best management practice, but this document has not changed in the past four years. However, the performance of the BMPs may not equal what was expected with the passage of time. For example, the NAS report states that technology-based BMPs could lose effectiveness over time due to clogging or general wear and tear. Given that the existing strategies have not allowed for updating BMPs that may be out of date, the current model could be overestimating the sediment and nutrient reductions.

Currently, the Bay jurisdictions compile the BMP verification information on an annual basis and then report it to the Chesapeake Bay Program (CBP). Given that the CBP is in charge of inputting the data and running the models, there is a delay of nine months between the data reporting and the progress assessments created by the CBP. However, in January 2011, the Partnership launched the BAY TMDL Tracking and Accounting System (BayTAS) to track each jurisdiction's progress towards meeting the TMDL, which should help in streamlining the reporting of BMP implementation data. Nevertheless, as long as the verification and monitoring strategies vary so widely across states, it will be difficult to streamline the implementation process and there could be a point where a jurisdiction is be severely overestimating its progress towards the TMDL when compared to other states. Given this particular situation, it is imperative to offer a new set of guidelines to deal with the issues with the current monitoring framework in the Bay.

Possible Ways of Streamlining the Tracking and Accounting Process

As discussed in earlier chapters, implementing the TMDL will likely be a costly affair for the Bay jurisdictions. Although establishing a comprehensive verification process remains a priority for the states, some would argue that any plan should be established with the goal of lowering transaction costs. However, even if states were to create lax verification rules that would, in theory, reduce transaction costs, these rules could lead to a reduction in the number of offset purchasers who would be wary of acquiring offsets (since under the current framework they could get fined for not achieving their required reductions). As a result, it might be best to establish a Bay-wide, comprehensive verification system, that while it might increase offset verification costs, could lead to an expansion in the number of participants in the offset system and thus lead to an overall reduction in the cost of meeting the TMDL.

The NAS report suggests that each state should have a verification program that has "a clear organizational framework for BMP reporting, geo-located data for accurate conversion of the data into the Watershed Model, a rigorous quality control process with field verification, a process for removing BMPs that are expired/non-functioning, processes to prevent double counting, and few underreported practices." These guidelines would go a long way towards addressing the problems noted above. Yet, it is clear that states at present are not close to meeting them. Nevertheless, even if states were to create programs that met these recommendations, tracking voluntary BMPs could remain an issue across the Bay, especially if these were under-reported at different rates in each state.

Therefore, the idea of establishing a Bay-wide verification program for agricultural BMPs should be strongly considered by the Bay states. The regional BMP program could be managed by an independent organization (as the EPA), which would coordinate with each states' Department of Agriculture to create a framework for tracking and ensuring that proper reporting of voluntary agricultural BMPs would be in place. As was suggested above, this could be achieved by a combination of improved geo-referencing practices and random field inspections of participants. In 1999, Florida implemented a similar system in its Watershed Restoration Act to meet the TMDL provisions of the Clean Water Act. The WRA required an agriculture agency in Florida to develop guidelines for landowners to enroll in BMP programs. The most interesting feature of the WRA was that while the verification process was based off grower surveys and site visits to a pre-set percentage of respondents, the respondents would be visited in a higher frequency in high-priority watersheds. This experience could be applied in the Chesapeake Bay if the states were to come together and agree upon establishing a combination of surveys plus field visits, particularly focused in the most important watersheds.

The current verification process for Maryland is largely based on self-reporting. That is, the state trains and certifies farmers to write down their nutrient management plans, and then the state inspects about 10% of the farmers to ensure compliance with the plans. On the other hand, the verification could be done by third party verifiers, which are not directly involved in the sale of the credit (thereby ruling out third party aggregators that sell credits). While the third-party verifiers would most likely be pre-assigned federal, state, or local agencies, some private companies could participate in this process. For example, the USDA Environmental Markets Office report on Verification of Environmental Credits suggests that organizations such as certified crop advisors, land trusts, watershed groups, or even engineers could take on such a role. These organizations would still have to demonstrate adequate technical knowledge, show an understanding of the market rules, and have the operational capacity to undertake regular verification activities.

Under an alternative framework, while a government agency could be in charge of the verification process, the program could provide incentives to private organizations by paying them to verify credits across the Bay. The payment money could be raised through the fees of the market program, which could be lower than under a single third-party verifier system to encourage competition among the private organizations. Regardless of which organization gets placed in charge of the verification process, it is important to establish that not all BMP practices require the same verification frequency. Given that land conversion practices are put in place permanently, they require less frequent monitoring; therefore, aerial photography could be enough to verify the practice being in place. Restoration practices focused on enhancing forests or wetlands could be dealt with in a similar manner, though they could be subject to visits every few years. On the other hand, annual practices such as cover cropping, tillage reduction, manure transport programs would require annual or bi-annual verification. Finally, planning practices to meet baseline would have to be continuously monitored before being given the green light to generate credits.

4. What will happen if the provider of an offset fails to fulfill the offset conditions?

Most credit purchasers have expressed their concern with the fact that they are liable, and thus subject to potential large fines, if the credit seller fails to come through and deliver the actual offset. This situation is due to the fact that the Appendix S document states that NPDES permit holders are to be accountable for meeting their nutrient WLAs. This situation makes establishing a comprehensive set of verification guidelines more important given that potential buyers could withdraw from the market if they could be subject to large fines. As a result, for example, Maryland's program prohibits the transfer of liability to the seller. Pennsylvania, on the other hand, takes a different approach by allowing the DEP to take on the liability by ensuring that water quality credits are actually being undertaken by the seller. A sensible solution to the liability problem would be for the verifying agencies to take over the liability from the buyers, thereby making it more enticing for permit holders to purchase offsets to meet their allocations, and introducing a credit retirement policy (as the majority of the states have already done) to account for any offsets that sellers do not deliver on.

In order to address these challenges, the Chesapeake Bay Partnership has recently established a team that, throughout 2012, will be focused on responding to the suggestions put forth by the NAS report and developing new verification principles. A document issued in January stated that any practices tracked by the CBP must be “properly designed, installed, and maintained to ensure they are achieving the expected nutrient and sediment reductions, consistent with the model, not previously reported (ensure no double counting, and not expired or removed from the landscape.” As can be seen by this quote, their guidelines largely follow the ones suggested by the NAS report, which shows that the focus should be placed on working with the different state agencies on actually implementing these guidelines, given that the basic principles seem to have already been agreed upon.

By requiring only highly visible conservation practices for certification (waste storage facilities, fences to keep animals out of water sources, contour plowing, etc.), states could use new GIS and satellite imagery to monitor conservation practice implementation. This allows for the initial monitoring to ensure that practices are implemented and also regular monitoring to ensure that practices are continually used. If there is a discrepancy or an observation of non-compliance, a more rigorous inspection can take place by staff on the ground.

Only using satellite-visible conservation practices could be problematic if these are not as cost effective as other, less visible conservation practices such as planting cover crops, conservation tillage, and manure transport. An evaluation of visibility of each type of practice in relation to its cost-effectiveness should be conducted to further determine the best array of practices.

Pennsylvania’s credit reserve affords some protection for permittees. This reserve is maintained by a 10% reserve ratio applied to all credits generated. Permittees relying on credits for NPDES compliance will be held responsible unless:

> (i) The failure is not due to negligence or willfulness on the part of the permittee.
>
> (ii) The Department determines that replacement credits will be available.
>
> (iii) The Department determines that the requirements for restoration, protection and maintenance of the water quality of the Chesapeake Bay will be met due to the requirements of this section, which may include the type of methodologies used when certifying credits, the existence of an approved legal mechanism that is enforceable by the Department, and the use of a credit reserve.

Offset providers, on the other hand, are held responsible for contractual obligations:

> (3) *Failure to implement.* The Department will not register credits if the person who generates the credits has not implemented, or demonstrates a lack of ability or intention to implement, operations and maintenance requirements contained in the certification, verification plan, or other requirements of this section. The Department will not register credits submitted by an aggregator that is currently not complying, or demonstrates a lack of ability or intention to comply, with this section.

5. Can intermediate parties serve as offset banks or other forms of aggregators of offsets?

The prospect of nutrient trading has been well received by many in Maryland as it is considered a "win-win" program by farmers due to the fact that it is a new revenue source, it is a cost-effective alternative for potentially expensive environmental regulations elsewhere, and it can help to enhance the Bay's water quality. It is in many ways an economic approach towards working towards improving the environment. Credits in this program either can be sold directly to a buyer or they may be sold to a third party, a broker or aggregator who works with a number of farms and allows the farms to work in a way that makes the most sense for their programs in order to ensure a profit.

Pennsylvania embraces third parties as aggregators, and even as credit verifiers. Many credits traded at auction are officially sold by aggregators such as Red Barn Trading Company, rather than by individual farmers.

Conclusion

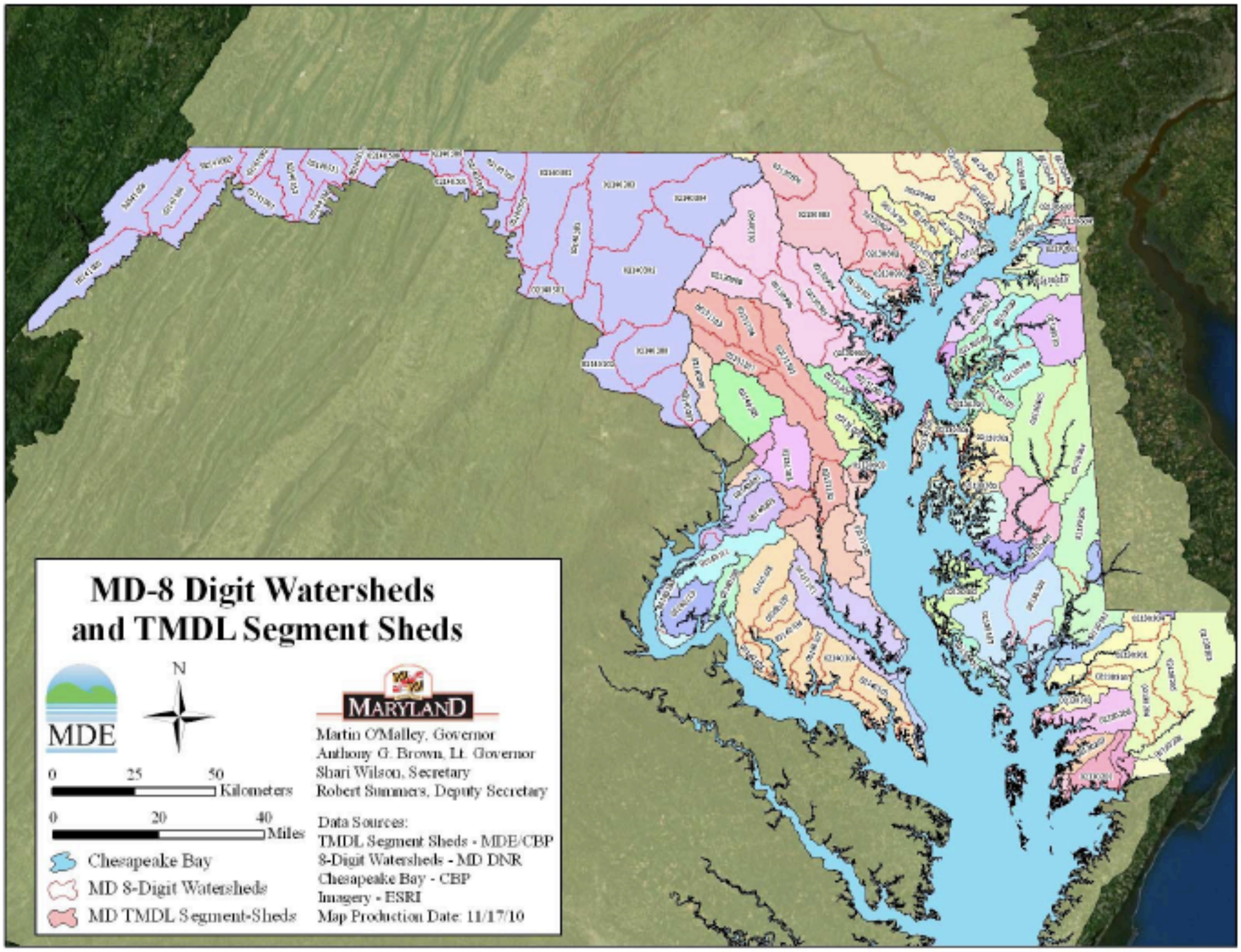
Clearly, in generating an offset policy, there are many issues to address as well as many different alternatives that have to be taken into consideration at various levels. While it may be frustrating that an overall offset policy has not been created and put into motion across the full Bay watershed, and that such slow progress that has been made on an issue that has been in existence for a while, it is understandable that issues dealing with offset requirements in many cases have gone unresolved. Different policies will have to be put into place for developers, future homeowners, farmers and more. In addition, the number of government agencies and policymakers at different levels make implementing and enforcing an offset policy difficult as well. Despite the many issues and questions that are raised in consideration of offsets, there is overall strong support to implement an offset policy as a means for accounting for future pollution and growth into the Bay states.

Chapter 8 – The Geography of Bay Nutrient Offsets

As discussed in Chapter 6 with respect to the "demand" side of an offset system, it is necessary to have a method of determining the circumstances and the number of offsets that will be allowable for a land developer or other contributor of increased nutrient flows to the Chesapeake Bay. In some cases, as noted there, it may be appropriate not only to permit the use of offsets but to require their use. Assuming that such "demand" elements of offset policy have been determined, it is important to turn to the "supply" side. This breaks down into two critical considerations. First, assuming offsets are allowed, how large will be the required reductions in nutrient loads somewhere else in order to generate an acceptable offset. This is partly a matter of the trading ratio, a subject discussed above in Chapter 7.

This chapter addresses a second policy concern. Given the specific location of a nutrient polluting party that wishes to obtain an offset, where geographically in the Chesapeake Bay watershed will this party be allowed to obtain its desired offsets. For Maryland, for example, the main possibilities are that the offset must be obtained: (1) anywhere within the same MD-8 digit watershed in Maryland; (2) anywhere within the same TMDL segment shed; (3) anywhere within the boundaries of the same local governing jurisdiction, (4) anywhere within the same river basin and within Maryland, (5) anywhere within the Chesapeake Bay watershed and also in Maryland, (6) anywhere within the same river basin within the Bay watershed (including the possibility of cross state offsets within the same basin), and (7) finally, and most encompassing of all, anywhere within the entire Chesapeake Bay watershed. Figure 8.1 shows the boundaries of the MD-8 digit watersheds and of the larger TMDL segment sheds. Previous chapters showed maps of the Maryland river basins (Chapter 1) and of the Maryland counties (Chapter 3).

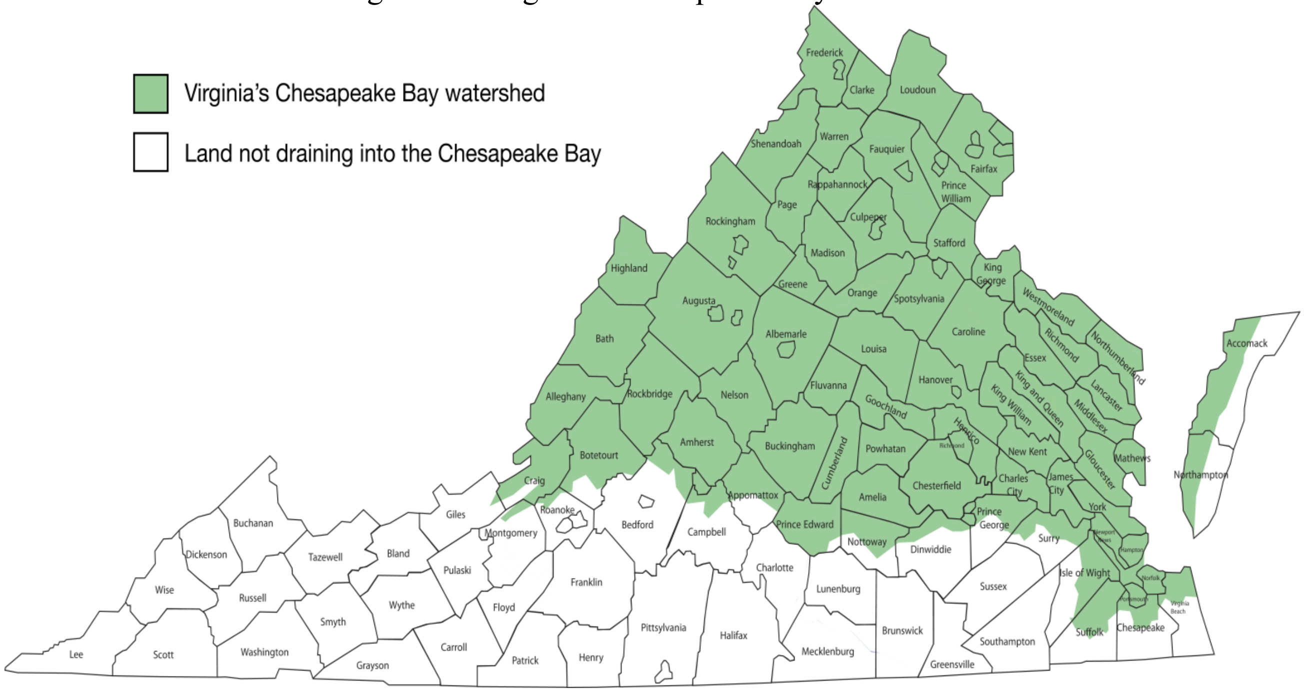
Figure 8.1 Maryland Watersheds and TMDL Segment Sheds



Source: Maryland Department of the Environment

Figure 8.2 shows the relevant local jurisdictions in Virginia that fall within the boundaries of the Chesapeake Bay watershed.

Figure 8.2 Virginia's Chesapeake Bay Watershed



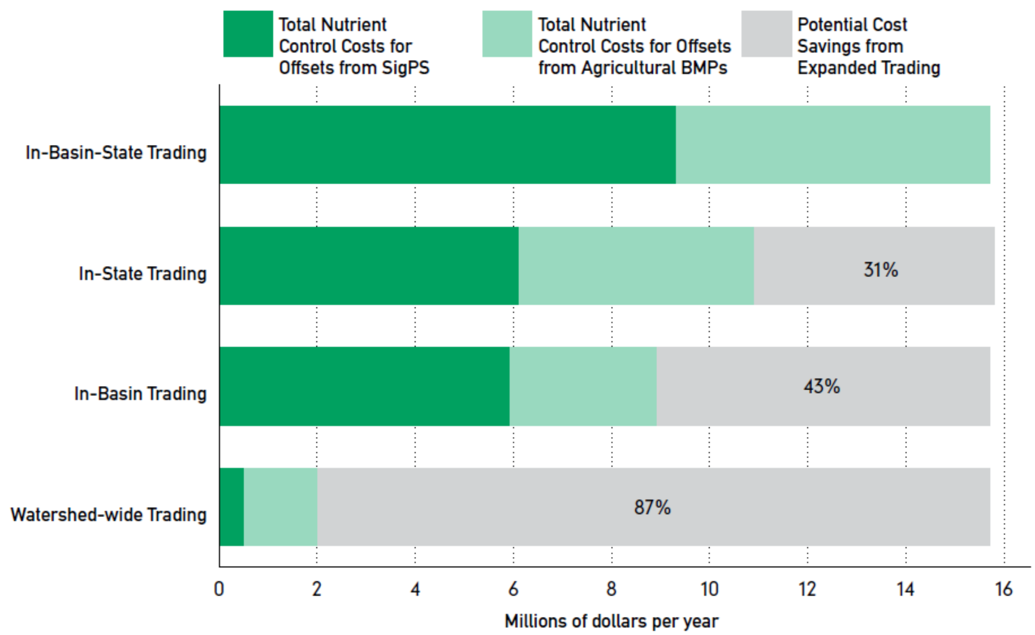
Source: Virginia Department of Conservation and Recreation

Broadly speaking, the wider the geographic area in which offsets can be obtained, the more options will be available in search for an offset that can be generated at the lowest possible cost. As a result, the wider the geographic area, the more cost effective will be the Bay cleanup as a whole. This will mean that either more cleanups can be obtained for less money, or that less money would have to be spent for a given degree of Bay cleanup. Hence, if the quality of the Bay's waters were the only concern, a party needing offsets would be permitted to obtain them anywhere in the Bay watershed, including in other states. A Maryland polluter, for example, might well obtain offsets in Pennsylvania because they could be less expensive to generate there and also reductions in nutrient loads in the Susquehanna River might well have more impact on overall Bay water quality than say the same level of reduction in nutrient loads to the Potomac River.

This cost saving potential is illustrated in a recent study of the economics of Bay cleanup by the Chesapeake Bay Commission (CBC). It was assumed that offsets were required as a result of particular assumed increases in nutrient flows from wastewater treatment plants (WWTPs). The analysis considered four alternatives – (1) allowable offsets had to be generated in the same river basin as the WWTP (and also in the same state); (2) allowable offsets had to be generated in the same state as the WWTP (but any river basin), (3) allowable offsets had to be generated in the same river basin as the WWTP (but could be in another state), and (4) offsets could be generated anywhere in the Chesapeake Bay watershed.

As shown in Figure 8.3, expanding the scope of the allowable offset area has a large impact on the potential Baywide cost savings achievable. As compared with offsets limited to the same river basin and state as the WWTP, expanding the eligible area for offsets to the whole state generated a 31 percent cost savings. Some basins such as the Potomac encompass multiple states. Allowing eligible offsets anywhere in the same river basin increased the cost savings to 43 percent. Most impressive of all, allowing offsets to be obtained anywhere in the Chesapeake Bay watershed generated potential costs savings for the Bay cleanup of 87 percent.

Figure 8.3 Costs of Nutrient Controls to Offset Loads from New SigPS Capacity



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

Hence, if the Bay cleanup were the only objective, there would be a strong case for allowing offsets to be generated anywhere in the Chesapeake Bay watershed. There are other considerations, however, that argue for limiting the geographic areas in which offsets can be obtained. One is known as the problem of "hot spots" in the cap and trade programs for sulfur dioxide and for nitrogen oxide under the Clean Air Act (the problem does not arise for greenhouse gases because any greenhouse gases released at one point in the world are climatically equivalent to any others released at another point in the world). In the case of a river basin, if a nutrient polluter is permitted to obtain offsets in another basin, the result will be an increase in nutrient loads in the original basin where the offset seeking party is located. This may be seen as undesirable both from an economic viewpoint and from a viewpoint of social equity.

As a result, offset policy makers may have to face tradeoffs between the cost-effectiveness of the entire Bay cleanup and the impacts of this cleanup on particular tributaries and basins. If the overall cost savings for the Bay cleanup are large enough, it may be desirable to expand the geographic areas in which offsets can be generated. If the local river basin consequences for water quality are too severe, however, it may be desirable to limit offsets to the same river basin. In that case, it will be much less likely that the buying and selling of offsets will negatively affect the river basin water quality. It is still possible, admittedly, that the acquisition of an offset that is geographically located downstream of the original acquiring party will have some negative overall consequences for the river basin.

When the issue is whether offsets must be acquired within the same state (but potentially from different river basins), it becomes less a matter of social equity and state politics. The acquirer of an offset may have to spend a considerable amount of money for this purpose. If the money is spent in a different state, it might be seen as a transfer of funds and jobs from one state to another. In addition, if the money is spent to generate offsets in a separate river basin, the water quality benefits that result from the offsetting action would not only be in a different river basin but also in a different state. Maryland might, for example, be willing to see one Maryland river basin improved to the detriment of another river basin (as long as the harm is not too large), if this produces significant cost savings and the other river basin is also in Maryland. If the other improved river basin is say in Virginia, however, the resulting overall Bay cost savings might count for less in the view of Maryland policy officials.

Geographic Alternatives for Acquiring Offsets: More Pros and Cons

Within The Same Local Governing Jurisdiction

An offset system could limit exchanges to within the geographic boundaries of the same local jurisdiction, regardless of basin considerations. This would primarily grant local governments the authority to administer the offset program in the manner they chose. Local government administration of such a system could range from a very involved to a very hands-off approach. For instance, local governments could qualify and monitor offsets, register and provide lists of offset generators, or collect fees to create offsets on behalf of nutrient generators; local governments could also intrude very little to an offset system by allowing offset seekers and generators to make contracts on their own and only validate contracts as needed.

Despite such possible benefits of administering an offset system at a local jurisdiction level, there are some potential problems. First, allowing offsets to take place within a local jurisdiction does not necessarily mean the offsets come from the same basin as the offset purchasing party. Hence, offsets obtained within a county might be helpful to the county but not necessarily to the specific river basin in which pollution reductions did not occur (they were offset elsewhere). Second, allowing offsets to be administered by each local jurisdiction could create confusion when trying to compare offsets across jurisdictions. One county may value the same offsets very differently than another county, and that could create equity issues if nutrient generators feel they are being treated unfairly. In order to address such concerns, it may be desirable to extend the area of eligibility for offset acquisitions to a wider geographic area.

Within the Same River Basin

Limiting offsets to the same river basin boundaries ensures that local water quality does not suffer from the increase in nutrient loads while buyers obtain offsets outside the basin. It also ensures that any financial benefits from offsets will be kept within the same basin. A within-basin policy is often seen as the most equitable solution that keeps the benefits and costs of offsets confined within the same group of affected people. It minimizes the creation of more distinct winners and losers, and the resulting potential political tensions, if offsets come from a different river basin than the original polluting source that is the acquirer of the offset.

In-Basin trading can refer to any offsets obtained within the same water basin and the same state, or it could allow trading across state lines within the same basin. For instance, if

Maryland Eastern shore allows offsets to be obtained from the same river basin in Delaware, the overall net benefits might be even greater. There would be the acquisition in Delaware of an offset in a cost effective way for Maryland and at the same time the Delaware offset would be occurring upstream of the Maryland source that was thereby allowed to continue polluting. A direct benefit to Maryland's Eastern shore water basin would still result. Cross-state In-Basin trading offers the same benefits and challenges as In-Basin trading within the same state but with the added consideration of qualifying, administering, and monitoring offsets across state lines. States will have to cooperate in order for these trades to happen. Since Cross-state In-Basin trading is the same as In-Basin trading within the state, both can be assumed when discussing In-Basin trading.

Bay-Wide Offset Availability

As noted, the greatest cost savings in terms of the cleanup of Chesapeake Bay would come from allowing offsets to be generated anywhere in the Bay watershed. High priority areas for nutrient reductions such as the Susquehanna River might receive more attention by allowing out-of-state purchases of offsets. It might also be argued that this would serve overall social equity. The greatest benefits of the Bay cleanup will be realized by the residents of Maryland and Virginia. Yet, the most cost effective ways of cleaning up the Bay may require that many nutrient reductions be made in Pennsylvania, even though many Pennsylvania residents live far from the Bay. One way that Maryland could reduce the Bay cleanup costs to Pennsylvania would be by allowing Maryland nutrient polluters to purchase their offsets in Pennsylvania. It might be argued that this would more closely align the location of benefits and costs. As the greatest beneficiaries of Bay cleanup, perhaps Maryland should also pay the greatest costs, a goal that could be served by an appropriately designed offset policy.

Cost-effectiveness considerations might similarly argue for letting Virginia nutrient polluters obtain their offsets from Maryland. Depending on the exact circumstances, the pollution reductions in Maryland might have a greater beneficial impact on Bay water quality, as compared with the same expenditures on pollution reductions in Virginia. For example, the James River flows into the Chesapeake Bay near the mouth of the Bay. As compared with pollution reductions made in river basins further north, a more limited part of the Bay is thus benefited from pollution reductions made in the James river basin. If the same nutrient load reductions were instead made in say the Patuxent River Basin in Maryland (perhaps paid for by James River polluters), the result would be to the overall benefit of Bay water quality, an advantageous result for affected parties in both Maryland and Virginia. Admittedly, the feasibility of the policy would depend on the impacts on the James River itself, if pollution load reductions were effectively transferred from the James River to the Patuxent River through the offset acquisitions.

Separate Offset Policies for Nitrogen and Phosphorus?

The three loads designed for reduction by the Chesapeake Bay TMDL are nitrogen, phosphorus and sediment. Nutrient trading systems have treated trades of nitrogen and phosphorus separately, but states under the TMDL appear to be seeking to establish common policies. It is important to recognize, however, that nitrogen and phosphorus have different physical characteristics that create important differences in their effects on aquatic plant growth in freshwater and saltwater.[57] Nitrogen is more readily dissolvable in water; this means that nitrogen travels faster to the Chesapeake Bay while phosphorus and sediment typically remain longer and move more slowly to the Bay.[58] As a result, phosphorus tends to contribute more than nitrogen to eutrophication of freshwater streams. By contrast, excess nitrogen typically creates the greatest problems of algal blooms in coastal waters with higher salt concentrations**.** Indeed, nitrogen is generally the primary limiting nutrient in the seaward portions of estuarine systems while in freshwater lakes, ponds, reservoirs and streams, phosphorus is the nutrient that has the most influence on plant growth and other nutrient pollution problems.

These different physical characteristics of nitrogen and phosphorus have potentially important implications for the geography of Bay offsets. For nitrogen, the potential for hot spots in individual river basins is significantly less than for phosphorus. The largest negative impacts of nitrogen pollution are felt in the Bay itself. This suggests that offset policy should allow acceptable exchanges for nitrogen over wider geographic areas, potentially even the whole Bay watershed. The potentially large improvement in cost effectiveness could be realized for nitrogen trading by allowing it to occur over wide geographic areas, while the disadvantages for individual river basins of such trading would be minimized – at least relative to phosphorus. For example, cross state nitrogen trading between Maryland and Pennsylvania might be permitted, while similar cross state trading for phosphorus might create different tradeoffs and be more difficult to implement.

TMDL "Attainment Areas"

In the administration of the Clean Air Act, the nation is divided into "attainment" and "non-attainment" areas for ambient air quality standards. There are large differences in the workings of the Clean Air Act according to the attainment or non-attainment status of an air quality basis. The river basins of the Chesapeake Bay can similarly be divided into attainment and non-attainment areas according to whether TMDL nutrient load targets are currently being met or not. For those river basins where 2025 TMDL load allocation targets have already been met, different offset policies might be followed, as compared with basins that have not yet come into "attainment" with TMDL targets.

In particular, if a river basin already meets its TMDL targets, the case for limiting offsets to the same river basin is much diminished. Rather, if the offsets are obtained in another river basin that has not met its targets, one might argue that this is itself preferable to a limitation on offset exchanges to the same river basin. One basin already in TMDL attainment would continue to be in attainment, while another separate basin – the provider of the offsets – would move closer to TMDL attainment.

The Chesapeake Bay water basins that are currently in attainment with TMDL targets are not the same for nitrogen, phosphorus and sediments.[59] For instance the D.C. Potomac River Basin is only in attainment for phosphorus at present, not nitrogen or sediments. Out of the 19 water basins of the Chesapeake Bay watershed, the D.C. Potomac River Basin has room to grow for phosphorus and three more basins are very close to their 2025 goals.[60] When considering the 92 impaired segments of the Bay watershed, eight segments have room to grow and ten are very close. Of these 92 segments in the overall Chesapeake Bay watershed, only three segments are now in attainment for nitrogen, phosphorus and sediments all together. If an offset system is established for sediments, however, 16 segments are already in attainment and thus have room to increase sediment levels currently. As this consideration suggests, the best way to establish offset trading policies is to consider nitrogen, phosphorus and sediments separately; the TMDL itself should be written to take these differences into account.

Allowing nutrient generators within river basins already in attainment to seek cheaper offsets without restriction to a local basin rewards these areas for early TMDL compliance and improves water quality for the Chesapeake Bay overall. Given that large reductions in future years should bring many more river basins into TMDL attainment, it is feasible to think that under such a policy many more river basins in the Bay watershed will come into attainment and will become eligible to exchange offsets outside the local basin in the future. According to USEPA, at present an estimated 9 million pounds of nitrogen and 200,000 pounds of phosphorus could be traded without causing water quality impacts in the tidal segment receiving the increase, or credited, load.[61]

Conclusion

Given a contributor of nutrient loads to the Bay with a potential need for an offset, an important policy question will be the allowable areas from which any such offsets might be obtained. The wider the possible geographic range for obtaining offsets, the greater will be the potential for reducing the costs of Bay TMDL implementation. However, if nutrient pollution is thereby shifted from one Bay location to another, there could be different impacts on the Bay, on local river basins and in terms of the distribution of the costs of Bay cleanup. The benefits of lowering total Bay cleanup costs by the wider geographic exchange of offsets will then have to be weighed against any such impacts that might adversely affect particular parties within the Bay watershed. The tradeoffs involved will vary significantly according to the specific locations, types of nutrient pollution involved, and other Bay circumstances.

Chapter 9 – Potential Unconventional Sources of Bay Nutrient Offsets

In its review of the Phase 2 WIPs, EPA encouraged the states to pursue more imaginative options for reducing loads. The various proposed and existing offset systems in the Bay area focus on maintaining or reducing nutrient loads by preventing their release into the watershed. However, as the focus of trading and offsets is to find the most cost effective means of restoring water quality, more attention should be given to enhancing natural nutrient assimilation processes. In some cases it may be cheaper to mitigate the effect of a pound of nutrient than to prevent its release. A nutrient assimilation offset may theoretically be achieved by increasing the capacity of the aquatic environment to remove nutrients. Offsets could be generated by harvesting plant biomass or by restoring former floodplain wetlands, which would increase the nutrient assimilative capacity of the aquatic ecosystem. There are three main ways in which nutrient assimilation services (NAS) can be created or enhanced: chemical transformation, nutrient harvest, and nutrient storage.

Chemical transformation refers to the processes that convert nitrogen into biologically unacceptable forms. This prevents consumption of the nitrogen by organisms such as algae, and therefore the harmful resulting environmental impacts. This transformation occurs naturally in wetlands, giving their preservation or creation the potential for offset generation. Nutrient harvest involves the removal of nutrient-saturated organisms, which prevents nutrient release in their decomposition or consumption. Organisms capable of sequestering Bay pollutants include algae, oysters, and other shellfish. Nutrient storage is similar to nutrient harvest, but the sequestration occurs in sediment rather than in biomass.

There is a great opportunity here for the creation of companies that both perform sought-after services and generate offsets. In many areas of the country, wind power would be economically infeasible without renewable energy credits. Similarly, a robust and creative nutrient credit trading market or other offset forms could make manure transport, oyster aquaculture, and other industries more competitive.

Manure transport is one option for preventing the release of nutrients to the Bay watershed. The Chesapeake Bay is more vulnerable than other estuaries due to its shallow depth, topography, and low flushing. Transporting waste to more resilient areas may be beneficial for nutrient reduction in the Bay without being overly detrimental to other water bodies. In its Phase 1 WIP, Pennsylvania stated that it was working to quantify all manure transported outside the watershed so that the EPA model might more accurately reflect these load reductions. More recently the state has accepted manure transport as a possible credit source, leading to twelve credit purchases in the last trading year.

Oysters are renowned for their ability to filter pollution and sediment from water. The Native Americans called the Bay the Chesapiook, or “Great Oyster Bay” because of the high population of this important species. At the time, prior to European settlement, oysters could filter all of the water in the Bay in only a couple of days. However, today’s oyster population is at less than 1% of its historic estimate, and now takes about a year to filter the entire Bay. This decline was caused first by overharvest and habitat loss, and later exacerbated by the diseases Dermo and MSX. In addition to filtering water, oyster bars act as the coral reefs of the Bay, providing habitat for other important species such as crabs.

In the Chesapeake Bay, investments in oyster aquaculture could generate NAS offsets in two ways: filter feeding offsets could remove nutrients from the Bay by an oyster de-nitrification process; and nutrient sequestration in phytoplankton by the oyster shell and meat. Oyster aquaculture presents some challenges for credit generation due to local water quality requirements in trading programs. It would most likely not be acceptable for pollution to continue or increase in, say, northern Pennsylvania because of an oyster reef in Maryland. However, there are some rivers outside of the main stem of the Bay in Maryland, Virginia, and Pennsylvania that are viable for oyster reef establishment. The surrounding areas could certainly take advantage of the opportunity, and greater use could be expanded following the creation of a Bay-wide trading program.

Other concerns about NAS-generated credits include the potential for leakage, or an unaccounted-for load increase. One example of this is that the expansion of oyster aquaculture might cause prices to drop and facilities to close elsewhere in the watershed. NAS expert Kurt Stephenson of Virginia Tech says that this problem should be avoidable with proper management and planning.

Given this potential source of offsets as an alternative to other nonpoint sources, Stephenson et al seek to establish the costs for nutrient assimilation programs. For example, the literature has estimated the cost of offsetting one pound in a range from $0 to $150 pounds per year. Part of the variation is due to the assumptions for oyster prices, input costs, growth and mortality rates. In order to fully offset a one million gallon per day expansion for a wastewater treatment plant operation, approximately 9,000 pounds per year of nitrogen reduction would be necessary, which would require between 21 and 69 million oysters, a number much greater than the total of 16 million that were produced from aquaculture operations in the Bay in 2008.

The cost of an algal turf scrubber has been estimated at around $24 per pound of phosphorous in Florida. The cost for restoring wetlands in Florida has been estimated to be between $14 and $94 per pound of nitrogen. There have been no corresponding estimates developed of the costs in the Chesapeake Bay.

Offsets from Conowingo Dams sediment Removal

Conowingo Dam is located near the Maryland-Pennsylvania border 10 miles upstream from the Susquehanna River's mouth. Construction was completed construction in 1928 as then the second largest hydroelectric plant in the U.S. The river water impounded by the dam forms a 14-mile long Conowingo reservoir. This reservoir has long trapped sediment and phosphorus. Scientists estimate that it traps about two-third of the sediment from the Susquehanna River and a third of phosphorus that becomes attached to sediment particles.[62]

During extreme storms, however, fast-flowing water will carry built-up sediment and associated phosphorus past the dam and into the Bay, thus degrading water quality. As estimated by scientists, such scouring takes place when river flows reach 400,000 cubic feet per second. In the past 44 years, this extreme situation has happened only 11 times, an average of once every four years. But a review of monitoring data by Bob Hirsch, a research hydrologist with the U.S. Geological Survey, finds that the scouring is happening more frequently. As the reservoir continues filling, scouring would take place when flows reach between 200,000 and 300,000 cubic feet per second. In other words, it means that scouring and Bay degradation would occur once every two years.

Moreover, in extreme high-flows of the Susquehanna River, it now carries sediments and phosphorus with significant higher concentration than those seen in the past. In 2004, a phosphorus concentration of 1.17 mg/l of water was observed during an extreme event, much higher than that anything observed since 1978—which never exceeded 0.4 mg/l.

Trapped sediment will block water and smother the habitat of for many species and associate phosphorus will feed algae blooms that rob oxygen from water.

It had been predicted that the Conowingo dam would reach its capacity to store sediment in 15 to 20 years under current conditions.[63] However, in June this year, Hirsch reported in a Chesapeake Bay Program scientific meeting that the storage of sediment and phosphorus is already nearing its capacity.[64] As a result, the trapped sediment and phosphorus is now posing a growing threat to the Bay and its water quality. This is becoming an urgent issue that cannot be put off to the future much longer.

In 2000, the Sediment Task Force was established by the Susquehanna River Basin Commission (SRBC) to evaluate this problem.[65] In 2001, the efforts were suggested to ship sediments behind the dam to abandoned coal mines in western Pennsylvania. After further calculations, however, it was estimated that $48 million would be required annually in order to dredge enough to keep up with the 1.5 million tons of new sediments arriving. It would cost far more to dredge out the 200 million tons already stored behind Conowingo dam as of 2001.[66] In September 2011, Governor Martin O'Malley requested an assessment to address sediment accumulation and potential for storms to affect water quality in the lower Susquenhanna River including the reservoir behind the Conowingo dam. This assessment, costing $1.4 million over three years, should help in developing broader strategies for this problem.[67]

The 2010 Bay TMDL establishes requires a maximum sediment and phosphorus load that could enter the Bay every year without degrading water quality. The TMDL assumed that upstream storage in the Susquehanna watershed would continue trap sediment and phosphorus through at least 2025.[68]The Bay TMDL incorporates the current sediment-trapping capacity of the Conowingo Dam at 55 percent phosphorus trapping capacity at 40 percent. However, if the Conowingo dam soon loses its further capacity to trap sediment and phosphorus, this will require more control actions to offset the increased flows into the Bay. In 2012, the Bay states submitted two-year milestones that demonstrated pollution reduction and prevention actions they would take in 2012 and 2013. If the pollution danger from Conowingo dam problem is near term, however, Pennsylvania, New York and a portion of Maryland should be required to identify and implement other control actions to meet EPA's standards.

Offsets generated elsewhere above the dam could be considered as an option in each of these states. This alternative has been proposed in some media outlets such as the Baltimore Sun.[69] Another possibility would be to help to fund dredging of the reservoir by making this activity an eligible form of offset for Bay pollutant sources below the location of the dam. It might be possible, for example, to undertake sufficient annual dredging to offset the annual flows of new sediment and phosphorus, thus maintaining the reservoir at the current status quo.

Investments in New Technology

As previously mentioned, one of the key elements of Pennsylvania's TMDL strategy is "new technology and nutrient trading." The state supports the idea of including waste to energy facilities as credit producers in its Nutrient Trading Program. The Pennsylvania Department of Environmental Protection (PADEP) and the Pennsylvania Department of Agriculture (PADA) are currently working together with EPA to determine the feasibility of co-generation of energy on dairy farms, and its applicability in the TMDL model. However, since these facilities are likely to cost around $50,000 each, the state has begun to collaborate with stakeholders in the hopes of creating a Technology Fund for projects such as this. Some current credit-applicable technologies listed in the Phase 2 WIP include:

- "ElectroCell Technologies Inc. has generated nitrogen credits that were registered for use in meeting NPDES permit limit requirements;
- Under a Water Quality Management Experimental Permit, Bion Technologies has constructed and operated a biological process for treating manure in Lancaster County; and
- EnergyWorksBioPower has initiated construction of the Gettysburg Energy and Nutrient Recovery Facility in Adams County."

Pennsylvania is also researching other technologies for manure such as de-nitrification, solids separation, flocculation, and combustion, as well as non-manure technology like algae-processing.

Conclusion

Given strict baseline requirements and other potential limits on the number of available offsets from existing pollution sources within the Bay watershed, the number of offsets required to handle increased nutrient flows from new development and other needs for offsets may be inadequate. With further research and development, however, it may be possible to discover new low cost sources of offsets. This could contribute importantly to reducing Bay pollutant loads and holding down the costs of Bay TMDL implementation in future years.

Appendices -- Offset Policy Development in each Bay State and in the District of Columbia

Appendix A – Offset Policy Development in Maryland

A nutrient offset policy is expected to play a significant role in Maryland's overall TMDL implementation strategy. Although a full offset program is not yet in place, a plan is scheduled to be finalized soon. Figure A-1 below shows the time line for the various steps thus far taken by Maryland as part of the development of its offset strategy and the steps now planned through 2013. According to Maryland officials, a full offset system ideally will be in place and working by the end of 2013.

Figure A-1: Offset Timeline for Maryland

May 2007: Discussions begin in Maryland with the Maryland Department of the Environment (MDE) to implement a TMDL in the Chesapeake Bay Watershed

April 2008: MDE, culminating a public policy process, announces a policy framework for a Nutrient Cap Management and Trading System.

September 2008: The EPA approves the Category 5 of Maryland's Integrated Report of Surface Water Quality which recommended the water bodies in Maryland that would be likely to require a TMDL

June 2010: Governor O'Malley's Green Jobs and Industry Task Force recommends the establishment of a working group to assess the existing programs and make recommendations on how to incentivize private ecosystem markets in Maryland. In response, DNR establishes the Ecosystems Services Working Group (ESWG) which includes State environmental, planning and economic development agency members as well as environmental restoration and investment companies and non-profit organizations that specialize in ecosystem markets for financing.

October 2010: Draft of Phase I of Maryland's WIP was released for public review to accept public comments, including mention of offsets.

December 2010: Maryland submits the final version of the Phase I WIP to the EPA. Here is where the original specific plan for offsets is established for Maryland in chapter Three of the WIP, titled *Accounting for Growth*. This sets the beginning plans for Maryland as well as future goals concerning development

2011: The state agencies and working group continue with research and development for more detailed approaches for offsets. They evaluate the need for legislative and regulatory changes for the strategy and obtain stakeholder and public comments. Plans are made to seek necessary authority to undertake research, the appointment of a taskforce, and/or authorization to implement elements of the offset procedures.

January 2012: MDE submits Maryland's Draft Phase II Watershed Implementation Plan

March 2012: MDE submits Maryland's Final Phase II WIP after undergoing public review.

Remainder 2012: Plans are in place to review results from the public process and make recommended edits to the strategy; finalize the development of the offset policies and procedures; evaluate the current State tracking/accounting for growth process; begin development of the comprehensive tracking/accounting for growth and offset program; evaluate the need for statutory and/or regulatory changes; develop next steps needed for initiating the offset policy and implementation.

Early 2013: Write and submit any needed legislation to the Maryland General Assembly; continue to work with the EPA/Bay Program Water Quality Implementation Team Trading and Offset workgroup to discuss and address, where needed, EPA recommendations common to all jurisdictions by the end of 2013

Remainder 2013: Add any regulations if needed; perform outreach to local governments to advance implementation of effective offset program for sectors with planned new or increased loadings; finalization of the development of the comprehensive State tracking/accounting for growth and offsets system; demonstrate that a specific sector will not experience growth in loading if needed

Maryland WIP Strategies for Dealing with Future Growth

As identified in Maryland's Phase 1 WIP, Maryland is planning to use seven policy measures to deal with future increases in nutrient and sediment loads coming from new development and increased population. [70] Offsets have a significant role to play in several parts of this broader growth strategy.

1. Accurately account for increased nutrient loads from new development
2. Require offsets for new development in a way that encourages development that results in relatively smaller increases in loads
3. Ensure an adequate supply of offsets including cost-effective load reductions in the agricultural sector
4. Use a variety of policy instruments to balance incentives between development in and outside of sewered areas, seeking to minimize increased loads from future development that can not be served by WWTPs.
5. Ensure that local governments are accountable in their use land use decisions for contributing directly to meeting TMDL goals.
6. Recognize State and local government accountability for impacts of land use decisions on the ability to meet TMDLs goals, and
7. Ensure that management of land and the regulation of pollution are mutually supportive.

The first of these policy measures calls for close monitoring and accounting for nutrient loads from all new development. The State will rely heavily on local governments, who regulate land use, to assist in this accounting. The second strategy calls for encouraging land development that will result in relatively smaller increases in nutrient loads to the Chesapeake Bay watershed from growth. Zoning and other land use management tools and programs can influence the nature of development and its post development nutrient loading rates. Another part of the Maryland approach involves enforcing of the Priority Funding Area (PFA) law that seeks to direct development to areas with higher existing densities and more infrastructure. By avoiding lower density and less developed areas, agricultural and resource lands in this way can be preserved. Concentrating growth in PFAs also helps to minimize stormwater pollution and to reduce the nutrient pollution from septic systems by directing development to areas where it more easily can be served by sewers and WWTPs.[71]

Nevertheless, even after taking these steps, future housing and other land development in Maryland will be creating significant new nutrient loads. Use of offsets is included as part of Maryland's strategy for the Bay's cleanup in chapter three of the Phase 1 WIP entitled, *Accounting for Growth.* First, as noted, future loads should be estimated and included in quantitative load reduction analysis. Second, policies and programs should be adopted as needed to ensure all future load increases are offset by commensurate load reductions elsewhere. The offset policy in the Phase I WIP offers a schedule for adopting nutrient offset programs for septic system and land development loads. This program will build on the existing Maryland nutrient trading policies and programs.[72] As previously discussed, a nutrient trading system is a particular market form of creating and acquiring offsets within a broader overall set of methods the could be used for facilitating offset transactions.

Maryland's final strategy to account for growth, which is on track to be completed by the end of 2013, will further outline such a policy and an implementation strategy to offset new loads. In 2011, the Task Force on Sustainable Growth and Wastewater Disposal first presented recommendations relevant to accounting for growth. The next steps in further development of the accounting for growth strategy will be to evaluate the 2012 legislative responses to the task force's original recommendations before finalizing the strategy and beginning the public process.

Options for Developing Maryland Offset Policies and Procedures

As examined in Part I above, the greater use of offsets has a high potential for addressing four types of core problems relating to the implementation of the Bay TMDL: (1) the high total costs – potentially politically unacceptable -- of TMDL implementation in the Bay states; (2) the low degree of cost-effectiveness of the TMDL and WIP allocations of pollution load reductions, a main reason for these high costs; (3) the significant concerns relating to the equity – both within and between Counties – of the TMDL and WIP allocations of nutrient load reductions; and (4) the difficulty in achieving 2017 and 2025 TMDL targets in the face of expected significant new development in Maryland and resulting major new increases in nutrient pollution loads from this development.

The role and use of offsets in helping to resolve these issues should be addressed as Maryland works collaboratively with local governments and stakeholders during 2012 and 2013 to complete key tasks to meet the 2013 offset policy implementation deadline. In developing the offset policies and procedures, Maryland has already specified that there will be a variety of steps as listed in the Phase I WIP that have to be taken into account and addressed:[73]

- A Statewide inventory classification of "High," "Moderate" and "Low" per capita nutrient loading areas with appropriate input from each relevant government jurisdiction
- Outreach and assistance for appropriate activities to local governments including evaluating the supply of offset credit generation within qualified geographic areas, assessing potential growth under alternative scenarios to support economic development
- Determining how institutional and market mechanisms for offsetting loads will be implemented in subsequent years, requiring a framework to address issues of nutrient credit supply transactions, regulatory accountability, and perpetuity in ways that will be practical and effective.

• Investigating options through which the State or local governments can better achieve the seven objectives of the growth and offset strategy. This could include making different offset ratios for high moderate and low PCLA areas and ensuring that offset ratios outside of low PCLA areas compensate for low or no offsets inside of such PCLA areas. Another matter that has been discussed is to explore the creation of new offsets that go beyond implementation of BMPs on individual sources. These could include an establishment of a fee in lieu mechanism to support collection, processing and distribution of palletized livestock and poultry manure; upgrades to additional major-minor WWTPs and retrofitting existing septic systems.

Over the next year, discussions will proceed towards establishing a more definite idea of how to establish an offset system, how to certify whether or not an action is able to classify as an offset, and other related issues. In 2011, the Chesapeake Bay Program formalized its Water Quality Trading Forum, and in doing so, created the Trading and Offset Workgroup (TOWG). This workgroup has three functions:

1. To provide a forum for discussion and information exchange among trading and offset stakeholders
2. To evaluate and facilitate strategies to exchange loads among affected source sectors, and
3. To build consensus on common approaches to some program design elements.

Maryland is an active participant in this Workgroup. Some of the upcoming discussions will include: how to ensure a no net load increase in the Bay watershed, how to use finance credits as well as how to use them to complement stormwater upgrades, how to ensure that local water quality remains protected during trading, ways of verifying credits and then attracting market participants, and issues dealing with uncertainty ratios for establishing offsets among different sectors.[74]

Maryland's Nutrient Trading Program

The Maryland Department of the Environment (MDE) developed a Nutrient Cap Management and Trading Policy which came into effect in April of 2008. Maryland's approach differed in some respects from other states. While other states allow offsets and nutrient trading in lieu of upgrading a WWTP, an upgrade of major WWTPs is mandatory in Maryland. Trading thus is not available as a substitute for these upgrades. Instead, Maryland is providing state funding for the upgrades through its flush tax.

As of the spring of 2012, trading had not yet occurred in Maryland, according to former Maryland graduate student Nicole Angeli, who worked in 2012 with the various local soil conservation districts in Maryland. Angeli states that "the real barrier to trade has been convincing farmers that they will not be prosecuted in the future if their farm is entered in the program to assess the TMDL baseline and they are above it." Also many farmers are hesitant to take a role in the nutrient trading program because they are concerned that "the system requires for them to meet the TMDL baseline before trading, while other forms of point sources can trade to fulfill their permits (i.e. MS4, NPDES), and this seems unfair." Until farmers are convinced of the practical workings of a nutrient trading system through seeing actual trades occur, "it is going to be difficult to get everyone on board."[75]

Conclusion

In considering offset policies in Maryland, there is still a great deal that needs to be discussed and finalized in order for effective implementation of offsets to take place. Development of offsets will be critical in Maryland in order to address future population and business growth at the same time as Maryland achieves 60 percent reductions in nutrients by 2017. It will be necessary in 2012 and 2013 to answer many of the questions that have been raised in the State regarding the successful development and execution of a Maryland offset policy.

Appendix A.a: Maryland Ecosystems Working Group Membership

Joe Gill (Chair)	Department of Natural Resources
Dan Baldwin	Department of Planning
John Campagna	Restore Capital
Denise Clearwater	Department of the Environment
Christine Conn	Department of Natural Resources
Marianne Dise	Office of the Attorney General
Renee Fizer	Department of the Environment
Dave Goshorn	Department of Natural Resources
George Kelly	EBX USA
Doug Lashley	GreenVest
Marya Levelev	Department of the Environment
Sean McGuire	Department of Natural Resources
Dominick Murray	Department of Business & Economic Development
Dan Nees	Environmental Finance Center, University of Maryland
Kelly Neff	Department of the Environment
Mary Owens	Critical Area Commission
Susan Payne	Department of Agriculture
John Rhoderick	Department of Agriculture
Dan Rosen	Department of Planning

Appendix A.b: Maryland Task Force on Sustainable Growth Membership

Chair -- Delegate Maggie McIntosh of Baltimore City, chair of the House Environmental Matters Committee
Vice Chair -- Jon Laria, partner in the law firm of Ballard Spahr and chair of the Maryland Sustainable Growth Commission

Members

Erik Fisher, land use planner with the Chesapeake Bay Foundation
Fred Tutman, executive director of the Patuxent Riverkeepers and a member of the Patuxent River Commission
Robert Mitchell, director of the Environmental Programs Division of Worcester County
C.R. Bailey, vice president of Marrick Properties
Madison "Jimmy" Bunting, Jr., Worcester County Commissioner
Rob Etgen, executive director of the Eastern Shore Land Conservancy
Pat Langenfelder, president of the Maryland Farm Bureau
Richard Hutchison, Talbot County farmer
Jim Rapp, executive director of Delmarva Low-Impact Tourism Experiences
Robert Sheesley, owner of Eco-Sense Inc. environmental consultancy
Dr. Kelton (Kelly) Clark, director of the Morgan State University Estuarine Research Center in St. Leonard and chair of the Patuxent River Commission
Brian Hammock, attorney, Venable LLC
Robin Truiett-Theodorson, member and former president of the Abell Improvement AssociationAdditional Members, as specified in the Executive Order:
State Senator Paul G. Pinsky of Prince George's County, lead sponsor of SB 846
Senator David R. Brinkley of Frederick County
Delegate Steve Lafferty of Baltimore County, lead sponsor of HB 1107
Richard Eberhart Hall, Secretary of Planning
Robert M. Summers, Secretary of Enviroment
Earl (Buddy) Hance, Secretary of Agriculture
John Griffin, Secretary of Natural Resources
Margaret McHale, chair of the Critical Area Commission
David Carey, Bel Air Mayor (representing the Maryland Municipal League)
Joe Adkins, Frederick Planning Director (representing the Maryland Municipal League)
Katheleen Freeman, Caroline County Planning Director (representing the Maryland Association of Counties)
Chris Trumbauer, Anne Arundel County Councilman (representing the Maryland Association of Counties)
Russ Brinsfield, executive director of the Harry R. Hughes Center for Agro-Ecology, Queenstown

Appendix B – Offset Policy Development in Virginia

As in Maryland, besides increasing the overall cost-effectiveness of the TMDL implementation, state officials in Virginia expect the use of offsets to play a large role in dealing with the problem of future increases in nutrient loads due to significant new development and associated population growth in Virginia in the next ten years. Figure B-1 shows the timeline for the development of offset policy in Virginia. Virginia has been ahead of the other Bay states in the development of a nutrient trading system as a means of providing offsets for a cost-effective tool for Bay cleanup. Indeed, Virginia in 2005 was the first Bay state to establish a nutrient trading system.

Figure B-1 Timeline for Offset Policy Development in Virginia

- April 2005 -- Virginia Nutrient Credit Exchange approved
- August 2005 -- Exchange Association chartered.
- January 2007 -- Watershed General Permit (WGP) effective
- January 2008 – Agricultural BMP Offset Guidance
- November 2008 -- Nutrient Credit Services Agreement executed
- March 2009 – General Assembly approves new nutrient offset program provisions as part of VA Stormwater Management Act
- July 2009 – Virginia Soil and Water Conservation Board approves stormwater nutrient offset implementation procedures
- December 2010 – Chesapeake Bay TMDL issued by EPA
- January 2011 -- Begin first Compliance Year under WGP
- 2011 – General Assembly approves SBs 1099, 1100 and 1102
- January 2012 -- DCR submits Virginia's Draft Phase II Watershed Implementation Plan
- March 2012: Department of Conservation and Recreation (DCR) submits Virginia's Final Phase II WIP after undergoing public review.

<u>Virginia's Nutrient Trading System</u>

Virginia's Phase I WIP gives a large role to the Chesapeake Bay Watershed Nutrient Credit Exchange Program, as established by the state of Virginia in 2005 legislation. Virginia sought to establish a flexible program for meeting cap load allocations that would be in line with the goals set in the 2000 Chesapeake Bay Agreement. Since its establishment, the program has grown in size and in scope. The Phase 1 WIP proposed an expanded role for the Credit (Offset) Exchange Program (a purchased "credit" in effect provides a specific form of "offset" that allows purchasers to avoid certain pollution reductions that otherwise would have been legally mandated for them). In response, the Virginia Department of Environmental quality has recently developed a proposal that would further expand the scope of the Credit Exchange Program, and the Virginia legislature is expected to consider legislation expanding the program in 2012.

The Chesapeake 2000 Agreement was agreed upon by the states of Virginia, Pennsylvania, Maryland, and the District of Columbia and the EPA to achieve pollution reduction in the Chesapeake Bay by 2010. To achieve this goal, the Agreement established caps on the loads of nitrogen and phosphorous delivered to the Bay watershed. Given that the

Agreement required point source dischargers to achieve significant reductions of these nutrients, Virginia sought to comply with the 2000 Agreement goals in part by establishing a market-based mechanism, based largely on nutrient trading (which had already been used in Virginia's air pollution control program). The program was largely developed by the Virginia Department of Environmental Quality (DEQ).

The role for this market-based mechanism was recognized in in the General Assembly in 2005 in approving the establishment of the Chesapeake Bay Watershed Nutrient Credit Exchange Program: "…the adoption and utilization of a watershed general permit and market-based point source nutrient credit trading program will assist in (a) meeting these cap load allocations cost-effectively and as soon as possible in keeping with the 2010 timeline and objectives of the Chesapeake 2000 Agreement, (b) accommodating continued growth and economic development in the Chesapeake Bay watershed, and (c) providing a foundation for establishing market-based incentives to help achieve the Chesapeake Bay Program's nonpoint source reduction goals." The Virginia Nutrient Exchange Program has been hailed by an EPA official as "a model not only for the Chesapeake Bay partners but also for watersheds across the country."

The legislation established a waste load allocation (WLA) for wastewater treatment plants (WWTPs) of nitrogen and phosphorous (non-point sources remained under voluntary programs). The WLA is expressed as a total annual mass load of phosphorous and nitrogen that can be released by the WWTP. Each individual WLA was set based on the limits of technology performance standards (4 mg/l for total nitrogen) times the point source's permitted design flow. The legislation covered 108 WWTP facilities in Virginia, 37 of which were located in the Potomac-Shenandoah river basin, 20 in the Rappahannock, 12 in the York, 34 in the James, and 5 in the Eastern Shore basin. These facilities are owned by 74 different owners, 53 of which were classified as public (government) entities, while 21 were private. Finally, the sum of individual point source WLAs across a river basin represents the point source watershed cap for that basin.

The Virginia trading system allowed for the joint aggregation of WLAs of multiple facilities under common ownership, which gave rise to 12 owner "bubbles" comprising 39 point source facilities. The facilities in a bubble are allowed to shift the expected credits among themselves, with the aggregate remainder being purchased or sold to the general market.

The Virginia Nutrient Exchange became effective in January 1st, 2007, by which time the WLAs had been established by the Water Quality Management Planning Regulation. However, the Bay TMDL, issued in late 2010, also established new WLAs for each point source discharger. As a result, the state of Virginia has established that "in cases where there is a conflict between the two [rules], the more limiting condition is used in the watershed general permit."

The Virginia Nutrient Exchange

Beginning in 2007, the Virginia Nutrient Exchange Program allowed for trading among WWTPs to help them in meeting their individual WLAs. WWTPs are allowed to purchase nutrient "credits" (in effect offsets) to enable them to meet their WLAs.

The Exchange provides benefits to facilities taking actions to reduce nutrient loads from their plants by potentially allowing them to sell credits/offsets. Even though this may in concept allow facilities to raise some revenue, in most cases it only allows in practice for partial cost reimbursement. For example, in early 2012 Arlington completed a major upgrade of its Water Pollution Control Plant (which cost $568 million) and has reduced the amount of nitrogen discharged into the Bay below state permit limits. As a result, this reduction in nitrogen has created credits that can be exchanged in the Virginia Exchange Program, where the resulting revenue could help pay for the cost of the improvements but will be far short of the total cost.

While the program focused on point source trading for existing WWTPs, it established different provisions for new or expanded facilities in order to accommodate new growth. From 1990 to 2000 the population of the Northern VA Metropolitan Area grew by 25.2%, double the national average for that period. This growth required new and expanded WWTPs in order to accommodate the additional nutrient discharges. The 2005 legislation stated that any new or expanding facility that discharged more than 100,000 gallons or more per day into tidal waters or 500,000 gallons or more per day would be required to acquire enough wasteland allocations to offset the increased discharges in phosphorous and nitrogen. The additional WLAs could be acquired by buying a portion of the WLAs from the existing (non-expanding) facilities within the same tributary (that were not using all their allocations), largely following the requirements established for credit acquisitions by existing sources.

If a sufficient number of allocations is not available to meet the need, the new or expanding facility is be allowed to purchase additional allocations from the Water Quality Improvement Fund. The Virginia Exchange Program also allows for the acquisition of non-point source load allocations through the adoption of best management practices (BMPs) within the same tributary as the discharger. Although the inclusion of non-point sources is likely to reduce the cost of achieving the TMDL (as all estimates have shown), Stephen Aultman has pointed out that point sources have expressed concern that if a non-point source offset provider fails to deliver the offset purchased by the point source, the point source violates the NPDES permit (administered by Virginia) for water pollution emissions, which could lead to financial penalties.

Administration of the Virginia Nutrient Exchange

The Virginia Nutrient Credit Exchange Association coordinates and facilitates participation in the nutrient exchange program by the dischargers and the credit/offset providers. The Association is required to develop a standard form of agreement for certifying the nitrogen and phosphorous credits, helping establish the market for buyers and sellers, and coordinating planning to help ensure that sufficient credits became available each year. In 2008, the Nutrient Credit Exchange helped facilitate Virginia's first non-point source nutrient bank: the Chesapeake Bay Nutrient Land Trust, LLC. The Exchange comprises the aforementioned 73 owners, 108 facilities, as well as a 10 member board. After the Watershed General Permit (WGP) – providing the WLAs to the dischargers – was established in 2007, 2011 was the first year for compliance under the WGP.

The Association is required to compile, on a yearly basis, the "Exchange Compliance Plan", which is then submitted to the DEQ. The Compliance Plan focuses on presenting which facilities are planning on introducing nutrient removal technology upgrades in order to comply with the phosphorous and nitrogen WLAs. This information is provided to meet each facility's requirement of developing a compliance plan, containing enough information on how the facility plans on meeting the individual WLAs. Furthermore, the Plan also serves as a "comprehensive document" for planning and implementing nutrient credit trading in each basin, which is regulated through the Association.

As discussed above, each facility is allocated a yearly Waste Load Allocation (WLA). The facility's WLA is measured against its Expected Load, which is the delivered load for any particular year (starting with 2012 in the latest report). This comparison then determines whether a facility is a net generator of credits or if it is required to purchase credits on the Exchange. The net credits for each basin are aggregated across all the facilities in that basin.

The Exchange has adopted a system of Class A and Class B compliance credit (offset) exchanges. Class A exchanges are advanced agreements among the members to purchase or sell the nitrogen/phosphorous credits (offsets) at a set price. On the other hand, Class B credits are traded as a means of "truing up" compliance for the previous calendar year. Facilities whose Expected Load has exceeded their WLA are required to show DEQ that by June 1st they have acquired sufficient credits; these credits can be filled through Class B credits. The later Class of credits was developed in order to ensure that facilities could still meet their WLAs in case they chose not to undertake an upgrade. The number of available Class B credits equals Actual Net Credits plus any Class A Credit purchases and minus any Class A Credit sales for the Compliance Year.

The trading of credits takes place through The Exchange, which is in charge of clearing the market by purchasing all Credits generated by Participants as provided. Therefore, the class A seller price is different than the Class A purchase price since there is a difference between the volume of credits supplied and purchased. Given that the volume of Class A credits supplied is currently larger than those purchased; the price of the former is lower. On the other hand, given that Class B credits just reflect a surplus to provide flexibility to facilities for the June 1st deadline, they are sold at a much lower price; for example, in the Upper James Basin they were sold at $0.14/credit.

Although almost all the credits (offsets) are exchanged officially through the Exchange, WWTP facilities are also allowed to undertake separate bilateral trades among themselves. However, only a few facilities have conducted these trades so far; among them, facilities in the following areas: Spotsylvania County and Town of Washington (Rappahannock/Phosphorus); RockTenn and White Birch-Bear Island (York/Phosphorus); Honeywell-Hopewell and Hopewell RWTF (James/Nitrogen); Chesterfield County and Dominion-Chesterfield (James/Phosphorus).

The most recent available Exchange Compliance Plan is for the year 2012. The following table presents the number of expected credits that will be exchanged, as well as the prices for the year 2012. As can be seen in Tables B-1 and B-2, each of the basins is currently generating net credits, which means that they are on track to meet their aggregate WLAs for the 2012 year. The Compliance Plan document also shows that each of the basins is expected to generate net credits in phosphorous and nitrogen. In short, the table shows that the credit exchange system is playing a large role in meeting WLA for each of the basins in Virginia, as can be seen in the size of the market of the Potomac-Shenandoah and the Rappahannock basins.

Table B-1 Expected Nitrogen Credits Traded in Virginia, by Basin

River Basin	Expected Net Credits	Class A Sales	Class A Sale Price	Class A Purchases	Class A Purchase Price	Class B (expected)	Class B Price
Potomac – Shenandoah	227,130	167,657	1.29	122,249	2.00	179,722	0.13
Rappahannoc k	86,763	39,104	0.51	11,263	2.00	58,922	0.03
York River	134,097	31,702	0.90	16,013	2.00	118,408	0.02
Upper James	485,289	399,663	1.10	245,260	2.00	330,886	0.14
Lower James	680,347	No Sale	No Sale	No Sale	No Sale	680,347	No Sale
Eastern Shore	6,031	2,813	No Sale	2,813	2.00	6,031	0.08

Table B-2 Expected Phosphorus Credits Traded in Virginia, by Basin

River Basin	Expected Net Credits	Class A Sales	Class A Sale Price	Class A Purchases	Class A Purchase Price	Class B (expected)	Class B Price
Potomac – Shenandoah	27,207	24,097	3.40	22,785	4.00	25,895	0.35
Rappahannoc k	10,526	3,549	2.18	2,151	4.00	9,128	0.09
York River	14,950	5,083	0.09	135	4.00	10,002	-----
Upper James	163,824	170,813	0.87	41,384	4.00	34,395	0.48
Lower James	13,949	No Sale	No Sale	No Sale	No Sale	13,949	No Sale
Eastern Shore	383	393	No Sale	393	4.00	383	0.41

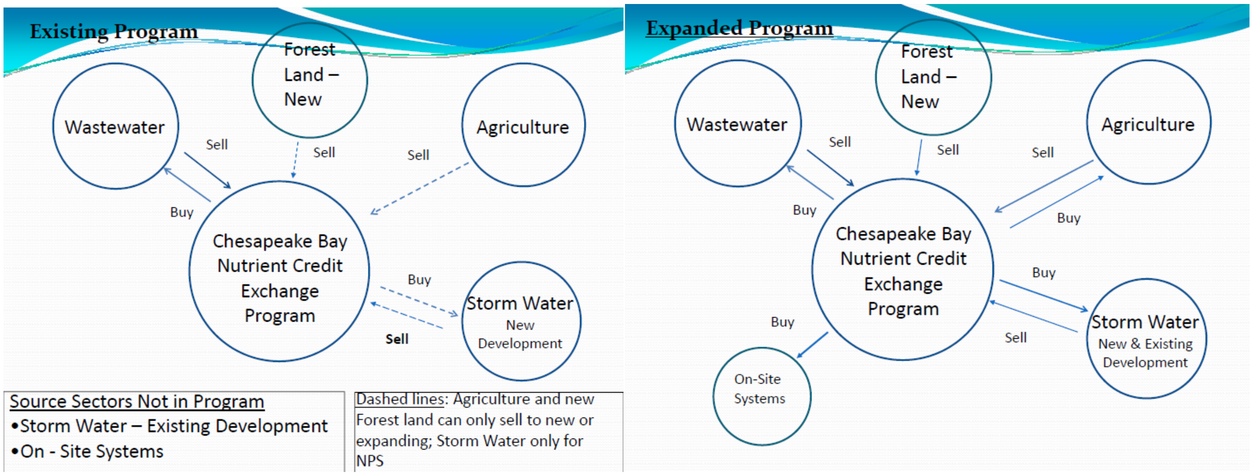
Source: Virginia DEQ Exchange Compliance Plan 2012 Annual Update

Phase II WIP Plan and proposed Nutrient Credit Exchange expansion

With the goal of providing further flexibility for meeting Virginia's load allocations under the Bay TMDL and improving its cost-effectiveness, Virginia's Phase 1 WIP plan called for an expanded nutrient credit exchange program. Furthermore, the WIP also set a timeline by which the guidelines for the expanded program should be established. As a result, a bill has been under consideration in the Virginia legislature setting out the terms for expanded availability of credits and offsets, now including nonpoint sources.

The bill gives the Virginia Department of Conservation and Recreation (DCR) the sole authority for certifying non-point source credits/offsets arising from activities that go beyond the established baseline requirements. DCR is to establish a process for certifying credits (offsets) coming from agricultural or urban stormwater BMPs, from use or management of manure, from land use conversion, from stream or wetlands restoration, or any from other proposed nutrient load reduction practices. The inclusion of manure management as a potential offset source follows the passage of SB 1102 (approved in March, 2011) which established that offsets generated from waste-to-energy or animal waste reduction programs would be considered point source reductions and thus not subject to a 2:1 trading ratio. Figure B-2 shows the differences between the existing and the proposed expansion to the trading program.

Figure B-2 Existing and Expanded Chesapeake Bay Nutrient Credit Exchange Program



Source: Presentation "Expanding the Nutrient Credit Exchange: Virginia's Watershed Implementation Plan and SJR 334" by Russ Baxter

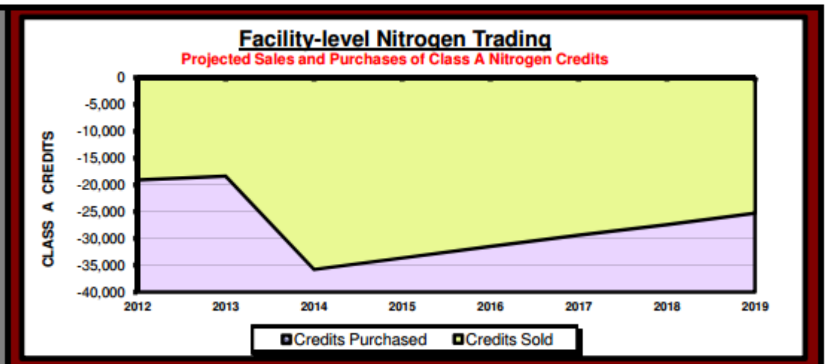
Although the new legislation does not include major changes to the credit establishment procedure, it does call for the creation of the Virginia Nutrient Credit Registry, which is a proposed online database of certified credits (offsets) for trading within the state. Other minor changes include requiring the retirement of five percent of certified credits to facilitate water quality improvement, as well as establishing a registration fee related to the cost of the application review as replacing the existing 6% fee on credit sales.

Figure B-3 shows an example of a facility's summary for nitrogen for the 2012-2016 period. The summary presents a projection for credit generation/purchases for the next five years as well as an estimate for 2017-2019; in this particular example, the Stafford Co-L. Falls Run facility discharging into the Rappahannock Basin will generate both Class A and Class B credits over the specified time period.

Figure B-3 Example Nitrogen Facility Summary

Stafford Co-L. Falls Run

RAPPAHANNOCK Trading Basin



Loading & Credit Summary	2012	2013	2014	2015	2016	2017	2018	2019
	Planning Period					*Future Estimates (non-binding)*		
Design Flow (mgd)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Projected Flow (mgd)	5.01	4.39	4.42	4.55	4.69	4.83	4.96	5.12
Projected Avg. Annual Concentration (mg/L)	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00
Discharged Load (end of pipe)	76,291	66,850	53,846	55,429	57,135	58,840	60,424	62,373
Delivery Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Expected Load	76,291	66,850	53,846	55,429	57,135	58,840	60,424	62,373
Delivered WLA	97,458	97,458	97,458	97,458	97,458	97,458	97,458	97,458
Expected Credits (delivered)	21,167	30,608	43,612	42,029	40,323	38,618	37,034	35,085
Transfers In (Out) within Owner Bubble	0	0	0	0	0	0	0	0
Transfers In (Out) from Private Exchange	0	0	0	0	0	0	0	0
WQIF-Held Credits	0	0	0	0	0	0	0	0
Expected Net Credits	**21,167**	**30,608**	**43,612**	**42,029**	**40,323**	**38,618**	**37,034**	**35,085**
Class A Credit Sales (Purchases)	**19,050**	**18,365**	**35,762**	**33,623**	**31,452**	**29,350**	**27,405**	**25,261**
Expected Class B Credits	**2,117**	**12,243**	**7,850**	**8,406**	**8,871**	**9,268**	**9,629**	**9,824**

Source: Virginia DEQ Exchange Compliance Plan 2012 Annual Update

Conclusion

Virginia has pioneered in the development of a nutrient trading system within the Chesapeake Bay watershed. This system has largely worked in practice to facilitate the buying and selling of nutrient credits (offsets) among wastewater treatment plants. Each WWTP is required to achieve a certain maximum level of nutrient load into the rivers of the Bay watershed. Some WWTPs, however, may be able to make reductions in nutrient loadings at considerably lower costs than others. The nutrient trading system allows the lower cost treatment plants to substitute their own reductions for the otherwise mandated reductions of the higher treatment cost plants. In effect, the lower cost plants "offset" the higher nutrient loads of the higher cost plants. In this way, the total cost to Virginia of any given level of total nutrient loadings from WWTPs can be reduced – and in concept even minimized. Virginia offers an example for other Bay states to examine and potentially adopt in part or in full.

Like other Bay states, Virginia has thus far had little experience with nutrient trading or other offset approaches that involved agriculture or other non-point sources. Future greater use of non-point sources to generate trading credits or other forms of offsets raises a number of issues, many of which were examined above in Part II of this report.

Appendix C – Offset Policy Development in Pennsylvania

As in other Bay states, nutrient offsets are expected to play a significant role in the implementation of the Chesapeake Bay TMDL in Pennsylvania. In its Phase 1 WIP, Pennsylvania states that new sewage discharges, for example, will be given a zero load allocation. Hence, where new housing or other development results in additional nutrient flows, it will be necessary to purchase offsets to these flows.

Like all the Bay states, Pennsylvania still must resolve a number of important policy questions, before it will be able to put a working offset system into full practical operation. Figure C-1 shows the offset policy development timeline for Pennsylvania.

Figure C-1 -- Offset Policy Development Timeline for Pennsylvania

Aug 2004	Pennsylvania Department of Environmental Protection (PADEP) submits Draft Chesapeake Bay Tributary Strategy. Announces intent to develop a nutrient trading program
Feb 2006	Pennsylvania Department of Environmental Protection (PADEP) Secretary begins holding Tributary Strategy Steering Committee meetings, including meetings of the Trading Workgroup.
Nov 2006	"Trading of Nutrient and Sediment Reduction Credits- Policy and Guidelines" available for comment.
Dec 2006	"Trading of Nutrient and Sediment Reduction Credits- Policy and Guidelines" is published.
March 2010	PADEP begins first discussions for Chesapeake Bay Watershed Implementation Plan (WIP).
May 2010	Chesapeake Bay Advisory Committee meets to provide guidance to PADEP on the structure of new WIP Management Team and its three workgroups.
July 2010	Pennsylvania Infrastructure Investment Authority (PENNVEST), in cooperation with PADEP, announces the creation of a Nutrient Credit Clearinghouse for the Potomac and Susquehanna river basins.
Sept 2010	PADEP submits Draft Phase I WIP.
Oct 2010	PADEP published 25 Pa. Code § 96.8, entitled "Use of offsets and tradable credits from pollution reduction activities in the Chesapeake Bay Watershed."

Jan 2011	PADEP submits Final Phase I WIP, stating a need for the use of offsets in WIP implementation.
	Dec 2012 PADEP submits Draft Phase II WIP. Introduces the Stormwater Offsetting Policy Workgroup with the expectation of final guidance issued in December 2013.Touts the success of the PA nutrient trading program: since Phase 1 WIP, 34 pollutant reduction activities were submitted for review and 36 pollutant reduction activities have been certified.
March 2012	PADEP submits Final Phase II WIP. Celebrated the success of Lycoming County's cost savings achieved through nutrient trading.Updates accomplishments since Phase 1 WIP: 37 pollutant reduction activities submitted for review and 39 pollutant reduction activities certified. Oversight of the Nutrient Trading Program is moved to the Bureau of Point and NonPoint Sources within the DEP. Future plans include review of stakeholder input, refined plan of action by end of 2012, and information on the consideration of EPA's Tier 1 and Tier 2 recommendations.
July 2012	PA budget requires "a review of the cost, 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" by Dec 2012.

History of Trading and Offsets in Pennsylvania

Pennsylvania and Virginia are the Bay states furthest along in the development of a nutrient credit trading system. That is not to say, however, that the process has been without its difficulties. Pennsylvania's Nutrient Credit Trading Program (NCT), administered by the Pennsylvania Department of Environmental Protection (PADEP), is a voluntary program for National Pollutant Discharge Elimination System (NPDES) by which permit holders reduce pollution in a cost-effective manner. As the program currently stands, only municipal or industrial permit holders may purchase credits; however, Pennsylvania policy is that credit generators need not be permit holders, and may be point or non-point sources. Trades generally may only occur within the same basin, and currently only include the Susquehanna and Potomac basins. Nitrogen, phosphorous, and sediment reductions are all eligible for credit generation. No trades in sediment have occurred to date, although some sediment projects have been certified. The Pennsylvania nutrient trading system follows many of the program guidelines enumerated in the EPA Final Bay TMDL Appendix S, for example, potential credit generators must first meet baseline requirements.[76]

In Pennsylvania, credits must pass through four procedural steps: certification, verification, contract approval, and registration.[77] Other forms of offsets (besides credits), on the other hand, must be approved by DEP regional offices, and do not follow the same review process as formal nutrient trading credits. PADEP uses an online tool called NutrientNet (developed by the World Resources Institute) to estimate potential credits, but does not use the

WRI trading program's online marketplace. Instead, once a credit is approved, it is sold at auction by the Pennsylvania Infrastructure Investment Authority, better known as PENNVEST, the semi-autonomous loan organization of the state.[78] Credits may also be bought and sold privately through contracts; however, by functioning as a clearinghouse, PENNVEST provides greater market certainty than could be achieved through private sales alone. In the most recent auction on September 12, 2012, certified (but unverified) credits were sold for future compliance years:[79]

Sales of Nitrogen in Susquehanna:

2012: 16,650 credits for $3.17 per credit
2013: 3,000 credits for $3.23 per credit
2014: 2,000 credits for $3.23 per credit
2015: 3,000 credits for $3.23 per credit
2012: 2,000 credits for $3.18 per credit
2014: 4,000 credits for $3.18 per credit
2015: 6,000 credits for $3.18 per credit

Sales of Phosphorous in Susquehanna:

2012: 200 credits for $2.60 per credit
2012: 400 credits for $2.25 per credit

Thirty-one separate projects were officially registered in the compliance year of October 2010 to September 2011 for a total of 358,971 lbs. of nitrogen and 10,546 lbs. of phosphorus.[80] Another three million certified credits are ready to be sold at auction.[81] PENNVEST has invested about $100,000 per year to administer the trading program and run auctions. The organization levies fees for its services; however, state support is still needed to fund the program.

While Pennsylvania has been a pioneer in the development of nutrient credit trading markets, EPA has expressed some concerns about the workings of the Pennsylvania trading program and its role in the Bay TMDL implementation. EPA's concern is that Pennsylvania's program of nutrient credit trading was created independently and prior to the Bay TMDL, and therefore does not comply with all the TMDL requirements. As a result, it may not be consistent with EPA's delivery load calculations or baselines required for agricultural non-point sources. In its WIP, Pennsylvania states that it projects no increase in agricultural production, agricultural land, or stormwater loading. EPA considers this to be unrealistic, and has asked for better data from Pennsylvania to support the projections, and/or to establish a sufficient offset program for future growth.[82]

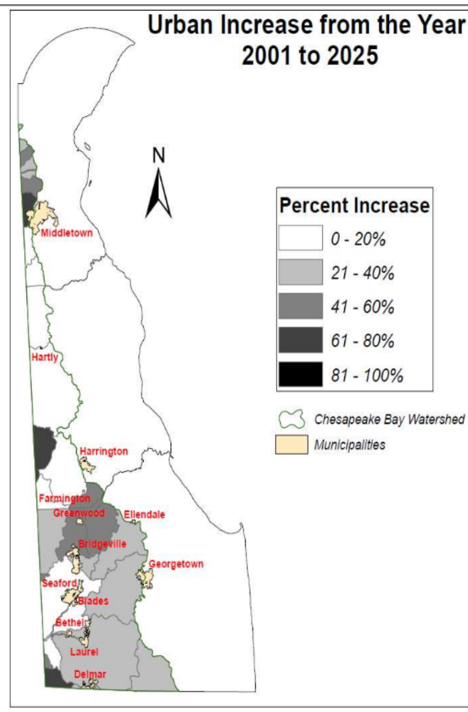
Pennsylvania sets the trading ratio for the nutrient trading system effectively at a ratio of 1.1 to 1, since trades require a 10% credit reserve for unforeseen losses to future reductions. However, in the event that these credit reserves must be applied, the ratio would drop down to a 1 to 1 ratio. EPA wants to ensure that Pennsylvania does not overestimate nutrient load reductions by counting reserves that are designed to safeguard against the unforeseeable.

In 2008, Lycoming County was faced with a major issue: seven wastewater treatment plants (WWTP) in need of $225 million in upgrades. To address this problem, Lycoming created a county-based nutrient trading program that followed the outline of the PADEP program. The Lycoming County Conservation District calculates credits, and DEP certifies them through the state's trading program. One WWTP in the county has already estimated that it can save $1.2 million over a 20 year period by purchasing credits rather than expensive upgrading.

Appendix D – Offset Policy Development in Delaware

Delaware's population increased from 783,600 in 2000 to 897,934 (14.6%) in 2010 (14.6%).[83] The US Census projects that it will increase by 29.2% from 2000 to 2030.[84] Most of this, however, was outside the Chesapeake Bay watershed. The number of people living in Delaware's Chesapeake Bay Watershed, based on the 1990 census, was approximately 63,000 persons.[85] Though the towns within Delaware's portion of the Chesapeake Bay Watershed are predominantly small, the established growth pattern throughout the state nevertheless is suburban sprawl which will result in more land consumed per capita.[86] As a result of this residential growth pattern so far, land use for agriculture has decreased 42,305 acres (7%), natural areas have decreased 16,116 acres (9%) and developed lands have increased 35,346 acres (272%) since 1984.[87] Urban growth is projected to continue in Delaware's Chesapeake Bay Watershed through the 2025 TMDL timeline. Figure D-1 shows anticipated percentage urban land increases from 2001-2025 for particular areas within the Bay watershed.

Figure D-1. EPA Estimated Urban Increase from Year 2001-2025 in Delaware



Source: Phase 2 Delaware Watershed Implementation Plan

Delaware has considered two alternative methods for addressing such increasing population and growth. One approach would estimate the load increases that will result from future growth and adjust the current Delaware TMDL plans to take account of this growth in order to meet the 2017 interim target and the 2025 target (assuming such growth). This strategy would require significant additional planned reductions in nutrient loads from existing sources in Delaware. Alternatively, Delaware can simply require that any new growth that occurs must obtain offsets to compensated for the increased nutrient loads that it will create.[88] Delaware would not have to project the growth and adjust its plans but developers and governments would be required to take offsetting actions that prevent the growth from exceeding nutrient targets.

Delaware has determined that information is lacking to accurately target nutrient loads that will result from future growth. In addition, it will be difficult to meet the required reductions from existing sources, even without taking account of future growth. Delaware therefore has decided to pursue an offset program. Overall, quantifiable and accountable offsets of new or increased loads will be required.

Status of Offset and Trading Program

Delaware does not currently have a nutrient trading program and does not believe large-scale formal trading will be necessary.[89] The state is starting with a simple offset approach rather than a full nutrient trading program for several reasons. First, there has been much skepticism from the agricultural community regarding full-scale nutrient trading.[90] There appears to be a wide view among farmers that they would prefer to participate in a voluntary BMP program to meet load reductions, such as installing riparian buffers. It helps that such BMP programs traditionally have been cost-shared with the federal government or the Delaware Department of Agriculture (DDA), which is both familiar and has long had an established financial incentive system for conservation practices.

According to Mark Davis from DDA, it was developers who were pushing for a trading program in order to get load reductions from agriculture. Farmers, however, perceive this as requiring agriculture to bear the burden for increasing development.[91] There is a general attitude that developers should have to "pay their way" instead of buying their way out of their impacts on water quality through the use of policies such as nutrient trading. Davis says Delaware farmers are used to working together and with DDA, so part of the resistance may come from unwillingness to work with developers or DNREC (who would manage any trading program), parties who are not as familiar.

However, to increase BMP cost-share programs would require finding more money from the federal or state governments. In contrast, nutrient trading would require that developers pay for reductions. Given the current fiscal situation of the federal government, it may be difficult to find additional funding for BMP cost-sharing from government sources.

Another factor is that a full 10% of land in Delaware's Chesapeake Bay Watershed, or 40,000 acres, is owned by the state; this includes 3,500 acres of agricultural land that is leased.[92] Land that is owned by the state should already have BMPs or be under state commitment to establish BMPs. It might therefore not be eligible for credit generation; this is a significant amount of land area that perhaps could not be used for the purposes of a nutrient trading program.[93]

The Delaware stormwater regulation will mandate compliance with new standards and include a fee-in-lieu option.[94] Buying nutrient credits could provide a flexible option for developers who cannot meet all requirements on-site, but a large-scale trading program may not be necessary.[95] It is still unclear whether nutrient credits for off-site mitigation will be in high demand or if most developers will be able to install the required stormwater mitigation on-site.[96]

Finally, with three out of four WWTPs in the Delaware portion of the Bay watershed operating well below permitted nutrient loading levels, there does not seem to be a need for an official nutrient trading program for this sector, especially when considering the projected load reserves by the 2025 timelines.[97] However, the EPA has suggested that "Delaware may need to offset any planned increases in wastewater loads from current loads in future milestones by reductions within other sectors."[98] In other words, Delaware WWTPs will not reach full capacity utilization for a long time and investing in expensive upgrades to that capacity does not make sense at this stage; however, if WWTPs do reach their proposed load allocations in the future, agricultural nutrient credits could be a more flexible and a less expensive solution.[99]

Currently, Delaware believes that there are two likely scenarios to address growth and WWTPs that have reached their load limits: the facilities may include more spray irrigation of wastewater or the facilities may enter into a nutrient trading program. As a result, the possibility of a nutrient trading program remains under consideration, but again it may not be implemented until further in the future.

Current Less Formal Offset Strategies

An offset program can still be adopted without going all the way to the adoption of a full scale nutrient trading system. Currently Delaware is pursuing two linked offset tracks to meet TMDL requirements: an offsets program for stormwater and an offset program for all land use changes. These two tracks have three implementation phases: Phase I established a fees-in-lieu program for stormwater (2011), Phase II establishes a statewide program that provides additional flexibility for offsets and will begin to identify offset "hotspots" or priorities (2013), and Phase III will determine whether to engage in a broader, market-based nutrient trading program that includes point sources, agricultural BMPs and multi-state trading (2017). Table D-1 shows the timeline for the development of the Delaware offset program as follows.

Table D-1 Delaware Offset Timeline

2000:	First time Delaware is included in Chesapeake Bay clean-up efforts. Signing of a multi-jurisdictional Memorandum of Understanding, committing signers to achieve water quality goals to protect and improve the Bay and tributary waters. Signers included the District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia, New York, Delaware, the US Environmental Protection Agency (EPA), and the Chesapeake Bay Commission (CBC).
May 12, 2009:	President Obama signs Executive Order 13508, placing increased focused on Bay Restoration since 2000 goals were not met.
Nov. 29, 2010:	Delaware submits Final Phase I WIP to the EPA.
Dec. 29, 2010:	Final TMDL established. Delaware meets the nutrient and sediment allocations in the final TMDL. Delaware's Phase I WIP established load allocations that were 3%, 12% and 33% under the nitrogen, phosphorus and sediment allocated by the EPA, respectively. Delaware applied the reserve loads back to the nonpoint source agriculture allocation.
Nov. 11, 2011:	Delaware revised CAFO regulations became effective.

December 2011: Start Action Notice: to begin developing regulations for offset program.

March 30, 2012: Phase II WIP submitted

Summer 2012: Sediment and Stormwater Program revisions to be finalized.

2013: Phase II of Delaware's offset program. Develop an implementation plan and identify priorities for statewide offsets (i.e. hotspots).

Delaware is considering allowing offsets to occur outside a sub-watershed but within a designated local basin.[100] A credit registry will be used for the statewide nutrient offset program and will keep track of credit exchange, but it will not result in a full-blown trading program that includes the aggregation of BMPs into tradable credits.

Stormwater Offsets

A new statewide Sediment and Stormwater Regulation effective in 2012 will develop an offset program for stormwater runoff. In order to establish a baseline, the new regulations will focus on water quantity instead of quality, similar to the District of Columbia (see below). Delaware has not yet determined baseline loads but will likely set them based on the assumptions and requirements of the TMDL.[101] The DNREC will not be taking an equivalent residential unit (ERU) approach for stormwater offset measurements.[102] The stormwater volume will be calculated by an updated version of the Delaware Urban Runoff Management Model (DURRM). The structure of the initial offset program will be managed by DNREC, but Delaware is considering allowing local jurisdictions to manage their own offset programs with approval.[103]

Stormwater Fee-In-Lieu

The DNREC will also establish a fee-in-lieu system as an alternative to the offset program for stormwater. If site constraints prevent complete on-site stormwater retention, then the fee will allow the DNREC to fund an offset on another site within the same basin.[104] Delaware used the District of Columbia's preliminary analysis of stormwater retention as support for the fee: if a portion of retention is retained off-site, the overall annual retention will increase because the amount of treated impervious surface increases and most rainfall events will not reach the maximum retention of 1.2 inches.[105] The fee will amount to $23 per cubic feet of volume of stormwater runoff and will be based on the greatest shortfall: either runoff volume reduction needed or pollutant reduction needed.[106] An analysis by the Center for Watershed Protection assisted in arriving at the $23/cu. ft. fee by taking into account the costs of implementing on-site accepted BMPs on new and redeveloped projects.[107] The DNREC is also considering an additional per-project fee rather than per-cubic foot, as well as establishing criteria for when the fee is allowed to be used by developers.[108]

Despite the initial timeframe of 2012 for the Sediment and Stormwater Regulations revisions to be complete, it does not look likely that the regulations will go into effect before the end of 2012.[109] So far, no fees have been collected and the determinations of which entities may collect fees, how the fees will be collected and spent, and how projects will be prioritized is yet to be determined, but will most likely be included in the regulation revisions.[110] The DNREC is also considering funds collected from the fee to be eligible to be used at the local government levels or by conservation districts.

Septic System Offsets

To address septic systems' loads in Delaware, an offset program for new net loads from development with on-site septic systems is in the process of being developed.[111] The DURMM will take the first attempt at calculating the loads from development and work to refine the tool for wastewater from septic systems.

Since Delaware's offset and nutrient credit program is still in development, the impact of the system is difficult to measure. It seems most likely that offsets will be used by nonpoint sources primarily and will occur in limited geographic areas in order to address local water quality first along with the Chesapeake Bay. The structure of the offset and eligibility of credit generation is still undecided and, therefore, so are the overall impacts.

Delaware's Phase 2 WIP met EPA expectations.[112] In regards to Delaware's offset and trading strategies, EPA believes that Delaware will be able to accommodate new loads with the new stormwater regulations, a fee-in-lieu program and offsets for residual nutrient loads (including from septic systems) from another site within the same basin as planned. Increasing the use of offsets will support increased BMP implementation by creating an economic incentive. Overall, EPA will be maintaining standard regulatory oversight for Delaware to ensure that commitments are implemented, which may include conducting stormwater assessments and NPDES permit reviews.[113]

<u>Conclusion</u>

Unlike Virginia and Pennsylvania, Delaware has thus far focused its offset policy on less formal systems than a full fledged nutrient credit trading system. Instead, Delaware has sought to determine in what circumstances a developer would be required to obtain an offset and how large this offset might have to be. It has also sought to determine how offsets would be generated and how they would be calculated and verified. In what circumstances, for example, would load reductions achieved in agriculture be counted as offsets. Given the particularly high cost of reducing stormwater nutrient flows, Delaware has been concerned to establish offset policies for stormwater. Developers might obtain offsets through bilateral negotiations with individual farmers or other parties, although aggregators might also have a role to play.

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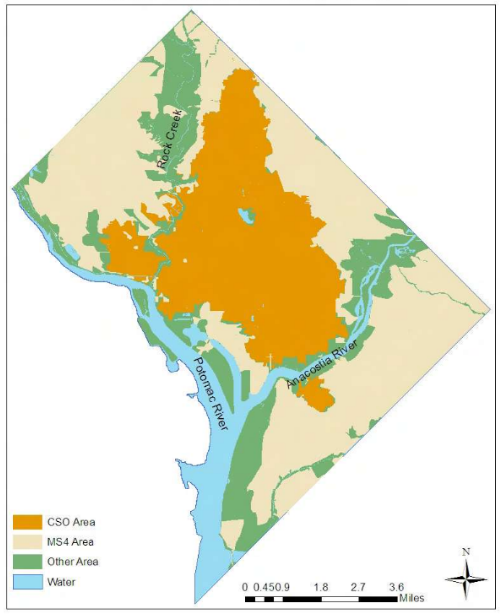
Appendix E – Offset Policy Development in the District of Columbia

Unlike the six Chesapeake Bay watershed states, the District of Columbia has no agricultural lands that serve as a source of nutrient loads to the Bay. To the extent that forthcoming offset policies in the six Bay states assume that agriculture will be a major source of cost-effective offsets, this circumstance thus does not apply to the District. Also, the District is not served by septic systems, so they will be neither a source of purchasers of offsets nor a potential supplier of offsets. A large part of the District nutrient flow comes from combined sewer overflows (CSOs) but there are no plans at present to require the acquisition of offsets to these flows. Instead, as described below, the District is seeking to minimize CSOs by reducing stormwater flows at the source and by building large additional underground storage capacities for use during heavy rainfall periods.

As shown in Figure E-1, approximately two-thirds of D.C. is served by separate stormwater and sewage systems. The separate stormwater systems are regulated under NPDES MS4 permits, which control specific polluters or areas that emit to MS4s.[114] The EPA is the NPDES permit authority for the District of Columbia.[115] Given the small size of the District and extensive coverage of MS4 permitted areas, a major source of future District TMDL reductions will come from enforcing the new MS4 retention standards.[116] According to these standards, any disturbance of land over 5,000 square feet will be responsible for the retention at the site of a minimum of 1.2 inches (1.2") of stormwater. Based on anticipated development and redevelopment rates, approximately 1% of the District's total land area will have to newly meet the new MS4 permit retention standards each year, which will have a substantial impact over time.[117] Reduction strategies for nonpoint sources in MS4 areas will result in an 11% decrease in nitrogen, 27% decrease in phosphorus and 26% decrease in sediment loads that the District MS4 area contributes to the Chesapeake Bay.[118]

Figure E-1 District of Columbia Drainage Boundaries for the CSO, MS4, and Direct Drainage (Other)



Source: Phase 1District of Columbia Watershed Implementation Plan

<u>The District Offset and Trading Program</u>

The District Department of the Environment (DDOE) will enforce the new mandated 1.2" retention standard. As part of its efforts to control stormwater flows, it is pioneering the development of an offset program within the District stormwater sector. According to DDOE, the offset program has the potential to result in greater stormwater reductions than just strict on-site retention.[119] A minimum baseline on-site retention standard has yet to be developed but will be included in the forthcoming Stormwater and Erosion Control regulations.[120] The District's offset program is projected to in place in 2013.[121] Table E-1 shows the timeline for offset program development in the District as follows.

Table E-1 Offset Timeline for District of Columbia

1994:	Combined Sewer Overflow (CSO) Policy—led to Long Term Control Plan (LTCP) for controlling CSOs.
April 19, 2000:	EPA Grants MS4 permit to DC
2000:	From 1985 to 2000, total nitrogen reduced by 40% and D.C. met the assigned goal before any other state was able to. Reductions primarily came from Blue Plains' upgrades (which contributed approximately 90% of the nitrogen load from D.C.). Phosphorus reductions were not met by 2000.
2000:	Passage of Wet Weather Water Quality Act of 2000. LTCP Program Plan

submitted.

2002: DC WASA submits final Long Term Control Plan (LTCP) to EPA in 2002, which was approved. CSOs remaining after the plan will not preclude water quality standards. No effluent limitations for Blue Plains set.

2004: D.C. Nutrient and Sediment Tributary Strategy: Collaborative partnerships in which DDOE participates.

2005: Consent Decree: DC WASA accused of violating the CWA and DC WQS. The LTCP was to be modified in response, which required planned nutrient, sediment and flow reductions.

February 2007: District Department of Environment (DDOE) established new District Stormwater Program and is responsible for managing District's MS4 Permit.

April 5, 2007: US EPA issued modifications to DC WASA's NPDES permit to include total nitrogen effluent limitations for Blue Plains Advanced Waste Water Treatment Plant.

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2007: Flow allocations among jurisdictions that discharged to Blue Plains (D.C. Maryland and Virginia) agreed to flow allocations through the Inter-Municipality Agreement.

2009: Upgraded D.C. Stormwater Management Plan, identifies how the District will implement the coming year's stormwater programs, outlines goals, outcomes to achieve. Federal grants.

2009: Energy Independence and Security Act of 2009 directs federal agencies to manage stormwater on-site better. Any agency facility that exceeds 5,000 square feet shall use site planning, design, construction, maintenance strategies. Established the 1.7" standard on-site for federal agencies.

Sept. 30, 2010: New NPDES permit for Blue Plains. Limits at 4,377,580 pounds of total nitrogen, .18 mg/L total phosphorus, and 7 mg/L total suspended solids (TSS). Nitrogen loads were not being met in 2010. Upgrades to the facility must be operational by 2014 and in compliance by 2015.

Early 2012: Stormwater regulation and Stormwater Retention Credit (SRC) Program: D.C. circulates regulations for 60 day public comment period Stormwater Management Guidebook is currently being updated to include how MS4 sites can use SRCs or fees to meet retention requirements. There will be a chapter on generation, certification and ownership of SRCs.

Summer 2012: Stormwater: D.C. finalizes Stormwater and Erosion Regulations, containing offset, trading and fee elements.

April 2, 2013: MS4 permit deadline for new stormwater regulations to take effect

The Stormwater Retention Credit (SRC) Market

No private market for SRCs currently exists, but DDOE will be solely responsible for credit certification and monitoring between buyers and generators.[122] Any transfers of SRCs between buyers and sellers will require an application signed by both parties.[123] The DDOE will help to facilitate SRC transfers by maintaining a list of SRC owners for potential buyers. Any party within D.C. may purchase or produce SRCs and credits may be used anywhere throughout the District. Areas that are most susceptive to localized water quality impacts (upstream) are actually more likely to have high implementation rates of required retention standards and SRC use.[124] The DDOE may also establish a credit banking system if deemed appropriate.[125] The possibility of using third party aggregators for a credit banking system is being discussed.

Although official eligible SRCs will most likely be established with the release of the updated Stormwater Management Guidebook in 2012, the current version of the Guidebook lists six acceptable groups of BMPs that can be used to meet stormwater water quality criteria that most likely will translate to SRCs.[126] These six groups include filtering systems, infiltration practices, storage practices, stormwater ponds, stormwater wetlands and open channels. To be considered a BMP, the design of the established practice must capture and treat the full water quality volume and have an acceptable longevity rate in the field.

Offset Ratios

Currently, development sites within D.C. MS4 areas require a 1:1 offset ratio for any retention unable to occur on-site but still within an MS4 area.[127] Additionally, the District law requires a 1.5:1 ratio for off-site mitigation performed in combined sewer and stormwater areas and a 2:1 ratio for fees-in-lieu for public or publicly financed projects in the Anacostia Waterfront Development Zone, which is an area that is experiencing growth.[128] These ratios encourage retention for development within MS4 areas to be done on-site or in other MS4 areas instead of conducting extra mitigation at combined stormwater and sewer sites or using the fee option (unless these options are cheaper). However, it has been discussed by DDOE to amend the law to allow 1:1 ratios for the Anacostia Waterfront Development Zone to encourage offsets to be provided in this area.[129] Another discussion is whether or not ratios should be set higher in order to develop a bank of insurance, or a margin of safety.[130] Regardless of the outcomes of these discussions, major stormwater reductions are expected as a result of the established retention standard changes, which facilitates redeveloped sites that retained little or no stormwater previously to now have the capability and other sites that were unlikely to be retrofitted in the near future will benefit when offsets are created.

Credit Calculation

The District is focusing on water quantity rather than quality when measuring retention, reductions and credits. An SRC will be equal to one gallon of retention capacity for one year and DDOE intends to certify credits for three years at a time.[131] The DDOE accounts for the possibility of degradation of practices over time by establishing mandatory maintenance requirements and inspections to be conducted during the three-year credit period. In the future, inspections may be carried out by third-parties or a blanket-approval system of certain types of stormwater management plans (SMPs) may be established. Sites that fall under the retention standard would have to continue to purchase and use SRCs or pay the fee-in-lieu to meet any volume not retained on site. The DDOE will not certify SRCs for the preservation of existing retention or SRCs outside the District.

To generate SRCs, development activity within the regulated MS4 areas must exceed their minimum requirements of 1.2" retained while non-MS4 sites must only exceed their current retention levels. The DDOE is planning to cap the SRC retention limit of any site at 1.7" of retained stormwater so credits cannot be generated past that maximum level. All sites must install SMPs, pass inspection and be subject to regular, ongoing maintenance before credits can be certified.[132]

Fees-In-Lieu

Fees-in-lieu of retention requirements will be paid annually to DDOE to establish off-site retention practices required by development activity within MS4 areas for sites that cannot completely meet the retention standard.[133] However, MS4 development sites will still require a minimum retention level on-site (i.e. a site cannot pay to cover the entire 1.2" retention capability off-site), which will be decided in the updated Stormwater Management Guidebook. The District has established that the fee must be high enough to cover all the costs DDOE will face when installing and maintaining off-site retention practices. The DDOE expects the fee to have a higher cost than the SRCs, which will discourage its use and, therefore, DDOE's active involvement in creating offsets.

More in-depth calculation standards of SRCs and the stormwater fee will be included in the updated Stormwater Guidebook. Revisions will be based on the Center for Watershed Protection's Runoff Reduction Method. There are no current measures being used by the District that account for the distance of runoff between generating and acquiring sources that could affect water quality.[134]

Tracking Credits and Loads

The DDOE will be responsible for tracking and safeguarding against double-counted SRCs by labeling each credit with a unique serial number and storing information on SRCs in a database.[135] Though loads are not required to be tracked by the stormwater management regulations, DDOE is required to track stormwater retention volumes.

Since development in the District is almost entirely redevelopment, the offset and trading program is expected to be very successful in achieving reductions. The MS4 Permit 1.2" retention standard is projected to achieve required load allocations while SRCs and fees will allow for flexibility and reduced costs by creating a market for stormwater retrofits of existing impervious surfaces that would otherwise be unlikely to be redeveloped.[136]

The DDOE strongly believes that the SRC offset and trading program will result in greater reductions than full on-site retention alone. This assertion is supported by a study conducted by the World Resource Institute (WRI) which compared two stormwater scenarios and found that a mixture of on-site and off-site retention practices resulted in greater annual volume retained as well as reduced costs to accomplish the retention standard.[137] The primary explanation is that many D.C. storms produce less than 1.2" of stormwater volume and therefore do not require the entire 1.2" retention capacity of SMPs on-site to be effective. By combining on-site and off-site mitigation, each site used their full retention capacity more frequently and annual retention totaled from both sites was approximately 53% higher than on-site alone.

The District government is the only NPDES point source currently expected to use SRCs or a fee-in-lieu to meet the retention standards, which will result in equal or greater load reductions.[138] Other NPDES sources in D.C. are not expected to use SRCs or fee-in-lieu because the retention standard for new and redevelopment will be possible on-site. The District is heavily built out and increased loadings from new development are not expected to be significant, but the offset program should provide for significant load reductions from existing development as retention standards are increased or retention on-site becomes more difficult.[139]

The Environmental Protection Agency (EPA) recommends D.C. milestones to have a fully effective offset program in place by December 2013 for sectors with planned new or increased loadings. The EPA expects D.C. to explain how new or increased loads that occur prior to the offset program in 2013 will be addressed, though D.C. appears to be making the case that there will be no new or increased loads to consider.[140] Though the District has established a 1:1 ratio for offsets, the EPA also suggests D.C. consider whether redeveloped areas will have the same or smaller loadings than pre-development use.[141] Overall, EPA is comfortable with the District's progress but wants to keep the door open for conversation as the District's situation changes and load allocation reduction needs become clearer.[142]

Appendix F – Chesapeake Bay Trading and Offsets Workgroup Membership

- **Evan Branosky(Chair)**, World Resources Institute
- **John Rhoderick(Vice-Chair)**, Maryland Department of Agriculture
- **Patricia Gleason(Coordinator)**, U.S. Environmental Protection Agency - Region 3
- **Victoria Kilbert(Staff)**, Chesapeake Research Consortium
- **Dan Baldwin**, Maryland Department of Planning
- **Russ Baxter**, Virginia Department of Environmental Quality
- **Vasco Bilbao-Bastida**, Linden Trust for Conservation
- **Allan Brockenbrough**, Virginia Department of Environmental Quality
- **Kevin DeBell**, U.S. Environmental Protection Agency
- **Olivia Devereux**, Devereux Environmental Consulting
- **Ron Entringer**, New York State Department of Environmental Conservation
- **David Foster**, Chester River Association
- **Dana Greenlee**, U.S. Environmental Protection Agency - Region 2
- **Joseph Hankins**, The Conservation Fund
- **Roy Hoagland**, HOPE Impacts, LLC
- **George Kelly**, Environmental Banc & Exchange, LLC
- **Teresa Koon**, West Virginia Department of Environmental Protection
- **Doug Lashley**, GreenVest, LLC
- **MaryaLevelev**, Maryland Department of the Environment
- **Audra Lew**, Interstate Commission on the Potomac River Basin (ICPRB)
- **Carl Lucero**, U.S. Department of Agriculture (USDA)
- **Paul Marchetti**, Pennsylvania Infrastructure Investment Authority
- **Joseph Maroon**, Maroon Consulting
- **Beth McGee**, Chesapeake Bay Foundation
- **Eileen McLellan**, Environmental Defense Fund
- **Matt Monroe**, West Virginia Department of Agriculture
- **Dave Montali**, West Virginia Department of Environmental Protection
- **Susan Frick Payne**, Maryland Department of Agriculture
- **MarelRaub**, Chesapeake Bay Commission
- **Bob Rose**, U.S. Environmental Protection Agency Office of Water
- **Glynn Rountree**, National Association of Home Builders
- **Kevin Schneider**, GreenVest, LLC
- **Mindy Selman**, World Resources Institute
- **Albert Todd**, Alliance for the Chesapeake Bay
- **Roger Ullman**, Linden Trust for Conservation
- **Jennifer Volk**, Delaware Department of Natural Resources and Environmental Control
- **Lee Ann Walling**, Delaware Department of Natural Resources and Environmental Control
- **Julie Winters**, U.S. Environmental Protection Agency
- **Andy Zemba**, Pennsylvania Department of Environmental Protection

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