Using Nutrient Credits and Offsets To Achieve Stormwater Compliance with the Chesapeake Bay TMDL: A Discussion Paper

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Abstract

Nutrient credit trading in the Chesapeake Bay watershed offers both risks and opportunities for meeting total maximum daily load (TMDL) nutrient reduction targets. Although most of the Bay states and the District of Columbia have already established nutrient trading or offset programs, the vast majority of trades have involved wastewater treatment plants, with little involvement from the stormwater sector. The Bay jurisdictions are now more fully exploring the role of stormwater compliance credits in state nutrient trading programs.

This paper discusses the potential to generate and purchase nutrient offsets and/or credits as a compliance option in response to the Chesapeake Bay TMDL and state stormwater regulations. We present a summary of the requirements for stormwater permittees who must comply with state stormwater regulations and the challenges of compliance with the Chesapeake Bay TMDL. We discuss three scenarios to generate and purchase stormwater credits and offsets as part of a potential structure for achieving future compliance.

Figure 1. Chesapeake Bay watershed. Source: Courtesy of USEPA (Chesapeake Bay TMDL webpage: http://www.epa.gov/chesapeakebaytmdl/)

Urban Stormwater and the Chesapeake Bay TMDL

Compliance with stormwater regulations in the Chesapeake Bay watershed (Figure 1) has recently become more complex with the development of a Bay-wide total maximum daily load (TMDL) for nitrogen, phosphorus, and sediment. The TMDL establishes a comprehensive "pollution diet" with rigorous accountability measures to achieve the water quality standards for the Chesapeake Bay and its tidal tributaries (US Environmental Protection Agency [USEPA] 2010a). This requires reducing nitrogen by 25%, phosphorus by 24%, and suspended sediment by 20% by 2025. To meet these load reductions, each of the six Chesapeake Bay states and the District of Columbia developed a watershed implementation plan, or WIP.

Urban stormwater is one of the major sources of pollution in the Bay. Because the TMDL essentially caps the total nutrient and sediment load to the Bay, any new or increased loads of these pollutants must be either (1) accounted for in the TMDL waste load allocation (WLA)[1] or load allocation (LA)[2] or (2) compensated for (offset) by reductions from other sources or additional reductions from the same source. USEPA allows for such offsets, provided they are generated under programs having certain common elements described in Appendix S of the TMDL (USEPA 2010a). In this paper, a unit of pollutant reduction (e.g., pounds per year of phosphorus) is an *offset* if it is used to counterbalance the loading of that same pollutant from a new or increased discharge; it is a *credit* if it is used to help an existing discharger achieve a pollution cap.

[1] The amount of pollution from existing point sources, including regulated municipal separate storm sewer systems (USEPA 2010b).
[2] The amount of pollution from existing nonpoint sources and natural background (USEPA 2010b).

It is unclear how Bay states and the District will implement policies for offsetting new loads, given that these policies are still under development and are quite variable in their approaches. For example, in Maryland, observers expect that developers will offset new loads using on-site best management practices (BMPs) and will purchase credits from the trading market (Accounting for Growth Workgroup 2013). In Virginia, offsetting some new source loads from development may become the responsibility of the municipal separate storm sewer systems (MS4s), although it is unclear how offsets for development outside of the MS4 boundaries, where much of the growth is likely to occur, will be accomplished. States have the option to demonstrate that a formal offset program is not necessary because loads from growth are sufficiently controlled by existing regulation and local planning. USEPA's requirements regarding this option remain unclear, and states generally have not yet arrived at policy approaches to address it.

This paper identifies key issues related to generating and purchasing nutrient offsets and credits as a means of stormwater compliance in response to the Chesapeake Bay TMDL and state stormwater regulations. MS4 communities and companies engaging in new development or redevelopment are the most likely purchasers of credits and offsets to meet their regulatory requirements, as described below.

The Challenges of Compliance with the Bay TMDL

Municipal Separate Storm Sewer System Permits

Section 402 of the Clean Water Act regulates stormwater discharges through the National Pollutant Discharge Elimination System (NPDES). According to USEPA (2010a), 423 communities in the Bay watershed are currently regulated under the NPDES MS4 permit program. Permits for MS4s are typically issued by the states (or by USEPA, as is the case for the

District of Columbia) on a five-year cycle; these permits require the development and implementation of a comprehensive stormwater management program to reduce stormwater discharges to the maximum extent practicable. Phase II MS4s, which are usually covered under a general permit, are required to implement six minimum programmatic measures as well as special conditions for TMDL compliance. Individual permits are developed for Phase I communities; in the Bay watershed, states have taken variable approaches regarding these requirements. Permits for the first permit cycle following development of the Bay TMDL have recently been drafted and/or finalized for the Bay jurisdictions. This "new generation" of MS4 permits generally include provisions for actions to meet the WLAs from all applicable TMDLs, including the Chesapeake Bay TMDL. The permits often describe these provisions as a suite of acceptable or minimum BMPs or performance standards (e.g., required level of treatment based on impervious cover or runoff volume) because of the challenges associated with establishing and enforcing numeric effluent limits (e.g., loads or concentrations) at each MS4 outfall. Table 1 presents some examples of the approaches of various Bay jurisdictions.

Table 1. The new generation of MS4 permits in the Bay: Requirements for the Chesapeake Bay TMDL.

Permit	Special Conditions for the Chesapeake Bay TMDL
Baltimore City, Maryland, MS4 Permit (Phase I, draft)	• Requires coordination with the Maryland WIP • Permit is regulatory backbone for meeting the Chesapeake Bay TMDL
Virginia General Permit (Phase II, final)	• Requires each MS4 operator to develop a Chesapeake Bay TMDL action plan that establishes required load reductions (using calculation tables provided) and identifies milestone activities and BMPs to achieve these reductions • For the current permit cycle, requires each operator to implement measures to

Permit	Special Conditions for the Chesapeake Bay TMDL
	reduce loads from new and existing sources equal to 5% of the total reductions specified in the Phase 1 WIP (total reductions to be accomplished by the end of the third permit cycle) • The operator may use a trading or offset program, in accordance with statutes and (still-evolving) regulations
Pennsylvania General Permit (Phase II, final)	• Requires each operator to develop a Chesapeake Bay pollutant reduction plan, which can be based on MS4 TMDL plans that address local nutrient or sediment TMDLs • Each plan must incorporate BMPs that reduce nutrients and sediment and are consistent with the Pennsylvania WIP • Each operator must ensure implementation of the plan and report on its implementation and pollutant reductions • Operators may participate in an approved trading and offset program
District of Columbia MS4 Permit (Phase I, final)	• Requires the District to develop, for each TMDL WLA assigned to the District, a consolidated TMDL implementation plan that supersedes any previous TMDL implementation plans • Each plan must be fully implemented upon USEPA approval • Each plan should include a schedule for compliance that includes numeric benchmarks specifying annual pollutant load reductions and actions to meet the

Permit	Special Conditions for the Chesapeake Bay TMDL
	benchmarks

Sources: USEPA Region 3 2012; Maryland Department of the Environment 2012; Commonwealth of Pennsylvania 2012; and Virginia Administrative Code (9 VAC 25-890-40).

The fairly generic permit requirements to develop and implement plans to achieve the required reductions are representative of the fundamental challenge of determining compliance with water quality provisions when it comes to stormwater (compared to the more quantitative numerical discharge limits in wastewater and other discharge permits). Although MS4s are regulated as if each were a single point source, an MS4 is actually a collection of numerous outfalls, into which nonpoint source runoff from parking lots, rooftops, streets, and urban lawns flows. Despite the numerous studies to identify and quantify pollutant loads from stormwater runoff, our knowledge about the sources of existing urban pollutant loads is still evolving because of the highly variable stormwater flow influenced by site and drainage area characteristics (National Research Council [NRC] 2009). Pollutant removal performance of stormwater BMPs is also highly variable and is affected by use of proper design, construction, and maintenance techniques (NRC 2009; NRC 2011). These factors create difficulties regarding how to quantify, track, and verify pollutant loads and reductions from urban areas, which must be done to calculate offsets in trades involving urban practices.

One compliance option for MS4s is to meet their permit requirements entirely within the MS4 boundaries. For most jurisdictions, this would require extensive implementation of BMPs, mostly through retrofits, which can be expensive because they typically involve modifying existing infrastructure. Recently, the World Resources Institute reported that stormwater retrofits cost upwards of $500 per pound of nitrogen removed, compared to $90 per pound for stormwater management on new development, $15 to $47 per pound for wastewater treatment plant (WWTP) upgrades, and less

than $5 per pound for agricultural BMPs (Jones et al. 2010). King and Hagan (2011) report costs for urban stormwater BMPs in Maryland that, when coupled with pollutant reduction costs calculated using Bay Model assumptions, result in a range of $250 to $12,000 per pound of nitrogen removed.

Site constraints, such as poor soils, limited space, and utility conflicts, also limit how much of the urban landscape can feasibly be retrofitted (Schueler et al. 2007). In a review of data over the past few years from retrofit inventories in Virginia, the Center for Watershed Protection found that, of the area assessed, only about 6% to 24% could feasibility be treated with retrofits because of the constraints noted above, with the higher end of the range reflecting more suburban conditions (Center for Watershed Protection, unpublished data). Another challenge is that, to achieve the required level of pollutant reduction through this method, many retrofits would need to be installed on privately owned land. The purchase of nutrient credits could allow for compliance at a significantly lower cost and could incentivize property owners to be more receptive to retrofitting because an economic value is assigned to the water quality improvement.

State Stormwater Regulations for New Development and Redevelopment

New development and redevelopment represent another major source of stormwater discharges that are regulated under the NPDES program. All new construction disturbing at least 1 acre must comply with states' versions of the construction general permit as well as any postconstruction standards contained in state or local codes and regulations. Redevelopment projects are also subject to stormwater requirements, but these are sometimes less stringent than for new development. In many situations, redevelopment may actually result in a net reduction of pollutants (i.e., when a highly impervious site with no prior stormwater management is redeveloped to provide at least some water quality treatment and/or reduce imperviousness).

Table 2 summarizes the major requirements for stormwater management on new development and redevelopment sites in the Bay states as well as any alternatives to on-site compliance that may exist in state stormwater standards or regulations. These alternatives may include the purchase of offsets, as discussed in this paper, or other available options, such as making a fee-in-lieu payment to the locality or finding and building a suitable off-site BMP. These latter options are not considered trades in the context of this paper, but they do fit into the broader universe of off-site compliance.

Table 2. Bay state stormwater standards for new development and redevelopment.

State	Performance Standard	Applicability	Alternatives to On-Site Compliance
DC	On-site retention of runoff from the 1.2-inch rainfall event	Disturbances greater than 5,000 square feet	In-lieu fee or purchase of stormwater retention credits
DE	*New development:* Provide runoff reduction to result in zero effective impervious cover for the resource protection event *Redevelopment:* 50% reduction in existing effective impervious cover for the site	Disturbances greater than 5,000 square feet	Off-site compliance, banking, trading, or in-lieu fee
MD	*New development:* Use environmental site design to the maximum extent practicable to achieve runoff for woods in good	Disturbances greater than 5,000 square feet	Alternatives available for redevelopment only

State	Performance Standard	Applicability	Alternatives to On-Site Compliance
	condition *Redevelopment:* Reduce existing impervious cover by 50% or treat runoff from 1 inch of rainfall (or combination)		
NY	*New development:* Provide runoff reduction for a minimum fraction of WQ_v for the 90^{th} percentile rain event *Redevelopment:* Either (1) treat 25% of WQv by reducing runoff or impervious cover or by using BMPs or (2) treat 75% of WQv with alternative practices	Disturbances greater than 1 acre	Offsets allowed in areas where MS4 operates a qualifying program
PA	*New development:* No increase in total runoff volume for all events up to the two-year storm *Redevelopment:* Treat 20% of existing impervious cover as if it were meadow condition	Disturbances greater than 1 acre	Guidance under development for offsets

State	Performance Standard	Applicability	Alternatives to On-Site Compliance
VA	*New development:* TP load from new development may not exceed 0.41 pounds per acre per year *Redevelopment:* Reduce existing TP load by 10%–20%, depending on disturbed area	Disturbances greater than 1 acre (2,500 square feet in Chesapeake Bay Preservation Act areas)	Off-site compliance, including local stormwater plan, pro-rata share, or purchase of nutrient credits within Bay watershed
WV	*New development:* Provide on-site runoff reduction for the first 1 inch of rainfall *Redevelopment:* Provide on-site runoff reduction for 0.25–0.8 inch of rainfall	Disturbances greater than 1 acre for MS4 areas	MS4 general permit authorizes off-site mitigation and in-lieu fee

Note: TP = total phosphorus. WQ_v = water quality volume; the storage needed to capture and treat 90% of the average annual stormwater runoff volume. Resource protection event = the runoff event produced by a storm having an annual probability of occurrence of 99%.
Source: Adapted from Schueler and Lane (2012).

In general, the major compliance options for new development and redevelopment projects are to (1) fully comply with all applicable stormwater standards on-site; (2) where such programs exist, pay a fee to the municipality (which the municipality then uses to fund water quality improvement projects) in lieu of meeting all requirements on-site; (3) provide some or all of the required treatment at an off-site location (i.e., off-site mitigation); or (4) purchase certified offsets from an aggregator, banker, or other approved source. On-site compliance can be a challenge particularly for redevelopment

sites; ultra-urban sites; and/or other sites having specific constraints, such as poorly drained soils, extensive impervious cover, potential contamination, or “surprise” underground utilities that either limit the feasibility of BMP implementation or drive up the cost significantly (or both).

Achieving Compliance through Credits and Offsets

Credits or offsets can be purchased or exchanged through a water quality trading or offset program. One of the purposes of these programs is to provide flexibility so nutrient load limits can be met in a more cost-effective way. Ideally, offsets should account for the portion of the discharge that reaches the receiving water, with consideration for the location of sources, delivery factors affecting pollutant fate and transport, equivalency of pollutants, a margin of safety, and the certainty of such reductions (relative to the certainty of reductions from on-site compliance). Credits and offsets are a viable option when (1) compared to on-site compliance, the purchaser can achieve the same or better pollutant load reduction at a lower cost and (2) a trade would not result in degradation of the water body into which the purchaser discharges.

Experts and stakeholders in the Bay watershed hold widely varying opinions about the acceptability of nutrient credits and offsets as a compliance strategy. Whereas some may view offsets as a “license to pollute” for permit holders, others see it as a means by which permit compliance will be economically feasible and achievable over time. The major challenge is to provide more cost-effective compliance options while ensuring restoration and protection of water quality. Despite the debate over the appropriateness of trading, most stakeholders agree that, as with any regulatory program, trading and offset programs must include features such as accountability, transparency, and the ability to verify pollutant reductions.

Stakeholder groups have raised a number of important concerns regarding stormwater trading. In particular, they suggest that such programs may create localized nutrient "hotspots" that impact local water quality standards, may ignore the variety of other pollutants that urban runoff contains (many of which can be harmful to human health, such as bacteria, heavy metals, and pesticides) in addition to nutrients and sediment, may involve the expenditure of local funds for projects outside the jurisdiction (which may not be publicly acceptable), and may involve uncertainties about whether BMPs implemented to attain compliance are actually achieving the required reductions.

To help provide more accountability for Bay jurisdictions undertaking trading and offset programs, USEPA includes a set of ten common elements of such programs in Appendix S of the Bay TMDL (USEPA 2010a). A demand for more specificity on these elements has led USEPA to begin developing a series of technical memoranda to provide additional guidance. Although most of the Bay states have already established nutrient trading or offset programs, the vast majority of trades have involved WWTPs purchasing credits from another plant (or from an agricultural operation in the case of Pennsylvania). Only Virginia, through various acts of the legislature and through regulation, has authorized development projects, MS4s, and other sources to participate in the State's trading program. As a result, much remains to be ironed out in terms of how exactly stormwater trades might work, although some trades are occurring as the market begins to take shape.

Potential Stormwater Credit and Offset Scenarios

Although the most likely credit and offset purchasers are MS4s and developers, at some point, nonregulated jurisdictions may have this need as well. This could happen if nonregulated jurisdictions become regulated under an expansion of the MS4 or postconstruction stormwater program—as would be possible with USEPA's proposed national stormwater

rulemaking—or if USEPA exercises its residual designation authority to achieve the required load reductions for the Bay TMDL. The pool of potential sources of credits and offsets, which is much broader than the pool of credit purchasers, includes agricultural practices (e.g., structural BMPs, land conversion, and fixed-term conservation practices); urban practices; septic upgrades; nutrient assimilation practices (e.g., stream restoration, nutrient wetlands, aquatic plant harvest, and shellfish aquaculture; see Stephenson and Shabman 2011); and other point sources, such as WWTPs, industrial stormwater facilities, and other MS4s. The level of uncertainty associated with stormwater offsets and credits can be quite variable, depending on how they are generated and whether the seller is regulated or unregulated. See Scientific and Technical Advisory Committee (2009) for more on the different forms of trading and associated strengths and limitations.

Table 3 presents three potential scenarios for generating and purchasing nutrient credits and offsets as a stormwater compliance option. Below, we address specific questions that may be of concern in these scenarios.

Table 3. Potential stormwater credit and offset scenarios.

Credit/Offset Purchaser	Description	Credit/Offset Generator(s)	Likelihood of Scenario	Examples
MS4	MS4 purchases term or perpetual credits to achieve required MS4 permit/WIP reductions from existing developed	Credit generators and aggregators: credits from agriculture, non-MS4 urban, septic upgrades, nutrient assimilation, other MS4s that	High; low for credits generated in urban areas (e.g., MS4s selling credits to other MS4s)	Chesapeake Bay Nutrient Credit Exchange in Virginia

	land or to offset new growth	achieve reductions beyond their requirements		
MS4	Cooperation or joint permitting among group of regional permittees, including MS4s, WWTPs, industrial permittees; could be as formal as bubble permit or watershed-based NPDES permit	Other MS4s, WWTPs, industrial stormwater permittees	Uncertain; high in cases with excess annual or term credits from WWTPs and where states authorize the arrangement	Neuse River basin, NC; Tualatin River; authorized by state law for MS4s in VA
Developer	Developer provides minimum controls on-site and purchases offsets to meet the remainder of the federal/state stormwater treatment requirements	Generators and aggregators: credits from agriculture, other developers, septic upgrades, nutrient assimilation, MS4s that achieve reductions beyond their requirements; important factor is geographic relationship between purchaser and credit	High; most nutrient banks will generate credits from agriculture; may be some options for developers or landowners to generate credits for sale, particularly within	Washington, DC, stormwater retention credits; Chesapeake Bay Nutrient Credit Exchange in Virginia; West Virginia MS4 general permit (limited application)

		generator (e.g., within same MS4 or tributary)	the same MS4	

How much should MS4s and developers control their own pollution before generating and purchasing credits? In a nutrient trading or offset system, both purchasers and generators must control their own pollution to some minimum level before generating or purchasing credits. For credit generators, this is referred to as the *baseline*, which is generally defined as the pollution control requirements that apply to the credit/offset generator in the absence of an offset. One can derive the baseline from a WLA or LA when a local TMDL exists. In the absence of a local TMDL, state and local regulations and/or existing practice can determine the baseline. To qualify as an offset/credit, the practices implemented must achieve additional pollutant reductions above and beyond the baseline. In other words, they must result in *additionality* (Scientific and Technical Advisory Committee 2009). Additionality is more of a concern when the credit/offset generator is an unregulated source, such as an agricultural operation or a non-MS4 urban area, because the baseline is more difficult to establish in the absence of regulatory requirements.

In most instances, credit/offset purchasers must also implement some level of pollutant reduction on-site (i.e., within the MS4 or on the development site) before they become eligible to purchase credits/offsets. In other words, purchasing credits/offsets does not necessarily enable the purchaser to opt out of all of its on-site regulatory obligations. This level of implementation by the purchaser is often referred to as *minimum controls.* The challenge with setting minimum controls is to make them stringent enough that local water quality is protected or improved, but not so stringent that the trading options become basically inaccessible.

Minimum controls for an MS4 are the technology-based standards defined in Phase II permits, which are expressed as six minimum control measures (although Phase I permits can include more specific requirements). MS4s must comply with the six minimum control measures on-site, within the MS4 boundaries, before they can consider purchasing credits to meet the pollutant reductions required under the Bay TMDL. The permit requirements that then *may* be tradable are the water quality–based requirements, which can be defined as those deemed necessary to meet water quality standards or numerical load reduction targets. In the Bay region, this includes requirements for meeting WLAs for local TMDLs as well as for the Chesapeake Bay TMDL.

In the case of developers purchasing credits/offsets to meet their permit requirements, the definition of minimum controls is quite variable, depending on state and local requirements. The Virginia stormwater regulations state that at least 75% of the required phosphorus reduction must be achieved on-site before off-site options are used. This requirement may be waived if the applicant can demonstrate that the 75% on-site rule cannot feasibly be met. 9 VAC 25-870. The 75% rule or alternative provisions appear to constitute the minimum controls as a calculated, numerical phosphorus reduction standard. In the District of Columbia, a minimum of 50% of the required retention volume must be retained on-site before a site owner will be eligible to purchase stormwater retention credits. Essentially, minimum controls for developers are linked to the protection of local water quality, as discussed below.

What are the potential impacts on local water quality? Stakeholder concerns about the potential impacts of trading on local water quality include not only the effects of individual proposed trades, but also the cumulative impacts of multiple trades on a stream segment and the potential to create hotspots of nutrients or other pollutants. The potential impact of trading on local water quality is a complex issue that is covered in greater detail elsewhere (Devereux 2013; Steinzor et al.

2012; Van Houtven et al. 2012). In this paper, we limit the discussion to local water quality impacts in the context of the most likely stormwater trading scenarios.

A recent study by Bay scientists (USEPA et al. 2012) highlights the concern over widespread contamination, beyond nutrients and sediment, throughout the Chesapeake Bay. They found that 72% of the Bay's tidal waters are fully or partially impaired (based on the states' listing of impaired waters under Section 303(d) of the Clean Water Act) due to the presence of toxic contaminants, including metals and PCBs. One of the unintended consequences of trading is a decreased level of BMP implementation in urban areas that may result in reduced efforts to address toxic contaminants. BMPs designed to reduce sediment and nutrients may, as an ancillary benefit, also reduce toxicants. In this instance, trading to meet the Bay TMDL could occur at the expense of local water quality, when those local impairments are for pollutants other than nutrients and sediment.

In some states, statutory protections for local water quality prohibit trades that would result in violation of local water quality standards. However, specific methods of ensuring that these statutory protections are maintained are currently under development. As demonstrated with Virginia's stormwater regulatory language on off-site compliance, authorizing a new development or redevelopment project to use offsets must not be in contravention of "water quality based limitations at the point of discharge" (9 VAC 25-870). Because water quality–based limitations in MS4 permits are not established for specific outfalls, it becomes a challenge to determine the conditions that would constitute this type of contravention. Other states use similar language and approaches. As a result, it may be up to state offset policies, or even individual MS4s, to clarify these conditions. Because the demand to use credits/offsets—and thus the pressure on MS4s to approve them for development projects—is likely to be high, it is particularly important to develop these policies and thresholds in terms that are clear, predictable, and understandable.

A local watershed plan or assessment may provide the ideal framework for the protection of local water quality by integrating local and Bay TMDL goals. Such a plan or assessment can identify high-priority retrofit or mitigation sites within the locality (especially those with multiple benefits), existing problem sites that must be addressed before trading can occur, and areas where new development may or may not access trading and other off-site options. The location of the offsetting practice is another important consideration, as MS4s/states can probably authorize offsets generated within a local TMDL watershed, but not those generated outside of it. Although all of the state MS4 permits include some type of TMDL action or implementation plan, some experts and stakeholders are concerned that these may end up simply being lists of preferred BMPs, without the critical analysis involved in a watershed plan or assessment. The benefit of the type of plan described here is that it can guide the establishment of these conditions so they can be addressed explicitly prior to trading.

Should credits/offsets be temporary, permanent, or a mixture of the two? The approaches adopted by Bay jurisdictions define credits/offsets as either fixed for a specific period of time or perpetual. In theory, loads from new and existing development must be offset by permanent credits/offsets because the impact (i.e., polluted runoff from impervious surfaces) is similarly permanent. However, because urban BMPs have a finite lifespan, more thought is required to determine how credit/offset purchasers can best fulfill their long-term responsibility to provide pollutant reductions.

Maryland's Accounting for Growth Workgroup has taken the approach that offsets must last as long as the new load exists, but the specific practices providing the offset may change, and the responsibility for maintaining the offset may be shifted to another entity with its consent (Accounting for Growth Workgroup 2013). Virginia, on the other hand, requires offsets to be perpetual if they are used to offset loads from development projects (Virginia Code § 62.1-44.19:21). For

instance, if the offset is generated on agricultural land in Virginia, the only practice that would qualify is conversion from crop or pasture use to forest, provided that a legal measure is in place for permanent protection (Commonwealth of Virginia 2012). However, MS4s may be able to purchase either term or perpetual credits, depending on plans to incrementally meet load reduction requirements.

Maryland, Pennsylvania, and West Virginia do not currently allow the conversion of farmland to other uses to qualify for trading (Branosky et al. 2011); however, it remains uncertain whether these states will ultimately follow an approach similar to that of Virginia. Farmland conversion is restricted as a credit/offset generator in these three states because of the strong interest in agricultural preservation; yet conversion of farmland to forest could play a very important role in trading by providing a net water quality benefit.

What is needed to verify urban BMPs used as offsets/credits? The verification of urban BMPs is important for both on-site and off-site BMPs. *Verification* refers to the process of determining whether the BMP is constructed as designed; is being maintained properly; and, most importantly, is performing as designed to reduce pollutant loads. The latter can be done through inspection checklists and visual indicators, as it would be impractical for every BMP to be monitored for water quality parameters.

The verification processes established by the Bay states' existing trading programs are variable and, in many cases, depend on the individual project (Branosky et al. 2011). They also do not specifically address the unique issues of urban BMPs because extensive stormwater trading has yet to come to fruition. Therefore, a separate protocol for verification of urban BMPs used for credits/offsets probably will be needed. Although a framework currently exists through MS4 permit requirements and the local development review process for verification of urban BMPs, this system has several problems

that need to be addressed if the current structure is to be used as the basis for verifying BMPs used as offsets/credits. For example, urban BMPs that are implemented outside the MS4 permit or local/state stormwater review process (e.g., reforestation or stream restoration) or are implemented in non-MS4 communities may not be properly counted, reported, or maintained because of limited regulatory authority (Goulet and Schueler 2012).

In addition, the buyer's responsibility for verification is not clear. Presumably, by paying to purchase an offset or credit, the buyer is also buying relief from this type of liability. However, the land use that requires the offset or credit is still present on the landscape and generating a pollutant load, and the permittee is ultimately responsible for the management of required load reductions. The regulatory structure for this is still unclear, but it is an essential question.

Conclusions

The use of nutrient credits and offsets is a critical policy and technical issue for the successful implementation of the Chesapeake Bay TMDL. Although this discussion paper focuses on issues that are unique to the use of credits/offsets for stormwater compliance, a myriad of other challenges face the development of offset programs (for a broader discussion of these issues, see USEPA 2007; Willamette Partnership et al. 2012; University of Maryland 2012). Some of the issues associated with the use of nutrient credits and offsets for stormwater compliance include:

- the need for MS4s and developers to control their own pollution before generating or purchasing credits/offsets;
- the potential impacts of stormwater trades on local water quality;
- the need to decide whether credits/offsets should be temporary, permanent, or a mixture of the two; and
- the importance of verification procedures for practices used to generate credits and offsets, including maintenance plans, financial surety, and regulatory oversight.

Although these issues may not be unique to the urban sector with regard to nutrient trading, the urban sector requires an approach that differs from that of other source sectors. As USEPA and the states develop additional policies on trading, they should consider these and other issues. States must develop credible policy frameworks to ensure that trading results in real, verifiable reductions that lead to sustainable restoration of local waters and the Bay.

Based on the information reviewed in this paper, it would be advantageous if trading programs pursued several positive outcomes. In particular, programs should encourage the development of local stormwater or watershed plans that provide a framework for the protection of local water quality by integrating local and Bay TMDL goals. These plans should identify high-priority mitigation sites that may qualify as credit-generating sites within the locality, problem sites that must be addressed on-site prior to trading, and areas where new development may or may not access trading and other off-site options. Further, accounting frameworks should document that (1) trades result in equal, or preferably better, load reductions compared to the strict application of on-site requirements and (2) credit-generating activities result in multiple benefits (e.g., goals related to habitat, open space, climate resiliency, and the urban tree canopy).

The interest in nutrient trading as a Bay TMDL implementation strategy is strong. It is up to all engaged stakeholders to make sure that the guidance and regulations for implementation are clear and understandable and, most importantly, will protect local water resources and help restore the Chesapeake Bay.

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