WATER QUALITY AND AGRICULTURE

Water Quality Trading in the Chesapeake Bay Watershed, USA

Sara Walker, World Resources Institute

Abstract

The Chesapeake Bay watershed in the United States has suffered from excess nutrients and sediment for decades. After voluntary attempts at improving water quality have failed to deliver adequate results, the U.S. Environmental Protection Agency worked with the states in the watershed to pioneer the largest and most complex total maximum daily load (TMDL) for nutrients and sediment in the country. Point sources face stringent nutrient discharge limits or limit of technology standards. Agricultural sources remain largely unregulated but are collectively subjected to a load allocation under the TMDL. Given dramatic price differentials among sectors for nutrient mitigation options, water quality trading has emerged as a market-based mechanism for cost-effectively meeting water quality goals and the TMDL. Three states in the watershed—Pennsylvania, Virginia, and Maryland—have developed nutrient trading programs for purposes of meeting permit limits and offsetting new loads. Through trading, regulated entities such as wastewater treatment plants can meet permit requirements at a lesser cost than under traditional command and control approaches, credit generators such as farmers can earn additional revenue through the sale of credits, growth can continue in a capped watershed without jeopardizing water quality, and water quality goals may be met at a faster pace than without trading. Based on experiences from the Chesapeake Bay watershed and elsewhere, a strong regulatory driver, stakeholder involvement, certainty in the program, and low transaction costs are critical for a water quality trading program to be viable.

National water quality context

More than half of assessed water bodies in the United States are impaired for their designated uses (U.S. EPA 2010). Nutrients from agricultural runoff, wastewater, and urban runoff are a primary source of these impairments. In many areas, point sources, such as wastewater treatment plants, have implemented nutrient-reducing technologies to control nutrient effluent discharge. Agriculture, however, has been largely unregulated and remains a significant contributor to impairments across the country.

The Chesapeake Bay watershed on the east coast of the United States is a prime example of these water quality challenges and solutions (see Figure 1). It is considered a “national treasure and resource of worldwide significance” (Chesapeake Bay Restoration Act of 2000). The Chesapeake Bay watershed is the largest estuary in the United States and one of the largest and most productive in the world. It spans 64,000 square miles, encompassing six states and the District of Columbia and is home to more than 17 million residents. Water quality remains poor as a result of excess nutrients and sediment. The most recent assessment (2012-2014) suggested that only a third of water quality standards for dissolved oxygen, chlorophyll *a*, and water clarity were being met. This level of achievement is comparable to findings over the past three decades (Chesapeake Bay Program 2016).

Figure 1 Map of Chesapeake Bay Watershed

Sources of nutrients in the watershed include wastewater, urban runoff, atmospheric deposition, and agriculture. The wastewater sector has been regulated with nutrient discharge concentration limits or limit of technology standards. Loads from urban runoff remain a challenge as land continues to be developed due to a growing population. Agriculture, although only making up a quarter of the watershed's land use, is the largest source of nutrients to the Bay.

The Chesapeake Bay Foundation has estimated that the Chesapeake Bay area provides more than $107 billion in ecosystem services such as flood and hurricane protection, air and water purification, and food production every year (2012). However, if current trends continue, the region could lose $5.6 billion annually in benefits. The Chesapeake Bay region continues to struggle with finding an appropriate balance of regulatory and voluntary measures, across all sectors, to ensure the Bay and its tributaries attain their water quality standards and the region continues to provide and benefit from the critical natural benefits that this national treasure provides.

National policy responses to manage water quality

The U.S. Clean Water Act (CWA) is the overarching law driving action on water quality issues across the country and in the Chesapeake Bay watershed. Section 303(d) of the CWA requires states to track water bodies that are impaired from excess pollutants and unable to meet their water quality standard designated uses (e.g., for drinking water, swimming, fishing). States must develop total maximum daily loads (TMDLs), an estimate of the maximum loading of a pollutant that can be discharged into a waterbody before water quality standards are compromised, for these impaired water bodies.

When TMDLs are established, the state assigns enforceable wasteload allocations to point sources in the form of discharge limits. The discharge limits are incorporated into the entities' National Pollution Discharge Elimination System (NPDES) permits which regulate discharges of pollutants from point sources to water bodies. Nonpoint sources, such as agriculture, receive a collective load allocation, but agriculture is largely unregulated under the CWA.

TMDLs are generally developed at a sub-watershed or stream segment scale. However, in 2010, the U.S. Environmental Protection Agency, in coordination with the states in the Chesapeake Bay watershed, pioneered a Chesapeake Bay TMDL, thereby applying a "pollution diet" for nutrients and sediment to the entire 64,000 square mile watershed, making it the largest and most complex TMDL in U.S. history. In total, the TMDL called for a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus, and 20 percent reduction in sediment. These reduction requirements were allocated down to the states, the major

river basins, and beyond. Pollution control mechanisms to meet these allocations, and fully restore the Bay, must be in place by 2025. In addition to the reduction requirements, all new sources of loads must be offset, as there are no allocations for future growth.

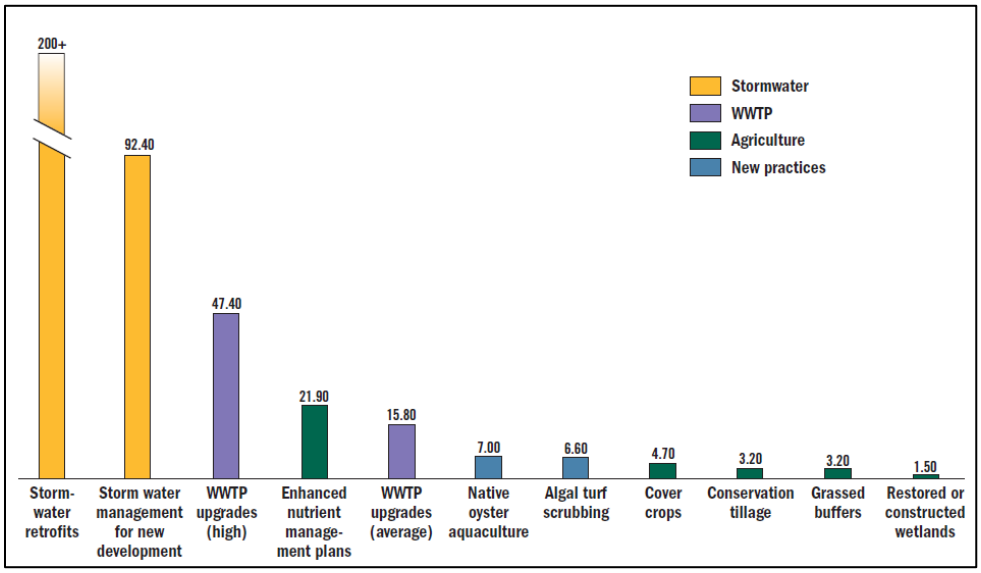
Water Quality Trading in the Chesapeake Bay Watershed

Water quality trading programs have been developed in three states in the Chesapeake Bay watershed—Pennsylvania, Virginia and Maryland—as one means to help cost-effectively meet TMDL allocations. Water quality trading is a market-based mechanism that allows sources with high pollution control costs to purchase credits, or pollution discharge reductions, from sources with lower pollution control costs.

Reason for reform and the introduction of the instrument

Traditionally, TMDLs and other water quality goals have been primarily addressed through traditional and costly command and control approaches on point sources. However, as shown in figure 2, costs for nitrogen mitigation varies greatly among sectors, with agricultural nonpoint source practices having significantly lower costs than point sources. Trading takes advantage of these cost differentials, offering a flexible mechanism for reducing nutrient loads more cost effectively than traditional approaches.

Figure 2 Cost to Reduce a Pound of Nitrogen in the Chesapeake Bay Watershed



Source: U.S. EPA and Abt Associates, 2009; Wieland, et al., 2009; MDNR, 2008; Stewart, E. A., 2006; WRI analysis using WWTP upgrade costs from MDE and VDEQ.

Furthermore, given that there are no load allocations for future growth under the Chesapeake Bay TMDL, there is the risk of stifling development without flexible mechanisms in place for handling growth. Trading is considered to be a critical mechanism for accommodating growth through acquiring pollution offsets.

Policy instrument design

- *How the instrument was selected and developed, including any cost-benefit analysis*

  Over the past decade, the states of Pennsylvania, Virginia, and Maryland have introduced nutrient trading programs to provide wastewater treatment plants (WWTPs) with flexible, cost-effective options for complying with and maintaining permitted nutrient load limits.

  Pennsylvania issued nutrient trading policy and guidance in 2006. The nutrient trading program was designed to offer a flexible and cost-effective mechanism for WWTPs to meet their NPDES nitrogen and phosphorus limits. Regulations followed in 2010 with some revisions. The program allows for point-to-point source trading, such as between WWTPs, and for point- to nonpoint-source trading, such as between a WWTP and the agriculture sector. Trading can be used by the permitted WWTPs to meet current permit obligations or to offset new and expanding loads.

  Virginia created its Chesapeake Bay Watershed Nutrient Credit Exchange Program in 2005 to provide schedule and cost flexibility for WWTPs to meet forthcoming limit of technology permit requirements. The law allowed point sources to purchase credits from other point sources to comply with wasteload allocations, and the Virginia Nutrient Credit Exchange was established to facilitate this compliance trading. New and expanding facilities could offset their additional loads by purchasing offset credits from other point sources or from nonpoint sources.

  In 2012, additional entities (i.e., municipal separate stormwater systems, industrial stormwater, and concentrated animal feeding operations) were authorized to use trading to comply with their permit requirements for nutrients. In addition, new and redevelopment in Virginia must meet post-construction phosphorous load requirements as implemented through a construction stormwater general permit. State law allows developers to meet a portion of their post-construction phosphorus load requirements by obtaining permanent phosphorus offset credits from other sources.

  Maryland started developing its nutrient trading policies in 2008 in order to implement voluntary Tributary Strategy plans targeted at restoring the Chesapeake Bay. Maryland's Tributary Strategy required all existing significant point sources to reach limit of technology (i.e., enhanced nutrient removal), and a Chesapeake Bay Restoration Fund was established by the state to finance these upgrades. As a result, unlike in Pennsylvania and Virginia, trading cannot be used for WWTP compliance purposes in Maryland. WWTPs can purchase permanent offsets to accommodate increased or new loadings from other point sources or from nonpoint sources such as agriculture.

  In addition, similar to Virginia, Maryland is developing trading policies to offset loads from new and redevelopment and to authorize compliance trading for urban stormwater municipalities.

- *How the instrument works, who pays and who benefits*

  Under water quality trading, regulated sources with the authority to trade can choose to meet regulatory requirements on site or acquire credits from another source to meet (in some cases, a portion of) those limits. The buyer is therefore the regulated entity, and the seller may be another regulated entity or another entity, such as agriculture. Table 1 displays the various trading scenarios and participants in Pennsylvania (PA), Virginia (VA), and Maryland (MD).

Table 1 Comparison of Allowable Trading Scenarios in Pennsylvania, Virginia, and Maryland

		Who can buy?				
		Wastewater	*Municipal Stormwater*	*Development Stormwater*	*CAFO*	*Septic*
When can trading occur?	**Who can sell?**					
To Comply	*Point sources*	VA, PA	VA		VA	
	Nonpoint sources	PA	VA, MD*		VA	MD*
To Maintain/ Offset	*Point sources*	VA, MD, PA	VA	VA, MD*	VA	
	Nonpoint sources	VA, MD, PA	VA	VA, MD*	VA	

*pending guidance or regulation

Source: World Resources Institute 2014

When developed and implemented properly, trading can benefit the buyers, or regulated entities; the sellers, which may include unregulated entities; and water quality. Buyers, such as WWTPs, benefit because they can realize cost savings and experience greater flexibility in meeting compliance schedules. Sellers, such as agricultural producers, benefit from another revenue stream. And water quality goals can be achieved more quickly through trading given the flexibility it provides.

- *How the instrument combines with other instruments*

As previously mentioned, water quality trading in the Chesapeake Bay watershed works within the framework provided by the Clean Water Act and the TMDL. The TMDL serves as the driver of demand for trading, and it also sets the baseline, or trading eligibility standard, beyond which one can generate credits. For example, Maryland has set a numeric, performance-based baseline for agriculture that reflects the sector's load allocation under the TMDL. Virginia has set a practice-based baseline, requiring a suite of practices that, if implemented, would result in a typical farm meeting its load allocation. To generate credits which can be used to meet a permit limit or offset a new load, reductions must be achieved that are beyond this baseline in order to guarantee additionally.

As NPDES permits are used to enforce the TMDL's wasteload allocations, permitting authorities are involved in writing water quality trading requirements with respect to these NPDES permits. As a result, trading programs are consistent with the NPDES requirements and framework.

Project/Policy Outcomes

- *Outcomes (social, economic, and environmental)*

Water quality trading can reduce costs of compliance, increase the speed of compliance, and provide greater flexibility in meeting regulatory requirements. It also provides a means for managing growth and water quality in a capped watershed. Trading can also create a new revenue source for farmers, as well as other innovators, who can be generators of credits. By doing so, it encourages farmers and other nonpoint sources to take an active role in managing water quality.

In addition, by seeking pollutant load reductions from the lower cost sectors, trading tends to value green infrastructure which provides important co-benefits in addition to water quality such as habitat creation, greenhouse gas mitigation, and recreation.

Water quality trading between point and nonpoint sources can create channels of communication between rural and urban communities, helping to build and improve relationships.

In Pennsylvania, trading has been successful as a flexible compliance option for WWTPs. From 2013-2015, 600,000 to 1.1M nitrogen credits and 55,000 to 100,000 phosphorus credits have been sold annually. These represent a mix of point-to-point trades and point-to-nonpoint trades.

Virginia's Nutrient Credit Exchange has proven to be an effective mechanism for facilitating compliance trading between point sources. Virginia's post-development phosphorus offset market has also been very active, and permanent offsets in this market are selling for upwards of $20,000 per pound, largely generated by land conversion activities.

- *Challenges with implementation*

  Maryland's nutrient trading program has yet to experience any trades, likely due to a number of reasons. First, because Maryland does not allow for compliance trading, there has not been demand yet from WWTPs like there has been in the other states. As WWTPs reach their capacity in the coming years or decades, this is expected to change. In addition, although Maryland has had trading guidance for years, a lack of binding regulations may have led to uncertainty for regulated entities who would find it too risky to purchase credits in lieu of addressing requirements onsite.

- *Lessons learned from the process and requisites to make the instrument work*

  Based on experiences from the Chesapeake Bay watershed and other trading programs developed around the United States and the world, perhaps the greatest factor for success is the need for a strong regulatory driver to generate demand for trading. Many programs have been developed in anticipation of drivers that either fail to come to fruition or are less stringent than anticipated, and as a result, there has been little to no activity.

  Where regulatory drivers are present, it is important that programs are designed to protect water quality and to create efficient and credible markets for participants who may perceive risks, particularly if engaging with nonpoint sources. Credit buyers may be uncertain if credits are real and represent equitable offsets, particularly when coming from diffuse sources such as agriculture where loads are challenging to quantify with any certainty. In addition, buyers may wonder if the credit generator will come through with the credits and if there will be adequate supply to meet regulatory requirements. Well-developed trading programs ensure that participants have the confidence to engage in transactions (Walker and Selman 2014).

  Similarly, it's crucial that stakeholders understand and buy-in to the concept of trading. Stakeholders should be engaged at the outset in discussions about developing a proposed trading program and consulted throughout the process to ensure their needs and concerns and heard, and to ensure that there would be willing participants once the program is established.

  And in order to ensure that water quality trading is indeed cost effective and that participants are willing to enter into the market, transaction costs must be minimized. There is limited data on transaction costs related to water quality trading programs, but common costs faced by program developers, administrators, and participants include costs to convene stakeholders, develop credit

quantification methodologies or tools, identify and connect buyers and sellers, review applications to generate credits and trade, and conduct on-site verifications of credit-generating activities. Program developers should consider what their transaction costs will be relative to the anticipated credit prices and improvements in water quality.

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