NUTRIENT TRADING EVALUATION REPORT

Presented to

PENN FUTURE
610 North Third Street
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for the

Ongoing Nutrient Trading Program
in the
Chesapeake Bay Tributaries within Pennsylvania

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EXECUTIVE SUMMARY

Century Engineering was contracted by PennFuture to conduct a technical assessment of the ongoing nutrient trading program. Century's effort is three-fold:

- To assess the technical aspects and regulatory framework of nutrient trading.
- To review trades that have occurred to date in Pennsylvania (PA).
- To compare the technical aspects of nutrient trading among the various Chesapeake Bay states (namely VA and MD) by utilizing data from a Pennsylvania trade to calculate what that may look like in other states.

With the looming Chesapeake Bay Total Daily Maximum Load (TMDL) limit implementation, states including PA have submitted Watershed Implementation Plans (WIPs) to achieve the required reductions for Bay pollutants including sediment, phosphorus, and nitrogen. It is clear from the PA plan that PA Department of Environmental Protection (PADEP) expects Nutrient Credit Trading (NCT) is to be a large part of PA's plan to meet the TMDLs. The PA NCT efforts date back to 2006 and have evolved into a codified regulation. The NCT program is intended to provide a framework to allow NPDES permit holders to offset a portion of their pollutant loads by contracting with a credit generating entity that can reduce its pollutant load at a reduced cost versus upgrading the NPDES holder's treatment facility. There are over 1,000 municipal sewage Publicly Owned Treatment Works (POTWs) in PA ranging in size from 0.02 to 250-million gallons per day. There is a general lack of funding to assist municipalities with upgrading their plants. Estimates are varied, but as much as a $45 billion gap in funding may be exist over the next 20 years to address drinking water and sewer service infrastructure needs in PA. It is hoped that NCT will provide an important tool in allowing non-point pollutant sources (NPS) such as farms to implement Best Management Practices (BMPs) that can offset the reductions that are being asked of point source (PS) dischargers at a reduced financial burden.

PA's program is codified under 25 Pa Code § 96.8. This rule incorporates with some changes the previous guidance document that was issued by PA DEP. In order for a trade to be consummated, there are four steps:

1. Certification – The generator (or his agent) of credits submits a proposal of the credit generating activity which defines the activity, the way it is to be verified, and any technical merits/data of the proposed activity. To date, well over 100 proposals have been submitted to PA DEP and at least 86 have been approved. 32 of the proposals approved are for manure export out of the basin.
2. Verification – A credit generator must demonstrate that the credit generating activity was completed. The approved verification plan must be implemented so that the proper number of credits can be accurately assessed. Currently, there are no restrictions on who verifies credits, but it is clear that PA DEP does not have primary responsibility in most cases.
3. Contract Approval – This is the legal contract between buyer and seller. It contains selling prices of the credits as well as contractual language for both parties. Because the seller does not have to be the generator, the NCT program enables the creation of brokers, aggregators, clearinghouses, and other third party entities to be players in the NCT marketplace. To date 10 trades have been approved by PA DEP.

4. Registration – This is the final step where verified credits are approved to be used to comply with the terms of a NPDES permit. In order to comply with nutrient load limits in a NPDES permit, the PS discharger's nutrient discharges minus credits purchased must be less than its allocated load.

The PA NCT program was evaluated and the following items are noteworthy:

- Primary enforcement of the NCT program is via PA DEP. It is clear that if the program continues to grow that the agency could be seriously understaffed.
- There is a general concern about enforcement actions related to a NPDES permit holder and what would happen if a credit generators defaults on their obligations. This ultimately may in some instances lead to plant upgrades in case where NCT would have been more cost effective. Fact sheets and better public education are required.
- Currently, most verifiers are nutrient management planners or agricultural consultants who have existing relationships with the credit generating entity. It appears that a third-party verifier is a necessary element to ensuring credit generating activities are doing what they are supposed to and that no conflicts of interest exist in the NCT system.
- The PA program for nutrient wasteload allocations (WLA's) is on an annual water year cycle (October 1st to September 30th). A yearly cycle is necessary due to variations in treatability of wastewater due to temperature considerations and gives plants some flexibility. Using a different annual cycle versus the annual calendar year, as used for other NPDES and PA DEP reporting (Chapter 94, biosolids, etc.), is cumbersome regardless of any technical merits. PA is the only state to adopt this compliance cycle.
- A two month truing period after the yearly compliance cycle ends allows for facilities, who need credits, to go out on the market and purchase them. This period also gives generators of credits two months to sell them or lose them, as credits can never carryover and must be used or sold and used in the year in which they were generated.
- The $100 million Technology Fund as proposed by PA DEP illustrates a potential issue with the PA NCT program. That is that cost sharing can be considered for nutrient credit reductions. It appears that credits generated by that portion of a project which is publicly funded should be placed into the state's credit reserves, be transferred to a nutrient credit bank, or be allotted back to the original funding entity. An allotment to the funded entity should not be an option.
- PENNVEST involvement in NCT is as a clearinghouse. They facilitate trades by aggregating credits. PENNVEST does not police credit generating activities nor do they set the price of credits. Annual auctions sponsored by PENNVEST and PA DEP occur during the truing period. So far the price per credit appears to be lower than expected and most buyers during the auction appear to have been speculators.
- Baseline requirements to participate in PA include adherence to applicable environmental regulations for nutrient and manure management as well as the erosion and sedimentation control (E&SC) rules. A final requirement is to maintain a riparian buffer, to provide a manure application exclusion zone near streams, or to retire 20% of the credits that are calculated. It does not appear that the baseline requirements are terribly onerous, and it is suggested that 20% of calculated credits be mandated to be retired in addition to the 10% that are currently being placed in reserve. This would in effect place the PA program as a 1.39:1 trading ratio as opposed to the current 1.1:1 ratio.
- The PA program relies on a site specific calculation methodology that is relatively data intensive. This approach allows for the credit generating process to be much more accurate than other state approaches and it gives greater flexibility in the type of credit

generating activities that can be considered. However, there is greater potential to overstate a credit generating activity, so the scrutiny of data used needs to be very high and the verification process is vitally important.

- Proposals for NCT should be reviewed by PA DEP as well as agricultural and conservation agencies. Multiple agency review should be mandatory not discretionary.
- Unlike many PA DEP programs, NCT does not employ prescribed forms, applications, and submission requirements for the proposal step. This is cumbersome and limits the transparency of the process for third-party reviewers and the public. Standardized forms and a submission checklist should be considered.
- There are two ratios used in the credit calculating process that are derived from the Bay model. The first is the Edge of Segment (EOS) Ratio which accounts for movement of pollutants within an individual watershed segment and accounts for local factors. The second is the Delivery Ratio which accounts for attenuation of a pollutant, that is how much of the original quantity is consumed by natural processes before it reaches the Bay. These ratios can be a source of problems if too much tradable load is allocated to a particular watershed segment. A local watershed impairment can result. PA DEP is in the process of allocating tradable loads to each watershed segment.
- PA DEP requires 10% of credits to be set aside into a reserve bank. In this regard, 111# of credits must be generated in order to sell 100#. This is the closest thing to an uncertainty ratio in the PA DEP program. The VA program, while very regimented and generic in its methodology, requires a 2:1 uncertainty ratio for PS to NPS trades (200# generated by a NPS per 100# used by a PS). MD requires 10% or more of credits to be retired, but this is limited to credit generating activities that are not explicitly accepted in the Bay model. WVA requires a 10% reserve ratio for PS and a 20% reserve ratio for NPS credit generators.
- As stated, the PA program does not specifically use an uncertainty ratio. Critics suggest the use of a 2:1 trading ratio. While employed in VA, it is important to understand that that program is very simplistic in its approach, making this a virtual requisite. Less time should be spent discussing uncertainty ratios and more time should be spent honing the methodologies and science that is supposed to be the central focus of Bay restoration.
- New development or new or expanding treatment facilities have no allocations for nutrient discharges and must be a net zero discharge for nutrients. Because new development has numerous ancillary effects and tends to spur additional development as well as causing numerous NPS sources (stormwater, urban, construction, etc.), a higher reserve ratio of perhaps 25% should be considered for these new or expanding sources that purchase credits. Their impact is simply not limited to their wastewater discharge activity.
- There does not appear to be a line drawn in the sand regarding after which a credit generating activity can be considered as eligible for credits. In this regard, a practice that has already been in place for years could be a recipient of credits. Historical activities are already factored into the baseline loading, so this should be changed. A date of January 1, 2005 is suggested.
- There are currently no applications fees or program administration user fees. These should be required. They should be prorated to the actual quantity of credits being generated.

Registered trades to date under the PA program were reviewed and the following observations were made:

- There have been 10 contracted trades to date. Six of these have been for new sources. All but one of these trades has been for poultry manure export.
- Some of the early trades used a 5% reserve ratio. This is no longer allowed. None of the trades reviewed used the 20% reduction, so trade ratios have been 1.15:1 or less.
- It is not clear if the importer of manure from a trade is required to follow the same requirements (regulatory, baseline, threshold, etc.) as the exporter. It is important that they be held to these same requirements.
- Manure analysis requirements are not as rigidly defined as other environmental sampling requirements. These requirements must be much more specifically defined in future proposals.
- Assumptions used in the manure export trades are problematic because they appear to assume that most of the volatilized ammonia returns as deposition to the watershed. This is suspect, particularly for eastern areas of the watershed where prevailing winds would transport ammonia out of the basin.
- Manure export has been recognized, even by PA DEP, as not being sustainable. Yet, proposals continue to be approved for this activity.
- Use of alternate EOS ratios for manure export is based on the underlying premise of ammonia volatilization and deposition in the watershed. This leads to calculated credits that are significantly higher than those that would be calculated if the published EOS ratios were employed. These alternate EOS ratios need to be rigorously justified on future trades.
- Trades are typically consummated for five-years. When they expire, future credits generated must be calculated using the credit calculation methodologies at that time. Fortunately, this means that the earliest trades in the program will not be grandfathered indefinitely. Necessary program revisions will eventually impact all trades.
- There is no obvious verification that chemical fertilizer is in fact being used in place of someone else's imported manure. This needs to be formalized as part of the verification steps outlined in the proposal.
- Alarmingly high corn silage yields were used for the continuous no till and cereal cover crop trade. The yield was verified by farm records by PA DEP, but could not be substantiated in a variety of published sources. This is not a user input in the MD and VA programs.
- If manure is not incorporated into the soil, the ag operation receives more credits than one who incorporates the manure quickly. This seems to be a bad policy holistically.

The final exercise in CEI's evaluation was to conduct a mock trade using data from the Brubaker Farm trade (continuous no till and cereal cover crop) for credit generation under the MD, VA, and PA programs. A sensitivity analysis was also conducted because of the extreme differences between the state programs in the quantity of calculated credits. The following observations were made:

- The VA program is very simplistic. There is no difference is the farm under consideration for NCT is 20 miles from the Bay or 220 miles away. The same number of credits are calculated. The VA program by its nature requires a large uncertainty ratio. It also has a very limited amount of BMP's and does not appear to have specific provisions for the addition of other credit generating activities.

- Cereal cover cropping is a baseline credit in VA so it cannot generate credits. All three programs differ significantly regarding the baseline requirements, with MD offering what may be the best approach which is to calculate what portion of credits is necessary for the farm to meet their obligation under the TMDL before trading the remaining credits.
- There is a significant difference between the number of nitrogen credits generated under the PA program (927#) versus MD (20#) and VA (55#) when using fictitious farms 20-miles from the Bay utilizing continuous no-till and cereal cover crops. For farms about 215-miles from the Bay, the PA farm (1508#) is still very high compared to MD (55#) and VA (74#) farms.
- Top to bottom in the Susquehanna River Basin there is an opportunity to increase the potential for credits by a factor of about 2/3 when comparing the same NCT activity on a farm near the Bay and one remote from it. Delivery ratios and EOS ratios do not translate as consistently as one may think, clearly more than distance was used when these values were developed.
- If the original trade used 21 tons per acre corn silage yield, which is the PSU Agronomy Guide value, then the PA program would not have even generated any credits utilizing the other Brubaker farm data. Of the factors evaluated in the sensitivity analysis, the agronomic data, particularly crop yield, has the greatest effect on the calculated credits.
- If you increase your chemical fertilizer application rate, you can actually receive increasingly more credits for trading. There would be obvious economic considerations for increasing the chemical fertilizer rate, but this would appear to be a bad anomaly for PA's NCT calculation methodology.

In general, the PA program provides a flexible framework for NCT that encourages innovation and technological advancement. This comes at the price of more intensive data requirements that must be carefully examined when proposed trades are evaluated by regulators. The PA program in its overall concept is a sound approach; however, there are some technical deficiencies which must be addressed. It is clear that NCT will not be the only solution to solving nutrient loading to the Bay, but if amended responsibly it will be a valuable tool. Particularly for PS dischargers who are struggling to meet the financial obligations that Bay preservation entails.

1. **Scope** – Century Engineering was contracted by PennFuture in the Spring of 2011 to conduct a technical assessment of the ongoing nutrient trading program. Century's effort is two-fold; to assess the trades that have occurred to date in Pennsylvania and to compare the technical aspects of nutrient trading among the various Chesapeake Bay contributing states. The purpose of this report is to provide PennFuture and its advocacy partners with a summary of this analysis.

   1.1. **Methods** – Century's effort consisted of a combination of data mining, literature reviews, and personnel interviews in person or by phone/email. Public information regarding trades to date in Pennsylvania was obtained by request from the PA DEP Office of Water Planning. Personnel interviews included a meeting held between Century Engineering staff and Ann Roda and Andrew Zemba of PA DEP, as well as email correspondence with staff members from the Maryland Department of the Environment (MDE), current and former members of Virginia Department of Environmental Quality (VA DEQ), and EPA – Region III. Significant information has been made available online regarding the Chesapeake Bay restoration efforts and the Nutrient Trading Program in Pennsylvania, and considerable research was completed utilizing this resource. In order to review the trades that have occurred to date in Pennsylvania, a review of the historical and current regulatory and policy aspects of trading is useful in understanding the context of trading.

2. Historical Background

2.1. **Chesapeake Bay** - The Chesapeake Bay (Bay) is the largest of 130 estuaries in the United States, stretching 200 linear miles from Havre de Grace, Maryland, to Virginia Beach, Virginia. The Bay and its tidal tributaries have around 11,684 miles of shoreline, exceeding the entire U.S. West Coast. The Bay holds more than 15 trillion gallons of water. It is home to more than 3,600 species of plants and animals, including 348 species of finfish, 173 species of shellfish, and over 2,700 plant species. In addition, it is home to 29 species of waterfowl and is a major part of the Atlantic Flyway. As a source of food, the Bay produces about 500 million pounds of seafood per year (www.chesapeakebay.net, 2011).

2.2. **Chesapeake Bay Watershed** - The Chesapeake Bay Watershed is home to more than 16 million people, who have come to depend on it as a source of water, food, recreation, transportation, and commerce. All residents in the watershed live just a few minutes from one of the more than 100,000 streams and rivers that drain into the Bay. There are about 150 major rivers and streams in the Bay watershed. About half of the Bay's water volume comes from the Atlantic Ocean. The rest comes from this large 64,000-square-mile watershed that includes parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia—and the entire District of Columbia. The Susquehanna River provides about 50 percent of the fresh water coming into the Bay at a rate of 19 million gallons of water per minute (www.chesapeakebay.net, 2011).

2.3. **Bay Impairment** – In 1998, the Environmental Protection Agency (EPA) added the Chesapeake Bay and several tributary tidal waters to the list of impaired waters. Under the Clean Water Act (CWA), impaired waters require the implementation of a Total Maximum Daily Load (TMDL) for pollutants to protect the designated uses of a water body. This designation had far reaching consequences, and in 2000, the

Chesapeake Executive Council signed Chesapeake 2000, a strategic plan that is one of the most aggressive and comprehensive watershed restoration plans ever developed (www.chesapeakebay.net, 2011). This agreement was intended to guide Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency in their combined efforts to restore and protect the Chesapeake Bay and to avoid the full scale implementation of an EPA directed TMDL program. Chesapeake 2000 was the culmination of EPA's listing of the Bay as an impaired watershed, as well as the region's effort under the Chesapeake Bay Commission, formed 20-years earlier, to cooperatively manage and restore this valuable watershed.

2.4. State Efforts – Under the Chesapeake 2000 agreement, partner states made substantial commitments to address water quality impairments by 2010. This cooperative approach was intended to allow the states and the District of Columbia more flexibility on how to reduce pollutant loads, and it was thought that providing flexibility would encourage innovative approaches to watershed restoration. Maryland, Pennsylvania, Virginia, New York, Delaware, West Virginia and the District of Columbia worked jointly toward developing the new water quality criteria, designated uses, and cap load allocations needed to restore Bay water quality and remove it from its impaired watershed status. Unlike a typical TMDL approach, the framework established by the executive council was intended to involve significant local stakeholder involvement through the tributary strategy process.

In order to coordinate the regulatory framework within the Bay Program's cooperative, consensus-based approach, the process incorporated local tributary regulatory TMDLs within the larger, basin wide cooperative framework (www.chesapeakebay.net, 2011). Partner states worked collaboratively over the next few years to develop new scientifically based water quality criteria for the Chesapeake Bay. Because the central issue with Bay impairment was oxygen depletion, focus of the standards was to address nutrient and sediment based pollution in the Chesapeake Bay. Partner states adopted revised state water quality standards in 2005. The new goals replaced the previous nutrient reduction goals established by the 1987 Chesapeake Bay Agreement. As part of Pennsylvania's commitment, a Chesapeake Bay Tributary Strategy was developed that involved significant stakeholder participation.

2.5. Pennsylvania's Chesapeake Bay Tributary Strategy (CBTS) – Pennsylvania's CBTS included the following nutrient and sediment reduction goals:

- Nitrogen discharges cap load of not more than 71.9 million pounds. In effect, this required a reduction goal of 37.3 million pounds from the year 2002 watershed model loads.
- Phosphorus discharges cap load of not more than 2.47 million pounds. In effect, this required a reduction goal of 1.11 million pounds from the year 2002 watershed model loads.
- Sediment discharges cap load of not more than 0.995 million tons. In effect, this required a reduction goal of 116,000 tons from the year 2002 watershed model loads.

Many previous efforts to limit nutrients were limited to end of the pipe permit limits from municipal and industrial point sources, however, agriculture, construction, and urban activities also implemented various Best Management Practice (BMP) based reduction approaches as well. CBTS goals bridge all aspects of human activities in the environment including forestry, agriculture, land development, stormwater discharges, industrial discharges, wastewater disposal, and any other point or non-point source (diffuse) activities that can contribute to surface water pollution. It looks at the entire Bay watershed and all activities within it. As part of CBTS development, Pennsylvania Department of Environmental Protection (PA DEP) sponsored several stakeholder meetings through spring of 2005 which culminated in the formation of a Tributary Strategy Steering Committee. Beginning in January of 2006, five workgroups were designated to work through various issues and concerns identified by many of the stakeholders: 1) Agriculture Workgroup; 2) Legacy Sediment Workgroup; 3) Point Source Workgroup; 4) Stormwater Workgroup; and 5) Trading Workgroup.

2.6. **Pennsylvania's Point Source Dischargers** – Point source (PS) dischargers include municipal wastewater treatment plant and direct industrial dischargers. Pennsylvania's geography and municipal government structure has resulted in the installation of over 1,000 Publicly Owned Treatment Works (POTW) that range in size from 0.02 to 250 Million Gallons Per Day (MGD) (PMAA, 2009). The total number of treatment plants is much larger when adding in institutional and educational systems, as well as small private systems including campgrounds, mobile home parks, developments, and industrial waste discharges. A large number of relatively small plants further complicates efforts to achieve nutrient reductions from these point sources, as economies of scale do not favor the cost effectiveness or technical viability of plant upgrades. The environmental returns on these capital investments are often not there. This is thought to be one of the many reasons why Pennsylvania chose not to pursue the more aggressive effluent limits that were chosen by some of its Bay state counterparts.

The Point Source Workgroup met on four occasions during 2006, and worked to develop, among other things, a waste load allocation strategy for National Pollution Elimination System (NPDES) point source direct discharge treatment plants. The result was a phased implementation strategy; where sewage facilities would be required treat effluent to 6.0 mg/L Total Nitrogen (TN) and 0.8 mg/L Total Phosphorus (TP) at design flow. These limits are considered within the current treatment limits of a standard Biological Nutrient Removal (BNR) plant, but do not approach the limits of technology (Enhanced Nutrient Removal (ENR)), which have been mandated in other states such as Maryland. The NPDES Permitting Plan under the CBTS called for a 5-Phase implementation schedule. This was broken down by plant capacity and geographical considerations, with 183 plants included in the first three phases of implementation and representing over 400-MGD of wastewater flow. Phase 4 is the last actual phase where cap loads were to be implemented. These were to occur when NPDES permits expired and were renewed after 1/1/2011. Phase 5 facilities, those between 0.02 and 0.2-MGD, were slated for monitoring requirements only when their permits were renewed after 1/1/2013. In reality, the first two phases of implementation have been delayed due to challenges made by the industry and EPA's movement to implement a formal TMDL for the Bay. As of Spring 2011, PA DEP remains in Phase 3 implementation.

It is important to note that the Commonwealth's 183 significant municipal dischargers (Phase 1 through 3) contribute approximately 11% percent of the nitrogen load to the Bay from Pennsylvania each year (another 1% comes from the rest of point source dischargers) (Metcalf & Eddy, 2008). This is despite significant attention that was initially given to these sources and the initial public perception that treatment plants were a large source of the Bay's problems. According to EPA's Phase 5.3 Watershed Model, the stark reality is that nearly 84% of the 2009 nitrogen loads delivered to the Chesapeake Bay were from non-point sources including agriculture, forestry, and urban development. PA DEP's 2011 Watershed Implementation Plan (WIP) suggests that agriculture alone contributes 56% of the nitrogen loadings to the Bay (PADEP, 2011).

2.7. **CBTS Costs for Point Source Dischargers** - In a report sponsored by the Pennsylvania General Assembly's joint Legislative Budget and Finance Committee, Metcalf & Eddy (Metcalf, 2008) calculated that the capital costs associated with nutrient-related construction costs if plant upgrades were completed by the significant municipal dischargers would approach $1.4 billion alone (2009 dollars). Early estimates during CBTS development had suggested capital costs ranging from $190 million to over $1 billion (Metcalf, 2008). The American Society of Civil Engineers in their 2010 Report Card of Pennsylvania's Infrastructure gave the Commonwealth a score of D+ for its wastewater facilities, citing the need for $2 billion per year over the next 20 years to meet the new regulatory requirements and repair/expand existing facilities to meet current and future needs (ASCE, 2010). According to the Governor's Sustainable Task Force on Infrastructure's report, published in November 2008, the estimated capital investment for improvements to the wastewater systems was estimated to be $36.5 billion over the next 20 years (2007 dollars). The report also indicated a $43.8 billion gap between available funding and total drinking water and sewer service needs. Costs of implementing the CBTS clearly represent a significant financial burden to PA communities. Unlike Maryland, where ENR plant upgrades were funded by user fees and grant/loan programs from the state for all of its 67 targeted municipal treatment plants, the PA CBTS program was largely an unfunded mandate. Numerous grant and loan funding sources have been made available through the Pennsylvania Infrastructure Investment Authority (PENNVEST), but these monies have largely been doled out to the larger treatment plants and for new plant construction. Sources of these monies included funding from the American Recovery and Reinvestment Act (ARRA) of 2009 ($65 million) and the $400 million dollar H2O Pennsylvania bond approved by Pennsylvania taxpayers in 2008. No matter the source of estimates, it was clear early in the process that Pennsylvania was not prepared financially to bear the burden of nutrient upgrades at its wastewater treatment plants within the Bay watershed, and that a variety of alternate approaches would be necessary in meeting its obligations to reduce pollutant discharges to the Bay. Nutrient trading was identified and billed early as an innovative and promising strategy for reducing the financial burden of Bay clean-up efforts.

2.8. **CBTS Nutrient Trading Workgroup** - The Trading Workgroup met six times in 2006, and made efforts to explore an innovative nutrient reduction approach focused on developing a framework for a market based nutrient trading program. This appeared to be especially important for financially strapped municipalities with no resources for upgrades, smaller treatment plants with limited viable technology

alternates, new sources with no waste load allocation, expanding plants (none of which additional waste load is allocated), or those who were simply limited in land available for plant upgrades. Considering the scope of non-point source contributions to nutrient loads to the Bay, nutrient trading provided the promise of much more cost-effective nutrient reductions than traditional "brick and mortar" plant upgrades. The "Final Trading of Nutrient and Sediment Reduction Credits – Policy And Guidelines" was issued in December of 2006, and was PA DEP's policy on how the nutrient trading program was to be implemented, including how credits could be generated and the methodologies to be employed for calculating credits. It would later be replaced by regulations published by PA DEP in October of 2010 (25 Pa. Code § 96.8).

3. Current Regulatory and Policy Aspects of Trading in Pennsylvania

3.1. NPDES Program – Pennsylvania's point source dischargers are covered by a variety of NPDES permit programs. There are three notable NPDES programs with which Pennsylvania has delegated authority to administer and operate. These include the Concentrated Animal Feeding Operation (CAFO) general and individual permit programs, the Sewage Discharge individual permit program, and the Industrial Wastewater Discharge permit program. Other programs administered by DEP include the Municipal Separate Storm Sewer (MS4), Aquaculture Operations, the Stormwater Construction Activities, and a variety of general permit programs. Regarding nutrient trading, the areas with greatest promise are NPDES CAFO and NPDES sewage dischargers, but the program is not specifically limited to these two groups and any point source or non-point source activity can generate or purchase credits. NPDES permits for sewage dischargers are currently being issued with nutrient limits that take effect for the 2011-2012 water year. The water year runs from October to September. Despite the implementation of a formal TMDL by EPA, PA DEP continues to issue permits with nutrient loads that are based on 6.0 mg/L TN and 0.8 mg/L TP at 2010 design flow. There was considerable concern by municipalities and other NPDES permit holders in various stages of evaluation and/or design regarding what the EPA TMDL would mean for them. However, Pennsylvania's Watershed Implementation Plan (WIP), developed in conformance with the TMDL process, specifically holds to the same nutrient load rationale that it set out to implement with its CBTS. This has eased anxieties within the basin and allowed entities to proceed forward with implementing their individual strategies for achieving compliance, be it by nutrient trading or by a bricks and mortar approach.

3.2. Nutrient Trading Program – As discussed, Pennsylvania's CBTS was finalized in 2005. Implementation of the program did not begin until late in 2006. Documents pertaining to the nutrient trading policy were issued in December of 2006. PA DEP's program was crafted to conform with EPA's National policy published in 2003. There were considerable questions regarding the viability and legality of the program, but optimism ran high during the initial roll-out of the program and several trade applications were made.

In a white paper commissioned by the Scientific and Technical Advisory Committee of the EPA Chesapeake Bay Program, it has been suggested that water quality trading is much more complicated and less likely to succeed than existing emission trading programs such as that under the Clean Air Act (CAA) for Sulfur Dioxide

(SO2) (National Sea Grant Law Center, 2007) (SGLC). SGLC suggests three reasons for this. First, Congress authorized the EPA to implement a market-based allowance trading system to deal with acid rain through the 1990 amendments to the CAA. EPA does not have such clear statutory authority with respect to water quality trading. Second, the major sources of SO2 pollution were stationary facilities already regulated by the EPA. With water pollution, the major sources – nonpoint sources – are essentially unregulated. Third, water quality trading is more technically challenging if only for the fact that it is far easier to measure the emissions from a smokestack than the runoff from a farm or parking lot. To date, there have been 57 water quality trading programs of one form or another worldwide (WRI, 2009). Of these, 26 are active, and 10 have been shuttered, with the remaining under development (WRI, 2009). There is some success with trading programs in the U.S., most notably the Long Island Nitrogen Credit Exchange Program in Connecticut, which is a point source to point source program to address the 2001 TMDL for dissolved oxygen. In that program, some 12 million credits have been bought and sold for a total market value of nearly $30 million (WRI, 2009).

On October 9, 2010, the PA DEP published its nutrient trading regulation, 25 Pa. Code § 96.8, entitled "Use of Offsets and Tradable Credits from Pollution Reduction Activities in the Chesapeake Bay Watershed," in the Pennsylvania Bulletin. See, 40 Pa. B. 5790. The regulation codifies, with some revisions, the Department's 2006 guidance document. Notable revisions included the formal definition of the reserve ratio as 10%, and that those persons seeking certification "may" use the most current Chesapeake Bay Watershed Model (CBWM) values for pollutant removal efficiencies, Edge-Of-Segment (EOS) ratios, and delivery ratios (Version 4.3 as of October 2010). Although nutrient trading has been codified, subsection (i) of the rule establishes that existing regulatory requirements take precedence over any decisions made under the rule, including any TMDL or anti-degradation requirements. During interviews between DEP and Century, several other technical refinements were also noted to have changed. These include the elimination of N/8 calculations for phosphorus estimating and the elimination of the 60% EOS factor. These were part of the calculation rationale for some of the early manure export trades that occurred within Pennsylvania's trading system. Trades using these methodologies will have to be re-calculated from the 2016 compliance year forward when recertification occurs.

3.3. TMDL and Pennsylvania's Watershed Implementation Plan - Executive Order (EO) 13508 was issued on May 12, 2009 by President Obama. The purpose of the EO was "to protect and restore the health, heritage, natural resources, and social and economic value of the nation's largest estuarine ecosystem and the natural sustainability of its watershed." In effect, it placed the full weight of the federal government in the Bay clean-up process and forced states to submit Watershed Implementation Plans (WIPs) as part of a formal TMDL process under the CWA. DEP submitted "Pennsylvania's draft Phase I Chesapeake Bay Watershed Implementation Plan (WIP)" to EPA on September 1, 2010. After public meetings and a formal comment meeting, DEP made three subsequent revisions, the November 29, 2010 WIP, the December 23, 2010 WIP and the Revised Final Phase I WIP on January 11, 2011. Development of the Phase II WIP is ongoing.

Table 1 illustrates the progress made to date versus the CBTS goals and the allocations proposed in the WIP under the Phase 5.3 Watershed Model.

Table 1 Comparison of Nutrient Allocations Versus CBTS and 2009 Progress

	Nitrogen (mpy)	Phosphorus (mpy)	Sediment (mty)
CBTS	71.9	2.47	0.995
2009 Progress	106.4	3.96	1.28
Proposed Allocation	76.77	2.74	0.95 – 1.05
Reductions Required	29.53	1.21	0.23 – 0.33

Since 1985, the Susquehanna River Basin's nitrogen load has decreased by 28%, its phosphorus load has decreased by 23%, and its sediment load has decreased by 40% (PA DEP, 2011). The proposed allocations under the TMDL are actually higher than those outlined in the CBTS. PA DEP highlights a number of things in the WIP regarding its progress including a variety of agricultural Best Management Practices (BMPs) that have been implemented to date. Within the first section of the WIP, it also reaffirms its commitment to nutrient trading and its role in developing new technologies and establishing environmental markets. It suggests that the nutrient trading program will enable the agriculture sector to make significant technological advancements in areas such as manure management, methane digestion, and energy production, and it proposes the creation of a Technology Fund of $100 million per year to stimulate these innovative technologies.

The suggested funding appears to provide an artificial decrease in the cost per credit generated, thereby stimulating dischargers to take a more serious look at the program and to increase the market demand for credits generated. In its "Facts about Nutrient Trading" white Paper, Chesapeake Bay Foundation (CBF) suggests that nutrient reduction benefits from government-funded nonpoint source practices should not be eligible for trading. Cost-share, while eligible to meet baseline requirements in all four Bay partner states, is only considered for generation of nutrient credits in Pennsylvania. It does appear duplicitous to fund nonpoint source nutrient reductions and then trade them away to point sources in lieu of treatment plant upgrades. However, these projects generally require a combination of public and private financing to make them go. They are no different than any other emerging environmental technology in that regard.

It is suggested and reasonable that the private financing portion does in fact provide meaningful nutrient reductions that would not have otherwise occurred. Further, it would suggest that the role of the Technology Fund is not as much about generating credits, but rather more about stimulating industry and agriculture to develop innovative technologies that could become self-sustaining in the future. The availability of private funds and stimulation of sustainable environmental markets appears to be a critical component of the success of the Bay program given the fiscal restraints that citizens have placed on local and state governments in the Bay area. Without it, progress will continue to be slow. It would appear that the Technology Fund is a separate and important effort that must be funded by the federal and Bay jurisdictions.

In the context of trading, the PA nutrient credit trading (NCT) rules do not restrict who the entity is that is generating the credits, and in fact over 35 of the certified nutrient credit generating activities to date have been by local conservation districts, other public entities, and Non-Governmental Organizations (NGOs). The nutrient

credit generation process should include accounting practices for those portions of public funding that generated the credits (unless that public funding entity is applying for the nutrient credits itself). These credits should be withdrawn above and beyond the 10% reserve ratio into the state's credit reserves, be transferred to a nutrient credit bank, or be allotted back to the entity with which the funding originated. In this regard, credit generation by a public entity could help to serve as a revolving source of funds for additional public projects since a portion of the original investment would be returned back in the form of revenue from credits sold. In Pennsylvania, PennVest would likely be the best suitor in Pennsylvania for receipt and disbursement of these funds, and since they currently have an important role as a clearinghouse in the process, they would provide the most efficient means of bringing publicly funded credits into the marketplace. To be clear, there would have to be specific limitations placed on activities that would be eligible under this program. Public funding that generates excess nutrient reductions at a municipal treatment plant would likely be one of many activities that should fall outside of the scope of this program. In those instances the reductions are already mandated under the CBTS and WIP.

4. Procedural and Technical Aspects of Trading

4.1. Nutrient Trading Process – The nutrient trading process is handled by PA DEP, who provides the review and approval/denial of credit generation applications. The credit generation process is broken into four procedural requirements/steps. Credits must be certified, verified, and registered before they can be used to comply with a NPDES permit. Credits cannot be registered unless a valid Contract between buyer and seller is in place and approved by DEP.

4.1.1. Certification – Otherwise known as the proposal submission (Step #1). As of May 2010, PA DEP had received 89 proposals and approved 59 of them for a total of 2,999,765 nitrogen credits and 249,543 phosphorus credits (EQB, 2010). By June of 2011, the number of approved proposals had reached 86 with well over 100 proposals having been submitted (See Attachment 1). In interviews with PA DEP, they have indicated that many of the unapproved proposals had fallen by the wayside when additional information was requested to better clarify the technologies proposed and the basis of nutrient calculations presented in the original proposal. While the number of proposals would indicate a lot of momentum within the nutrient trading program, it is important to note that 4 (5%) of the proposals that were approved are recertifications that are counted twice, 32 (37%) of the approved proposals are for manure export out of the watershed and that at least 34 (40%) of the approved proposals are contingent on the sale (CS) of credits and thus the activity will not be installed/conducted unless the credits are purchased. Many of the 32 manure export proposals are contingent on the sale of credits.

4.1.2. Verification – The second requirement (Step #2) and a key component of DEP's certification decision is a review of the "verification" plan included in the certification request. A verification plan explains how verification will occur. Verification is going to be project specific or at the least technology specific. It fundamentally has to demonstrate that the pollutant reduction

activity was conducted and other requirements, such as baseline and threshold, are met. DEP establishes through its review process who the primary verifier is going to be.

DEP does not generally accept primary responsibility for verification; however, they do retain primary enforcement activities such as monitoring, inspection of sites and, performance of compliance audits. Currently, many of the verifiers appear to be private entities, many of which are nutrient management planners and agricultural consultants who may have previous relationships with some of the larger ag operations. It appears that a third-party verifier would be the most logical and effective means of ensuring that credit generating activities are occurring, and it appears that implementation of a third-party certification would not place an undue burden on any of the parties involved. This would help to alleviate any potential conflicts of interest which may conceivably be an issue under the current program. Self-verification should never be a primary means of verifying credits, unless it is done under the auspices of an individual certification or licensing program.

4.1.3. Contract Approval – PA DEP requires that buyers and sellers enter into a legal contract for nutrient credit trading (Step #3). The contract establishes the length of sale, price per pound of nutrients that are exchanged, and the name of the buyer and the seller. The seller does not have to be the generator of the credits, and as such, the program permits the existence of aggregators, brokers, clearinghouses, and other market type players. Because the approved proposal during the generation step of the process outlines the verification methodologies to be employed, and the registration step solidifies the availability of the credits for use by a NPDES permit holder in a given calendar year, the contract merely establishes the price to be paid and establishes with some legal comfort that a buyer exists to justify the costs for implementing a given activity and that a seller has reasonable assurance that NPDES compliance for effluent nutrient loadings is achievable.

Generally, the contract does provide language regarding contractual verifications that the nutrient reduction activity is occurring, but enforcement of the activity resides with PA DEP. This is what enables an aggregator or broker to exist without placing burdensome obligations on the aggregator or broker to police the activity themselves or without requiring the actual NPDES permit holder to police the activity. In interviews with DEP, it was agreed that primary enforcement of the nutrient trading program is via their efforts. Since the number of trades to date has been small, enforcement has not been an issue given staffing levels. It is expected as the number of nutrient trades on the books increase, staffing levels will need to be increased in order to ensure proper monitoring and enforcement. (PA DEP Interview, 2011).

Among the regulated community, the uncertainty of nutrient credit generating activity compliance and its verification is one of the biggest challenges facing the viability of the program. Some plant operators have been hesitant to travel down the path of nutrient credit trading, and have instead elected to

take a "bricks and mortar" approach to reaching compliance. This may be despite economic analysis that clearly shows that purchasing of nutrient credits is more cost effective than plant upgrades. In this regard, the current demand for nutrient trading credits has not been as strong as expected or hoped. It will be critical moving forward that advocates of the program do a better job of educating the regulated community about the nutrient trading credit program and dispel any misconceptions that may circulate around it.

4.1.4. Registration – Registration (Step #4) is a condition of the original approval of credits. This is DEP's accounting mechanism to track verified credits before they are used to comply with the NPDES permit effluent limits. DEP publishes notice of registration in the Pennsylvania Bulletin as an informational item. Once registered, credits may be used to comply with a NPDES permit with nutrient limits. A point source discharger's actual nutrients discharged minus its offsets and minus its credits purchased must total less than its allocated load.

4.1.5. NPDES Permits & Tracking – NPDES Permits that are currently issued by DEP for Phase I and II dischargers have explicit language regarding Chesapeake Bay compliance schedules, nutrient requirements, and the use of offsets and nutrient credits. Compliance schedules outline various milestones and subsequent due dates in order to ensure compliance with nutrient requirements by the mandated compliance dates. Completion of plant upgrades, offsets, nutrient credit contracts, or other compliance measures are required one year in advance of the compliance deadline. This allows an entire water year to pass, thereby permitting a demonstration period for compliance of the yearly nutrient load allocations.

Nutrient requirements spell out applicable definitions, compliance cycles, and the various administrative reporting, tracking, and procedural requirements. Operators are required to track monthly discharges of nutrients using supplemental DMR forms and prepare an Annual Nutrient Summary which is due by November 28th following each compliance year (October 1 through September 30th). For purposes of nitrogen tracking Total Nitrogen is defined as the sum of Kjeldahl-N (TKN) plus Nitrate-Nitrite-N, where TKN represents the forms of organic nitrogen and Nitrate-Nitrite-N represents the forms of inorganic nitrogen. While loadings are calculated and tracked on a monthly basis, the Total Mass Loads for a compliance year are the basis for determining whether a facility has met its Bay nutrient obligations. In this regard, operators have flexibility to achieve better than permitted removal for some months to account for upset conditions or more challenging conditions in other months. This is not a universally adopted approach among the Bay states, but there would appear to be valid scientific reasons for this approach in Pennsylvania given spatial and temporal scales as well as climatic conditions that may be very different between the significantly colder regions of the upper versus the lower and warmer regions of the Bay Watershed.

Nutrient credits and offsets are defined in newly issued NPDES permits, as are the tracking and reporting mechanisms to be used should a permittee employ one or both. PA DEP has differentiated certain activities as offsets

versus other activities as credits. This has been specifically instituted so that activities defined as offsets cannot be used by anyone other than the NPDES permitee who is responsible for the load reduction. DEP approves offsets through its regional office, with the only unilateral offsets being granted for retirement of on-lot sewage systems (OLDS) (25# TN per year per home) and the acceptance of septage (3# TN per 1,000 gallons accepted). Other Bay states have adopted the OLDS retirement concept in one form or another. This is because most on-lot systems leave nitrogen virtually untreated. Other Bay states have defined their OLDS offsets differently depending on whether the system has failed or is functioning and the proximity of the system to water bodies. Pennsylvania permits the highest OLDS offsets, with other states ranging between 4.6# TN and 12.2# TN depending on the system, its location, and the individual state rules. Attachment 2 provides a comparison of the various state programs in this regard.

Specific requirements in a NPDES permit regarding use of nutrient credits include the rule that credits applied in a given water year must be from activities within that same year. There are no provisions for banking or carryovers. This would include any reserve credits banked by DEP. Supplemental forms are required to be submitted with each month's DMR. Credits cannot be applied unless they have been listed on DEP's website as registered credits. To date, only the Fairview Township Authority has been listed for having registered credits for the October 2010 – September 2011 compliance year. Additional registered credits are likely to be posted up to and through the truing period.

Within the permits being issued that contain Chesapeake Bay nutrient provisions, DEP has established a truing period. This is essentially a 2-month reconciliation period that allows treatment plant operators to complete their calculations for the total nutrient discharges for the most recent water year. During the truing period, facilities may purchase credits to make up for any shortfall or they may place excess credits on the market. This in effect creates a spot market, and it provides owners and operators with an additional level of comfort for NPDES compliance. In the case of excellent performing years, there is also an ability to collect revenue through a non-user revenue stream. In order for this to occur, a municipal plant would have likely already had to go through the proposal approval process in order to provide sufficient time to consummate a trade, but nonetheless the opportunity still exists. A number of proposals for treatment plants have already been received and approved by PA DEP to date, and these could be sold in the spot market during the truing period or through the auction process. This has already occurred during the 2010 auction cycle. Given that the current market rates for nitrogen and phosphorus are relatively low in relation to the likely costs of generating them, it is not expected that most plants will intentionally treat to a higher level of removal efficiency solely to collect revenue from nutrient credit sales. It does, however, encourage facilities to live less "on the edge" of compliance and to maintain a consistent level of treatment throughout a permit cycle. This is especially true with tertiary treatment technologies such as chemical precipitation and filtration

where there are process controls for the level of treatment by adjustment of chemical dosing levels and the rate of carbon source supplementation. It appears that the truing period has the potential to generate additional nutrient reductions that would not have otherwise occurred, especially if nutrient trading becomes a robust marketplace as intended.

One of the more difficult oddities within current permits is the possible confusion that operators will have regarding two different permit cycles and two different pollutant concentration limits for the same pollutant in the same permit. The actual NPDES permit discharge limits are set by the local receiving stream considerations, the variations in assimilative capacity of a stream between winter and summer months, and the limitations that plants have on achieving nutrient reductions in winter months because of temperature kinetics. One section of a typical permit may indicate an average monthly permit limit of 2.0 mg/L for total phosphorus (TP), while the Chesapeake Bay TMDL mandated provisions for annual phosphorus loadings are set to 0.8 mg/L of TP at design hydraulic load. It is envisioned that operators will not understand this discrepancy and there may be noncompliance for smaller systems as they become subject to these requirements. It is likely a short-term issue until an operator becomes more familiar with their permit and realizes the need to focus on the lesser of the local receiving stream limits or the Bay load allocation. Calendar years are used to track a facility's obligation under PA's Chapter 94 wasteload reporting requirements and its biosolids generation reporting, and this year is the fundamental basis with which operators think. Pennsylvania is the only Bay state that has chosen to use the water year for tracking and compliance purposes. Regardless of the technical or administrative merits of this decision, it is cumbersome for two different compliance cycles to exist for the same permitted facility.

4.1.6 PENNVEST Clearinghouse - PENNVEST involvement in the trading program was initiated as an effort to provide an aggregator of credits within the system. As such, a point source does not need to expend additional resources to manage multiple contracts from multiple sellers. It is hoped that these efforts will reduce costs for the buyer and encourage more players to enter the trading market. An important item to distinguish is that PENNVEST does not police nutrient credit trading activities. They merely facilitate them to reduce the burden on both parties. They also do not verify credits. This is the fundamental difference between PennVest and a broker of credits, who in many cases is accepting responsibility for verification of the credits generated. Also, PennVest does not set the price for nutrient credits that are traded. Auctions are sponsored by DEP and PENNVEST to encourage the active selling and bidding of credits during the truing period and to establish credit prices.

As reported by PA DEP, PENNVEST completed two auctions in 2010. The results are as follows:

October Auction		
3 year- 21,000 N credits exchanged at $3.04		
Buyer	**Seller**	**Credits Exchanged**
PPL EnergyPlus LLC	County of Lycoming- AG generated	9,153 lbs/yr
	ElectroCell Technologies- AG generated	12 lbs/yr
	City of Lancaster- PS generated	11,835 lbs/yr

November Auction		
1 year- 41,000 N credits exchanged at $2.75		
Buyer	**Seller**	**Credits Exchanged**
PPL EnergyPlus LLC	County of Lycoming- AG generated	3,722 lbs/yr
	Elizabethtown Borough- PS generated	7,369 lbs/yr
	City of Lancaster- PS generated	29,908 lbs/yr

It is apparent from the prices that were agreed upon that the demand side of nutrient credit trading may still not be where it needs to be in order to ensure a viable marketplace. The cost of nutrient credits had been previously been cited between $3.81 and $9.00 (weighted average $5.52) per pound TN and $4.00 per pound TP based on data obtained from the PA Legislative and Budget Committee report prepared by Metcalf & Eddy in November of 2008. It also appears the Buyer in every case was not a regulated NPDES entity, but was rather a speculator who may have been attracted to buy given the low auction prices. It is not clear how the role of a speculator will exist in the marketplace, as the credits auctioned are specific for the previous compliance period (water year); unless it is the intent of the speculator to quickly turn the credits at a profit. There appears to be limited opportunity, and this appears to be a good thing, for there to become a "futures" market for credits. As stated before they can be only used in the compliance year for which they were generated. Two additional auctions have been scheduled for November of 2011 for credits generated during the Oct. 2010 to Sept. 2011 water year. Having been scheduled for near the end of the truing period, it is unlikely for speculators to enter the market during this cycle.

The fundamental concept of PENNVEST as a credit clearinghouse makes sense if the marketplace does become robust. With delays of the Phase III treatment plants, it is hard to tell whether the concept of an auction will be viable moving forward. It is anticipated that the next two to three years will tell the proverbial tale.

4.2. Nutrient Calculation Methodologies – Pennsylvania's trading methodologies were reviewed prior to analysis of the actual registered trades that have been made. There are several important considerations regarding the framework of nutrient credit generation. Although the focus of this analysis is Pennsylvania's program,

these will be reviewed and evaluated against other Bay partner states when applicable. Attachment 2 provides a tabulated synopsis of the various program elements by Bay partner state.

4.2.1. Demonstration of Baseline Compliance – There are specific baseline compliance measures that must be met prior to an applicant being considered for nutrient credit generation. In Pennsylvania, and specifically for the agricultural sector where most credit generating activity has occurred, there are two main requirements.

First, the agricultural operation must be in compliance with applicable environmental regulations. This has been taken to mean regulations for nutrient management (Act 38 of 2005), manure management (25 Pa Code §91), and erosion & sedimentation control (E&SC) (25 Pa Code §102) programs. Act 38 is specific to Concentrated Animal Operations (CAOs) and Concentrated Animal Feeding Operations (CAFOs), so they do not apply to many agricultural operations. The manure management rules, which are nitrogen based, are broader in scope (than Act 38) and apply to all farms who land apply manure. Chapter 102 rules for E&SC are the most far reaching in that they extend to both agricultural tilling and plowing activities as well as animal heavy use areas, effectively meaning that nearly all agricultural operations are covered. These rules are focused on sediment loss, which is an obvious source of nutrients, but nonetheless nutrients are not specifically covered. Nor is there anything regarding fertilizer application. PA's fertilizer laws are geared towards licensing, labeling, and protecting consumers from adulteration or misbranding, they do nothing for nutrient management. In short, there is no holistic nutrient management regulatory program that enables PA DEP to look at an entire agricultural operation and ensure that it's per acre annual nutrient loadings do not exceed acceptable standards. Only the largest agricultural operations come close through nutrient management planning and the manure management rules.

Bay partner states of Maryland and West Virginia mandate that agricultural operations achieve their portion of state nutrient reduction goals for nonpoint source agriculture before nutrient trading, with these assessed on a per acre annual basis. Virginia applies a one-size fits all mandate by requiring five specific BMPs to be employed before nutrient trading activities. Table 4-1 summarizes the various state baseline requirements.

Table 4-1 Agricultural Baseline Requirements in the Bay Partner States

Maryland	Pennsylvania	Virginia	West Virginia
Achieve required portion of state nutrient reduction goal, a per-acre annual loading rate (# TP/acre and # TN/acre) calculated from the applicable TMDL allocations. Also: • Be in compliance with applicable regulations. • Implement a Nutrient Management Plan. • Develop a soil and water conservation plan, including (if applicable) a waste management system plan.	Be in compliance with applicable regulations, including nutrient management, manure management, and erosion and sedimentation control. Also, implement one of three threshold measures: • Implement a 100-foot manure setback. • Implement a 35-foot vegetative buffer. • Reduce the farm's total nutrients 20% below reductions required by regulation.	Operations must implement the following BMPs (as applicable): • Soil conservation plan. • Nutrient management plan. • Cereal cover crops. • Surface water exclusionary livestock fencing. • Vegetative buffers.	Achieve required portion of state nutrient reduction goal, a per-acre annual loading rate (# TP/acre and # TN/acre) calculated from the applicable TMDL allocations. Also: • Implement a whole-farm nutrient management plan.

The second requirement in PA is that an agricultural operation must implement one of three threshold measures: 1) implement a 100-foot manure application setback from surface water; 2) implement a 35-foot vegetative buffer; or 3) reduce the farm's total nutrient balance by 20% below the reductions achieved through regulations. From a practical standpoint, at the end of a nutrient calculation exercise for an ag operation (where the 20% reduction is chosen), 20% is taken off prior to the 10% reserve reduction, for an overall reduction of 28% of the calculated nutrient reduction. As an example, if a farm calculates a nitrogen credit of 100# for its operation, the tradable credit is 72#. This essentially equates to a 1.39:1 trading ratio.

It is important to note, that in the case of many existing operations already subject to the manure management requirements (CAOs, operations accepting manure from CAOs, and operations accepting manure from CAFOs), the buffer requirements are already required. So in many cases the PA requirement can be summarized as "comply with existing applicable regulations regarding nutrient and manure management". In our opinion, Pennsylvania should consider whether the baseline requirements should be revised to include both the 20% reduction and either the 100-foot manure setback or the 35-foot vegetative buffer. Alternately, the farm should be required to demonstrate that their nutrient and sediment loadings are consistent with Bay model allocations and that they are meeting any of their nutrient reductions as may be mandated under the WIP. In essence, this would look like the MD or WV program. In addition, a whole-farm nutrient management plan should be required for all agricultural operations, regardless of whether they participate in nutrient credit trading or not. It would appear that the statutory authority for this has been previously made in Pennsylvania through the Clean Streams law.

4.2.2. Fundamental Approach - Point source credit calculation is a relatively straightforward process, because NPDES mandated monitoring of flows and nutrient discharges serve as the basis for what has been discharged, and the permit itself establishes what can legally be discharged. Point sources are

required to follow the same process to establish a certified/verified trade, but the calculation process is fairly straightforward and site-specific, so it has been omitted from this analysis. Regarding NPS nutrient loading calculations, there have been three common approaches historically taken, direct measurement through monitoring, pre-determined nutrient reductions for specific practices, and site-specific calculations (WRI, 2009).

4.2.2.1. **Direct Measurement** - Direct measurement through monitoring is an academic exercise which has merit in establishing the true nutrient reductions for a given activity under a given set of circumstances, but is completely impractical and cumbersome from a practical standpoint. By its very nature, NPS pollution is defined as diffuse pollution, and it has no generally defined discharge point. Nutrient contributions to the Bay from an agricultural operation can include overland flow, discrete flow through ditches and stormwater conveyances, nutrient laden groundwater discharge into streams, and atmospheric deposition from volatiles such as ammonia nitrogen which are converted. To place a bubble around every farm that participates in a nutrient trade would be completely impractical. None of the Bay state partners are implementing an approach such as this.

4.2.2.2. **Predetermined Reductions** - Pre-determined nutrient reductions for specific practices is a second approach, but it is also wrought with several deficiencies. These include no consideration of local water quality impairment, no consideration of site-specific characteristics including soil type, slope, hydrology, and proximity of the site to the water body that is being protected. Additionally, this practice does not in any way discern the most cost-effective activities for generating credits. The appeal of this program is the ease of tracking. Activity A generates X pounds per acre for L nutrient. Activity B generates Y pounds per acre for M nutrient. The Virginia Water Quality Trading Program largely centers on this concept. It only distinguishes between what side of the fall line the project site is on, and what watershed the activity is occurring in.

4.2.2.3. **Site Specific Calculations** – Pennsylvania, West Virginia, and Maryland adopt this strategy. It provides the most opportunity for meaningful, accurate, and practical calculation of nutrient credits. It also provides a framework that does not necessarily limit practices to a canned set of BMP's from a list. Emerging technologies or alternate approaches have an opportunity to be evaluated. It does provide two challenges; 1) it is much more data intensive; 2). because of the various data inputs, it requires careful attention to those inputs, their origin, and their validity. There is great opportunity to reward a particular operation for its particular practices and success, but there is also great opportunity to overstate the current or future impact of the farm operation and the effect that a particular practice may have in generating credits. This will be vetted thoroughly in subsequent sections of this report.

It appears that, of the three, site specific calculation is the best approach, but it makes it imperative that the transparency of the trading process is upheld and that multiple stakeholders and/or reviewers are involved in the process. Agronomic portions of the calculation must be reviewed and agreed upon by agricultural industry professionals or regulators. Fate and transport assumptions must be peer reviewed as applicable. And any other technical aspect of the trade must be reviewed by the appropriate authorities. It is not reasonable to assume that one entity will or should have complete reviewing authority. In the Pennsylvania program, our discussions with PA DEP led us to the conclusion reviews by multiple entities is happening, however, it is encouraged that this process be both more transparent and more regimented. This should be left to agency discretion, as may currently be the case.

4.2.3. Technical Aspects of a Proposed BMP - According to PA DEP's website regarding credit trading, the following credit calculation requirements apply:

- The calculations must demonstrate how the pollutant reductions will be achieved from the proposed pollutant reduction activity to generate credits for the applicable period of time.
- The pollutant reductions must be expressed in pounds per year.
- The calculations used must be based on methodologies that DEP determines are appropriate under 25 Pa. Code § 96.8(c).
- The calculation for a point source may include excess load capacity attributable to activities such as effluent controls or the use of offsets.
- The calculation must include a 10% set aside for the Department's credit reserve.

Pennsylvania and Maryland have both implemented an interactive online program to facilitate nutrient credit calculations. For Pennsylvania, a number of spreadsheets have been developed to assist credit generators in calculating credits for common NPS practices. These spreadsheets were developed by World Resources Institute (WRI), Pennsylvania Environmental Council (PEC) and PA DEP along with input from the Chesapeake Bay Tributary Strategy Steering Committee Agricultural workgroup and others in 2006-2007. Both states programs are based around WRI's NutrientNet platform. The PA spreadsheets provide calculation efficiencies for a total of 20 agricultural BMPs that have been peer reviewed and included in Phase 5.0 of the CBWM, with an additional 7 undergoing additional peer review. These include a number of land use conversions including wetland restoration, riparian grass buffer, and riparian forest buffer as well as changes in agricultural practices such as cereal cover crop, continuous no-till, precision grazing, and off-stream watering. PA DEP permits additional BMP calculation efficiency tables to be used on a case by case basis.

PA DEP maintains documents that provide a description of and efficiencies for Agriculture, Urban and Mixed Open BMPs that have been or are pending approval for use in the Chesapeake Bay Program Watershed Model (Version 4.3) (See Attachment 3).

When the PA DEP spreadsheets are utilized, we found that the data inputs were fairly robust. They account for reduction mechanisms occurring on the farm and in the surface water body through use of EOS ratios and delivery ratios. They also account for manure applications (quantity and frequency), chemical fertilizer applications, crop yield, tillage methods, and soil type.

Unlike many PA DEP programs with specific forms, checklists, and formats for permit submissions that must be adhered to, this is not the case with the NCT proposals that have been completed to date. Of the proposal reviewed under the scope of our work, while most appeared to provide the required elements, they were organically constructed and no two were the same. From a reviewer standpoint, this is problematic and cumbersome. It may also lend itself to mistakes by reviewing agencies, and it does not provide a high degree of transparency for interested third-parties. It would be appropriate for the Department to develop standardized forms, formats, and checklists as they have done for other projects at this point in time, not later when there may be hundreds of proposals in various formats and of various qualities.

4.2.4. Edge of Segment (EOS) Ratio – EOS ratios are defined within the CBWM for all trading programs (WRI, 2011). In MD and PA these can be explicitly seen in the credit calculation methods, while in VA these are factored into the nutrient removal rates that have been derived for specific BMPs. The EOS ratio accounts for movement of a pollutant within a watershed segment and provides an estimate of the amount of land-applied nutrients expected to reach the surface waters at the boundary of a model segment. The EOS ratio accounts for differences between each watershed segment regarding soils, topography, land use, climatology, groundwater flow, and other watershed factors. Attachment 4 provides the Delivery and EOS Ratios currently in use in PA for agricultural nutrient credit generators. EOS ratios are not user defined and cannot be manipulated. They are derived from the Bay model. Published values are based on watershed simulations completed by EPA's Chesapeake Bay Program Office. While EOS ratios are not farm specific, to date their does not appear to be a scientifically defensible alternate strategy to determine EOS nutrient loads in another manner.

4.2.5. Reserve Ratio – A reserve ratio is a set aside, and thus a portion of the eligible nutrient credits are banked. In the PA program, this is intended to create an insurance pool should purchased credit sources default, as an uncertainty factor, and to provide liquidity in the market. A 10% mandatory reserve ratio is applied to all credit generating activities. As an example, in a credit generating scenario where 111# of credits are generated, 11# are placed into PA DEP's reserve and cannot be traded, and the remaining 100# can be utilized by the trading partner. West Virginia is the only other Bay state that applies a reserve ratio, using 10% for point source generators and 20% for NPS generators respectively (WRI, 2011). Maryland applies an analogous ratio for non-point source credit generators called the retirement ratio, but is calculated by the buyer when purchasing credits. In essence, the buyer has to overbuy credits so that 10% can be retired by the MDA. As an example, under the MD program, a buyer would purchase 111# of credits so that 100# could be used and 11# could be retired.

Because PA has no true uncertainty factor, its reserve ratio is the closest analogous factor used in nutrient credit calculations. Many detractors of the PA program point to this factor as being too lenient and not reflective of the inherent uncertainty and variability of agricultural practices in generating the pollutant load reductions that are granted under the credit. This will be considered in greater detail in subsequent sections of this report.

4.2.6. Delivery Ratios – Delivery ratios are premised on the underlying fate and transport of pollutants in surface water bodies. Coupled with the EOS Ratio, they are meant to account for the complete attenuation of a pollutant as it moves through the environment. As nutrients travel towards the Bay, they are continually subjected to physical, chemical, and biological processes. In this regard, it is perfectly logical that a pound of nitrogen discharged into the Susquehanna River from an agricultural source in upland areas such as New York State have a significantly less effect on the Bay than a pound of nitrogen discharged into Baltimore's Inner Harbor from an urban runoff source. Delivery ratios can help to equilibrate the location of activities between the generator and seller. From an economic perspective, they help to influence the actual cost of a credit. Delivery ratios are based on scientific consensus and in this regard are a defensible approach. They are specified within the CBWM.

While delivery ratios do not in of themselves control whether a particular area would be subject to a high concentration of nutrient credit generating or selling activities, they can have a significant effect. Because delivery ratios are generally much less further from the Bay, it is very conceivable that a buyer of credits would seek a trading partner in an area with a lower delivery ratio to maximize credits generated. There also has been some anecdotal discussion within the industry that generators of emerging technologies which generate nutrient credits as part of their Performa are looking to locate in areas where the delivery ratios are more favorable and that in some cases this can be one of the most significant reasons for locating in a particular area.

A high concentration of nutrient credit generation or selling in a particular area may have the effect of impairing a local watershed. This issue has become a recognized concern, and efforts are ongoing to allocate where nutrient reductions are to occur on a watershed segment basis. In Pennsylvania, 26 watershed segments have been carved out of the Chesapeake Bay Watershed. Eligible loads for tradable nitrogen and phosphorus have been allocated among these watershed segments. PA DEP tracks planned sales, contingent on sale credit generation, and implemented nutrient loads on a per pound basis. To further ensure that the Trading Program is not trading away reductions that are needed to meet the WIP goals for NPS reductions, DEP has established these maximum tradable loads for each watershed segment. A proposed Tradable Load for compliance year 2009-2010 is included in Attachment 5.

4.2.7. Uncertainty/Margin of Safety – While BMPs used to generate credits have undergone peer review and some level of scientific consensus, there is still

some uncertainty regarding the underlying mechanisms of soil and water transport, pollutant accumulation/degradation/attenuation, site specific practice nutrient removal efficiencies, and the role that nutrient cycles, hydrology, and climatology play in the life cycles of Bay inhabitants. There has been much discussion regarding the application of a uncertainty ratio, particularly in the case of NPS to PS trades. A wide variety of ratios have been suggested. Advocates of the Uncertainty Ratio have suggested a ratio as high as 2:1 (or even higher) be applied to all trades. In a recent comparison by WRI, only Virginia has adopted this rigorous of a ratio (WRI, 2011). Since the Virginia program makes no consideration regarding site specific data, including agronomic data particular to each farm, an uncertainty ratio of 2:1 could virtually be considered a requisite for its relatively simplistic approach. The values used are based on numerous assumptions that may not be representative of the actual farm under consideration. Maryland has proposed ≥10 percent for credits generated by nonpoint sources, however, this is limited to those BMPs not approved by the Chesapeake Bay Program (CBP) (WRI 2011). West Virginia has adopted a similar strategy.

Pennsylvania has been criticized because it does not have any uncertainty ratio applied in its calculations. As discussed, the Reserve Ratio is a 10% uncertainty ratio provided that the insurance pool that it creates is not ever tapped into. Further, this reserve ratio is applied to all trades regardless of CBP approval of the BMP. In discussions with PA DEP, it has been suggested that the overall trading ratio is about 1.6:1 in Pennsylvania when considering the reserve ratio and the various ratios that are employed in the credit calculation process (PA DEP Interview, May 2011). Others have suggested that an overall trading ratio of 1.3:1 best approximates the Pennsylvania program. Based on our evaluation of the trading calculation methodologies, it has been concluded that the ratio is between 1.11:1 and 1.39:1 depending upon the baseline requirements that have been selected by the credit generator.

As a whole, uncertainty ratios are the most arbitrary ratio proposed in the various nutrient credit trading programs, and they have nothing to do with scientific or statistical information. In economic terms, they create inefficiencies in the market and can either inflate or deflate the true market price of an activity. Given that the application of science is supposed to be the central focus of restoring the Bay, it would appear that increased efforts should be placed on eliminating uncertainty in the model and variables used, including refinement of EOS and delivery ratios (which are fundamentally based on scientific principles) as opposed to debating uncertainty ratios which are acknowledged as being arbitrary.

4.2.8. Missing or Alternate Considerations - There has been much discussion during development of the Bay TMDL and the nutrient trading programs about the inherent differences between non-point sources and point sources, the difference between existing sources and new sources, the use of site specific factors versus assumptions, and the timing of a BMP implementation in relation to when nutrient trading and the TMDLs are implemented. The

following considerations, while not currently made in the various state programs, are worth consideration:

4.2.8.1. New Development Ratio –One of the technical aspects we found curious during our analysis is why there are no ratios applied to the Buyer of credits. There is no consideration given to the "ripple" effects a buyer may have. Credits purchased by a developer to build a new treatment plant do not take into account the various other point and nonpoint nutrient sources are occurring, be it construction related runoff, urban runoff from impervious surfaces, additional development to support the primary development activity (stores, services, etc.), or increased agricultural activity in the surrounding area for increased food supplies. In this regard, a pound of nitrogen purchased for new development has a considerably different effect than a community at or near build-out with aged infrastructure and treatment plants that are space and economically constrained. Even with the rigorous implementation of E&SC practices, post-construction stormwater BMPs, and agricultural BMPs, the net discharge of nutrients from new development is clearly not limited to what comes out of a pipe of a sanitary waste treatment plant. It would appear that a ratio for the actual use of the credit be applied to the buyer side of a trade depending on the nature of the buyer itself. New or expanding point source dischargers as a result of new development should be expected to purchase additional offsets/credits to account for the "ripple" effect that they enable. In the case of PA, where no allocations are being granted to expanding or new point sources, this would have the effect of encouraging existing point sources, which in some cases already have excess capacity, to be the primary areas where development would occur. PA's program used the August 2005 design flow of its existing facilities, and we would propose that any new or expanding source after this point, which would have a net zero nitrogen and phosphorus discharge requirement, be subject to a new development ratio requiring perhaps 25% of credits purchased to be placed in DEP's credit reserve pool. As an example, if a new or expanding source required 100 credits to operate, 133 would need to be purchased so that 25% (33 credits) could be placed in reserve.

4.2.8.2. Point Source versus Non-Point Source Discharges – There has been some discussion among conservation groups regarding the issue of whether a pound of nutrient pollution from point sources is inherently more harmful to the environment than a pound from nonpoint sources. The issue in large part revolves around some growing evidence around the country regarding the secondary benefits of advanced wastewater treatment techniques. While advanced treatment to ENR levels and beyond is not specifically designed for removal of synthetic organic compounds found in municipal wastewater streams, including pharmaceuticals and health products, including antibiotics, birth control pills, anti-bacterial

agents, and other endocrine disrupting compounds (EDCs), these advanced levels of treatment are known to provide higher removal efficiencies of these types of compounds. While these benefits may be real, they need to be scientifically quantified and they should be evaluated on the basis of their benefit in relation to the costs required to achieve them. This is no different than most regulation of pollutants. What seemingly is not discussed in this same context is the benefit of secondary non-point source reductions ancillary to the primary nutrient reduction objectives. Synthetic organic pesticides, petroleum hydrocarbons, miscellaneous inert ingredients and micro-nutrients from fertilizer application, and a host of other anthropogenic compounds are discharged from urban runoff, agricultural and silviculture operations, and construction sites. It would appear that the use of an artificially high uncertainty ratio may be intended to deter the use of nutrient credits and encourage a brick and mortar treatment approach to achieve these secondary benefits. It appears that this is counter productive in achieving nutrient reductions in the most cost effective way, and that it undermines the credibility of Bay restoration efforts, which may be perceived as a series of moving targets and may create the perception, fair or not, that there is no end to the cycle of upgrades.

4.2.8.3. Current versus Future Practices – There has been some discussion in the industry regarding at what point a practice can be considered a BMP, or at what point prior to that it is considered part of the historical pollutant load associated with the operation. In PA, the Chapter 96 rules are clear in this regard that the pollutant load considered within the baseline requirements is that which was occurring as of January 1, 2005. So any practice implemented prior to this date should not be considered for nutrient credit generation. While it appears clear in the regulations, this may not be reflected within the credit calculation methodology as will be discussed in Section 5. It would appear that Bay loadings in the model are already accounting for the reductions that may have been historically occurring from advanced agricultural or other practices, so to allow these to be traded would appear to provide absolutely no additional net benefit to the Bay.

4.2.8.4. Program and Verification Fees – There are currently no application fees or user fees associated with the nutrient credit programs. It would appear that application fees should be required to offset the cost of agency reviews and technical evaluations and that yearly fees would be appropriate to offset the cost of enforcement, verification, and other agency expenses associated with the program. Since a unit in the form of pounds of a pollutant exists in the context of nutrient credit trading, the user fees could be assessed on a per pound basis. A reporting mechanism in the form of supplemental DMR tracking forms already provides recordkeeping to facilitate this without additional burden to an end user. In this regard, the program would be structured very much

like the current water and wastewater facility program in PA, where fees are assessed based on the facility's discharge volume.

5. **Review of Registered Trades to Date** - To date there have been 10 trades in Pennsylvania which have been formally accepted as legitimate contracted agreements (See Table Below). Six of 10 trades have been from new sources. These sources appear to be mobile home parks, camps, or other small sites that had to either abandon OLDS or sewage holding systems and are constructing actual treatment plants, or they are entirely new developments.

Contract/Trade Information

	Buyer	Seller	Region	Date of Agreement (signature date)	Length of Agreement	N Credits*	Price	P Credits*	Price
1	Mount Joy Borough Authority	Brubaker Farms	SC	02/26/07	3 years	11,718	$3.81	-	-
2	Dunn Lake	Red Barn Trading Company	NE	10/17/06	5 years	223	$9	3	$4
3	Hamm Equities LLC	Red Barn Trading Company	SC	02/02/07	5 years	1,592	$9	73	$4
4	Fairview Township, York County	Red Barn Trading Company	SC	04/10/08	15 years	20,000	$5/N in 2010 and up to $7.56/N in 2024	-	-
5	Tamarack Mobile Home Park	Chesapeake Nutrient Management, LLC	SC	04/28/08	20 years	-	-	21.5	$4.50
6	Quail Creek Homeowner's Association	Chesapeake Nutrient Management, LLC	SC	07/14/08	20 years	538	-	40	-
7	Airy View Heights	Red Barn Trading Company	SC	02/20/09	5 years	635	$10	48	$5
8	Camp Iroqoina	Red Barn Trading Company	NE	03/17/09	5 years	8	$15	11	$10
9	PPL EnergyPlus, LLC	Red Barn Trading Company	SC	07/08/10	1 year	Up to 57,000	-	-	-
10	Mt. Hope Nazarene Retirement Community	Red Barn Trading Company	SC	12/08/10	5 years	546	$15	53	$10

To date, all but one of the non-point source trades have been a result of poultry manure export. The exception has been for the use of continuous no-till practices and cereal cover crops. Century provided a date request for all trades early in the process. Because many of the trades are from the same seller and are an identical activity (albeit at a possibly different agricultural operation), DEP suggested, and Century agreed to work together early to define a smaller number of trades that would represent those that have been contracted. Red Barn Trading Company's 27 certified proposals have been with regard to poultry manure export out of the basin, and these 27 certified proposals are the basis for seven of the 10 nutrient trading contracts to date. In our analysis, the certified proposal for Client 0136 in Watershed Segment 710 in Lancaster County, PA was selected as a representative proposal with nutrient credit trading calculations that were common among the other 26 certified proposals. Chesapeake Nutrient Management LLC has been the designated seller in two nutrient trading contracts to date, and both of its trades are regarding poultry export from the basin. The technical proposal reviewed regarding Chesapeake's trades is for the Esbenshade's Farm in Watershed Segment 110. The Mount Joy Borough contract with Brubaker Farms represents a unique seller and credit generating activity, and the 10th and last contract that was reviewed during our project efforts.

5.1. Red Barn Trading Company - Red Barn's nutrient credit proposal for Client 0136 in Watershed Segment 710 in Lancaster County, PA was submitted by McNees, Wallace, and Nutrick on behalf of Red Barn, and the revised proposal which served as the basis for credit generation was revised December 12, 2006. The local receiving stream is an unnamed tributary to Chickies Creek. The farm met baseline requirements regarding an approved NMP and a current E&SC plan. The ultimate disposition of manure from this farm has historically been within the basin through a manure broker. Future disposition of the material was not specified other than to say that it will go out of the basin, and possibly out of the state, and that neither southeastern Pennsylvania PA DEP or the Commonwealth's mushroom industry will be the final disposition site. Total manure production is estimated at 471-tons per year. Century has made the following observations regarding the proposal and supporting calculations:

- The proposal was subject to the interim trading policy from October 2005, and as a result was approved with only a 5% reserve ratio. The current reserve ratio requirement is 10%. PA DEP has made this clear in adopting formal regulations under 25 Pa. Code § 96.8. For this trade, 7699 #/yr of Nitrogen credits were generated, and 7,314 #/yr were available to be purchased, so this difference materially affects the credits available for trading by some 385 #/yr.
- The proposal does not discuss whether the agricultural operation has met the threshold requirement regarding manure application setbacks, riparian buffers, or the 20% reduction. It is not reflected in the actual nutrient credit calculations. As previously discussed, the 20% reduction should be mandatory for all trades including manure export.
- The approval letter from DEP suggests that, if the export farm is replacing its exported material with replacement material, it is required to inform DEP. This implies that a shell game of exporting manure but replacing it with someone else's within the basin will not be permitted. The language should be clearer in this regard if future manure export approvals occur. Part of the credit verification should be to verify that chemical replacement is occurring.

- For manure export trades, the importing form should be subject to the same baseline and threshold requirements.
- Chickies Creek was listed by EPA in the CWA 303 (d) impairment listings in 2001. PA's 1996 303(d) list reported 10 miles of the main stem to be impaired by nutrients from agriculture. The final impaired stream mile total on the 1998 Section 303(d) list is 30.6 miles. These segments were listed on PA's 1998 303(d) list because of impacts by nutrients and siltation due to agriculture. Nitrogen is not explicitly covered in the Chickies Creek TMDL, just phosphorous and sediments. Regardless of Chesapeake Bay efforts, removal of nutrient sources is clearly a good idea for this particular watershed.
- Red Barn provided a single manure analysis with the proposal that appears to have been used correctly in the credit generation calculations. However, sample analysis was conducted on an as sampled basis and does not appear to be corrected for moisture. Further evaluation may need to be conducted to define whether this an issue. It appears that PA DEP should prescribe specific sampling and analysis procedures that are consistent with environmental standards. The biosolids methodologies that are currently employed appear more rigorous and reflective of the actual nutrient content and make consideration for the effects of varying moisture in a manure which may result from differing storage practices.
- It was assumed in the credit calculation that nutrients from the manure no longer applied in the watershed would be replaced by commercial fertilizer. For manure, it was assumed that 85% of the nitrogen was lost to the environment, as opposed to 50% lost for chemical fertilizer. The difference between these two loss rates is essentially the credit generating activity. The 85% factor is adapted from the PSU Agronomy Guide and represents that portion of the nitrogen in manure that is not available for plant uptake assuming that it is not incorporated. This does not necessarily mean 85% of the nitrogen was discharged or eventually makes it to a surface water body as appears to be assumed. Nitrogen loss consists largely of volatilization of ammonia, nitrogen runoff, soil nitrification/denitrification processes, and leaching of nitrate by rainfall. 100% of these processes do not result in a discharge of nitrogen to the Bay as is suggested in the calculations. Volatilization of ammonia can be very rapid, so this loss can be particularly high and may represent a significant portion of the 85% lost. There appears to be a fundamental flaw with assuming that a lot of the nitrogen is predominantly ammonia, is lost to the atmosphere, and then undergoes deposition back in to the same basin. This is particularly the case for eastern portions of the Susquehanna basin, as in the case of this trade, where it would be expected that most of the ammonia volatilized would not be deposited back into the basin. Formal modeling and additional calculations should have been required to provide the rational and technical basis to justify this assumption.
- It is not clear if verification of chemical fertilizer substitution is to occur in order to register credits, but it clearly should be.
- The actual amount of nutrient loading from this operation appears overstated on the basis of atmospheric deposition. Given that the Ammonia Nitrogen represents only 14% of the Total Nitrogen in the manure analysis report used to calculate the credits, it appears that the 85% loss to the environment may be overstated, at least from a watershed perspective.

- Regarding verification, the revised proposal indicates a manure analysis frequency of once per every three trucks removed from the poultry operation. The analysis will ultimately dictate what nutrient credits are actually generated, and DEP makes it clear that these adjustments are to be made. There is no discussion regarding sampling or analytical methods to be employed, sample type (grab or composite), or any details regarding the manure analysis. This is not consistent with most environmental protocols, where this type of detail would be required. Manure analysis in combination with certified scale truck weight slips and a shipping record are the verification documents. Red Barn has assumed responsibility for exporting the manure and recordkeeping requirements by a certified manure hauler.
- The Red Barn proposal uses the TN/8 equals TP delivered to the Bay. This rationale is no longer being permitted. As a result, there is no consideration made for baseline phosphorus concentrations in the soil at the beginning of the project, so there is no distinction made as to whether the soil contains excess phosphorus at the beginning of BMP implementation. It is possible that early years of the trade will result in fewer reductions than anticipated. Actual calculations for phosphorous loading, crop uptake, and loss to the environment are now required, as is the requirement for testing of background soil phosphorus.
- The delivery ratio of 0.97 used in calculating the credits is consistent with the current ratio that DEP has referenced.
- Use of the EOS ratio of 0.50 was not explained within the proposal and information provided to Century by DEP, and the source of this ratio is not apparent. The EOS ratio for this particular watershed segment is 0.28 according to published DEP data. Using the published EOS ratio utilizes a nitrogen credit of 4,311 #/yr, or 56% of that which was granted under the approved proposal.
- Within the CBWM, the practice of manure transport has been listed as pending approval. However, DEP's summary of agricultural BMPs and their nutrient removal efficiencies (see Attachment 3) indicates that because of the difficulty in tracking manure transport and possible transportation issues, this practice has not been considered in the nutrient reduction strategy at this time. It is not clear what this means for the 7 trades that are currently under contract regarding it. Further, manure trades continue to be approved so it appears that manure export will continue indefinitely.
- It is important to note that only Pennsylvania has approved manure export trades under its nutrient trading program. As a whole, the practice of manure export does not appear sustainable. It is very much dictated by fuel prices related to transport, and it would inherently dictate volatility in the price of credits or the artificial inflation of prices to account for this uncertainty. Variability of nutrients in the manure further complicates and adds uncertainty to arriving at a fair price and ensuring that a discharger has enough credits to meet their obligation. As it currently stands, transport of manure from one agricultural operation to another outside of the basin provides some benefit but seems to be of very limited applicability for the future. If the basin to which it were transported becomes the subject of TMDL implementation, such as the case for western Pennsylvania, which is predominantly in the Mississippi River basin, then the trade is no longer viable. There are serious Mississippi delta hypoxia concerns being expressed at large. EPA has in as much declared

publicly that the success of the Chesapeake Bay program will enable basins such as these to become the target of future TMDL efforts.

- DEP has acknowledged that this manure export practice is likely not a long-term viable solution. It has indicated that pioneers of the program were anxious to exercise the program and get it off the ground. They have suggested that there may be some promise regarding manure export to mining sites, and there has been some work in evaluating the feasibility of this practice. There may be some merits in establishing a program such as this as long as the use does not constitute outright disposal. The surficial application of manure to establish better and more uniform vegetative cover on mine spoil sites and abandoned mining lands may very well be a viable practice if conducted in an environmentally responsible manner. However, in general manure export should not be considered as an approved BMP for generation of future nutrient credits, nor should existing approved trades be allowed to be renewed, unless significantly more scientific research and validation is conducted to substantiate the claims being made.
- It appears that this trade could be considered a 1.1:1 trade based on the ratios and methodologies employed.

5.2. **Chesapeake Nutrient Management LLC** – Chesapeake's nutrient credit proposal for CNM – E110 is a poultry layer operation known as Esbenshade Farms in Rapho Township, Lancaster County, PA. This operation resides in Watershed Segment 110 and the nutrient generating proposal was submitted by Mavickar Environmental Consultants on behalf of Chesapeake. The proposal that served as the basis for credit generation was submitted on October 2008. This project is also within the Chickies Creek watershed. The farm met baseline requirements regarding compliance with a CAFO permit, an approved NMP and a current E&SC plan. The ultimate disposition of manure from the farm has historically been within the basin for agricultural crop production. Future disposition of the material has not been specified other than to say that it will go out of the basin, and possibly out of the state, and that it will be used for mining reclamation or agricultural crop production. Total manure production is estimated at 15,000-tons per year. Century has made the following observations regarding the proposal and supporting calculations:

- Calculations use the current reserve ratio requirement of 10% as adopted formally in the regulations under 25 Pa. Code § 96.8.
- The proposal does not discuss whether the agricultural operation has met the threshold requirement regarding manure application setbacks, riparian buffers, or the 20% reduction. A 20% reduction is not reflected in the actual nutrient credit calculations, so it is assumed that one of the other two requirements was met. As discussed, the baseline and threshold requirements should apply to the import farm.
- The proposal discusses the listing of unnamed Chickies Creek tributaries in PA's 2008 Impaired Stream Listing, but suggests that Chickies Creek itself is not impaired. This appears inconsistent. The EPA issued a TMDL for Chickies Creek in 2001. Impairments to the main stem and tributaries are listed as a result of agriculture. PA DEP's TMDL Plan suggests a combination of Agricultural BMPs to be implemented in order to achieve the TMDL. Manure export is not explicitly stated. As of 2001, a 76% reduction for cropland was

required to meet the sediment TMDL and a 64% reduction was required for phosphorous. Nitrogen is not included in this TMDL.

- Chesapeake provided five manure analyses with the proposal that were taken between 2007 and 2008 and analyzed by one of two different labs. These appear to have been used in the credit generation calculations. Sample analysis was conducted on an as sampled basis by both labs. One of the labs does provide moisture analysis. It is not apparent in the discussion regarding verification as to whether moisture will be reflected in the nutrient credits generated.
- It appears that the same 85% loss to the environment was assumed in this trade and this entire portion was deposited back within the basin and reached the bay (minus the delivery and EOS ratios).
- Regarding verification, the revised proposal indicates a manure analysis frequency of three grab samples per week. This proposal provides greater detail regarding what analysis will be conducted versus the Red Barn proposal.
- The Chesapeake proposal also uses the TN/8 equals TP delivered to the Bay methodology which will no longer be allowed on future trades.
- The delivery ratio of 0.961 that was used in calculating the credits is consistent with the current ratio that DEP has referenced on their website.
- Use EOS ratios of 0.50 and 0.60 were used and were differentiated as EOS Manure and EOS Excess in the calculations. Apparently the higher value is for when manure is to be transported regularly from the farm. It was the applicant's response "intend to have the manure transported daily out of the watershed" according to a comment response letter submitted to DEP. This appears to be an overly ambitious and an unrealistic frequency unless the size of the operation truly does dictate that this is already occurring. This is not clear and there is nothing explicitly that prohibits the facility from building storage facilities to accumulate manure. DEP's approval letter does indicate "manure transport timeframe" as part of the basis for certification validity. It is not clear in their approval regarding whether future additional analysis automatically requires recalculation of credits generated. The language in the approval is vague in this regard.
- Use of the hybrid EOS ratios of 0.5 and 0.6 resulted in a tradable nitrogen credit of 502,350 #/yr. If the published EOS ratio of 0.31 was used, the tradable nitrogen credit would be 270,900 #/yr, or 54% of that which was granted under the approved proposal.
- It appears that this trade could be considered a 1.1:1 trade based on the ratios and methodologies employed.
- Within the CBWM, the practice of manure transport has been listed as pending approval. However, DEP's summary of agricultural BMPs and their nutrient removal efficiencies (see Attachment 3) indicates that because of the difficulty in tracking manure transport and possible transportation issues, this practice has not been considered in the nutrient reduction strategy at this time. It is not clear what this means for the two trades that are currently under contract regarding it.
- The same overall conclusions regarding this operation are applicable to the Red Barn discussion.

5.3 Brubaker Farm – Brubaker Farms underwent two iterations of nutrient credit calculations. The first were submitted by ARRO Consultants on behalf of Mount Joy

Borough Authority in 2006 and were specifically for 930 acres of conversion from conventional to no-till practices. A subsequent submission was provided by TeamAg Incorporated over the course of 2010 for no-till planted corn and cover crop plantings following corn harvest. These applications are unique in that it has been driven by the WWTP, not a broker or aggregator. The Brubaker operation is primarily a 765 head dairy operation, but it also raises 52,000 broilers and uses all of the manure from a 900 head swine finishing operation. This operation resides in Watershed Segments 110 and 710. This project is within the Little Chiques Creek watershed. The nutrient management plan for the Brubaker Operation is divided into 161 field IDs. Calculations for activities generating credits are conducted on a field by field basis for those fields in which a nutrient credit generating activity is occurring. Some of the fields are grouped together for the same activity. There is an enormity of calculations included in the Brubaker Farms application, and most of it is duplicitous. Century selected the calculations for Field ID's COW 1, 2, and 3 as the basis for its review because it represents 83-acres of the farm and uses both no-till and cereal cover crop as the basis for generating credits. This is the predominant activity for generating credits. The following observations have been noted:

- The credit generating methodology employs the use of the NutrientNet spreadsheets. This is the only Contracted Trade to date that has used these modeling programs. These forms appear to provide better uniformity for agency and third-party review.
- The farm appears to have met baseline requirements regarding compliance with a CAFO permit and an approved NMP. They also make mention of having current NRCS conservation plans. The actual calculations indicate the answer of "YES" for compliance with Chapter 102 E&SC requirements.
- The proposal indicates that the agricultural operation has met the second baseline requirement by selecting the 100-foot setback for manure application.
- Calculations use the current reserve ratio requirement of 10% as adopted formally in the regulations under 25 Pa. Code § 96.8.
- For corn silage yield, the approved trade uses 29 tons per acre. 21 tons per acre appears to be a more recognized average yield for Lancaster County, as will be discussed in the sensitivity analysis in Section 6 of the report. In the Virginia and Maryland NCT systems, crop yield is not a user input.
- Fertilizer application rates are below the PSU Agronomic Recommendations for Nitrogen Application Rate. There is a conflict between the Nutrient Management Plan chemical fertilizer application rate (135# N per acre) versus what is specified in the calculations (106# N per acre). This issue will be explored the sensitivity analysis in Section 6 of the report.
- The manure application is listed as "No Incorporation", meaning that this liquid product is left on the soil surface for longer than 7 days. This issue will be explored in the sensitivity analysis in Section 6 of the report, but in short, the nutrient credit model encourages farmers not to incorporate applied manure because a greater amount of credits can be obtained. We are not sure that this is a sound policy holistically. In the context of no-till farming, incorporation is more challenging as it would required injection as opposed to tillage for incorporation.
- The portion of credit given for the Continuous No Till BMP appears to be the difference between the acceptable "T" (Tolerance) soil loss versus this practice. Additionally, continuous no till was listed as both the pre and post

trade tilling practice. In this regard, credit appears to have been given for an activity that was already in place, not a proposed BMP implementation. The net effect of this part of the trade is 300 #/yr of credits being generated for an activity that was already occurring.

- There is no place in the worksheets where the applicant can acknowledge whether the individual BMPs were in place before the January 1, 2005 timeframe. It is not clear if the cereal cover crop BMP had been put in place prior to then. If it was, then the entire trade may have occurred without any additional net benefit to the Bay, and it would appear to be inconsistent with the Chapter 96 requirements.
- It is not clear in the proposal how the 100-foot manure setback is verified.
- The Brubaker nutrient credit application is specific to nitrogen. No phosphorus credits have been sought.
- The delivery ratio of 0.97 used in calculating the credits is consistent with the current ratio that DEP has referenced on their website.
- The EOS ratio of 0.28 used in calculating the credits is consistent with the current ratio that DEP has referenced on their website.
- It is clear from this most recent trade that the process has tightened with regard to detail, uniformity of calculations, and conformance with the current provisions for nutrient trading. This trade was easier to review and more transparent regarding underlying assumptions and data sources.
- The BMPs used to generate nutrient credits for this trade appear to be sustainable agricultural practices which have been employed for several decades. One may argue that they become standard practices in many areas and that should be required of all farmers, that they should not be part of nutrient credit generating activities, and that they should in fact be part of the required non point source reductions to satisfy the WIP. While a one size fits all such as this may not be appropriate for all situations, it does further highlight the baseline requirements in PA's program and their possible inadequacy.

5.4 Summary of Trades to Date - In general, the nutrient trading process in Pennsylvania has been an evolving process. Many of the informalities, assumptions, and ratios that had been employed on earlier and existing certified proposals and existing contracted trades are no longer valid. As these proposal and contracts are renewed, they become subject to the nutrient trading rules in effect at that time. Some of the trades in place appear to have been rushed out before the proper methodologies and procedures were in place. There are no standard forms or formats used to provide the requisite information that PA DEP requires, and it is hard for third-party observers to decipher and distill the proposals. Standardized forms should be required to promote greater transparency. Information submitted under many of the original trades as confidential should be available to the public for review and does not appear to contain trade secrets or business sensitive information that may need to be withheld.

There is no long-term "grandfathering" of nutrient trading activities. They have a defined shelf-life. This appears to be a standard, consistent, and appropriate practice for most environmental policy and rulemaking. It does provide buyers with an understandable amount of uncertainty and fear regarding the reliability of nutrient credit trading to meet their needs. What if the regulating activity becomes

unaccepted? What if the amount of nutrient credits that were generated from an activity become significantly decreased and another contract is required? What if the price of nutrient credits for that new contract is significantly higher than the prices used in my original decision making process to buy credits or upgrade my plant? What if the higher prices force me to go back to my ratepayers and tell them it now makes sense to upgrade my plant? These are perceptions about the program that can be real and valid concerns. They can significantly skew the value of credits such that owners of a treatment system will only purchase credits if the difference between purchasing of credits and upgrading their plants becomes overwhelmingly large. Only with time, experience, transparent access to information, and public education can these concerns be moderated in a way to influence buyers to come into the market.

6. **Projected Pennsylvania State Trade in Other States** – Century was asked to take a look at what a trade completed within PA would look like if it were to be conducted in one of the other Bay states. MD has had no successful trades to date. Virginia has had at least one actual trade to date. Since the PA program is further along and has had more trades, data from an existing PA trade was utilized in this analysis. Because Virginia comes at the nutrient trading process from a fundamentally different perspective, it would appear likely that it would generate very different nutrient credit trading values. Virginia Department of Environmental Quality (VA DEQ) has prepared a concise, easy to follow guidance document called the "Trading Nutrient Reduction from Nonpoint Source Best Management Practices in the Chesapeake Bay Watershed: Guidance for Agricultural Landowners and Your Potential Trading Partners" (VA DEQ, 2008). This is prepared primarily for an agricultural NPS audience. The Maryland program, having been constructed with the same type of trading platform as PA, would be expected to yield similar results to PA, all things considered. There have been previous attempts to conduct similar analyses, but it appears that this is the first effort to actually evaluate a trade among the states using data from an executed trade in Pennsylvania. Others, including a Virginia Tech team from the University's Department of Agricultural and Applied Economics have conducted a more theoretical analysis (Latane and Stephenson, 2011).

   6.1. **Program Differences** - It is important to preface our analysis with the differences in the programs and the challenges that occur when trying to make an apples to apples comparison. Virginia and Pennsylvania have some significant differences with the terminology that they use, and there are significant differences even with the analogous concepts that are employed. For instance, in Virginia what PA calls nutrient credits are known as offsets. PA defines offsets in its Chesapeake Bay program as an entirely different concept and not part of its trading program. Also, as discussed previously PA and MD use an EOS ratio to define movement of a pollutant on the farm and within an individual watershed segment, and they use a delivery ratio to define the ultimate impact that a pollutant has given the proximity of the watershed segment to the Bay itself. VA incorporates these values into its Nutrient Removal Rates for specific BMPs, but these are not explicitly detailed in the guidance documents, nor are they as specific with regard to sub-watersheds. Tables prepared for the VA program with these values make the convenient distinction of whether you are to the east or west of Interstate-95 (an approximation of the fall line) as to which removal rate is selected. Otherwise, an entire watershed is given a single Nutrient Removal Rate.

The VA Nutrient Removal Rates are analogous to PA's Nutrient Removal Efficiencies for approved BMPs, but they already have the EOS and delivery rations incorporated into them. It makes virtually no difference in the VA program whether a pound of pollutants are discharged at Westmoreland, VA approximately 17 miles from the start of the Bay or if that same pound of pollutants is discharged in Front Royal, VA approximately 215 miles from the Bay. Everything in the Shenandoah-Potomac Basin has the same assigned nutrient removal rate to the west of I-95. It would appear that the VA model is either overly conservative or overly simplified. As mentioned, Virginia has taken the conservative approach of requiring that a 2:1 uncertainty ratio be applied between NPS and PS trading partners, while MD and PA have not. This may be necessary given the program's simplicity.

The MD program utilizes a mapping tool to define the exact farm on which the nutrient credit generating activity is occurring, and delivery and EOS ratios are assessed at the county level. The PA program is based on watershed segments which break the basins into smaller discrete sub-basins that are deemed to have a common nutrient loading potential. It has been suggested that programs such as PA's do a better job at identifying the most cost-effective activities for generating nutrient reductions because they look at the biophysical heterogeneity within a watershed (WRI, 2009). This is provided that the underlying methods and science of generating EOS and delivery ratios is sound and the user input values can be rigorously defended as being appropriate and factual.

6.2. **Relative Restrictiveness of the PA and VA Programs** - The Virginia program appears at first glance to be very limited from the perspective of encouraging innovation and technological advancement. It has very limited flexibility as compared to the MD and PA programs. There is no flexibility in the program for administrators to apply valid alternative approaches, nor is there any opportunity to apply agronomic data that may be specific to each farm. It specifies exactly what BMP or combination of BMPs can be used to generate offsets, and the agronomic data is built into the nutrient removal rates with no opportunity to provide farm specific data in the calculation. The VA program is limited to 7 BMP Enhancements and 6 Land Conversions. There appear to be no specific provisions for the addition of other activities. This compares to the PA program which recognizes 20 agricultural BMPs, with an additional 7 undergoing additional peer review. It is clear from proposals reviewed and approved to date that PA is open to innovation and alternate credit generating practices. The MD program recognizes 8 agricultural BMPs, 4 Land Use Conversions, 2 streambank restoration BMPs, 3 riparian/conservation BMPs, and 2 wetland BMPs. It can be said that the VA program, while limited, is less susceptible to tweaking of the model by an end-user to generate additional credits, and it places much less burden on the VA DEQ to verify the accuracy of the assumptions and data used to generate them. Of the 3 programs, the PA program clearly requires the most oversight and critical review of proposals.

6.3. **Utilization of Actual Trading Data** - Because the only trade in PA that is likely considered sustainable is that of the Brubaker Farm's Continuous No Till and Cereal Cover Crop agricultural activities, this is the trade that has been selcted to project what the nitrogen credit available to trade would be like in other Bay states such as MD and VA. This is also considered a good trade because one of the two activities (cereal cover crop) recognized by PA for NCT is actually a required baseline threshold BMP

under the VA program. In the original field lots analyzed by Century, a total of 810 nitrogen credits were eligible for trading and were formerly approved by PA DEP. This compares with EOS nitrogen reductions from these BMP implementations of 927.5, resulting in an approximate 1.15:1 trading ratio.

6.4. Trade Comparison – Century has utilized the current WRI NutrientNet excel spreadsheet as made available on the PA DEP Nutrient Trading website (Attachment 6). For VA, the Virginia BMP Enhancement and Land Conversion Offsets Calculation Worksheet that is used in the VA DEQ guidance document were completed (Attachment 7). For the MD trades the online nutrient trading tool available on the MDE website has been employed (Attachment 8). The Brubaker Farm in its current locations cannot be accurately compared to the MDE and VA DEQ program because of the EOS and Delivery Ratios that are applied in the PA model, so the farm was kept in Lancaster County, but moved to a more downstream location, Peach Bottom, PA, that is proximate to the main stem of the Susquehanna and in watershed segment 140. In all 6 cases analyzed (2 in each state), the farms are assumed to be bordering a surface water body, and all of the farms have been assumed to have provided a riparian grass buffer for the streams/rivers that they border. All of the agronomic and nutrient application data that was used and approved by PA DEP under the Brubaker Farm nutrient trade was used in these trade scenarios. For the VA calculations, because cereal cover cropping is a baseline condition, no credits are generated for that activity. For the PA trade involving Cereal Cover Cropping BMP only, a Conservation Till operation exists that meets "T" is assumed. In MD, the same data used in the Westmoreland, VA trade was applied across the river to an area known as Oakland Cove. All 3 locations of the first analysis are approximately 17-miles from the Bay. Table 5 summarizes the results of this analysis.

Table 5 – Hypothetical Trade Comparison – Westmoreland, VA, Peach Bottom, PA, and Oakland Cove, MD Using Brubaker Farm Agronomic Data

Agricultural Activity	Estimated VA Nitrogen Offsets Created (#/year)	Estimated PA Nitrogen Credits Generated (#/year)	Estimated MD Nitrogen Credits Generated (#/year)
Cereal Cover Crop with Conservation Till	None - Baseline Requirement	808	None-Continuos No-Till or Drilling Required
Continuous No-Till with Cereal Cover Crop	55	927	20
Continuous No-Till Only	55	343	Does not Meet MD Baseline

A second hypothetical trade was run. This time the farms moved to Renovo, PA (watershed segment 60), Williamsport, MD, and Front Royal, VA. All 3 locations are approximately 215-miles upstream of the Bay. Otherwise the same assumptions from the first run are made. Table 6 summarizes this analysis. Attachments 6, 7, and 8 provide the actual credit calculations.

Table 6 – Hypothetical Trade Comparison – Front Royal, VA, Renovo, PA, and Williamsport, MD Using Brubaker Farm Agronomic Data

Agricultural Activity	Estimated Virginia Nitrogen Offsets Created (#/year)	Estimated Pennsylvania Nitrogen Credits Generated (#/year)	Estimated MD Nitrogen Credits Generated (#/year)
Cereal Cover Crop with Conservation Till	None - Baseline Requirements	1,314	None-Continuos No-Till or Drilling Required
Continuous No-Till with Cereal Cover Crop	74	1,508	55
Continuous No-Till Only	74	559	66

6.5. Sensitivity Analysis – Because the PA program generates considerably higher nutrient credits, we have conducted a sensitivity analysis to try and better understand what variables are causing the biggest change in the number of credits being generated.

6.5.1. Watershed Segment – We conducted a series of calculations using various watershed segments. Similar to the Renovo, PA and Peach Bottom, PA analysis, we moved our farm around within the Susquehanna River Basin to see what the net effect of location is with regard to Nitrogen credits generated. All other values from the original Brubaker Farm trade have been utilized. Table 7 provides a summary of this analysis.

Table 7 – Nitrogen Credits Generated from Various Watershed Segments Utilizing Otherwise Equivalent Data

Watershed Segment	Location	Nitrogen Credits Generated (#/year)
140	Peach Bottom, PA – Lower Lancaster County	927
710	Original Brubaker Farm Approved Trade (Fields COW1, COW2, & COW3) – N. Lancaster County	810
110	Southern Dauphin County	871
80	Snyder County	904
70	Lycoming County	1,102
60	Northern Lycoming County – Just South of Bradford County Border	1,508
700	Central Bradford County	953
20	Northern Bradford County	564
60	Renovo, PA – Clinton County	1,508

In this table, the watershed segments are arranged by their relative distance from the Bay, with Renovo appearing to be the furthest. It would appear logical

that the nitrogen credits generated would be consistently higher as you move further up the basin. This is not necessarily the case. There are numerous anomalies within the EOS and Delivery ratios applied. It is assumed that these have to do with the stream order into which the particular watershed segment discharges, topography, existing land use, availability of data to generate the trading ratios, and other watershed considerations. More importantly, the maximum credit increase that can be realized by moving an activity from all the way at the bottom of the basin to a very remote part of the basin is only about a 63% increase. While significant, it does not explain the discrepancy between the various state programs.

6.5.2. Crop Yield – A series of calculations was then completed using various crop yield values for Corn Silage. Based on a literature search of published values, it was concluded that the 29 tons per acre (tpa) used in the Brubaker trade appeared erroneously high. PA DEP suggests 21 tpa in their reference tables, which is believed to be fairly representative of literature sources referenced during the project. In subsequent due diligence with PA DEP, it has indicated that the farm substantiated the 29 tpa claim with farm yield records. For the sensitivity analysis, the model was run for the Peach Bottom, PA farm at silage yields between 17 and 33 tpa. All other values from the original Brubaker Farm trade have been utilized in these iterations. In the case of the MD analysis, corn silage yields were estimated at a maximum of 8.53 tpa (which appears overly conservative), a considerable difference given equal chemical fertilizer and manure applications. Table 8 provides a summary of this analysis.

Table 8 – Nitrogen Credits Generated from Various Corn Silage Yields Utilizing Otherwise Equivalent Data

Corn Silage Yield (tons per acre)	Nitrogen Credits Generated (#/year)
33	754
29 (Brubaker Data)	810
25	None
21 (PSU Agronomy)	None
17	None

It is interesting to note that the 21 tpa corn silage yield as referenced in the DEP reference tables in the NCT worksheets yielded no nitrogen credits. If the yield were only 8.53 tpa as suggested in the MD modeling, the PA program would actually have been the most conservative because it again would have not allowed any credits to be taken. Crop yield has an obvious effect on nutrient uptake and it is apparent that use of higher crop yields has the potential to generate significantly extra credits. This variable is of critical importance and should be critically examined during the application review process, or it should not be a user defined input in the PA program. It would appear that at least for MD, the crop yield and uptake values are flawed and should be reviewed.

6.5.3. Tillage Practice - We conducted a series of calculations using pre and post tillage practices. All other values from the original Brubaker Farm trade have been utilized. Table 9 provides a summary of this analysis.

Table 9 – Nitrogen Credits Generated from Various Tillage Practices Utilizing Otherwise Equivalent Data

Pre-Nutrient Credit Tillage Practice	Post-Nutrient Credit Tillage Practice	Nitrogen Credits Generated (#/year)
Conventional	Continuous No-Till	1,241
Conventional	Conservation	1,180
Conservation	Continuous No-Till	1,091
Continuous No-Till	Continuous No-Till	927

It is apparent that going from a conventional tillage practice to a no-till practice would generate the largest amount of credits. It is interesting to note that only 25% of the credit generated in this instance is from the change in tillage practice, while the remaining 75% is for continuous no-till itself. In the case of an operation who already practiced continuous no-till (the Brubaker Farm), 927 # of credits were generated (11.2 #/acre) by doing nothing different.

6.5.4. Fertilizer/Nutrient Loading Rate- We conducted a series of calculations using different commercial fertilizer application rates. In the original Brubaker Farm trade, a combination of liquid manure and commercial fertilizer were used. The Nutrient Management Plan indicates a nitrogen application rate of 135 #/acre in 2009, however an application rate of 106 #/acre was used in the NCT application. Upon subsequent due diligence with PA DEP, it was indicated that the NMP indicates the maximum application rate, while the application rate used in the calculations is the actual rate as verified by farm records. A series of calculations was run using varying fertilizer application rates. All other values from the original Brubaker Farm trade have been utilized. Table 10 provides a summary of this analysis.

Table 10 – Nitrogen Credits Generated from Various Fertilizer Application Rates Utilizing Otherwise Equivalent Data

Commercial Fertilizer Nitrogen Application Rate (# per acre)	Nitrogen Credits Generated (#/year)
91	827
97	867
106 (Brubaker Data)	927
115	987
125	1,054
135 (Brubaker NMP)	None

One of the things that can be concluded from this analysis is that the maximum fertilizer application rate as allowed under the NMP would yield no credits. This is because the nitrogen applied would exceed PSU published standards, a criterion of the NCT methodology. There are also two oddities in this analysis.

First, with yields of 29 tpa of corn silage, one would expect that this aggressive of a yield would require the maximum fertilizer application rate that can be applied. Apparently, the manure application rate is satisfying the large nitrogen requirements for this yield. Since it was previously documented in other trades that 85% of nitrogen in manure is lost to the atmosphere, it would appear that there are significant losses of nitrogen to the environment that could have been mitigated if a commercial fertilizer was used instead. Which leads to a second oddity, that an agricultural operation can actually generate more nutrient credits by increasing its commercial fertilizer application rates, not decreasing them as would be expected. If the sale of the credits added to the increased yield of the field crops (assuming more fertilizer equals more yield) offsets the cost of the fertilizer, it would be a win for an agricultural operation looking to maximum its operation. Does the current NCT program have the opposite effect of what was intended? This is beyond the scope of this effort but may require additional consideration and analysis.

6.5.5. Manure Incorporation Practice – For our final sensitivity calculations, we conducted a series of calculations using different manure incorporation rates. In the original Brubaker Farm trade, no incorporation of manure was indicated in the calculations. A series of calculations was run using by varying the days to incorporation. All other values from the original Brubaker Farm trade have been utilized. Table 11 provides a summary of this analysis.

Table 11 – Nitrogen Credits Generated from Various Manure Incorporation Rates Utilizing Otherwise Equivalent Data

Days to Incorporation	Nitrogen Credits Generated (#/year)
Not Incorporated (Brubaker Data)	927
Within 7 Days	927
5 to 7 Days	927
2 to 4 Days	None
Less than 1 Day	None
Incorporation Same Day	None

7. **Conclusion** – Throughout this paper we have made some observations and recommendations worth serious consideration. It would appear based on the analysis that none of the state NCT programs is without its share of warts. Of most concern would be the Pennsylvania program, which would appear to be short on baseline requirements, overly generous on nutrient credit generation, and short on verification assurances. While the nutrient trading program is expected to continue to grow and be used as a method to assist Pennsylvania in further reductions of its nutrient load, the NCT program needs to be changed. As Phase II and III POTWs come into compliance with the requisite nutrient load limits being issued to them, it is expected that many of the smaller plants will not upgrade but will rather purchase credits to satisfy their need (Interview PA DEP, 2011). Further nutrient credits are expected to be purchased on more of a spot market if and when treatment plants subject to upset periods identify non-compliance during the truing period.

We do believe that growth and development is unavoidable in the Bay region. In some regards, it is this growth that provides the economic resources to support conservation efforts. Crumbling factories and a jobless population base will not likely support efforts to restore the Bay. It is apparent that nutrient trading provides a mechanism for expanding treatment plant capacity and for new development that could not have occurred without it. However, development whose net impact on nutrient discharges is minimized is much better than development unchecked. And that is the real challenge in the nutrient trading debate: providing the correct regulatory framework, accounting/verification methodologies, and application of science to ensure that a pound of pollutants is a pound of pollutants. The continued application of science to refine and improve nutrient trading will ensure its viability as we move to decrease the human impact we have made to the Bay and its inhabitants. Guesses and uncertainty ratios are not the answer.

Nutrient trading, sustainable building practices, smart growth, regional planning, implementation of modern agricultural and forestry practices, and improvement of Bay communities infrastructure must be coupled with the tremendous conservation efforts that have been made by the numerous organizations in the Bay region. These are some of the many tools in the toolbox of Chesapeake Bay Restoration. While not the savior of Bay restoration efforts, as may have been hoped, nutrient trading will remain important as we move forward to restore the Bay as the resource it was and could be.

8. References

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Attachment 1

Proposals Under the Pennsylvania Nutrient Trading Program

Attachment 1

Proposal Registry
As of September 22, 2010

#	Applicant and proposal description	Watershed Segment #	N Credits	P Credits	S Reductions	Status
1	HRG/Milton Regional Authority: Facility generated credits through the process/treatment of the wastewater. These credits may be revised once the facility receives their final NPDES permit.	40	46,000	6,000		P (not counted towards Tradable Load)
2	Red Barn Trading Company - Client 113: credits generated by exporting poultry manure from Juniata to a location outside of the watershed.	100	8,246	1,031		CS
3	Red Barn Trading Company - Client 205: credits generated by exporting poultry manure from Snyder to a location outside of the watershed.	80	24,405	3,051		CS
4	Red Barn Trading Company - Client 204: credits generated by exporting poultry manure from Huntington to a location outside of the watershed.	100	9,036	1,130		CS
5	Red Barn Trading Company - Client 28: credits generated by exporting poultry manure from Schuylkill to a location outside of the watershed.	80	21,141	2,643		CS
6	Red Barn Trading Company - Client 198: credits generated by exporting poultry manure from Union to a location outside of the watershed.	70	10,525	1,317		CS
7	Red Barn Trading Company - Client 139: credits generated by exporting poultry manure from Juniata to a location outside of the watershed.	100	11,154	1,394		CS
8	Red Barn Trading Company - Client 11: credits generated by exporting poultry manure from Franklin to a location outside of the watershed.	730	68,122	8,515		CS
9	Red Barn Trading Company - Client 292: credits generated by exporting poultry manure from Snyder to a location outside of the watershed.	80	11,050	1,381		CS
10	Red Barn Trading Company - Client 374: credits generated by exporting poultry manure from Juniata to a location outside of the watershed.	100	9,243	1,155		CS
11	Red Barn Trading Company - Client 289: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	120	36,679	4,585		CS

12	Red Barn Trading Company - Client 239: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	450	14,269	1,784		CS
13	Red Barn Trading Company - Client 401: credits generated by exporting poultry manure from Lebanon to a location outside of the watershed.	110	55,387	6,923		CS
14	Red Barn Trading Company - Client 429: credits generated by exporting poultry manure from York to a location outside of the watershed.	140	22,860	2,857		CS
15	Red Barn Trading Company - Client 282: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	720	12,344	1,543		CS
16	Red Barn Trading Company - Client 388: credits generated by exporting poultry manure from Perry to a location outside of the watershed.	80	17,319	2,165		CS
17	Red Barn Trading Company - Client 303: credits generated by exporting poultry manure from Adams to a location outside of the watershed.	110	24,724	3,090		CS
18	Red Barn Trading Company - Client 173: credits generated by exporting poultry manure from Snyder to a location outside of the watershed.	80	15,621	1,953		CS
19	Red Barn Trading Company - Client 54: credits generated by exporting poultry manure from Juniata to a location outside of the watershed.	100	6,671	834		CS
20	Red Barn Trading Company - Client 428: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	720	7,054	882		CS
21	Red Barn Trading Company - Client 136: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	710	7,699	962		CS
22	Red Barn Trading Company - Client 221: credits generated by exporting poultry manure from Lancaster to a location outside of the watershed.	720	15,624	1,953		CS
23	Mount Joy Borough Authority: Continuous No-till with a three year contract in place for the generation of these credits. Implementation began in 2006.	710	11,718			I
24	Berks County Conservation District: Cover crops planted on ten tracts of land, credits were generated during Compliance Year 2006.	110	1,491			I

		720	360			I
25	Chesapeake Nutrient Management: Poultry manure export from Adams County to a location outside of the watershed, credits were generated during Compliance Year 2006.	110	6,236	780		I
26	Lititz Run Watershed Association: Stream restoration project; credits are non-transferable. The project was completed in 2005.	720	1,381	68	129	I
27	Berks County Conservation District: Cover crops planted on forty-four tracts of land, credits were generated during Compliance Year 2007.	110	7,212			I
		720	622			I
28	Bion Environmental Technologies: use of a proprietary livestock waste treatment technology for a scrape dairy operation located in Lancaster County. This project can generate credits for multiple years.	This certification was revised and re-issued to Bion on April 2, 2010.				
29	Union County Conservation District: installation of field lane stabilization project on 7 farms. This project can generate credits for multiple years.	70	78	2	23,323	I
		80	68	0	12,141	I
30	Lebanon County Conservation District: installed 2 mortality composters. This project can generate credits for multiple years.	110	2	1		I
		720	2	1		I
31	Dauphin County Conservation District: worked with 2 landowners to installed stream bank fencing, planted a riparian buffer and installed a mortality composter. These projects can generate credits for multiple years.	80	3,463	183		I
32	Chester County Conservation District: worked with 8 land owners to have cover crops, credits were generated during Compliance Year 2007.	450	7,042			I
		800	32,935			I
33	Cumberland County Conservation District: generated by the installation of animal waste systems. This proposal will generate credits for multiple years.	80	2,628	146		I
		110	3,886	217		I
34	Mifflin County Conservation District: credits generated by the implementation of no-till during Compliance Year 2007.	100	1,419			I
35	Red Barn Trading Company - Client 153: credits generated by exporting poultry manure from Juniata to location outside of the watershed.	100	24,160	3,020		CS

36	Red Barn Trading Company - Client 164: credits generated by exporting poultry manure from Dauphin to location outside of the watershed.	110	24,378	3,047		CS
37	Red Barn Trading Company - Client 369: credits generated by exporting poultry manure from Lancaster to location outside of the watershed.	140	16,035	2,004		CS
38	Red Barn Trading Company - Client 391: credits generated by exporting poultry manure from Montour to location outside of the watershed.	70	25,217	3,152		CS
39	Red Barn Trading Company - Client 444: credits generated by exporting poultry manure from Juniata to location outside of the watershed.	100	7,162	895		CS
40	Red Barn Trading Company- Client 535: credits generated by exporting poultry manure from Lancaster to location outside of the watershed.	710	138,781	17,348		CS
41	Lancaster County Conservation District: Nitrogen credits to be generated by the implementation of cover crops and no-till. Credits available in Compliance Year 2009.	710	3,590			I
42	Lancaster County Conservation District: Nitrogen and Phosphorus credits generated by poultry manure export.	710	10,680	1,335		I
43	Berks County Conservation District: Nitrogen credits generated by the implementation of grazing BMPs. This proposal will generate credits for multiple years. Implementation began in 2007-2008.	110	11			I
44	PA Environmental Council and Capital RC&D: Nitrogen credits generated by the implementation of no-till in Bradford County. This proposal will generate credits for multiple years. Note: these nitrogen credits were revised and re-certified. The current amount of credits available is shown at number 50.	700				I
45	Chesapeake Nutrient Management LLC: credits to be generated by exporting poultry manure from Lancaster to a location outside of the watershed.	110	502,350	62,850		CS
46	Chesapeake Nutrient Management LLC: credits to be generated by exporting poultry manure from Lancaster to a location outside of the watershed.	110	184,714	23,089		CS
47	Lancaster County Conservation District: credits generated by exporting poultry manure from Lancaster to location outside of the watershed.	710	43,055	5,382		I
48	AET Agriculture Consulting: Nitrogen credits are to be generated from off-stream watering with stream fencing (pasture), precision grazing and stream restoration on conventional till and pasture. This proposal will generate credits for multiple years.	30	1,151			I

49	Lancaster County Conservation District: Nitrogen credits generated by the implementation of no-till and cover crops.	710	615			I
50	Capital RC&D: Nitrogen credits generated by implementation of no-till in Bedford County.	90	11,656			I
51	PA Environmental Council and Capital RC&D: Nitrogen, phosphorous credits and sediment reductions are generated by implementation of no-till in Bradford County. This proposal will generate credits for multiple years.	700	3,271	42	3	I
52	Lycoming County Conservation District: Nitrogen credits generated from the implementation of precision grazing, off-stream watering, stream bank fencing, off-stream watering without fencing, horse pasture management and a riparian forest buffer by Client MucMoT0001.This proposal will generate credits for multiple years.	70	845			I
53	American Farmland Trust: Nitrogen credits generated through the BMP Challenge for Planned Nutrient Reduction Project by Client PA09-004.	140	437			I
54	American Farmland Trust: Nitrogen credits generated through the BMP Challenge for Planned Nutrient Reduction Project by Client PA09-002.	710	435			I
55	American Farmland Trust: Nitrogen credits generated through the BMP Challenge for Planned Nutrient Reduction Project by Client PA09-003.	140	85			I
56	EnergyWorks BioPower, LLC: Nitrogen and phosphorous credits to be generated through the operation of the Gettysburg Energy and Nutrient Recovery Facility that, as described in the submission, will process poultry manure from a farm in Adams County in an enclosed facility to generate renewable energy, nutrient reductions and an ash by-product that can be used for fertilizer or for a feed supplement. Note: The values listed may change when the facility is operational and credits are verified.	110	1,051,570	53,853		CS
57	Lycoming County Conservation District: Nitrogen and phosphorous credits to be generated through the export of poultry litter from the Chesapeake Bay Watershed for Client WhCWaT0001.	70	7,897	937		CS

58	Bion Environmental Technologies and Bion PA1, LLC: This certification describes a process for the calculation of annual credits that provides Bion with the flexibility to operate under various scenarios which include: the operation of the microaerobic biological reactor and combustion of the coarse solids; and the operation of the microaerobic biological reactor and the export all or a portion of the coarse solids out of the Chesapeake Bay Watershed. With the certification, Bion is authorized to develop and implement two studies to: 1- demonstrate that there is a difference in the level of nitrogen bioavailability occurring in the field as a result of the use of the effluent (both liquid and fine solids) discharged from the reactor compared to the manure currently used at the Kreider Farm; and 2- demonstrate that there is a difference in the level of denitrification occurring in the field as a result of the use of the effluent (both liquid and fine solids) discharged from the reactor compared to the manure currently used at the Kreider Farm. Note: The values listed may change when the facility is operational and credits are	710	106,289			CS
59	Cove Area Regional Digester ("CARD"): This certification describes a process for the calculation of annual credits for CARD for the part of the operation of the Facility that, as described, will process dairy manure from contracted participants. The manure, and all other waste streams, will be trucked to the regional digester and will be processed through a two stage anaerobic digestion process to generate renewable energy, nutrient reductions and a by-product that can be used as a fuel source for co-generation. Note: The values listed may change when the facility is operational and credits are verified.	90	627,443	35,781		CS
60	Bellefonte Wastewater Treatment Plant: This certifcation describes a process for the calcualtion of annual credits for the treatment plant. Note: The values listed may change when the credits are verified.	60	11,142	1,305		P (not counted towards Tradable Load)
61	Northwestern Lancaster County Authority: This certifcation describes a process for the calcualtion of annual credits for the treatment plant. Note: The values listed may change when the credits are verified.	710	10,330	434		P (not counted towards Tradable Load)

62	City of Lancaster Advanced Wastewater Treatment Plant: This certifcation describes a process for the calcualtion of annual credits for the treatment plant. Note: The values listed may change when the credits are verified.	720	138,939 (Compliance Year 2010); 130,148 (Compliance Year 2011); 127,894 (Compliance Year 2012); 125,063 (Compliance Year 2013); 121,580 (Compliance Year 2014)	10,350 (Compliance Year 2010); 9,858 (Compliance Year 2011); 9,731(Compliance Year 2012); 9,573 (Compliance Year 2013); 9,378 (Compliance Year 2014)		P (not counted towards Tradable Load)
63	ElectroCell: This certification is applicable to the operation of the Patz® OZy™ unit on a farm located in Lancaster County. This certification includes a verification plan, and authorizes the generation of nitrogen and phosphorous credits. Note: The values listed may change when the credits are verified.	710	3,138	462		CS
64	AET Agriculture Consulting: Nitrogen credits are to be generated from the manuare mangement change and the installed buffer. This certification includes a verification plan, and authorizes the generation of nitrogen credits.	30	1,239			
65	Lycoming County Conservation District: Nitrogen credits to be generated from the installed best management practices (BMPs) that include riparian buffer, off-stream watering with streambank fencing and rotation grazing for Client MuCFrT0001. This certification includes a verification plan, and authorizes the	60	687			
66	Lycoming County Conservation District: Nitrogen credits to be generated from the installed best management practices (BMPs) that include riparian buffer, off-stream watering with streambank fencing and rotation grazing for Client LaCCoT0001. This certification includes a verification plan, and authorizes the	60	2,142			

67	Lycoming County Conservation District: Nitrogen credits to be generated from the installed best management practices (BMPs) that include riparian buffer, off-stream watering with streambank fencing and rotation grazing for Client LaCCoT0002. This certification includes a verification plan, and authorizes the	60	735			
68	Lycoming County Conservation District: Nitrogen credits to be generated from the installed best management practices (BMPs) that include riparian buffer, off-stream watering with streambank fencing and rotation grazing for Client LyCLyT0001. This certification includes a verification plan, and authorizes the	60	589			

The Department has given conditional pre-approval to ElectroCell Technologies, Inc., for calculating credits, related to a hog manure technology that the company operates.

P= Planned Project that has been certified and will be installed regardless of the credits being sold.
CS= Contingent on Sale Project that has been certified but the project will only be installed if the credits are purchased.
I = Implemented Project that has been certified and has been completed regardless of the sale of credits.

69 Projects per 05-03-11 Print-Out

→ 61 of which were submitted 2005 to 04-19-08

Attachment 2

Nutrient Trading Program Comparison by State

Attachment 2 – State Comparison of Nutrient Credit Trading[1]

Point Source Dischargers Subject to Nutrient Requirements

Maryland	Pennsylvania	Virginia	West Virginia
• Municipal WWTPs >0.5 MGD annual average design flow. • Industrial WWTPs > 75# TN/day and 25# TP/day. • Expanding non-significant WWTPs with < 0.5 MGD annual average flow.	• Municipal WWTPs > 0.4 MGD using design flow as of August 2005. • Industrial WWTPs	• Municipal WWTPs above the fall line >0.5 MGD annual average design flow. • Municipal WWTPs below the fall line >0.1 MGD annual average design flow. • Equivalent industrial WWTPs.	• Municipal WWTPs >0.05 MGD annual average design flow.

New and Expanding Point Source Discharger Requirements

Maryland	Pennsylvania	Virginia	West Virginia
• New or expanding significant sources have no nutrient allocation and must offset loading. • Caps for expanding non-significant WWTPs. • ENR for all new PS >0.1 MGD. • Secondary treatment for all new PS <0.1 MGD.	• All PS allocations have been granted. New or expanding sources have no nutrient allocation and must offset loading. Net discharge must equal zero after offsets and credit trading.	• New municipal WWTPs >0.001 MGD must offset increased loading. • Expanding municipal WWTPs >0.04 MGD must offset increased loading. • Equivalent new or expanding industrial plants offset increased loading.	• Municipal WWTPs >0.05 MGD annual average design flow.

Baseline Requirements for Agricultural Operations

Maryland	Pennsylvania	Virginia	West Virginia
Achieve required portion of state nutrient reduction goal, a per-acre annual loading rate (# TP/acre and # TN/acre) calculated from the applicable TMDL allocations. Also: • Be in compliance with applicable regulations. • Implement a Nutrient Management Plan. • Develop a soil and water conservation plan, including (if applicable) a waste management system plan.	Be in compliance with applicable regulations, including nutrient management, manure management, and erosion and sedimentation control. Also, implement one of three options: • Implement a 100-foot manure setback. • Implement a 35-foot vegetative buffer. • Reduce the farm's total nutrients 20% below reductions required by regulation.	Operations must implement all of the following BMPs (as applicable): • Soil conservation plan. • Nutrient management plan. • Cereal cover crops. • Surface water exclusionary livestock fencing. • Vegetative buffers.	Achieve required portion of state nutrient reduction goal, a per-acre annual loading rate (# TP/acre and # TN/acre) calculated from the applicable TMDL allocations. Also: • Implement a whole-farm nutrient management plan.

Cost Share Funds Eligibility for Credit Generation

Maryland	Pennsylvania	Virginia	West Virginia
No	Yes	No	Yes

Compliance Cycle & Life of Credits and Offsets

Maryland	Pennsylvania	Virginia	West Virginia
• Last one year. • BMPs generate credits or offsets for the full year after installation. • Use of calendar year.	• Credits generated in a compliance year must be used for the same compliance year. • A 2-month truing period allows for purchase of credits after the end of a compliance year. • Compliance year is October 1st through September 30th.	• Last one year. • Use of calendar year.	• Last one year. • Use of calendar year. • A 2-month truing period allows for purchase of credits after the end of a compliance year.

Credits for Idling or Farmland Conversion

Maryland	Pennsylvania	Virginia	West Virginia
• None for farm idling whole or large portions of farming operations. • None for farm to development conversion • Credit eligibility for conversion from one to other agricultural operation.	• None for farm idling whole or large portions of farming operations.	• None	• None for farm conversion to other land uses.

Onlot Disposal System (OLDS) Removal

Maryland	Pennsylvania	Virginia	West Virginia
• 12.2 #/yr for retired OLDS in the critical area. • 7.5 #/yr for retired OLDS within 1000-ft of a perennial stream. • 4.6 #/yr for retired OLDS in other areas.	• 25# TN offset for retired OLDS, not tradable. Must be used by the same system.	• Case by case.	• 9.5# per capita of TN for failed systems. • 5.7# per capita of TN.

Credit Calculation Ratios and Factors

Ratio/Factor	Maryland	Pennsylvania	Virginia	West Virginia
Delivery Ratio	• Provided from Bay Model	• Provided from Bay Model	• Used to calculate the trading values in the lookup tables.	• Provided from Bay Model
Edge of Segment Ratio	• Provided from Bay Model	• Provided from Bay Model	• Provided from Bay Model	• Provided from Bay Model
Reserve Ratio	• None	• 10% of generated credits are placed in the DEP reserve and cannot be traded.	• None	• None
Retirement Ratio	• 5% retired for PS credit generators • 10% retired for NPS credit generators	• None	• None	• None
Uncertainty Ratio	• At least 10% for credits generated by NPS not approved by the Bay plan.	• None	• Point sources must purchase 2 credits for every 1 credit required.	• At least 10% for credits generated by NPS not approved by the Bay plan.
Baseline Ratio	• None	• If a generator cannot meet either the 35-foot riparian buffer or 100-foot manure setback, 20 % of the credits generated must be retired.	• None	• None

1. Portions of this summary are an adaptation from WRI's May 2011 Fact Sheet.

Attachment 3

Pennsylvania BMP List

Chesapeake Bay Program Best Management Practices

Agriculture BMPs – Approved for CBP Watershed Model

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	Cost
Animal Waste Management System – Livestock	Animal Waste Management Systems are designed for the proper handling, storage, and utilization of wastes generated from animal confinement operations and include a means of collecting, scraping, or washing wastes from confinement areas into appropriate waste storage structures. Lagoons, ponds, or steel or concrete tanks are used for the treatment and/or storage of liquid wastes, and storage sheds or pits are common storage structures for solid wastes. Landuse applied to: manure acre Reductions per system = system AEU's/145 times manure acre loading rate times reduction efficiency** (see footnote)	AEU's*	75%	75%	N/A	
Animal Waste Management System – Poultry	Animal Waste Management Systems are designed for the proper handling, storage, and utilization of wastes generated from animal confinement operations and include a means of collecting, scraping, or washing wastes from confinement areas into appropriate waste storage structures. Landuse applied to: manure acre Reductions per system = system AEU's/145 times reduction efficiency** (see footnote)	AEU's*	14%	14%	N/A	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Barnyard Runoff Controls - With Storage & Without Storage	This practices includes the installation of practices to control runoff from barnyard areas. This includes practices such as roof runoff control, diversion of clean water from entering the barnyard and control of runoff from barnyard areas. Use the first percent efficiency if controls are installed on an operation with a manure storage; and the second percent if the controls are installed on a loafing lot without a manure storage. The sediment efficiency has not been incorporated into the current watershed model but will be included in the updated model that is under development at this time. Landuse applied to: manure acre Reductions = Total animals using barnyard (counted as AEU's)/145 times manure acres loading rate times reduction efficiency.	Acres/ AEU's	10%/20%	10%/20%	40%	
Carbon Sequestration	Carbon Sequestration refers to the conversion of cropland to hay land (warm season grasses). The hay land is managed as a permanent hay land providing a mechanism for sequestering carbon within the soil. (Note: this practice has not be incorporating into the watershed model nor has specifications been developed for its use as an approved BMP) Landuse conversion: conventional till and conservation till to hayland Reduction = original landuse loading rate – hayland loading rate times total acres converted. (Temporary reduction methodology not officially approved for use)	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Cereal Cover Crops	Cover crops grown to provide winter cover of cropland, non-harvested Landuse applied to: conventional till and conservation till	Acres	Convent. Till Early - 45% Late — 30%	Convent. Till Early - 15% Late — 7%	Convent. Till Early - 20% Late — 10%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Cereal Cover Crops (cont)	Reduction = landuse loading rate times total acres planted times reduction efficiency. Efficiency varies by when planted. If planted up to 7 days prior to published first frost date use early value. If planted up to 7 days after published first frost date use late value.		Conserv. Till Early – 45% Late – 30%	Conserv. Till Early – 0% Late – 0%	Conserv. Till Early – 0% Late – 0%	
Commodity Cereal Cover Crops	Commodity cover crops grown to provide winter cover of cropland, harvested. Landuse applied to: conventional till and conservation till Reduction = landuse loading rate times total acres planted times reduction efficiency. Efficiency varies by when planted. If planted up to 7 days prior to published first frost date use early value. If planted up to 7 days after published first frost date use late value.	Acres	Convent. Till Early - 25% Late — 17% Conserv. Till Early – 25% Late – 17%	Convent. Till Early - 0% Late — 0% Conserv. Till Early – 0% Late – 0%	Convent. Till Early - 0% Late — 0% Conserv. Till Early – 0% Late – 0%	
Conservation Plans (Farm Plans)	This is a comprehensive plan that addresses natural resource management on agricultural lands and utilizes best management practices that control erosion and sediment loss and manage runoff. These plans include conservation tillage, crop rotations and structural practices such as grassed waterways, sediment basins and grade stabilization structures. Landuse Applied to: conventional till, conservation till, hayland and pasture Reductions = landuse loading rate times acres of BMP implemented times landuse percent efficiency.	Acres	Convent. Till - 8% Conserv. Till - 3% Hayland 3% Pasture 20%	15% 5% 5% 10%	25% 8% 8% 14%	
Conservation Till	Conservation Tillage involves planting and growing crops with minimal disturbance of the surface soil. No-till farming is a form of conservation tillage in which the crop is seeded directly into vegetative cover or crop residue with no disturbance of the surface soil. Minimum tillage farming involves some disturbance of					

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Conservation Till (cont.)	the soil, but uses tillage equipment that leaves much of the vegetative cover or crop residue on the surface. Landuse conversion – conventional till to conservation till Reductions = conventional till loading rate minus conservation till loading rate times total acres converted Note: Through 2002 progress reporting, the amount of conservation-tilled land for Pennsylvania has been based on data acquired by the Chesapeake Bay Program from the Conservation Technology Information Center (CTIC). The CTIC provides an estimate of the amount of conservation-tilled acres by year. PA has not reported this practice as a BMP and has deferred to the CTIC data.	Acres	Landuse conversion	Landuse conversion	Landuse conversion	
Nutrient Management-Agriculture	Nutrient Management is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. These plans detail the type, rate, timing, and placement of nutrients for each crop. Landuse applied to: conventional till, conservation till and hay The reductions associated with implemented nutrient management plans are computed by the model for each model run. Reductions vary by landuse and by model segments and range between 20 to 30 percent.	Acres	Built into model simulation	Built into model simulation	Built into model simulation	
Phytase Feed Additives – Poultry	Use of Phytase as a poultry feed to reduce phosphorus concentrations in poultry litter. Reduction applies as a change in manure phosphorus content. This practice is currently being credited	AEUs	N/A	16%-26%	N/A	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	automatically in all model assessment runs					
Retirement of Highly Erodible Land	Retirement takes marginal and highly erosive Agricultural land cropland out of production by planting permanent vegetative cover such as shrubs, grasses, and/or trees. Land retired and planted to trees would be reported under the "tree planting" BMP Landuse conversion: conventional till and conservation till conversion to mixed open landuse Reductions = original landuse loading rate minus mixed open landuse loading rate times total acres converted	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Riparian Forest Buffers – Agriculture	Riparian Forest Buffers are linear wooded areas planted along rivers and streams. Reduction credits for riparian include both a percentage reduction and a landuse credit for the acres of trees planted Landuse conversion: conventional till, conservation till, hayland or pasture to forest land Reductions = original landuse loading rate minus forest loading rate times acres of total acres converted Plus: Upland landuse loading rate time's total acres treated times percent efficiency. For nitrogen every 435.6 linear feet of buffer is estimated to treat 5 upland acres of land and for phosphorus and sediment every 435.6 linear feet of buffer is estimated to treat 2 upland acres of land (100 foot buffers).	Acres	Landuse Conversion Plus	Landuse Conversion Plus	Landuse Conversion Plus	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Riparian Forest Buffers – Agriculture (cont.)	Upland landuse efficiency varies by hydrologic setting as follows: Appalachian Plateau Blue Ridge Mesozoic Lowlands Piedmont – Carbonate Piedmont – Crystalline Valley and Ridge – Carbonate Valley and Ridge - Silicicastic		 60% 45% 70% 45% 60% 45% 44%	 60% 50% 70% 50% 60% 50% 45%	 60% 50% 70% 50% 60% 50% 45%	
Riparian Grass Buffers	Grassed Buffers are linear strips of maintained grass or other non-woody vegetation between the edge of fields and streams, rivers or tidal waters. Reduction credits for riparian grass buffers include both a percentage reduction and a landuse credit for the acres of trees planted Landuse conversion: All landuses except manure acre and developed land converted to mixed open Reductions = Original landuse loading rate minus mixed open loading rate times total number of acres planted. Plus: Upland landuse loading rate time's total acres treated times percent efficiency. For nitrogen every 435.6 linear feet of buffer is estimated to treat 5 upland acres of land and for phosphorus and sediment every 435.6 linear feet of buffer is estimated to treat 2 upland acres of land (100 foot buffers). Upland landuse efficiency varies by hydrologic setting as follows: Appalachian Plateau	Acres	Landuse Conversion Plus 41%	Landuse Conversion Plus 60%	Landuse Conversion Plus 60%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Blue Ridge Mesozoic Lowlands Piedmont – Carbonate Piedmont – Crystalline Valley and Ridge – Carbonate Valley and Ridge – Silicicastic		31% 48% 31% 41% 31% 37%	50% 70% 50% 60% 50% 65%	50% 70% 50% 60% 50% 65%	
Rotational Grazing/ Grazing Land Protection with Stream Fencing	This practice involves dividing pasture areas into cells or paddocks. Each paddock is intensively grazed for a short period, and then allowed to rest and recover before being grazed again. The amount of time each cell is grazed and then rested relates to the time of year, quality of the forage and the growth stage of the forage. Landuse applied to: pasture Reductions = Pasture land loading rates times acres of pasture with rotational grazing times percent efficiency. A second reduction is calculated to account for the portion of land between the installed fence and the stream that is no longer pastured. This reduction is calculated as landuse conversion of pasture to mixed open land Reductions = pasture loading rate minus mixed open land loading rate times total aces excluded.	Acres 0f grazed land and Acres of excluded Land	20% and Landuse Conversion	20% and Landuse Conversion	20% and Landuse Conversion	
Stream Protection with Fencing and with Off-Stream Watering	Stream protection with fencing involves the fencing of narrow strips of land along streams to completely exclude livestock. The fenced areas may be planted to trees or grass. Landuse applied to: pasture Percent efficiency reductions = upland landuse loading	Length of Fence and	60% and	60% and	75% and	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Stream Protection w/ Fencing and Off-Stream Watering cont.)	rate times total acres treated times percent efficiency (for this calculation every 208 linear feet of buffer is estimated to treat two upland acres of land) A second reduction is calculated to account for the portion of land between the installed fence and the stream that is no longer pastured. This reduction is calculated as a landuse conversion of pasture to mixed open land Reductions = pasture loading rate minus mixed open loading rates times total acres excluded	Acres of Excluded Land	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Stream Protection without Fencing with Off Stream Watering	This option involves the use of troughs or "watering holes" in remote locations away from streams, as well as the placement of stream crossings. Stream crossings usually have some length of fencing adjacent so that livestock will not bypass the crossings. In some instances, trees are planted away from the stream to provide shade for the livestock. The protected area acts as a buffer between stream and livestock. Landuse applied to: pasture Percent efficiency reductions = upland landuse loading rate times total acres treated times percent efficiency (for this calculation every 208 linear feet of protected area is estimated to treat two upland acres of land)	Acres	30%	30%	38%	
Tree Planting	Reforestation practices or planting of trees that are not classified as riparian forest buffers. Planted trees are considered permanent.	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Landuse conversion: any combination of conventional till, conservation till, hayland, pasture, mixed open, and pervious developed land to forest Reductions = original landuse loading rate minus forest loading rate times number of acres planted					
Wetlands – Ag land	Wetland Restoration is the reestablishment of wetlands on agricultural lands where they used to exist. Restored wetlands may be any wetland classification including forested, scrub-shrub or emergent marsh. Landuse conversion: conventional till, conservation till, hay or pasture to forest Reductions = original landuse loading rate minus forest loading rate times acres converted. Plus: Upland landuse loading rate time's total acres treated times percent efficiency. For nitrogen every 435.6 linear feet of buffer is estimated to treat 5 upland acres of land and for phosphorus and sediment every 435.6 linear feet of buffer is estimated to treat 2 upland acres of land (100 foot buffers). Upland landuse efficiency varies by hydrologic setting as follows: Appalachian Plateau Blue Ridge Mesozoic Lowlands Piedmont – Carbonate Piedmont – Crystalline	Acres	Landuse Conversion plus 60% 45% 70% 45% 60%	Landuse Conversion Plus 60% 50% 70% 50% 60%	Landuse Conversion Plus 60% 50% 70% 50% 60%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Valley and Ridge – Carbonate Valley and Ridge - Silicicastic		45% 44%	50% 45%	50% 45%	
Yield Reserve	Agricultural Yield Reserve programs are intended to provide incentives through yield insurance for crop losses to farmers who apply nitrogen and phosphorus at levels below their recommended application rates. Participating farmers would be paid to apply 15 percent to 25 percent less nutrients on crops than is recommended in their Nutrient Management Plan. Landuse applied to: conventional till and conservation till Reductions estimated for using watershed model simulations. An approved reduction methodology has not been developed. Efficiency varies by landuse and model segment.	Acres	15%-25%	15%-25%	N/A	
Agriculture BMPs – CBP Watershed Model approval pending						
Advanced No-Till	Advanced No Till involves planting and growing crops with minimal disturbance of the surface soil. No-till farming is a form of conservation tillage in which the crop is seeded directly into vegetative cover or crop residue with minimal or no disturbance of the surface soil. To qualify as advanced no-till, a minimum of 50% crop residue must be maintained. Landuse applied to: Conservation tillage Reductions = conservation till loading rate times total acres of advanced no-till times reduction efficiency	Acres	N/A	35%	35%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
Ammonia Emission Controls	This practice involves a reduction in livestock housing ammonia emissions through use of capture or control technologies. Currently, ammonia emission controls will focus on poultry, swine and dairy production. Landuse applied to: N/A – results in a reduction in nitrogen emissions and subsequent air deposition Emission Reductions = Animal Equivalent Units (AEU) within the housing facility times the reduction in pounds per AEU. Reductions apply to nitrogen only. The watershed model will simulate reductions in deposition and subsequent delivered loads.	Reductions per AEU	Nitrogen Reductions Only Poultry - Layers Belt house – 5.31 lbs/yr High Rise – 38.16 lbs/yr Poultry Broilers – 1.68 lbs/yr Swine Finishers – 19.22 lbs/yr Producers – 4.79 lbs/yr Dairy – 2.96 lbs/yr	N/A		
Horse Pasture Management	Use of rotational grazing practices to minimize nutrient and sediment loss from equine pastures. Practices may include streambank fencing, cross fencing to create paddock areas, off-stream watering structures and stabilization of heavy use areas. This practice assumes 5 acres per AEU is available for full pasturage based operations and 2 acres per AEU for limited pasturage operations that include stabilized heavy use aeas or roofed shelters in additional to rotational paddocks. Landuse applied to: mixed open – within the current	Acres	20%	20%	20%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	watershed model, horse pasture areas are not included in the agricultural pasture acres, but are accounted for within the mixed open landuse category Reductions = mixed open loading rate times efficiency times acres of horse pasture being managed.					
Managed Precision Agriculture	Use of multiple management systems beyond standard nutrient management practices to further minimize nutrient loses. This practice identifies variables such as soil types, weather conditions and yield data to more specifically apply and vary nutrients within field areas. Landuse applied to: conventional till and conservation till Reductions associated with implemented managed precision agriculture are computed by the watershed model for each model run. Reductions vary by landuse and by model segments and vary between 25% to 38%.	Acres	An Additional 15% over regular Nutrient Management	An Additional 15% over regular Nutrient Management	An Additional 15% over regular Nutrient Management	
Manure Transport	Transport of livestock manure from areas of high concentration to areas of low concentration, or the transport of manure out of the Chesapeake Bay watershed. Because of the difficulty in tracking manure transport and possible transportation issues, this practice has not been considered in the nutrient reduction strategy at this time.	Tons				
Mortality Composter	Composting of mortality carcasses for future land application as a nutrient source. Animal manure is typically used as a nitrogen and carbon source to aid in the composting process. Facilities utilize roof structure and stabilized surface pads to prevent nutrient loses.	AEU	14%	14%	N/A	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Landuse applied to: manure acre Reductions per system = system AEU's/145 times manure acre loading rate times reduction efficiency** (see footnote)					
Phytase Feed Additives – Swine	Use of Phytase as a swine feed additive to reduce phosphorus concentrations in swine manure Reduction applies as a change in manure phosphorus content.	AEUs	N/A	17%	N/A	
Precision Feeding of Dairy Livestock	Reduction in overfeeding of dairy livestock through the formulation of improved feed rations to meet specific nutrient needs of individual operations. Includes the targeting of minimum nitrogen and phosphorus feed concentrations while maintaining acceptable production levels so as to minimize the quantity and nutrient content of livestock manure. Landuse applied to: N/A - results in a reduction in manure nutrient content The watershed model simulates the reductions for this practice as a decrease in the nitrogen and phosphorus content of manure being land applied based on the AEUs of livestock being precision feed. Within the model, manure is considered a nutrient input. This practice, in effect, reduces the manure nutrient concentrations used by the model to estimate nutrient loads.	AEU	27%	17%	N/A	
Precision Rotational Grazing	The purpose of this BMP is to increase the level of forage and livestock implementation, increase forage nutrient removal, density and average height resulting in improved infiltration and decreased runoff. It Utilizes	Acres 0f Grazed land	25% and	25% and	25% and	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	a Resource Management System (RMS) level grazing plan. Landuse applied to: pasture Reductions = Pasture land loading rates times acres of pasture with rotational grazing times percent efficiency. A second reduction is calculated to account for the portion of land between the installed fence and the stream that is no longer pastured. This reduction is calculated as landuse conversion of pasture to mixed open land Reductions = pasture loading rate minus mixed open land loading rate times total aces excluded.	and Acres of excluded Land	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Urban and Mixed Open BMPs – Approved for CBP Watershed Model						
Erosion and Sediment Controls – Urban Land	This practice involves erosion and sediment controls applied during construction activities on urban (developed) land. Due to the relative short nature of permitted construction activities, permitted acres are reported on a yearly basis (not cumulatively). Landuse affected: pervious developed land Reductions = pervious developed landuse loading rate times acres permitted times percent efficiency	Acres	33%	50%	50%	
Impervious Surface Reduction – Non-structural Practices	This practices involves the removal of urban impervious surfaces with pervious surfaces which increases water infiltration and deceases surface water runoff. Landuse conversion: impervious developed land to pervious developed land	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Reductions = impervious developed landuse loading rate minus pervious developed landuse loading rate times acres converted.					
Nutrient Management (Developed Land and Mixed Open Land)	Optimum use of nutrients (principally chemical fertilizers) to minimize loss. Includes applications by commercial and residential lawn care companies. Landuse applied to: mixed open land and pervious developed land Reduction = landuse loading rate times number of acres with implemented nutrient management times efficiency	Acres	17%	22%	N/A	
Non-urban Stream Restoration	Reduction in 2010 projections for the conversion of urban land. This results in "returning" urban land to forest, mixed open and agricultural land. (see footnote) Landuse conversion: impervious and pervious developed land to forest, mixed open and agricultural landuses Reduction = urban land loading rate minus new (non-urban) loading rate times acres of land not converted to urban. This will be credited as a landuse projection and not a field practice	Acres	Landuse Change	Landuse Change	Landuse Change	
Voluntary Air Emission Controls	Riparian Forest Buffers are linear wooded areas planted along rivers and streams. Reduction credits for riparian include both a percentage reduction and a landuse credit for the acres of trees planted Landuse conversion: pervious developed land to forest land Reductions = original landuse loading rate minus forest loading rate times acres of total acres converted	Acres	Landuse Conversion Plus	Landuse Conversion Plus	Landuse Conversion Plus	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Plus: Upland landuse loading rate time's total acres treated times percent efficiency. (for this calculation every 435.6 linear feet of buffer is estimated to treat 5 upland acres of land)		25%	50%	50%	
Riparian Grass Buffers-Developed Land	Grassed Buffers are linear strips of maintained grass or other non-woody vegetation between the edge of fields and streams, rivers or tidal waters. Applies to conversion of impervious land to grass. Landuse conversion: impervious developed land to mixed open land Reduction = impervious developed land loading rate minus mixed open land loading rate times total acres converted.	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	
SWM Wet Ponds & Wetlands	This stormwater management category includes practices such as wet ponds, wet extended detention ponds, retention ponds, pond/wetland systems, shallow wetlands, and constructed wetlands. Landuse applied to: pervious and impervious developed land Reductions = Urban loading rate times BMP drainage area times percent efficiency	Acres	30%	50%	80%	
SWM Dry Detention & Hydro-dynamic Structures	This stormwater management category includes practices such as dry detention basins and hydrodynamic structures designed to moderate flows. The structures remain dry between storm events Landuse applied to: pervious and impervious developed land Reductions = Urban loading rate times BMP drainage area times percent efficiency	Acres	5%	10%	10%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
SWM Dry Extended Retention Ponds	This stormwater management category includes practices such as dry extended detention ponds and extended detention basins. Landuse applied to: pervious and impervious developed land Reductions = Urban loading rate times BMP drainage area times percent efficiency	Acres	30%	20%	60%	
SWM Infiltration Practices	This stormwater management category includes practices such as infiltration trenches, infiltration basins, and porous pavement that reduce or eliminate the runoff. Landuse applied to: pervious and impervious developed land Reductions = landuse loading rate times BMP drainage area times percent efficiency	Acres	50%	70%	90%	
SWM Filtering Practices	This stormwater management category includes swales (dry, wet, infiltration, and water quality), open channel practices, and bioretention that transmit runoff through a filter medium. Landuse applied to: pervious and impervious developed land Reductions = landuse loading rate times BMP drainage area times percent efficiency	Acres	40%	60%	85%	
Stream Restoration – Urban	Restoration of urban (developed) stream channel to stable configuration Landuse applied to: pervious and impervious developed land Reductions = linear feet of channel restored times	Linear Feet	0.02 lbs/ft	0.0035 lbs/ft	2.55 lbs/ft	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	indicated reduction in lbs per foot.					
Tree Planting Urban and Mixed Open land	Reforestation practices or planting of trees that are not classified as riparian forest buffers. Planted trees are considered permanent Landuse conversion: mixed open and pervious developed land to forest land Reductions = original landuse loading rate minus forest loading rate times number of acres planted	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Wetlands – Mixed Open Land	Wetland Restoration is the reestablishment of wetlands on mixed open land where they used to exist. Restored wetlands may be any wetland classification including forested, scrub-shrub or emergent marsh. Landuse conversion: mixed open Reductions = mixed open landuse loading rate minus forest loading rate times acres converted.	Acres	Landuse Conversion	Landuse Conversion	Landuse Conversion	
Other BMPs - Approved for CBP Watershed Model						
Abandoned Mined Land Reclamation	This practice involves reclamation of abandoned mined land through planting of grass, shrubs or trees. Applied to: mixed open land Reductions = Mixed Open land loading rate times total acres reclaimed times 2 times percent efficiency (1 to 2 effectiveness)	Acres	43%	38%	50%	
Forest Harvesting Practices	Erosion and sediment control practices used during harvesting of timber Landuse applied to: forest	Acres	50%	50%	50%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Reductions = forest loading rate times efficiency times acres of forest land protected by harvest practices					
Septic System Hookups	Removal of On-lot septic systems by hooking up to a POTW or other treatment system. Since septic systems are accounted for as nonpoint source loads within the watershed model, this action results in a decrease in nonpoint loads and an increase in point source loads for the facility now treating the increased flow. Credit is on the premise that treatment system hook-ups are done because of a need (e.g., failing or aging systems) and not normally for correctly functioning septic systems Applied to: septic systems Reductions: Credited as number of systems removed	Equivalent Domestic Units	Units Removed	N/A	N/A	
Septic System Denitrification (new and refit)	System design that includes an anaerobic biological reduction of nitrate nitrogen (e.g., nitrates in soil or wastewater) to nitrogen gas and/or the removal of total nitrogen from a system. Landuse applied to: N/A – applies to individual septic systems Reductions = number of septic systems times loading rate times reduction efficiency.	Units	50%	N/A	N/A	

Other BMPs - CBP Watershed Model approval pending

Street Sweeping in Urban Areas	This practice reduces the wash off of detritus and air deposited compounds from urban areas by regular sweeping of impervious streets.	Acres	10%	10%	10%	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation
	Landuse applied to: impervious developed land Reductions = Impervious developed land loading rate times acres swept times percent efficiency					
Dirt and Gravel Road Erosion and Sediment Controls	Implementation of practices to stabilize dirt and gravel roads adjacent to streams. The purpose of this BMP is to significantly reduce the erosion of sediment and the nutrients within the sediment from the road and adjacent areas into the stream. Landuse applied to: forest and mixed open Reductions = length of road with controls times reduction in lbs per foot.	Feet	.02 lbs/ft	.0035 lbs/ft	2.55 lbs/ft	
Non-urban Stream Restoration	Restoration of stream channels in non-urban areas to stable configuration. The purpose of this BMP is to restore natural stream hydrology and landscape so the stream is neither aggrading nor degrading. Landuse applied to: all landuses except pervious or impervious developed land Reductions = linear feet of channel restored times indicated reduction in lbs per foot.	Feet	.02 lbs/ft	.0035 lbs/ft	2.55 lbs/ft	
Voluntary Air Emission Controls	Voluntary practices implemented to reduce air emissions of nutrients. Type and nature of practices will vary depending on the nature and type of the emission source (e.g., utility versus industrial/commercial facility) and the methodology employed. Landuse applied to: N/A Reductions calculated from actual reduction measurements or estimated from process change or equipment efficiency.	Pounds Reduction	Varies by source	Varies by source	N/A	

BMP	Description	Units	Nitrogen Efficiency	Phosphorus Efficiency	Sediment Efficiency	BMP Implementation

AEU = Animal Equivalent Units.

** Animal waste management systems credits are applied against the manure acre landuse within the watershed model. For modeling purposes each manure acre is defined as a pasture acre having the equivalent of 145 AEU's of manure applied. The number of manure acres treated by an AWM system is defined as the AEU's that the system services divided by 145. For example, a dairy operation with 218 AEU's of livestock would be credited with 218/145 = 1.5 manure acres effectively treated.

***Change in urban growth is based on a comparison of the projected yearly growth in urban acres through 2010 to the estimated actual urban acres for each year leading to 2010. Reductions are realized as a change (i.e., reduction) in the amount of non-urban land that is consumed by urban growth. If increases in urban land acres occur over that currently projected, increases in the modeled load will also occur.

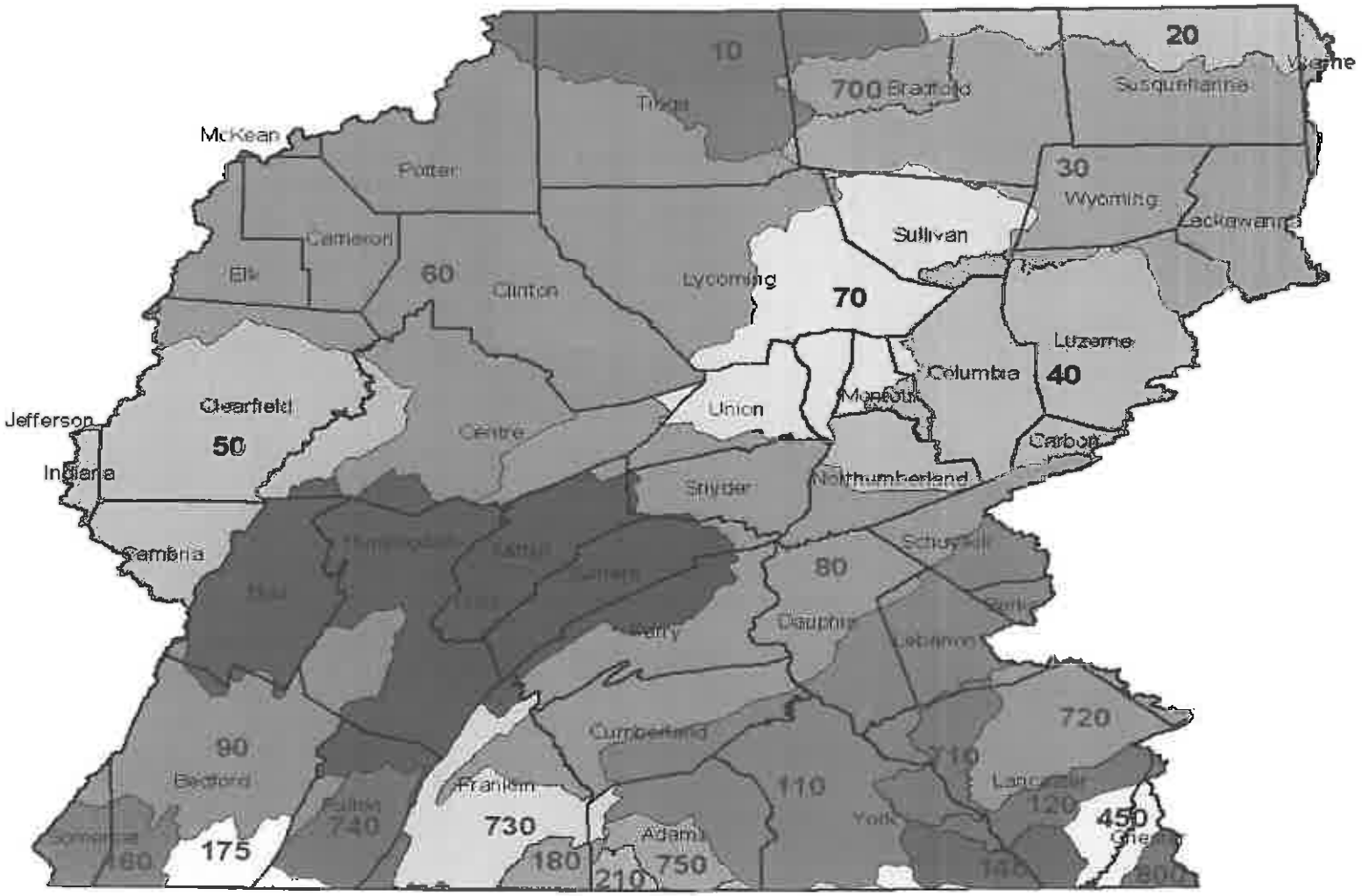
CBP Watershed Model approval pending:
Note: Efficiencies shown for these BMPs are interim and are subject to revision. These efficiencies need to be reviewed and approved by the Chesapeake Bay Program's Tributary Strategy Workgroup before they can be considered as final efficiencies.

Attachment 4

Delivery and EOS Ratios

Watershed Segment Map

This map is coded by colors and each color corresponds to a segment (the number in green). This segment number will then allow you to choose the appropriate nitrogen or phosphorous delivery ratio and appropriate nitrogen or phosphorous edge of segment ratio from the table listed on the second page. For example, if your property is in Bedford, you would be in segment 90 which would give a nitrogen delivery ratio of 0.897 and a nitrogen edge of segment ratio of 15 % to 45% depending on the tillage practice.



Delivery and EOS Ratios

Watershed Segment	Nitrogen Delivery Ratio	Nitrogen EOS Ratio (see Notes 1 & 2)				Watershed Segment	Phosphorus Delivery Ratio	Phosphorus EOS Ratio (see Notes 1 & 2)			
		Conventional Till	Conservation Till	Hay	Pasture			Conventional Till	Conservation Till	Hay	Pasture
10	0.474	36%	29%	89%	15%	10	0.436	10%	4%	4%	15%
20	0.495	38%	31%	34%	16%	20	0.436	13%	7%	5%	16%
30	0.733	43%	31%	78%	16%	30	0.436	11%	6%	7%	16%
40	0.871	42%	38%	60%	12%	40	0.436	12%	10%	7%	12%
50	0.836	50%	38%	97%	18%	50	0.436	15%	6%	14%	18%
60	0.93	55%	31%	78%	15%	60	0.436	11%	4%	16%	15%
70	0.941	45%	45%	86%	13%	70	0.436	27%	7%	12%	13%
80	0.951	32%	25%	75%	10%	80	0.436	12%	7%	7%	10%
90	0.897	45%	34%	49%	15%	90	0.436	11%	4%	12%	15%
100	0.88	35%	29%	32%	12%	100	0.436	8%	3%	5%	12%
110	0.961	31%	22%	27%	10%	110	0.436	9%	5%	5%	10%
120	0.98	29%	21%	20%	9%	120	0.436	8%	3%	4%	9%
140	0.99	30%	22%	22%	9%	140	0.436	25%	10%	7%	9%
160	0.583	33%	28%	59%	23%	160	0.67	32%	27%	7%	23%
175	0.7	33%	22%	29%	20%	175	0.67	5%	5%	6%	20%
180	0.819	34%	38%	58%	9%	180	0.67	9%	7%	4%	9%
210	0.72	46%	33%	40%	10%	210	0.669	11%	7%	7%	10%
450	1	30%	22%	16%	9%	450	1	5%	2%	2%	9%
470	1	25%	17%	23%	6%	470	1	22%	3%	3%	6%
700	0.7	40%	35%	37%	13%	700	0.436	7%	6%	5%	13%
710	0.97	28%	21%	15%	9%	710	0.436	6%	2%	2%	9%
720	0.891	27%	21%	16%	9%	720	0.436	6%	3%	3%	9%
730	0.683	23%	22%	43%	11%	730	0.67	15%	8%	6%	11%
740	0.749	21%	17%	50%	12%	740	0.67	12%	8%	8%	12%
750	0.627	47%	33%	38%	10%	750	0.67	13%	7%	5%	10%
800	1	48%	34%	34%	9%	800	1	15%	8%	11%	9%

Notes:

1. The portion of nutrient loads leaving a watershed were estimated by adding the manure, fertilizer, air deposition and mineral/residual nutrient inputs for each watershed and subtracting the estimated crop uptake from the total nutrient inputs. The remaining nutrient loads after crop uptake were then divided by the estimated loads leaving the watershed to calculate the edge of watershed percents.
2. All calculations based on watershed simulations completed by EPA's Chesapeake Bay Program Office.

Attachment 5

Tradable Load for Compliance Year 2009-2010

Attachment 5

Tracking PA's Tradable Load

To ensure that the Trading Program is not trading away reductions that are needed to meet the Pennsylvania Tributary Strategy goals for nonpoint source reductions, the Department has established maximum tradable loads for each watershed segment. The final tradable loads were determined to be 5,760,000 lbs TN/yr and 397,000 lbs TP/yr. The scenario values and the tradable load values will change as new BMPs are developed or the efficiencies of existing BMPs are revised. This table over time will track the implemented BMPs (that were referenced in the Tributary Strategy) and will provide a summation of what is remaining for the tradable loads. Currently, this table includes a summation off all activities that have been certified and have not expired (i.e. credits generated for future years). A large majority of the practises (i.e. point source reductions, manure export and technology reductions) do not count towards the tradable load. A complete description of the tradable load determination can be found at:
http://www.dep.state.pa.us/river/Nutrient%20Trading_files/PA%20Tradable%20Load.pdf

Estimated Loads Eligible for Trading as of June 28, 2010								
Watershed Segment #	Nitrogen Tradable Load (lbs/yr)	Planned	Contingent on Sale	Implemented	Phosphorus Tradable Load (lbs/yr)	Planned	Contingent on Sale	Implemented
10	198,000				470			
20	9,300				1,200			
30	709,000			1,151	20,800			
40	442,000	46,000			12,100	6,000		
50	298,000				2,500			
60	863,000	11,142			11,900	1,305		
70	362,000		43,639	923	65,400		5,406	2
80	561,000		89,536	6,159	72,000		11,193	329
90	433,000		627,443	11,656	15,600		35,781	
100	338,000		75,672		29,600		9,459	
110	493,000		1,843,723	3,899	62,800		152,852	218
120	99,300		36,679		8,500		4,585	
140	66,300		38,895		14,700		4,861	
160	32,000				3,300			
175	40,900				1,100			
180	60,000				6,000			
210	33,000				1,900			
450	126,000		14,269		3,100		1,784	
470	5,000				230			
700	103,000		3,271		2,400		42	
710	40,500	10,330	252,769		5,300	434	18,310	
720	172,000	121,580 - 138,939	35,022	1,386	7,200	9,378 - 10,350	4,378	69
730	97,100		68,122		32,200		8,515	
740	71,200				3,500			
750	84,500				9,900			
800	23,700				3,100			
Totals	**5,760,800**	**189,052 - 206,411**	**3,129,040**	**25,174**	**396,800**	**17,117 - 18,089**	**257,166**	**618**

Note: This table provides the tradable load amount available for compliance year 2009-2010.

Attachment 6

Pennsylvania Nutrient Credit Trading Worksheets

927 credits (106)

Attachment 6

CREDIT CALCULATION FORM- Effective December 4, 2007

This form will help assist the agricultural sector in determining how many nitrogen reduction credits may be generated from the implementation of particular Best Management Practices (BMPs). Calculations on this sheet are based on expected yield. This form should be completed and submitted to Pennsylvania Department of Environmental Protection (PA DEP) as part of a proposal to generate credits. A submitted proposal should follow the guidelines outlined in the Trading of Nutrient and Sediment Reduction Credits- Policy and Guidelines[1] regarding submission criteria for approvals of activities that reduce nutrients and potentially create credits. Please check the PA DEP Nutrient Trading Website or Pennsylvania's Water Quality Trading Marketplace[2] to ensure you are using the most up-to-date Credit Calculation Form.

1. The Final Trading Policy can be found on the PA DEP Trading Program website at:http://www.dep.state.pa.us/river/river_trading.htm
2. Pennsylvania's Water Quality Trading Marketplace (http://pa.nutrientnet.org) is an online trading platform where users buy and sell credits under PA's Trading Program.

To complete this form please fill out all required fields in yellow. Dark blue fields are automatic calculations performed on the spreadsheet. The annual credit generation period is October 1-September 30th.

Date:	6/21/2011
Project Name:	Brubaker Farm Base Data

Contact Information[1]

Name:	Heath Edelman, PE, CHMM
Organization:	Century Engineering
Phone Number:	(717) 901-7055
Email Address:	

1. This is the contact information for the person submitting the proposal to DEP.

Attachment 6

1. Baseline Requirements to Generate Credits

a. Is farm in compliance with Act 38 Nutrient Management Regulations, Chapter 102 Erosion & Sedimentation Regulations, Chapter 91.36 (for agricultural operations), and Chapter 92 (for CAFO operations), as applicable?*

Yes

b. Who has verified compliance in part (a.): Other Authorized Agent

If other, please explain: Nutrient Mangement Planner

2. Threshold Requirements to Generate Credits

A 100 ft manure application setback is followed; Manure is not mechanically applied within 100 ft of surface water.

If a 35 ft or greater riparian buffer is currently in place, please fill out the next question below:

Type of Buffer

Total Acres of Land in Buffer Strip

acres

*Compliance can be determined through a site inspection or verification of the development and implementation of a Nutrient Management Plan, E&S Plan (or an acceptable conservation plan), or Manure Management Plan, as applicable.

**In order to meet the threshold for a buffer, a minimum of 35 ft of permanent vegetation should be established and maintained between the field and surface water. The area can be grazed or cropped under a specific management plan, however permanent vegetation must be maintained at all times; Permanent vegetative buffers greater than 50 ft in width may qualify to generate nutrient reduction credits.

3. General Information

a. Current crop:[1] Corn-Field, for silage (mature)

b. Acres of Current Crop: 82.6

c. Expected yield: 29 ton per acre

d. Current tillage method: Continuous No-Till

e. Watershed segment number: 710

1. If your current crop is not listed, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.

Fill out all current AND planned sources of nitrogen applied to the field for the given year. Applications for the year may be separated out for different application times and manure types. Nitrogen credits may be generated if the planned nitrogen application is less than the current application (for example, a planned decrease in nitrogen application due better nutrient management).

4. Nitrogen Application[1]

	Current	Planned
Application #1 *(Use if Needed)*		
a. Nitrogen applied from commercial fertilizer:[2]	106 lbs/ac	106
b. Total Available Nitrogen- Application #1:	106.00 lbs/ac	106.00 lbs/ac
Application #2 *(Use if Needed)*		
a. Time of Year	Spring or summer	Spring or summer
b. Manure type:	Dairy- Lactating Cows Liquid	Dairy- Lactating Cows Liquid
c. Do you have a recent manure analysis test?[3]	Yes	Yes
If so, nitrogen concentration in manure:	23.2 lbs/1000 gallons	23.2 lbs/1000 gallons
d. Manure application rate:	8 1000 gallons/ac	8 1000 gallons/ac
e. Days until incorporation:	No incorporation	No incorporation
f. Total Applied Nitrogen- Application #2:	185.60 lbs/ac	185.60 lbs/ac
g. Total Available Nitrogen- Application #2:	37.12 lbs/ac	37.12 lbs/ac
Application #3 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Application #4 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #4:	0.00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #4:	0.00 lbs/ac	0.00 lbs/ac

Total Nitrogen Applied:	**Current**	291.60 lbs/ac	**Planned**	291.60 lbs/ac
Total Nitrogen Available for Crop Uptake:	**Current**	143.12 lbs/ac	**Planned**	143.12 lbs/ac

If you plan on reducing nitrogen applications ("Planned Nitrogen Applied" is less than "Current Nitrogen Applied" above), is this because:

- (●) Not Applicable
- ( ) Farm is no longer importing manure
- ( ) Farm is now exporting manure, or has increased manure exports
- ( ) Other (please specify below):

1. If biosolids are applied as fertilizer, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.
2. Please total up all commercial fertilizer applications over the year and include them here.
3. There are no default nitrogen concentrations for treated manure in the spreadsheet-- please enter nitrogen concentrations for treated manure in the field below.

5. Residual Nitrogen[1]

a. Frequency of past manure applications:	Continuously received manure (4-5 out of 5 yrs)
b. Residual N from previous crop:	NONE
Soil series type:	Duffield
Yield if soybeans provide residual nitrogen:	bu/ac
Total Nitrogen from Residuals:	35.00 lbs/ac

1. Residual Nitrogen is the amount of nitrogen in the soil from previous manure applications or legume crops.

The section below gives a snapshot of nitrogen application and loading rates. The first heading, "Nitrogen Reductions from Change in Application Rate," determines if any nitrogen credits are received from a reduction in nitrogen application rates. Nitrogen application rates used in this calculation are found in line 85 of this sheet. The second heading, "Nitrogen Loading Calculations," determines the amount of nitrogen available for runoff, and is calculated by subtracting the nitrogen uptake from the crop by the total nitrogen on the field (from applied nitrogen and residuals). BMPs chosen in Section 7 below are applied against the "Nitrogen Load to Reach Edge of Watershed Segment" calculated here to determine the nitrogen reductions achieved by the BMPs implemented.

6. Nitrogen Application Reductions and Loading Snapshot

PSU Recommended Nitrogen Application Rate:[1]		203.00	lbs/ac/yr
Nitrogen Available- Current:		178.12	lbs/ac/yr
Nitrogen Available- Planned:		178.12	lbs/ac/yr
Is "N Available- Planned" greater than PSU Recommended Rate?		No	
Is farm able to generate credits?		Yes	
Nitrogen Reductions from Change in Application Rate:			
Edge of Field Nitrogen Reductions:[2]		0.00	lbs/ac/yr
Edge of Field Nitrogen Reductions:		0.00	lbs/yr
EOS Ratio:	(x)	0.28	
EOS Nitrogen Reductions:[3]	(=)	0.00	lbs/yr
Nitrogen Loading Calculations:			
Total Nitrogen on Field- Planned:[4]		326.60	lbs/ac/yr
Nitrogen Uptake from Crop:[5]	(-)	187.80	lbs/ac/yr
Nitrogen Load to Reach Edge of Field:[6]	(=)	138.80	lbs/ac/yr
EOS Ratio:	(x)	0.28	
Preliminary EOS Nitrogen Load:	(=)	38.87	lbs/ac/yr
N Reduction for Conservation or Continuous No-Till:	(-)	11.14	lbs/ac/yr
N reduction for currently having riparian buffers in place:	(-)	0.00	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	27.73	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	2290.10	lbs/yr

1. Source: Pennsylvania State Agronomy Guide and AASL Handbook.

2. Edge of Field Nitrogen Reductions= [(Current Nitrogen Applied)-(Planned Nitrogen Applied)]. *Credit is not received for the decrease in nitrogen applications that exceed PSU recommended application rates.*

3. The Edge of Segment (EOS) Nitrogen Reductions determines the amount of nitrogen reductions that reach the edge of the watershed segment from the farming field. The EOS Ratio is derived from the Chesapeake Bay Model.

4. Total Nitrogen on Field = [(Planned Total Nitrogen Applied) + (Total Nitrogen From Residuals)]

5. Nitrogen uptake from crops varies by crop type and expected yield. Source: USDA Plant-Crop Nutrient Tool.

6. Nitrogen Load to Reach Edge of Field= [(Planned Nitrogen on Field)-(Nitrogen Uptake from Crop)]. If the "Planned Nitrogen on Field" is less than "Nitrogen Uptake from Crop," then the Nitrogen Load is determined by [(Planned Nitrogen Applied) - (Planned Nitrogen Available)].

Use the drop down options below to select any number of BMPs to implement that may generate nitrogen credits. The total nitrogen reduced for all BMPs chosen in this section appears on Line 156. If you are only generating credits from reducing nitrogen application rates (calculated above) then you can skip this section.

7. Planned Nitrogen Reductions- Best Management Practices[1]

a. Cropland and pasture BMPs to generate credits:

	Continuous No-Till*
(use if needed)	Cereal Cover Crop
(use if needed)	
(use if needed)	

1. Total acres of BMP:[2] 82.6 acres
2. If cover crops will be planted:
   Cover crop planting time: Late-Planting - Up to 7 days after published first frost date

b. Streambank BMPs to generate credits:

(use if needed)	

1. If riparian buffers or wetland restoration are planned:
   Total acres of BMP:[2] acres
2. If streambank restoration is planned:
   Total feet of streambank to be restored: ft

EOS Nitrogen Reductions from BMP Implementation: 927.49 lbs/yr

1. BMPs listed are only those that have an approved nitrogen reduction efficiency by the Chesapeake Bay Model. If a practice is not listed above then the submitting entity must determine their own acceptable calculation, which can be done in conjunction with PA DEP. Contact PA DEP Water Planning Office for more specific information.

2. This calculation assumes that all BMPs are implemented together on the same field (or pasture). If cropland and/or pasture BMPs are implemented in separate locations then please fill out a separate Credit Calculation Form for each.

*If you plan on implementing Continuous No-till and you are currently doing conventional till (Section 3 above), then please select both "Conservation till" AND "Continuous nc-till" in the drop down boxes to receive full N reduction credits.

Section 8 below calculates the total number of possible credits generated from the above management practices. The "Nitrogen Reductions to Edge of Watershed Segment" is a combination of nitrogen reductions from a reduction in nitrogen application rate (Section 6), if applicable, as well as reductions from any BMPs implemented (Section 7).

8. Credit Calculation

Nitrogen Reductions to Edge of Watershed Segment:		927.49	lbs/yr
Delivery Ratio:[1]	(x)	0.97	
Nitrogen Reductions to Chesapeake Bay:	(=)	899.67	lbs/yr
Credits Retired to Meet the Threshold:	(x)	0%	
Total Credits Generated:	(=)	900	Credits/Year
Credits sent to DEP Reserve:[2]	(x)	10%	
Total Credits Available to Trade	(=)	810	**Credits/Year**

1.The Delivery Ratio compensates for the natural attenuation, or loss, of nutrients and sediments as they travel in water. The Delivery Ratio is also known as the Delivery Factor.

2. According to the PA DEP Final Trading Policy, 10% of all credits generated will be placed in the DEP Credit Reserve. The DEP Credit Reserve contains credits set aside by the Department to address nutrient and sediment reduction failures, uncertainty, and to provide liquidity in the market.

CREDIT CALCULATION FORM- Effective December 4, 2007

This form will help assist the agricultural sector in determining how many nitrogen reduction credits may be generated from the implementation of particular Best Management Practices (BMPs). Calculations on this sheet are based on expected yield. This form should be completed and submitted to Pennsylvania Department of Environmental Protection (PA DEP) as part of a proposal to generate credits. A submitted proposal should follow the guidelines outlined in the Trading of Nutrient and Sediment Reduction Credits- Policy and Guidelines[1] regarding submission criteria for approvals of activities that reduce nutrients and potentially create credits. Please check the PA DEP Nutrient Trading Website or Pennsylvania's Water Quality Trading Marketplace[2] to ensure you are using the most up-to-date Credit Calculation Form.

1. The Final Trading Policy can be found on the PA DEP Trading Program website at:http://www.dep.state.pa.us/river/river_trading.htm
2. Pennsylvania's Water Quality Trading Marketplace (http://pa.nutrientnet.org) is an online trading platform where users buy and sell credits under PA's Trading Program.

To complete this form please fill out all required fields in yellow. Dark blue fields are automatic calculations performed on the spreadsheet. The annual credit generation period is October 1-September 30th.

Date:	6/21/2011
Project Name:	Peach Bottom, PA Farm (Use Brubaker Farm Ag. Data)

Contact Information[1]

Name:	Heath Edelman, PE, CHMM
Organization:	Century Engineering
Phone Number:	(717) 901-7055
Email Address:	

1. This is the contact information for the person submitting the proposal to DEP.

1. Baseline Requirements to Generate Credits

a. Is farm in compliance with Act 38 Nutrient Management Regulations, Chapter 102 Erosion & Sedimentation Regulations, Chapter 91.36 (for agricultural operations), and Chapter 92 (for CAFO operations), as applicable?*

Yes

b. Who has verified compliance in part (a.): Other Authorized Agent

If other, please explain: Nutrient Mangement Planner

2. Threshold Requirements to Generate Credits

A 100 ft manure application setback is followed; Manure is not mechanically applied within 100 ft of surface water.

If a 35 ft or greater riparian buffer is currently in place, please fill out the next question below:

Type of Buffer

Total Acres of Land in Buffer Strip

acres

*Compliance can be determined through a site inspection or verification of the development and implementation of a Nutrient Management Plan, E&S Plan (or an acceptable conservation plan), or Manure Management Plan, as applicable.

**In order to meet the threshold for a buffer, a minimum of 35 ft of permanent vegetation should be established and maintained between the field and surface water. The area can be grazed or cropped under a specific management plan, however permanent vegetation must be maintained at all times; Permanent vegetative buffers greater than 50 ft in width may qualify to generate nutrient reduction credits.

3. General Information

a. Current crop:[1]	Corn-Field, for silage (mature)
b. Acres of Current Crop:	82.6
c. Expected yield:	29 ton per acre
d. Current tillage method:	Continuous No-Till
e. Watershed segment number:	140

1. If your current crop is not listed, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.

Fill out all current AND planned sources of nitrogen applied to the field for the given year. Applications for the year may be separated out for different application times and manure types. Nitrogen credits may be generated if the planned nitrogen application is less than the current application (for example, a planned decrease in nitrogen application due better nutrient management).

4. Nitrogen Application[1]

	Current	Planned
Application #1 *(Use if Needed)*		
a. Nitrogen applied from commercial fertilizer:[2]	106 lbs/ac	106
b. Total Available Nitrogen- Application #1:	106.00 lbs/ac	106.00 lbs/ac
Application #2 *(Use if Needed)*		
a. Time of Year	Spring or summer	Spring or summer
b. Manure type:	Dairy- Lactating Cows Liquid	Dairy- Lactating Cows Liquid
c. Do you have a recent manure analysis test?[3]	Yes	Yes
If so, nitrogen concentration in manure:	23.2 lbs/1000 gallons	23.2 lbs/1000 gallons
d. Manure application rate:	8 1000 gallons/ac	8 1000 gallons/ac
e. Days until incorporation:	No incorporation	No incorporation
f. Total Applied Nitrogen- Application #2:	185.60 lbs/ac	185.60 lbs/ac
g. Total Available Nitrogen- Application #2:	37.12 lbs/ac	37.12 lbs/ac
Application #3 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Application #4 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #4:	0.00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #4:	0.00 lbs/ac	0.00 lbs/ac

Total Nitrogen Applied:	**Current**	291.60 lbs/ac	**Planned**	291.60 lbs/ac
Total Nitrogen Available for Crop Uptake:	**Current**	143.12 lbs/ac	**Planned**	143.12 lbs/ac

If you plan on reducing nitrogen applications ("Planned Nitrogen Applied" is less than "Current Nitrogen Applied" above), is this because:

- (●) Not Applicable
- ( ) Farm is no longer importing manure
- ( ) Farm is now exporting manure, or has increased manure exports
- ( ) Other (please specify below):

1. If biosolids are applied as fertilizer, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.
2. Please total up all commercial fertilizer applications over the year and include them here.
3. There are no default nitrogen concentrations for treated manure in the spreadsheet-- please enter nitrogen concentrations for treated manure in the field below.

5. Residual Nitrogen[1]

a. Frequency of past manure applications:	Continuously received manure (4-5 out of 5 yrs)
b. Residual N from previous crop:	NONE
Soil series type:	Duffield
Yield if soybeans provide residual nitrogen:	bu/ac
Total Nitrogen from Residuals:	35.00 lbs/ac

1. Residual Nitrogen is the amount of nitrogen in the soil from previous manure applications or legume crops.

The section below gives a snapshot of nitrogen application and loading rates. The first heading, "Nitrogen Reductions from Change in Application Rate," determines if any nitrogen credits are received from a reduction in nitrogen application rates. Nitrogen application rates used in this calculation are found in line 85 of this sheet. The second heading, "Nitrogen Loading Calculations," determines the amount of nitrogen available for runoff, and is calculated by subtracting the nitrogen uptake from the crop by the total nitrogen on the field (from applied nitrogen and residuals). BMPs chosen in Section 7 below are applied against the "Nitrogen Load to Reach Edge of Watershed Segment" calculated here to determine the nitrogen reductions achieved by the BMPs implemented.

6. Nitrogen Application Reductions and Loading Snapshot

PSU Recommended Nitrogen Application Rate:[1]		203.00	**lbs/ac/yr**
Nitrogen Available- Current:		178.12	lbs/ac/yr
Nitrogen Available- Planned:		178.12	lbs/ac/yr
Is "N Available- Planned" greater than PSU Recommended Rate?		No	
Is farm able to generate credits?		Yes	
Nitrogen Reductions from Change in Application Rate:			
Edge of Field Nitrogen Reductions:[2]		0.00	lbs/ac/yr
Edge of Field Nitrogen Reductions:		0.00	lbs/yr
EOS Ratio:	(x)	0.30	
EOS Nitrogen Reductions:[3]	(=)	0.00	lbs/yr
Nitrogen Loading Calculations:			
Total Nitrogen on Field- Planned:[4]		326.60	lbs/ac/yr
Nitrogen Uptake from Crop:[5]	(-)	187.80	lbs/ac/yr
Nitrogen Load to Reach Edge of Field:[6]	(=)	138.80	lbs/ac/yr
EOS Ratio:	(x)	0.30	
Preliminary EOS Nitrogen Load:	(=)	41.64	lbs/ac/yr
N Reduction for Conservation or Continuous No-Till:	(-)	10.54	lbs/ac/yr
N reduction for currently having riparian buffers in place:	(-)	0.00	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	31.10	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	2568.85	lbs/yr

1. Source: Pennsylvania State Agronomy Guide and AASL Handbook.

2. Edge of Field Nitrogen Reductions= [(Current Nitrogen Applied)-(Planned Nitrogen Applied)]. *Credit is not received for the decrease in nitrogen applications that exceed PSU recommended application rates.*

3. The Edge of Segment (EOS) Nitrogen Reductions determines the amount of nitrogen reductions that reach the edge of the watershed segment from the farming field. The EOS Ratio is derived from the Chesapeake Bay Model.

4. Total Nitrogen on Field = [(Planned Total Nitrogen Applied) + (Total Nitrogen From Residuals)]

5. Nitrogen uptake from crops varies by crop type and expected yield. Source: USDA Plant-Crop Nutrient Tool.

6. Nitrogen Load to Reach Edge of Field= [(Planned Nitrogen on Field)-(Nitrogen Uptake from Crop)]. If the "Planned Nitrogen on Field" is less than "Nitrogen Uptake from Crop," then the Nitrogen Load is determined by [(Planned Nitrogen Applied) - (Planned Nitrogen Available)].

Use the drop down options below to select any number of BMPs to implement that may generate nitrogen credits. The total nitrogen reduced for all BMPs chosen in this section appears on Line 156. If you are only generating credits from reducing nitrogen application rates (calculated above) then you can skip this section.

7. Planned Nitrogen Reductions- Best Management Practices[1]

a. Cropland and pasture BMPs to generate credits:		Continuous No-Till*
	(use if needed)	Cereal Cover Crop
	(use if needed)	
	(use if needed)	
1. Total acres of BMP:[2]		82.6 acres
2. If cover crops will be planted: Cover crop planting time:		Late-Planting - Up to 7 days after published first frost date
b. Streambank BMPs to generate credits:		
	(use if needed)	
1. If riparian buffers or wetland restoration are planned: Total acres of BMP:[2]		acres
2. If streambank restoration is planned: Total feet of streambank to be restored:		ft

EOS Nitrogen Reductions from BMP Implementation: 1040.39 lbs/yr

1. BMPs listed are only those that have an approved nitrogen reduction efficiency by the Chesapeake Bay Model. If a practice is not listed above then the submitting entity must determine their own acceptable calculation, which can be done in conjunction with PA DEP. Contact PA DEP Water Planning Office for more specific information.

2. This calculation assumes that all BMPs are implemented together on the same field (or pasture). If cropland and/or pasture BMPs are implemented in separate locations then please fill out a separate Credit Calculation Form for each.

*If you plan on implementing Continuous No-till and you are currently doing conventional till (Section 3 above), then please select both "Conservation till" AND "Continuous no-till" in the drop down boxes to receive full N reduction credits.

Section 8 below calculates the total number of possible credits generated from the above management practices. The "Nitrogen Reductions to Edge of Watershed Segment" is a combination of nitrogen reductions from a reduction in nitrogen application rate (Section 6), if applicable, as well as reductions from any BMPs implemented (Section 7).

8. Credit Calculation

Nitrogen Reductions to Edge of Watershed Segment:		1040.39	lbs/yr
Delivery Ratio:[1]	(x)	0.99	
Nitrogen Reductions to Chesapeake Bay:	(=)	1029.98	lbs/yr
Credits Retired to Meet the Threshold:	(x)	0%	
Total Credits Generated:	(=)	1030	Credits/Year
Credits sent to DEP Reserve:[2]	(x)	10%	
Total Credits Available to Trade	(=)	927	Credits/Year

1. The Delivery Ratio compensates for the natural attenuation, or loss, of nutrients and sediments as they travel in water. The Delivery Ratio is also known as the Delivery Factor.

2. According to the PA DEP Final Trading Policy, 10% of all credits generated will be placed in the DEP Credit Reserve. The DEP Credit Reserve contains credits set aside by the Department to address nutrient and sediment reduction failures, uncertainty, and to provide liquidity in the market.

CREDIT CALCULATION FORM- Effective December 4, 2007

This form will help assist the agricultural sector in determining how many nitrogen reduction credits may be generated from the implementation of particular Best Management Practices (BMPs). Calculations on this sheet are based on expected yield. This form should be completed and submitted to Pennsylvania Department of Environmental Protection (PA DEP) as part of a proposal to generate credits. A submitted proposal should follow the guidelines outlined in the Trading of Nutrient and Sediment Reduction Credits- Policy and Guidelines[1] regarding submission criteria for approvals of activities that reduce nutrients and potentially create credits. Please check the PA DEP Nutrient Trading Website or Pennsylvania's Water Quality Trading Marketplace[2] to ensure you are using the most up-to-date Credit Calculation Form.

1. The Final Trading Policy can be found on the PA DEP Trading Program website at:http://www.dep.state.pa.us/river/river_trading.htm
2. Pennsylvania's Water Quality Trading Marketplace (http://pa.nutrientnet.org) is an online trading platform where users buy and sell credits under PA's Trading Program.

To complete this form please fill out all required fields in yellow. Dark blue fields are automatic calculations performed on the spreadsheet. The annual credit generation period is October 1-September 30th.

Date:	6/21/2011
Project Name:	Renovo, PA Farm (Brubaker Farm Base Data)

Contact Information[1]

Name:	Heath Edelman, PE, CHMM
Organization:	Century Engineering
Phone Number:	(717) 901-7055
Email Address:	

1. This is the contact information for the person submitting the proposal to DEP.

1. Baseline Requirements to Generate Credits

a. Is farm in compliance with Act 38 Nutrient Management Regulations, Chapter 102 Erosion & Sedimentation Regulations, Chapter 91.36 (for agricultural operations), and Chapter 92 (for CAFO operations), as applicable?*

Yes

b. Who has verified compliance in part (a.): Other Authorized Agent

If other, please explain: Certified Nutrient Mangement Planner

2. Threshold Requirements to Generate Credits

A 100 ft manure application setback is followed; Manure is not mechanically applied within 100 ft of surface water.

If a 35 ft or greater riparian buffer is currently in place, please fill out the next question below:

Type of Buffer

Total Acres of Land in Buffer Strip ____ acres

*Compliance can be determined through a site inspection or verification of the development and implementation of a Nutrient Management Plan, E&S Plan (or an acceptable conservation plan), or Manure Management Plan, as applicable.

**In order to meet the threshold for a buffer, a minimum of 35 ft of permanent vegetation should be established and maintained between the field and surface water. The area can be grazed or cropped under a specific management plan, however permanent vegetation must be maintained at all times; Permanent vegetative buffers greater than 50 ft in width may qualify to generate nutrient reduction credits.

3. General Information

a. Current crop:[1]	Corn-Field, for silage (mature)
b. Acres of Current Crop:	82.6
c. Expected yield:	29 ton per acre
d. Current tillage method:	Continuous No-Till
e. Watershed segment number:	60

1. If your current crop is not listed, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.

Fill out all current AND planned sources of nitrogen applied to the field for the given year. Applications for the year may be separated out for different application times and manure types. Nitrogen credits may be generated if the planned nitrogen application is less than the current application (for example, a planned decrease in nitrogen application due better nutrient management).

4. Nitrogen Application[1]

	Current	Planned
Application #1 *(Use if Needed)*		
a. Nitrogen applied from commercial fertilizer:[2]	106 lbs/ac	106
b. Total Available Nitrogen- Application #1:	106.00 lbs/ac	106.00 lbs/ac
Application #2 *(Use if Needed)*		
a. Time of Year	Spring or summer	Spring or summer
b. Manure type:	Dairy- Lactating Cows Liquid	Dairy- Lactating Cows Liquid
c. Do you have a recent manure analysis test?[3]	Yes	Yes
If so, nitrogen concentration in manure:	23.2 lbs/1000 gallons	23.2 lbs/1000 gallons
d. Manure application rate:	8 1000 gallons/ac	8 1000 gallons/ac
e. Days until incorporation:	No incorporation	No incorporation
f. Total Applied Nitrogen- Application #2:	185.60 lbs/ac	185.60 lbs/ac
g. Total Available Nitrogen- Application #2:	37.12 lbs/ac	37.12 lbs/ac
Application #3 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #3:	0.00 lbs/ac	0.00 lbs/ac
Application #4 *(Use if Needed)*		
a. Time of Year:		
Manure type:		
Do you have a recent manure analysis test?[3]		
If so, nitrogen concentration in manure:	0	0
Manure application rate:	0	0
Days until incorporation:		
Total Applied Nitrogen- Application #4:	0 00 lbs/ac	0.00 lbs/ac
Total Available Nitrogen- Application #4:	0.00 lbs/ac	0.00 lbs/ac

Total Nitrogen Applied:	**Current**	291.60 lbs/ac	**Planned**	291.60 lbs/ac
Total Nitrogen Available for Crop Uptake:	**Current**	143.12 lbs/ac	**Planned**	143.12 lbs/ac

If you plan on reducing nitrogen applications ("Planned Nitrogen Applied" is less than "Current Nitrogen Applied" above), is this because:

- (●) Not Applicable
- ( ) Farm is no longer importing manure
- ( ) Farm is now exporting manure, or has increased manure exports
- ( ) Other (please specify below):

1. If biosolids are applied as fertilizer, contact PA DEP Water Planning Office (717-772-4785) for a more specific calculation methodology.
2. Please total up all commercial fertilizer applications over the year and include them here.
3. There are no default nitrogen concentrations for treated manure in the spreadsheet-- please enter nitrogen concentrations for treated manure in the field below.

5. Residual Nitrogen[1]

a. Frequency of past manure applications:	Continuously received manure (4-5 out of 5 yrs)
b. Residual N from previous crop:	NONE
Soil series type:	Duffield
Yield if soybeans provide residual nitrogen:	bu/ac

Total Nitrogen from Residuals: 35.00 lbs/ac

1. Residual Nitrogen is the amount of nitrogen in the soil from previous manure applications or legume crops.

The section below gives a snapshot of nitrogen application and loading rates. The first heading, "Nitrogen Reductions from Change in Application Rate," determines if any nitrogen credits are received from a reduction in nitrogen application rates. Nitrogen application rates used in this calculation are found in line 85 of this sheet. The second heading, "Nitrogen Loading Calculations," determines the amount of nitrogen available for runoff, and is calculated by subtracting the nitrogen uptake from the crop by the total nitrogen on the field (from applied nitrogen and residuals). BMPs chosen in Section 7 below are applied against the "Nitrogen Load to Reach Edge of Watershed Segment" calculated here to determine the nitrogen reductions achieved by the BMPs implemented.

6. Nitrogen Application Reductions and Loading Snapshot

PSU Recommended Nitrogen Application Rate:[1]		203.00	lbs/ac/yr
Nitrogen Available- Current:		178.12	lbs/ac/yr
Nitrogen Available- Planned:		178.12	lbs/ac/yr
Is "N Available- Planned" greater than PSU Recommended Rate?		No	
Is farm able to generate credits?		Yes	
Nitrogen Reductions from Change in Application Rate:			
Edge of Field Nitrogen Reductions:[2]		0.00	lbs/ac/yr
Edge of Field Nitrogen Reductions:		0.00	lbs/yr
EOS Ratio:	(x)	0.55	
EOS Nitrogen Reductions:[3]	(=)	0.00	lbs/yr
Nitrogen Loading Calculations:			
Total Nitrogen on Field- Planned:[4]		326.60	lbs/ac/yr
Nitrogen Uptake from Crop:[5]	(-)	187.80	lbs/ac/yr
Nitrogen Load to Reach Edge of Field:[6]	(=)	138.80	lbs/ac/yr
EOS Ratio:	(x)	0.55	
Preliminary EOS Nitrogen Load:	(=)	76.34	lbs/ac/yr
N Reduction for Conservation or Continuous No-Till:	(-)	22.48	lbs/ac/yr
N reduction for currently having riparian buffers in place:	(-)	0.00	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	53.86	lbs/ac/yr
Nitrogen Load to Reach Edge of Watershed Segment:	(=)	4448.74	lbs/yr

1. Source: Pennsylvania State Agronomy Guide and AASL Handbook.

2. Edge of Field Nitrogen Reductions= [(Current Nitrogen Applied)-(Planned Nitrogen Applied)]. *Credit is not received for the decrease in nitrogen applications that exceed PSU recommended application rates.*

3. The Edge of Segment (EOS) Nitrogen Reductions determines the amount of nitrogen reductions that reach the edge of the watershed segment from the farming field. The EOS Ratio is derived from the Chesapeake Bay Model.

4. Total Nitrogen on Field = [(Planned Total Nitrogen Applied) + (Total Nitrogen From Residuals)]

5. Nitrogen uptake from crops varies by crop type and expected yield. Source: USDA Plant-Crop Nutrient Tool.

6. Nitrogen Load to Reach Edge of Field= [(Planned Nitrogen on Field)-(Nitrogen Uptake from Crop)]. If the "Planned Nitrogen on Field" is less than "Nitrogen Uptake from Crop," then the Nitrogen Load is determined by [(Planned Nitrogen Applied) - (Planned Nitrogen Available)].

Use the drop down options below to select any number of BMPs to implement that may generate nitrogen credits. The total nitrogen reduced for all BMPs chosen in this section appears on Line 156. If you are only generating credits from reducing nitrogen application rates (calculated above) then you can skip this section.

7. Planned Nitrogen Reductions- Best Management Practices[1]

a. Cropland and pasture BMPs to generate credits:

	Continuous No-Till*
(use if needed)	Cereal Cover Crop
(use if needed)	
(use if needed)	

1. Total acres of BMP:[2] 82.6 acres
2. If cover crops will be planted:
   Cover crop planting time: Late-Planting - Up to 7 days after published first frost date

b. Streambank BMPs to generate credits:

(use if needed)	

1. If riparian buffers or wetland restoration are planned:
   Total acres of BMP:[2] _____ acres
2. If streambank restoration is planned:
   Total feet of streambank to be restored: _____ ft

EOS Nitrogen Reductions from BMP Implementation: 1801.74 lbs/yr

1. BMPs listed are only those that have an approved nitrogen reduction efficiency by the Chesapeake Bay Model. If a practice is not listed above then the submitting entity must determine their own acceptable calculation, which can be done in conjunction with PA DEP. Contact PA DEP Water Planning Office for more specific information.

2. This calculation assumes that all BMPs are implemented together on the same field (or pasture). If cropland and/or pasture BMPs are implemented in separate locations then please fill out a separate Credit Calculation Form for each.

*If you plan on implementing Continuous No-till and you are currently doing conventional till (Section 3 above), then please select both "Conservation till" AND "Continuous no-till" in the drop down boxes to receive full N reduction credits.

Section 8 below calculates the total number of possible credits generated from the above management practices. The "Nitrogen Reductions to Edge of Watershed Segment" is a combination of nitrogen reductions from a reduction in nitrogen application rate (Section 6), if applicable, as well as reductions from any BMPs implemented (Section 7).

8. Credit Calculation

Nitrogen Reductions to Edge of Watershed Segment:		1801.74	lbs/yr
Delivery Ratio:[1]	(x)	0.93	
Nitrogen Reductions to Chesapeake Bay:	(=)	1675.62	lbs/yr
Credits Retired to Meet the Threshold:	(x)	0%	
Total Credits Generated:	(=)	1676	Credits/Year
Credits sent to DEP Reserve:[2]	(x)	10%	
Total Credits Available to Trade	(=)	1508	**Credits/Year**

1. The Delivery Ratio compensates for the natural attenuation, or loss, of nutrients and sediments as they travel in water. The Delivery Ratio is also known as the Delivery Factor.

2. According to the PA DEP Final Trading Policy, 10% of all credits generated will be placed in the DEP Credit Reserve. The DEP Credit Reserve contains credits set aside by the Department to address nutrient and sediment reduction failures, uncertainty, and to provide liquidity in the market.

Attachment 7

Virginia BMP Enhancement and Land Conversion Offsets Calculation Worksheet

Appendix A: BMP Enhancement and Land Conversion Offsets Calculation Worksheet

Westmoreland, VA

Nutrient Reduction Calculation for BMP Enhancements, Upon Achieving BMP Baselines

How many pounds of nutrients will your selected BMP enhancements reduce?

Step 1: Locate the BMP Enhancement and Land Conversion Nutrient Removal Rates tables at the end of this worksheet. Find the appropriate table on the basis of the basin in which the tract of land is located, the BMP enhancement(s) you intend to implement, and the land's location to the east or west of I-95.

Step 2: Copy the appropriate delivered pounds per year of nutrient(s) reduced to the applicable BMP rows for total nitrogen and total phosphorus in the calculation worksheet provided below.

Step 3: Indicate for each BMP enhancement the number of acres to be treated.

Step 4: Multiply the delivered pounds per year of nutrients reduced by the number of acres. Be sure to account for both total nitrogen (TN) and total phosphorus (TP) for the BMP enhancement, if applicable.

Step 5: Add the values in the Pounds Reduced column to calculate the total pounds of nutrients reduced (Value X).

BMP	TN[a]	TP[a]	Acres	Pounds reduced
Example – Early Planted Cover Crops (implemented east of I-95)[b]	2.01	--	10	20.10
Early Planted Cover Crops				
15% Nitrogen Reduction on Corn				
Continuous No-Till	1.32	N/A	82.6	109.03
Early Planted Cover Crops & 15% Nitrogen Reduction on Corn				
Early Cover Crop & Continuous No-Till				
15% Nitrogen Reduction on Corn & Continuous No-Till				
Early Cover Crop & 15% Nitrogen Reduction on Corn & Continuous No-Till				
Total pounds of nutrients reduced (Value X)				

[a] pounds per year of nutrient(s) reduced

[b] This example used the *Eastern Shore Basin BMPs: Single BMP* table (the first table in the BMP Enhancement and Land Conversion Nutrient Removal Rates section later in this appendix).

Offsets Required 2:1 NPS:PS therefore 54.5 pounds offset a PS Requirement

Appendix A: BMP Enhancement and Land Conversion Offsets Calculation Worksheet

Front Royal, VA

Nutrient Reduction Calculation for BMP Enhancements, Upon Achieving BMP Baselines

How many pounds of nutrients will your selected BMP enhancements reduce?

Step 1: Locate the BMP Enhancement and Land Conversion Nutrient Removal Rates tables at the end of this worksheet. Find the appropriate table on the basis of the basin in which the tract of land is located, the BMP enhancement(s) you intend to implement, and the land's location to the east or west of I-95.

Step 2: Copy the appropriate delivered pounds per year of nutrient(s) reduced to the applicable BMP rows for total nitrogen and total phosphorus in the calculation worksheet provided below.

Step 3: Indicate for each BMP enhancement the number of acres to be treated.

Step 4: Multiply the delivered pounds per year of nutrients reduced by the number of acres. Be sure to account for both total nitrogen (TN) and total phosphorus (TP) for the BMP enhancement, if applicable.

Step 5: Add the values in the Pounds Reduced column to calculate the total pounds of nutrients reduced (Value X).

BMP	TN[a]	TP[a]	Acres	Pounds reduced
Example – Early Planted Cover Crops (implemented east of I-95)[b]	2.01	--	10	20.10
Early Planted Cover Crops				
15% Nitrogen Reduction on Corn				
Continuous No-Till	1.79	N/A	82.6	147.85
Early Planted Cover Crops & 15% Nitrogen Reduction on Corn				
Early Cover Crop & Continuous No-Till				
15% Nitrogen Reduction on Corn & Continuous No-Till				
Early Cover Crop & 15% Nitrogen Reduction on Corn & Continuous No-Till				
Total pounds of nutrients reduced (Value X)				

[a] pounds per year of nutrient(s) reduced

[b] This example used the *Eastern Shore Basin BMPs: Single BMP* table (the first table in the BMP Enhancement and Land Conversion Nutrient Removal Rates section later in this appendix).

Offsets Required 2:1 NIS: PS therefore 73.9 #

Attachment 8

Maryland Nutrient Trading Worksheets

No Till Only - Oakland Cove, MD (copy @ 2011-08-23) > Field 1 > Baseline Load

Worksheet PCL-000754

General | Soil | Baseline Crop Management | Baseline BMPs | Baseline Nutrient Load | Future Crop Management | Future BMPs | Future Nutrient Load

Edge of Segment Baseline Load Summary

Below is a summary of the current field's estimated edge-of-segment load. For comparison purposes, the target baseline load for your segment is displayed. Baseline eligibility cannot be determined for your parcel/tract until all fields have been evaluated. In order to meet baseline, your parcel/tract must, in aggregate, meet the target baseline load for all crop/pasture acres, as well as meet the practice-based baseline criteria for animal confinement areas (if applicable).

This farm does not meet baseline.

In order to qualify to generate credits you will need to reduce your farm load by changing your management practices and/or by implementing additional BMPs in the Baseline Crop Management and Baseline BMPs tabs for one or more fields.

Nitrogen

Baseline Load (EOS):	921.3 lb	11.1 lb/ac
Current Load (EOS):	1,194.7 lb	14.4 lb/ac

Phosphorus

Baseline Load (EOS):	96.3 lb	1.2 lb/ac
Current Load (EOS):	261.2 lb	3.1 lb/ac

Crop Management Summary

Review the nutrient and yield values for your baseline crop management. The values do not take BMPs effects into account and are not all used for credit calculation purposes.

The values below are measured at the edge of field (EOF), unlike the *lower* values above which are measured at the edge of stream (EOS).

	Baseline
Total N (before BMPs applied)	34.71 lb/ac
Sediment (Organic N)	17.89 lb/ac
Soluble N (NO_3)	16.82 lb/ac
Tile Drained N	0.00 lb/ac
Total P (before BMPs applied)	13.11 lb/ac
Sediment P (Organic P)	8.47 lb/ac
Soluble P (PO_4)	4.64 lb/ac
Tile Drained P	0.00 lb/ac
Flow	11.73 in
Sediment	N/A
Carbon	N/A
Crop Yield	
Corn Silage	8.53 t/ac

Continue

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Maryland Department of the Environment
1800 Washington Blvd., Baltimore, MD 21230
Phone: 410-537-3000

MDE

Maryl
50 Harry S

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Maryland Nutrient Trading

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Getting Started | Worksheets

Cover & No-Till - Oakland Cove, MD > Field 1 > Reduced Load

Worksheet PCL-000750

General | Soil | Baseline Crop Management | Baseline BMPs | Baseline Nutrient Load | Future Crop Management | Future BMPs | Future Nutrient Load

Reduced Load for Field

Review the nutrient reductions and credits generated by this project.

Nitrogen Summary

Baseline Load (EOS):	921.3 lb	11.1 lb/ac
Current Load (EOS):	790.9 lb	9.5 lb/ac
Planned Load (EOS):	771.2 lb	9.3 lb/ac
Reductions Eligible to Generate Credits (EOS):	19.7 lb	0.2 lb/ac
Delivery Ratio:	1.00	
Reductions to Chesapeake Bay:	19.7 lb	0.2 lb/ac

Credits Generated: 20 credits/yr

Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

Phosphorus Summary

Baseline Load (EOS):	96.3 lb	1.2 lb/ac
Current Load (EOS):	94.6 lb	1.1 lb/ac
Planned Load (EOS):	94.6 lb	1.1 lb/ac

Reductions Eligible to Generate Credits (EOS):	0.0 lb	0.0 lb/ac
Delivery Ratio:	1.00	
Reductions to Chesapeake Bay:	0.0 lb	0.0 lb/ac
Credits Generated:	0 credits/yr	Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

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No Till Only - Williamsport, MD > Field 1 > Reduced Load

Worksheet PCL-000755

General | Soil | Baseline Crop Management | Baseline BMPs | Baseline Nutrient Load | Future Crop Management | Future BMPs | Future Nutrient Load

Reduced Load for Field

Review the nutrient reductions and credits generated by this project.

Nitrogen Summary

Baseline Load (EOS):	**921.3 lb**	11.1 lb/ac
Current Load (EOS):	**430.0 lb**	5.2 lb/ac
Planned Load (EOS):	**342.3 lb**	4.1 lb/ac
Reductions Eligible to Generate Credits (EOS):	**87.7 lb**	1.1 lb/ac
Delivery Ratio:	**0.75**	
Reductions to Chesapeake Bay:	**65.8 lb**	0.8 lb/ac
Credits Generated:	**66 credits/yr**	Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

Phosphorus Summary

Baseline Load (EOS):	**96.3 lb**	1.2 lb/ac
Current Load (EOS):	**91.0 lb**	1.1 lb/ac
Planned Load (EOS):	**79.5 lb**	1.0 lb/ac

Reductions Eligible to Generate Credits (EOS):	11.5 lb	0.1 lb/ac
Delivery Ratio:	0.67	
Reductions to Chesapeake Bay:	7.7 lb	0.1 lb/ac
Credits Generated:	8 credits/yr	Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

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No-Till/Cereal - Williamsport, MD > Field 1 > Reduced Load

Worksheet PCL-000756

General | Soil | Baseline Crop Management | Baseline BMPs | Baseline Nutrient Load | Future Crop Management | Future BMPs | Future Nutrient Load

Reduced Load for Field

Review the nutrient reductions and credits generated by this project.

Nitrogen Summary

Baseline Load (EOS):	921.3 lb	11.1 lb/ac
Current Load (EOS):	361.9 lb	4.4 lb/ac
Planned Load (EOS):	288.1 lb	3.5 lb/ac
Reductions Eligible to Generate Credits (EOS):	73.8 lb	0.9 lb/ac
Delivery Ratio:	0.75	
Reductions to Chesapeake Bay:	55.4 lb	0.7 lb/ac
Credits Generated:	55 credits/yr	Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

Phosphorus Summary

Baseline Load (EOS):	96.3 lb	1.2 lb/ac
Current Load (EOS):	52.6 lb	0.6 lb/ac
Planned Load (EOS):	46.0 lb	0.6 lb/ac

Reductions Eligible to Generate Credits (EOS):	6.6 lb	0.1 lb/ac
Delivery Ratio:	0.67	
Reductions to Chesapeake Bay:	4.4 lb	0.1 lb/ac
Credits Generated:	4 credits/yr	Note: credits generated by crop and pasture fields are determined in aggregate and not at the per-field level.

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