Appendix B

Source Sector and Habitat Specific BMP Verification Guidance

Chesapeake Bay Program Agriculture Workgroup's Agricultural BMP Verification Guidance

PROLOGUE: CRITICAL OVERARCHING ISSUES

In developing this verification guidance for agricultural practices, the Agricultural Work Group wrestled with a host of complicated and sometimes competing interests and perspectives. In completing the guidance, the Work Group concluded that three critical overarching issues warranted future consideration by entities other than the Work Group.

Critical Overarching Issue One: Revisiting of the Guidance's "Less than 5%" Criteria

The guidance attempts to follow the targeting recommendation of the BMP Verification Review Panel; i.e., that verification efforts should be targeted, e.g., to either those practices that accomplish the greatest pollution load reductions or those practices that are the most vulnerable. In considering this recommendation, the verification guidance proposes that jurisdictions apply less comprehensive verification efforts to those practices accounting for 5% or less of a pollutant load (see Guidance, Section XXX). In reaching this conclusion, the Work Group determined that the sum total of practices accounting for 5% or less within a jurisdiction was not likely to reach a significant level. That is, the sum total of practices receiving less verification because of the "less than 5%" criteria would not exceed, hypothetically, 25% or 50%. The actual number of practices receiving reduced levels of verification because of these criteria is not, however, actually known. The Work Group determined that **the actual impact of this guidance decision needs to be re-examined and re-evaluated** by **the Chesapeake Bay Program partners** in two years. At that time, if the actual numbers indicate that the "less than 5%" criteria led to an unreasonable level of practices receiving less comprehensive verification, the Bay Program partners may need to adopt revised criteria.

Critical Overarching Issue Two: USDA's 5% Verification Cap

USDA currently places a cap on its level of verification of contracted cost-share practices at 5%. USDA documents reflect that USDA bases this verification level primarily on dollars spent, not pollution control achieved. In addition, USDA limits access to location information of the practices for purposes of conducting verification. The Agricultural Work Group recognized that the Bay Program's state jurisdictions cannot alter the federal USDA verification standards, and that only a sister federal agency such as EPA has the ability to challenge and, as appropriate, rework this federal standard for Chesapeake Bay water quality improvement. The Work Group determined that **EPA and USDA** must take the necessary steps **to together determine the appropriate federal standard for verification of USDA contracted cost-share practices** from a water quality, natural resource stewardship perspective.

Critical Overarching Issue Three: Application of the "Independent Review" Definition to Agricultural Practices.

The BMP review panel defines "independent review" as follows:

> Independent Review: a review carried out by someone within the same organization having technical expertise in the subject matter to a degree at least equivalent to that needed for the original work, but who was not involved as a participant, supervisor, technical reviewer, or advisor in the development or operations of the program/practice under review.
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> External Independent Review: a review carried out by a separate outside organization with technical expertise in the subject matter to a degree at least equivalent to that needed for the original work. Generally, this level of review is sought when considering key decisions that are being made that could affect the overall verification program.

In considering the practicalities of development and implementation of agricultural practices within some jurisdictions, the definitional phrase "who was not involved as a participant, supervisor, technical reviewer, or advisor in the development or operations of the program/practice under review" could place significant restrictions on the ability to conduct verification of agricultural BMPs. There are areas in Bay jurisdictions where only one office of several staff is geographically able to conduct the verification. The current definition, because of the language referring to "supervisor," "reviewer," and "advisor," may eliminate any and all staff as one able to conduct an "independent review." The Work Group determined that **the BMP Review Panel** needs to **re-examine the definition** and determine if revision is necessary for the agricultural sector.

Part 1: The Need for Agricultural BMP Verification and the Bay Program Process
With the establishment of a Chesapeake Bay Total Maximum Daily Load (TMDL) and the jurisdictions' commitment to demonstrate reasonable assurance that the TMDL goals will be met, tracking, reporting, and verification of best management practice (BMP) implementation is essential. An improved approach to verification is needed to expand the tracking and reporting of implemented BMPs from agency incentive programs to private, non-cost shared and resource improvement practices in a manner that ensures public confidence that the water quality benefits from the practices are achieved. The Chesapeake Bay TMDL has brought new urgency to the matter, reinforced by calls for enhanced verification by:

- The Chesapeake Bay Independent Evaluation Report developed by the National Research Council's (NRC) panel identified five specific science-based conclusions. These conclusions focused on the finding that "accurate tracking of BMPs is of paramount importance because the CBP relies upon the resulting data to estimate current and future nutrient and sediment loads to the Bay."

- President Obama's Chesapeake Bay Executive Order Strategy committed relevant federal agencies, including the U.S. Department of Agriculture (USDA) and the U.S. Environmental Protection Agency (EPA), to develop and implement "mechanisms of for tracking and reporting of voluntary conservation practices and other best management practices installed on agricultural lands" by July 2012.

- EPA's Chesapeake Bay TMDL's Appendix S outlined the common elements for the jurisdictions to develop and implement trading and offset programs in conjunction with the requirements of the TMDL.

- Several of the Chesapeake Bay Program's independent advisory committees, including the Scientific and Technical Advisory Committee (STAC) and the Citizen's Advisory Committee (CAC), have consistently requested Bay Program partners to develop and implement an open and transparent process to verify cost-share and non-cost shared BMPs being annually tracked and reported by the jurisdictions to the Chesapeake Bay Program Office (CBPO).

In 2012 the Chesapeake Bay Program (CBP) partners' Water Quality Goal Implementation Team requested each of the source and habitat sector workgroups, including the Agriculture Workgroup, to develop guidance for jurisdictions as they seek to enhance verification of BMP implementation. As a part of this effort, the Agriculture Workgroup identified several key factors critical to building a verification protocol for agricultural BMPs.

- Were public funds used to implement the practice, or was the practice funded entirely with private dollars?

- Was the practice implemented to satisfy a federal or state regulatory requirement, or is it external to regulatory oversight?

- Is the practice structural, with a multi-year life-span, or must it be implemented annually?

- Is the practice implemented "on-the-ground" or is it a plan or other enhancement of farm management?

These factors influence the reliability of reported information and the reasonable assurance of whether the practice is implemented properly and remains functional. The following narrative considers these factors and the consequent guidance to jurisdictions for a science and best professional judgment informed verification protocol.

Part 2: Defining and Categorizing Agricultural BMPs

The Bay Program partners approved agricultural BMPs represent the largest and most diverse group of conservation practices and land use conversions across all sectors. The diversity of BMPs reflects the diversity of agricultural production and land uses across the Chesapeake Bay watershed. To address the challenge of providing verification guidance for this diverse collection of BMPs in a simple format, agricultural BMPs are organized into three categories (Table 2). The three BMP categories are based on the assessment method for their physical presence, primarily, as well as on the respective life spans or permanence on the landscape.

2a. Visual Assessment BMPs - Single Year

A practice that can be visually assessed and with a limited physical presence in the landscape over time, i.e., lasting as short as several months to a single growing season. In order to accurately account for nutrient and sediment load reduction benefits, this type of BMP must be verified and reported on an annual basis.

2b. Visual Assessment BMPs - Multi-Year

A practice that can be visually assessed and has a protracted physical presence on the landscape, i.e., of more than one year when properly maintained and operated. This type of BMP often requires increased technical and financial resources to implement compared with a single year practice.

2c. Non-Visual Assessment BMPs

A practice that cannot typically be visually assessed because it is a type of management system or enhanced approach, rather than a physical BMP. This class of BMPs is more challenging to verify since it does not have a physical presence on the landscape. However, considerable nutrient and sediment reductions are possible in well-implemented plans that can last either a single season or multiple years.

Table B-1. Examples of agricultural BMPs by category.

B-1a. Visual Assessment-Single Year	B-1b. Visual Assessment - Multi-Year	B-1c. Non-Visual Assessment
Conservation Tillage	Animal Waste Management Systems	Decision/Precision Agriculture
High-Residue Minimum Disturbance Management	Barnyard Runoff Control	Swine Phytase
Traditional Cover Crops	Stream Side Grass Buffers	Enhanced Nutrient Management Plans
Commodity Cover Crops	Prescribed Grazing	Soil Conservation and Water Quality Plans
	Pasture Alternative Watering Systems	Poultry Litter Transport

Part 3: Defining Implementation Mechanisms for Agricultural BMPs

The diversity of agricultural BMPs is mirrored in the range of approaches and funding sources supporting implementation and the resultant level of oversight across the Chesapeake Bay watershed. The sources of BMP implementation data and their maintenance oversight are grouped into four broad categories with potential for mixing between categories dependent upon the specific BMP. How a BMP is funded and implemented has direct implications for how verification of presence and function is conducted:

3.a. Non-Cost-Shared (Privately Funded) BMPs

BMPs that are implemented without public funding assistance are a source of agricultural BMPs installed without the verification benefits inherent to the other categories - public cost-share, regulatory programs, and permit-issuing programs. As a result, the establishment of verification programs providing similar certainty to those for publically funded or regulated practices will be needed.

Non-cost share BMPs are typically financed by the operator or other non-public entity or source, and may or may not meet the practice standards associated with federal and state cost-share programs. Non-cost-shared practices may lack the contractual provisions of cost-shared BMPs as well as the corresponding implementation and maintenance oversight. Non-cost share BMPs also include BMPs which are described as “resource

improvement (RI) practices." Resource Improvement BMP's are practices which provide similar annual environmental benefits for water quality but may not fully meet all the design criteria of existing governmental design standards. See Resource Improvement Practice Definitions and Verification Visual Indicators Guidance Document for applicable verification guidelines.[1]

In order to satisfy the expectation for verification of non-cost shared BMPs, it is recommended that a jurisdiction verify 100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards.[2] Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.[3]

Additionally, it is recommended that a jurisdiction adopt one of the two approaches detailed below regarding follow up sub-sampling verification of non-cost shared BMPs. It is recommended that jurisdictions adopt the first approach as a default. The second approach for follow up sub-sampling may be proposed by a jurisdiction with documentation as an alternative strategy for review and approval.

1. During the course of the physical lifespan period of multi-year BMPs, reoccurring annual assessments are recommended to be implemented so that BMPs are verified as being maintained and operated in accordance with the appropriate federal, state or CBP practice standard. As a default, random, follow-up assessments are recommended to be conducted on 10% of those multi-year BMPs which are known to collectively account for greater than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario. (See Appendix A Example). For example, if the Chesapeake Bay Program partners' Watershed Model estimates that 7% of all the nitrogen reductions from a jurisdiction's agricultural nitrogen load resulted from the collective implementation of prescribed grazing, then the jurisdiction should conduct random, follow-up inspections on 10% of all farms with reported prescribed grazing systems.[4]

2. A jurisdiction may propose an alternative strategy for follow up sub-sampling of non-cost shared BMPs. Any such alternative shall be accompanied by documentation of the rationale for the alternative. The BMP Verification Review Panel shall review the

[1] http://www.chesapeakebay.net/publications/title/21973
[2] For BMPs that constitute ≤5% of the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario, 5% statistical sub-sampling of tracked and reported practices is allowable for the non-cost share and regulatory program BMP categories in this section. For cost-shared category BMPs, 5% of the active contracts is permissible, and for permit-issued BMPs, 20% sampling is recommended.
[3] For BMPs that constitute ≤5% of the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario, 5% statistical sub-sampling of tracked and reported practices is allowable for the non-cost share and regulatory program BMP categories in this section. For cost-shared category BMPs, 5% of the active contracts is permissible, and for permit-issued BMPs, 20% sampling is recommended.
[4] For BMPs that constitute ≤5% of the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario, 5% statistical sub-sampling of tracked and reported practices is allowable for the non-cost share and regulatory program BMP categories in this section. For cost-shared category BMPs, 5% of the active contracts is permissible, and for permit-issued BMPs, 20% sampling is recommended.

alternative strategy and make a recommendation to EPA on the adequacy of the alternative. An example of one such alternative is currently being developed by the Agriculture Workgroup for review and approval, at which time it will be provided to Bay Program partners as a supplemental document to the agricultural BMP verification guidance.

It is important to note that BMPs which were initially implemented and/or operated under a cost-share, regulatory, or permit program but are transitioned out of these programs and no longer are under the oversight of a cost-share agreement, regulation, or permit, will be verified by the same level of verification described for non-cost shared BMPs if they are continued to be considered for ongoing pollution reduction crediting.

3. b. Cost-Shared BMPs

BMPs that are implemented with public funds; these funds are managed by federal, state, and county agencies, and in some cases non-governmental organizations (NGOs). Cost-shared BMPs typically have contractual oversight elements such as the required involvement of certified engineers, planners and technicians who evaluate the BMPs according to governmental established design standards. These standards are intended to ensure proper installation and maintenance of the BMP over the life span of the contract and consequently so as to allow tracking and reporting on the BMPs during the life of the contract. BMPs implemented through these programs typically have existing defined verification protocols in place for the BMP during the life of the contract with the landowner dictating implementation, operation and maintenance requirements, and may provide a sufficient level of verification.

In order to satisfy the expectation for verification of cost-shared BMPs, it is recommended that a jurisdiction verify 100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards. Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.

Additionally, it is recommended that a jurisdiction adopt one of the two approaches detailed below regarding follow up sub-sampling verification of cost-shared BMPs. It is recommended that jurisdictions adopt the first approach as a default. The second approach for follow up sub-sampling may be proposed by a jurisdiction with documentation as an alternative strategy for review and approval.

1. During the period of contractual oversight for multi-year BMPs, reoccurring annual contractual compliance inspections are recommended to be implemented so that BMPs are verified as being maintained and operated in accordance with the funding agency's standards. As a default, random, follow-up assessments are recommended to be conducted on 10% of those multi-year BMPs which are known to collectively account for greater than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario. (See Appendix A Example). For example, if the Chesapeake Bay Program partners' Watershed Model estimates that 6% of all the nitrogen reductions from a jurisdiction's agricultural nitrogen

load resulted from the collective implementation of grass buffers, then the jurisdiction should conduct random, follow-up inspections on 10% of all farms with reported grass buffers.

2. A jurisdiction may propose an alternative strategy for follow up sub-sampling of cost-shared BMPs. Any such alternative shall be accompanied by documentation of the rationale for the alternative. The BMP Verification Review Panel shall review the alternative strategy and make a recommendation to EPA on the adequacy of the alternative. An example of one such alternative is currently being developed by the Agriculture Workgroup for review and approval, at which time it will be provided to the Bay Program partners as a supplemental document to the agricultural BMP verification guidance.

3.c. Regulatory Programs

Programs that provide oversight of a BMP through a legally imposed regulatory system. Some BMPs may be specifically identified as a legal requirement, while others may be the result of implementation of a legally-required management plan or system. Because regulations differ by state, there are differences in oversight by state and local agencies across the Bay watershed.

BMPs implemented under the requirements of governmental regulatory programs typically have existing but varied verification protocols in place for BMP implementation, operation, and maintenance over the design lifespan of the practice and may provide a sufficient level of verification.

Included within the regulatory program, understanding that offset and credit programs are continuing to evolve, are BMPs tied to offsets, mitigation, and trading. Agricultural verification protocols need to include procedures for identifying and separately managing practices which are tied to offset, mitigation, and trading programs to ensure that BMPs are not double-counted. BMPs tied to offsets, mitigation, and trading programs typically have their own specified verification protocols to achieve their intended programmatic environmental objectives.

In order to satisfy the expectation for verification of regulatory program BMPs, it is recommended that a jurisdiction verify 100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards. Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.

Additionally, it is recommended that a jurisdiction adopt one of the two approaches detailed below regarding follow up sub-sampling verification of regulatory program BMPs. It is recommended that jurisdictions adopt the first approach as a default. The second approach for follow up sub-sampling may be proposed by a jurisdiction with documentation as an alternative strategy for review and approval.

1. During the time period of the identified physical lifespan period of multi-year BMPs, reoccurring annual regulatory compliance inspections are recommended to be

implemented so that BMPs are verified as being maintained and operated in accordance with the appropriate federal or state regulatory practice standards. As a default, random, follow-up assessments are recommended to be conducted on 10% of those multi-year BMPs which are known to collectively account for greater than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario. (See Appendix A Example). For example, if the Chesapeake Bay Program partners' Watershed Model estimates that 9% of all the nitrogen reductions from a jurisdiction's agricultural nitrogen load resulted from the collective implementation of animal waste management systems, then the jurisdiction should conduct random, follow-up inspections on 10% of all farms with reported animal waste management systems.

2. A jurisdiction may propose an alternative strategy for follow up sub-sampling of regulatory program BMPs. Any such alternative shall be accompanied by documentation of the rationale for the alternative. The BMP Verification Review Panel shall review the alternative strategy and make a recommendation to EPA on the adequacy of the alternative. An example of one such alternative is currently being developed by the Agriculture Workgroup for review and approval, at which time it will be provided to the Bay Program partners as a supplemental document to the agricultural BMP verification guidance.

3.d. Permit-Issuing Programs

Regulatory programs that require an agricultural production operation to operate or conduct certain activities under a permit. Inspections conducted by the regulating authority are typically a condition of the permit. A permit may require periodic renewals for multi-year extensions. Implementation, operation and maintenance of BMPs are permit elements.

BMPs implemented under the oversight of permitting programs typically include defined verification protocols for all stages of BMP implementation, operation, and maintenance for the life of the permit, and may provide a sufficient level of verification.

In order to satisfy the expectation for verification of permit-issuing program BMPs, it is recommended that a jurisdiction verify 100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards. Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.

Additionally, it is recommended that a jurisdiction adopt one of the two approaches detailed below regarding follow up sub-sampling verification of permit program BMPs. It is recommended that jurisdictions adopt the first approach as a default. The second approach for follow up sub-sampling may be proposed by a jurisdiction with documentation as an alternative strategy for review and approval.

1. During the permit cycle, and the identified physical lifespan period of multi-year BMPs, reoccurring annual permit compliance inspections are recommended to be

implemented so that BMPs are verified as being maintained and operated in accordance with the appropriate federal or state permit practice standards. As a default, random, follow-up inspections are recommended to be conducted on 20% of those permitted multi-year BMPs, which is consistent with the EPA Concentrated Animal Feeding Operation (CAFO) program agreements with the jurisdictions for non-major permits. All CAFO permits are defined by EPA as being non-major permits. [5]

2. A jurisdiction may propose an alternative strategy for follow up sub-sampling of non-federal state permit-issuing program BMPs. Any such alternative shall be accompanied by documentation of the rationale for the alternative. The BMP Verification Review Panel shall review the alternative strategy and make a recommendation to EPA on the adequacy of the alternative. An example of one such alternative can be found in Appendix B.1.

Part 4: Agricultural BMP Verification Methods

Depending on the jurisdiction, a significant number of agricultural operations may legally operate without oversight from federal and state permitting and regulatory programs or participation in voluntary cost-share programs. Verification of BMPs for all farms, regardless of presence or absence of cost-shared or regulatory programs can be accomplished through the following or combination of the following:

4a. Farm Inventory

A survey or listing of physical BMPs completed by certified, trained technical staff, or by the producer. The survey or listing is based on physical inspection. The reliability of the information and the level of verification depends upon the intensity and frequency of the survey, the training of the person completing the survey, and whether the person completing the survey must certify to its accuracy with penalties for false information. Producer completed inventories without third-party verification are not considered an adequate method for verification.

4b. Office/farm Records

An evaluation of paperwork on record at the conservation district office or the farm operation itself rather than an on-site inspection of physical BMPs. Records alone are not considered an adequate method for verification, but can be a critical compliment to other methods, especially when associated with non-visual assessment BMPs.

4c. Transect Survey

An inspection of a statistical-based sampling of BMPs. A transect survey is appropriate for a single year visual assessment of practices such as tillage management. The reliability of this method is based on the sampling and inspection methods and the training and independence of the inspectors. Transect surveys as a visual verification method are not considered an adequate method for verifying non-visual BMPs, or multi-

[5] Federal NPDES Program requirements for CAFO compliance evaluation programs are available in section 40 CFR123.26 (b) (1-2) of the federal regulations.

year visual BMPs which require direct inspection, office/farm records, or certified training and engineering.

4d. Agency-sponsored Surveys

A survey of a statistical sampling of farms. Limitations on the reliability of data are similar to those for farm inventory and office/farm records. Periodic surveys and associated reports published by the National Agricultural Statistics Service (NASS), Conservation Effects Assessment Program (CEAP) and Natural Resources Inventory (NRI) are examples of this type of survey.

4e. Remote Sensing

A science-based review of images or photographic signatures verified through aerial photography, satellite imagery, or similar methods to identify physical practices on the landscape. This method may involve site-by-site imaging or statistical sampling. Implementing a sufficient land-based sampling validation protocol is necessary for ensuring the analysis of the remote images or photographic signatures are calibrated to actual conditions.

Part 5: Agricultural BMP Verification Priorities

The CBP's BMP Verification Committee and the BMP Verification Review Panel have acknowledged the potential financial and technical limitations that exist when seeking to fully implement the elements of this verification guidance. For this reason, public and private entities engaged with agricultural BMP verification are encouraged to direct their verification efforts in direct proportion to the environmental benefits that a BMP contributes towards the TMDL pollutant reduction for a jurisdiction's agricultural source sector. Agricultural BMPs that result in the highest pollutant reductions for each jurisdiction's agricultural source sector should correspondingly be the highest priority for implementing statistically significant verification protocols.

The Jurisdictional Agriculture Verification Protocol Design Table described in the following section (Tables 4-6) provides specific guidance to identify the default levels of verification inspections by agricultural BMP category (Visual – 1 year, Visual – multi-year, and Non-Visual). Tracked and reported BMPs achieving greater than 5% of the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario should receive the highest level of verification rigor. Those BMPs calculated to achieve ≤5 % of the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario, can be verified with less rigor.

Part 6: Jurisdictional Agricultural Verification Protocol Design Table and Supplementary Information

The CBP's Jurisdictional Agriculture Verification Protocol Design Table provides the jurisdictions, the CBP and public with a streamlined guidance and overview of the default verification levels for agricultural BMP verification (Tables 4-6), supplementary to the "Chesapeake Bay Program Best Management Practice Verification Program Design Matrix" and the "State Protocol Components Checklist" provided in the draft basin-wide framework report by the CBP. The elements of the Jurisdictional Agricultural Verification Protocol Design Table follow:

6a. BMP Priority

As described within the draft basin-wide verification framework report, jurisdictions can choose to vary the level of verification based on the relative importance of a specific practice to achieving the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario. By clearly documenting the relative load reduction priority for a BMP or group of closely related BMPs, a jurisdiction can target its verification investments to those BMPs which provide the greatest pollution reductions, or are employed the most often.

6b. BMP Grouping

Jurisdictions do not need to develop and document detailed protocols for individual BMPs across the universe of BMPs that they track, verify, and report for nutrient and sediment reduction load credit. Instead, jurisdictions should take their complete listing of tracked and reported BMPs and organize them by the categories that best account for the jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario, in logical groupings of the data specific to the jurisdiction, and consideration of the BMP types described in the relevant Agriculture Verification Guidance. Then, as presented within the Jurisdictional Agricultural Verification Protocol Design Table, the jurisdiction would document the appropriate protocols and procedures followed for each logical grouping of BMPs.

6c. Initial Inspection and Follow-up Checks

The Jurisdictional Agricultural Verification Protocol Design Table illustrates the CBP partners' BMP Verification Review Panel's recommendation to the jurisdictions for structuring their verification programs to carry out an initial inspection for answering the question "is the BMP there?" and then follow-up checks carried out at the appropriate frequency to answer the question "is the BMP still there and operating" throughout the lifespan of the practice.

6d. Lifespan and Sunsetting Practices

The Jurisdictional Agricultural Verification Protocol Design Table prompts jurisdictions to provide documentation on procedures in place for conducting follow-up checks of BMPs at the end of their approved contractual, permitted or physical lifespan. Jurisdictions would also document procedures for removing BMPs which will not go beyond their lifespans and do not require follow-up checks to confirm the BMP is still present and operational.

6e. Data Quality Assuring, Recording, and Reporting

This section documents the systems and processes utilized by the jurisdictions to confirm that initial inspections and follow-up checks were conducted, to prevent double counting, and to ensure quality assurance of the reported data prior to acceptance by the jurisdiction. Because BMP data will likely be reported to a jurisdiction from multiple sources in addition to the state agencies, written procedures are necessary to assure the quality of the data accepted by the jurisdiction. Any additional steps taken in properly recording the accepted data prior to its reporting through the jurisdiction's NEIEN node should also be documented.

Part 7: Guidance for Development of an Agricultural Practice Verification Protocol
The guidance provided within Sections 2 – 6 above will enable the jurisdictions to select and tailor the verification for agricultural practices that best suits their respective BMP priorities while ensuring conformity in terms (definitions), choices for methods, and approaches basin-wide. Jurisdictions should refer to the *State Protocol Component Checklist*[6] for the key elements of a complete state verification protocol process. If a jurisdiction decides to eliminate a component because it is unnecessary for its state process, it should provide documentation for why that component was deleted.

Once jurisdictions have identified the BMP priorities and BMP groupings, the specific verification methodologies that the state intends to use should be established and documented including the appropriate personnel (training or qualifications) for conducting the data collection, reporting, and verification process.

Jurisdictions will select methods of documentation that provide adequate information about the BMP to enable independent spot-checks by appropriately trained individuals. Jurisdictions will also develop an appropriate statistical selection process with the recommended review cycles of BMP implementation in their State Quality Assurance Plan.

Independent verification of BMP reporting programs and BMP implementation data will be addressed in state verification protocols. The State Quality Assurance Plans will ensure that the reported data is valid and representative of BMP implementation in the state. Independent verification can be conducted by agency personnel or qualified third parties, as long as they are trained to accurately assess BMP implementation data. Quality assurance personnel should be independent reviewers as defined by the Chesapeake Bay Program partners.

All reported BMPs, whether non-cost shared, cost shared, regulatory or permit-required, should have distinct, CBP-approved definitions, appropriate design standards and/or indicators to enable accurate, reliable reporting of the BMP to receive the commensurate credit.

Jurisdictions will develop a method to review data reported to the NEIEN submission system to ensure that it was accurately entered and submitted according to CBP guidance documents. If BMP implementation information reported by states comes from external entities it will be subject to appropriate validation as required by the CBP.

Jurisdictions will develop a methodology to determine when and how to remove data from their BMP reporting system. Long term historical BMP's should have a distinct life spans where they are either re-verified or removed from the reporting system.

Part 8: Supplemental Assistance for Development of an Agricultural Practice Verification Protocol
Because a single verification method will not be relevant to all BMPs, or even across a single category of BMPs, jurisdictions will need to carefully evaluate the resources available for verification and the relative priority or significance of the BMPs it expects to verify. To assist jurisdictions, the Agriculture Workgroup has developed detailed supplemental matrices for the categories of agricultural BMPs described in Part 2:

[6] The full State Protocol Component Checklist is provided in Table 11 in Section 14.

- Visual Assessment BMPs - Single Year (Table 4)
- Visual Assessment BMPs - Multi-Year (Table 5), and
- Non-Visual Assessment BMPs (Table 6).

The supplementary matrices, Tables B-6 through B-8, which are arranged by type of verification method, provide additional detail of specific verification methods and their applicability of use for providing verification and reliability factors as determined by the implementation mechanisms. These tables supplement Tables B-3 through B-5, which provide an overview of verification for each of the three primary BMP categories. Tables B-3 through B-5 include a specific example for each BMP category.

Table B-2. Descriptions of the BMP performance measures provided by Supplementary Matrices for Jurisdictional Use.

BMP Performance Measure	**Description**
BMP detection	Can the practice be physically detected through visual or other assessment methods such as sample analysis, historic images or photographic signatures, or farm and office records.
Meets USDA/State/CBP design specifications	Those practices which are designed and implemented according to applicable federal or state standards which typically form the basis for assigning relative environmental benefits by the Chesapeake Bay Program partners.
Meets federal/state/CBP operation and maintenance (O&M) specifications	Those practice which are being operated and maintained in accordance to applicable federal or state standards which typically form the basis for assigning relative environmental benefits by the Chesapeake Bay Program partners.
Resource Improvement (non-specification)	Those practices which provide similar annual environmental benefits for water quality but may not fully meet all the design criteria of existing governmental design standards.
Installation date	The installation date of the practice is important for determining the period of time it has provided environmental benefits, and if those benefits should be reported for credit, or have been previously accounted for in the Chesapeake Bay Program partners' calibrated modeling tools.
Expiration date	The expiration date of the may refer to the physical effective lifespan of the practice such as the expiration of a management plan, or may refer to the expiration of the associated permit or contract, which could necessitate the use of an alternative verification assessment method for further crediting.

Table B-3. Jurisdictional Agriculture Verification Protocol Design Table: Visual Assessment BMPs—Single Year Chesapeake Bay Program Agriculture Workgroup

A. BMP Priority	B. Data Grouping	C. BMP Type	D. Initial Inspection (*Is the BMP there?*)				E. Follow-up Check (*Is the BMP still there?*)			F. Lifespan/ Sunset (*Is the BMP no longer there?*)	G. Data QA, Recording & Reporting
			Method	Frequency	Who inspects	Documentation	Follow-up Inspection	Statistical Sub-sample	Response if Problem		
High / Low	Visual Assessment: Single Year	Non-Cost Shared BMPs	**On-Site Visual Assessment (Limited Statistical Sampling)**	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet appropriate government and/or CBP practice standards	Single Year	10%[1] / 5%[2] QA of All Tracked & Reported BMPs (within the year)	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document inspections/follow-up checks, prevent double counting, and QA reported data
High / Low	Visual Assessment: Single Year	Cost-Shared Programs	On-Site Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet appropriate government and/or CBP practice standards	Single Year	10% / 5% QA of All Active Contractual BMPs (within the year)	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document inspections/follow-up checks, prevent double counting, and QA reported data

Appendix B
Agriculture BMP Verification Guidance

High / Low	Visual Assessment: Single Year	Permit-Issuing Programs	On-Site Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Single Year	20% Annually of All Active Permits	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document inspections/follow-up checks, prevent double counting, and QA reported data
EXAMPLE BMP	Visual Assessment: Single Year	Cost-Shared Programs: Traditional Cover Crop-Early Drilled Rye	On-Site Visual Assessment: Cover Crop Establishment	100% of All Active Contracts	County Conservation District USDA-NRCS Certified Field Technician	Cost-Share Program BMP Certification Form	On-Site Visual Assessment: Cover Crop Termination	10% QA of All Active Contractual BMPs	Cost-Share Program Contract Compliance Policy	Contract Year	Cost-Share Program Documentation / 10% QAQC Compliance Checks by State Agency / Tracking & Reporting Protocol

Table B-4. Jurisdictional Agriculture Verification Protocol Design Table: Visual Assessment BMPs—Multi-Year Chesapeake Bay Program Agriculture Workgroup

A. BMP Priority	B. Data Grouping	C. BMP Type	D. Initial Inspection (*Is the BMP there?*)				E. Follow-up Check (*Is the BMP still there?*)			F. Lifespan/ Sunset (*Is the BMP no longer there?*)	G. Data QA, Recording & Reporting
			Method	Frequency	Who inspects	Documentation	Follow-up Inspection	Statistical Sub-sample	Response if Problem		
High / Low	Visual Assessment: Multi-Year	Non-Cost Shared BMPs	**On-Site Visual Assessment (Limited Statistical Sampling)**	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet appropriate government and/or CBP practice standards	Multi-Year	10%[1] / 5%[2] Annually of All Tracked & Reported BMPs	Bring into compliance within one year or less, or remove from reported BMPs	Multi-Year	Document inspections/follow-up checks, prevent double counting, and QA reported data
High / Low	Visual Assessment: Multi-Year	Cost-Shared Programs	On-Site Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet appropriate government and/or CBP practice standards	Multi-Year	10% / 5% of All Active Contractual BMPs	Bring into compliance within one year or less, or remove from reported BMPs	Multi-Year	Document inspections/follow-up checks, prevent double counting, and QA reported data

Appendix B
Agriculture BMP Verification Guidance

High / Low	Visual Assessment: Multi-Year	Permit-Issuing Programs	On-Site Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Multi-Year	20% Annually of All Active Permits	Bring into compliance within one year or less, or remove from reported BMPs	Multi-Year	Document inspections/follow-up checks, prevent double counting, and QA reported data
EXAMPLE BMP	Visual Assessment: Multi-Year	State CAFO Permit Program: Animal Waste Storage Structure	On-Site Visual Assessment: Initial CAFO Permit Inspection	100% of All Active CAFO Permits	State Agency CAFO Certified Inspector	State CAFO Permit Inspection Certification Form	On-Site Visual Assessment: State CAFO Permit Compliance Inspection	20% of All Active CAFO Permits	State CAFO Program Permit Compliance Policy	State CAFO Permit Lifespan: 5 Years	State CAFO Program Documentation / 5% QAQC Compliance Checks by EPA / Tracking & Reporting Protocol

[1]BMP High: Default verification levels for follow-up sub-sampling of BMPs which are known to collectively account for greater than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario.
[2] BMP Low: Default verification levels for follow-up sub-sampling of BMPs which are known to collectively account for equal to or less than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario.

Table B-5. Jurisdictional Agriculture Verification Protocol Design Table: Non-Visual Assessment BMPs Chesapeake Bay Program Agriculture Workgroup

A. BMP Priority	B. Data Grouping	C. BMP Type	D. Initial Inspection (*Is the BMP there?*)				E. Follow-up Check (*Is the BMP still there?*)			F. Life-span / Sunset (*Is the BMP no longer there?*)	G. Data QA, Recording & Reporting
			Method	Frequency	Who inspects	Documentation	Follow-up Inspection	Statistical Sub-sample	Response if Problem		
High / Low	Non-Visual Assessment	Non-Cost Shared BMPs	On-Site Non-Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Single Year	10%[1] / 5%[2] Annually of All Tracked & Reported BMPs	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document inspections/follow-up checks, prevent double counting, and QA reported data
High / Low	Non-Visual Assessment	Cost-Shared Programs	On-Site Non-Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency/NGO field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Single Year	10% / 5% of All Active Contractual BMPs	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document initial inspections/follow-up checks, prevent double counting, and QA reported data

High / Low	Non-Visual Assessment	Regulatory Programs	On-Site Non-Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Single Year	10% / 5% Annually of All Tracked & Reported BMPs	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document initial inspections/follow-up checks, prevent double counting, and QA reported data
High / Low	Non-Visual Assessment	Permit-issuing Programs	On-Site Non-Visual Assessment Only	100% of All Tracked & Reported BMPs	Trained and certified technical agency field staff or engineers	BMPs meet the appropriate government and/or CBP practice standards	Single Year	20% Annually of All Active Permits	Bring into compliance within one year or less, or remove from reported BMPs	Single Year	Document initial inspections/follow-up checks, prevent double counting, and QA reported data
EXAMPLE BMP	Non-Visual Assessment	State Regulatory Programs: Nutrient Application Management	On-Site Non-Visual Assessment: Nutrient Management Plan Implementation	100% of All Tracked & Reported Nutrient Application Management Plans	County Conservation District Technician - State Nutrient Management Program Certified	State Nutrient Management Program Certification Form	On-Site Non-Visual Assessment: Nutrient Application Management O&M Compliance	10% of All Tracked & Reported Nutrient Application Management Plans	State Nutrient Management Regulatory Compliance Policy	3 Year Plans	State Nutrient Management Program Documentation / 5% QAQC Compliance Checks by State Agency / Tracking & Reporting Protocol

Table B-6. Agricultural BMP Verification Guidance Matrix: Visual Assessment BMPs – Single Year

Chesapeake Bay Program Agriculture Workgroup

The following BMP verification methods have been identified by the Agriculture Workgroup as representing primary pathways for BMP verification and reporting being utilized by the Bay Program partners. The associated opportunities and limitations inherent for each method and BMP category type represent the current level of confidence that a sufficient level of verification can be implemented to ensure that the BMPs have been (1) implemented, are currently operational, and are being maintained to meet the BMP definition and relevant practice standards and requirements; and (2) be in compliance with the Chesapeake Bay Program partners' BMP Verification Principles, including any supporting addendums.

Visual Assessment BMPs - Single Year: Conservation Tillage; High-Residue Minimum Soil Disturbance; Cover Crops; Commodity Cover Crops / **Interim BMPs-** Dairy Manure Injection; Annual No-till; Poultry Litter Injection

Agricultural BMP Verification Methods	Assessment Methods	Verification Expectations	Visual Assessment BMPs - Single Year	Cost-Sharing Information					BMP Performance					
				Federal C/S	State C/S	NGO C/S	Private Funded	Previously C/S BMPs (Expired Contract)	BMP Detection	Meets USDA/ State Design Specs	Meets Federal/State O&M Specs	Resource Improvement (Non-Spec)	Installation Date (M/Y)	Expiration Date (M/Y)
1.) Permit Issuing Programs	Verified compliance with federal NPDES (CAFO) or state agricultural operational permit program requirements.	Annual frequency of permit compliance inspections for all or sufficient statistical percentage of permitted operations during permit life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible

2.) Regulatory Programs	Verified compliance with federal or state agricultural regulatory requirements (non-operational permit).	Annual frequency of regulatory compliance inspections for all or sufficient statistical percentage of regulated operations. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
3.) Financial Incentive Programs	Verified compliance with federal program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Eligible	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
4.) Financial Incentive Programs	Verified compliance with state or county program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Eligible	Potentially Eligible	Not Eligible	Not Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible

5.) Financial Incentive Programs	Verified compliance with NGO program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Potentially Eligible	Eligible	Not Eligible	Not Eligible	Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Eligible	Eligible
6.) Farm Inventory	Farm inventory by trained and certified federal, state, and/or county agency personnel.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
7.) Farm Inventory	Farm inventory by trained and certified NGO personnel.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
8.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified federal, state and/or county personnel verify on-site.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible

9.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified NGO personnel verify on-site.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
10.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
11.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified NGO personnel. No on-site verification.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
12.) Farm Inventory	Farmer with training and certification completes self-certified inventory survey.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

13.) Farm Inventory	Farmer without training and certification completes self-certified inventory survey.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
14.) Office Records	Review of existing office records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of office records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
15.) Farm Records	Review of existing on-farm records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
16.) Farm Records	Review of existing on-farm records by trained and certified NGO personnel. No on-site verification.	Annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
17.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified federal, state and/or county personnel.	Annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

18.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified NGO personnel.	Annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
19.) CEAP Survey	CEAP statistical survey conducted in-person at field-level scale following NASS verification protocols.	Non-annual frequency of statistical CEAP surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
20.) NASS Survey	NASS statistical survey conducted at farm-level scale following NASS verification protocols.	Annual frequency of statistical NASS surveys for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
21.) NRI Point (NRCS) or some other statistically selected sites	Statistical survey conducted in-person at field-level with NASS trained and certified personnel.	Non-annual frequency of statistical NRI surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

22.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Annual frequency of statistical remote sensing surveys implemented by trained and certified agency personnel, for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
23.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Annual frequency of statistical remote sensing surveys implemented by trained and certified NGO personnel, for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

Table B-7 Draft Agricultural BMP Verification Guidance Matrix: Visual Assessment BMPs – Multi-Year

Chesapeake Bay Program Agriculture Workgroup

The following BMP verification methods have been identified by the Agriculture Workgroup as representing primary pathways for BMP verification and reporting being utilized by the Bay Program partners. The associated opportunities and limitations inherent for each method and BMP category type represent the current level of confidence that a sufficient level of verification can be implemented to ensure that the BMPs have been (1) implemented, are currently operational, and are being maintained to meet the BMP definition and relevant practice standards and requirements; and (2) be in compliance with the Chesapeake Bay Program partners' BMP Verification Principles, including any supporting addendums.

Visual Assessment BMPs - Multi-Year: Animal Waste Management Systems; Barnyard Runoff Control; Bio-filters; Continuous No-Till; Forest Buffers; Grass Buffers; Land Retirement; Steam-Side Forest Buffers; Stream-Side Grass Buffers; Stream-Side Wetland Restoration; Tree Planting; Lagoon Covers; Loafing Lot Management; Mortality Composters; Non-Urban Stream Restoration: Shoreline Erosion Control; Off-Steam Watering w/o Fencing; Stream Access Control with Fencing; Prescribed Grazing; Precision Intensive Rotational Grazing; Horse Pasture Management; Pasture Alternate Watering Systems; Soil Conservation & Water Quality Plan Elements; Water Control Structures; Wetland Restoration / **Interim BMPs-** Alternative Crops; Dirt & Gravel Road Erosion & Sediment Control; Cropland Irrigation Management; Irrigation Water Capture Reuse; P-Sorbing Materials in Ag Ditches; Vegetative Environmental Buffers- Poultry

Agricultural BMP Verification Methods	Assessment Methods	Verification Expectations	Visual Assessment BMPs - Multi-Year	Cost-Sharing Information					BMP Performance					
				Federal C/S	State C/S	NGO C/S	Private Funded	Previously C/S BMPs (Expired Contract)	BMP Detection	Meets USDA/ State Design Specs	Meets Federal/State O&M Specs	Resource Improvement (Non-Spec)	Installation Date (M/Y)	Expiration Date (M/Y)

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1.) Permit Issuing Programs	Verified compliance with federal NPDES (CAFO) or state agricultural operational permit program requirements.	Non-annual frequency of permit compliance inspections for all or sufficient statistical percentage of permitted operations during permit life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Not Eligible	Eligible	Eligible
2.) Regulatory Programs	Verified compliance with federal or state agricultural regulatory requirements (non-operational permit).	Non- annual frequency of regulatory compliance inspections for all or sufficient statistical percentage of regulated operations. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Not Eligible	Eligible	Eligible
3.) Financial Incentive Programs	Verified compliance with federal program contractual requirements.	Non- annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Eligible	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Eligible	Eligible	Eligible	Not Eligible	Eligible	Eligible

4.) Financial Incentive Programs	Verified compliance with state or county program contractual requirements.	Non-annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Eligible	Potentially Eligible	Not Eligible	Not Eligible	Eligible	Eligible	Eligible	Potentially Eligible	Eligible	Eligible
5.) Financial Incentive Programs	Verified compliance with NGO program contractual requirements.	Non-annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Potentially Eligible	Eligible	Not Eligible	Not Eligible	Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Eligible	Eligible
6.) Farm Inventory	Farm inventory by trained and certified federal, state, and/or county agency personnel.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible
7.) Farm Inventory	Farm inventory by trained and certified NGO personnel.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible

8.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified federal, state and/or county personnel verify on-site.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible
9.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified NGO personnel verify on-site.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible
10.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified federal, state and/or county agency personnel. No on-site verification.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible
11.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified NGO personnel. No on-site verification.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible

12.) Farm Inventory	Farmer with training and certification completes self-certified inventory survey.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible
13.) Farm Inventory	Farmer without training and certification completes self-certified inventory survey.	Non-annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible
14.) Office Records	Review of existing office records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Non-annual frequency of office records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible
15.) Farm Records	Review of existing on-farm records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Non-annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible
16.) Farm Records	Review of existing on-farm records by trained and certified NGO personnel. No on-site verification.	Non-annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible

17.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified federal, state and/or county personnel.	Non-annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible
18.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified NGO personnel.	Non-annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible
19.) CEAP Survey	CEAP statistical survey conducted in-person at field-level scale following NASS verification protocols.	Non-annual frequency of statistical CEAP surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible
20.) NASS Survey	NASS statistical survey conducted at farm-level scale following NASS verification protocols.	Non-annual frequency of statistical NASS surveys for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible
21.) NRI Point (NRCS) or some other statistically selected sites	Statistical survey conducted in-person at field-level with NASS trained and certified personnel.	Non-annual frequency of statistical NRI surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible

22.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Non-annual frequency of statistical remote sensing surveys implemented by trained and certified agency personnel, for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible
23.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Non-annual frequency of statistical remote sensing surveys implemented by trained and certified NGO personnel, for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Not Eligible	Not Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible

Table B-8 Draft Agricultural BMP Verification Guidance Matrix: Non-Visual Assessment BMPs

Chesapeake Bay Program Agriculture Workgroup

The following BMP verification methods have been identified by the Agriculture Workgroup as representing primary pathways for BMP verification and reporting being utilized by the Bay Program partners. The associated opportunities and limitations inherent for each method and BMP category type represent the current level of confidence that a sufficient level of verification can be implemented to ensure that the BMPs have been (1) implemented, are currently operational, and are being maintained to meet the BMP definition and relevant practice standards and requirements; and (2) be in compliance with the Chesapeake Bay Program partners' BMP Verification Principles, including any supporting addendums.

Non-Visual Assessment BMPs: Dairy Precision Feeding; Swine Phytase; Poultry Litter Transport; Poultry Litter Treatment; Poultry Phytase; Decision/Precision Ag, Enhanced Nutrient Management; Nutrient Application Management; Soil Conservation & Water Quality Plans

Agricultural BMP Verification Methods	Assessment Methods	Verification Expectations	Non-Visual Assessment BMPs	Cost-Sharing Information					BMP Performance					
				Federal C/S	State C/S	NGO C/S	Private Funded	Previously C/S BMPs (Expired Contract)	BMP Detection	Meets USDA/ State Design Specs	Meets Federal/State O&M Specs	Resource Improvement (Non-Spec)	Installation Date (M/Y)	Expiration Date (M/Y)
1.) Permit Issuing Programs	Verified compliance with federal NPDES (CAFO) or state agricultural operational permit program requirements.	Annual frequency of permit compliance inspections for all or sufficient statistical percentage of permitted operations during permit life span. Review of office/farm records.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

2.) Regulatory Programs	Verified compliance with federal or state agricultural regulatory requirements (non-operational permit).	Annual frequency of regulatory compliance inspections for all or sufficient statistical percentage of regulated operations. Review of office/farm records.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
3.) Financial Incentive Programs	Verified compliance with federal program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible
4.) Financial Incentive Programs	Verified compliance with state or county program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Eligible	Eligible	Eligible	Non-Applicable	Eligible	Eligible

5.) Financial Incentive Programs	Verified compliance with NGO program contractual requirements.	Annual frequency of contractual compliance inspections for all or sufficient statistical percentage of contracted operations during contractual life span. Review of office/farm records.	Eligible	Potentially Eligible	Potentially Eligible	Eligible	Potentially Eligible	Potentially Eligible	Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Eligible	Eligible
6.) Farm Inventory	Farm inventory by trained and certified federal, state, and/or county agency personnel.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
7.) Farm Inventory	Farm inventory by trained and certified NGO personnel.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
8.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified federal, state and/or county personnel verify on-site.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

9.) Farm Inventory	Farmer completes self-certified inventory survey and trained and certified NGO personnel verify on-site.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
10.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
11.) Farm Inventory	Farmer completes in-office self-certified inventory with assistance of trained and certified NGO personnel. No on-site verification.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span. Review of office/farm records.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
12.) Farm Inventory	Farmer with training and certification completes self-certified inventory survey.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

13.) Farm Inventory	Farmer without training and certification completes self-certified inventory survey.	Annual frequency of inventories for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
14.) Office Records	Review of existing office records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of office records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
15.) Farm Records	Review of existing on-farm records by trained and certified federal, state and/or county agency personnel. No on-site verification.	Annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
16.) Farm Records	Review of existing on-farm records by trained and certified NGO personnel. No on-site verification.	Annual frequency of on-farm records review and verification for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Potentially Eligible	Not Eligible	Not Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
17.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified federal, state and/or county personnel.	Annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Non-Applicable	Not Eligible	Not Eligible

18.) Transect Survey	Statistically designed and recognized transect survey completed by trained and certified NGO personnel.	Annual frequency of statistical transect surveys for a sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Non-Applicable	Not Eligible	Not Eligible
19.) CEAP Survey	CEAP statistical survey conducted in-person at field-level scale following NASS verification protocols.	Non-annual frequency of statistical CEAP surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
20.) NASS Survey	NASS statistical survey conducted at farm-level scale following NASS verification protocols.	Annual frequency of statistical NASS surveys for all or sufficient statistical percentage of operations during BMP life span.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible
21.) NRI Point (NRCS) or some other statistically selected sites	Statistical survey conducted in-person at field-level with NASS trained and certified personnel.	Non-annual frequency of statistical NRI surveys for a sufficient statistical percentage of operations during BMP life span may limit verification.	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Potentially Eligible	Non-Applicable	Potentially Eligible	Potentially Eligible

22.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Annual frequency of statistical remote sensing surveys implemented by trained and certified agency personnel, for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Non-Applicable	Not Eligible	Not Eligible
23.) Remote Sensing	Statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification.	Annual frequency of statistical remote sensing surveys implemented by trained and certified NGO personnel, for all or sufficient statistical percentage of operations during BMP life span.	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Non-Applicable	Not Eligible	Not Eligible

Relative Influence of BMPs To-Date on Load Reductions <u>Agriculture Sector</u>

Objectives

- Identify the agricultural BMPs reported by states to-date (through 2013 Progress) and quantify their relative contribution to nutrient and sediment load reductions from a No-Action condition to 2013 Progress.
- Results in the following slides are focused on the agricultural sector.

Method

- Create a NO ACTION Scenario.
- Determine load reductions between 2013 Progress Scenario and NO ACTION.
- Isolate each 2013 Progress BMP in a separate scenario using CAST processing rules.
- Determine load reductions from the isolated BMP scenario to the NO ACTION.
- Compare the relative load reductions among the BMPs.

Agriculture Practices

LandRetire	Land Retirement	PrecRotGrazing	Prescribed Grazing
ForestBuffers	Forest Buffers	UpPrecIntRotGraze	Precision Intensive Rotational Grazing
ConserveTill	Conservation Tillage	MortalityComp	Mortality Composting
CoverCrop	Cover Crop	EffNutManDecAgVA	Decision Agriculture
AWMS	Animal Waste Management Systems	ForestBuffersTrp	Forest Buffers on Fenced Pasture Corridor
GrassBuffers	Grass Buffers	NoTill	Continuous NoTill
EnhancedNM	Enhanced Nutrient Application Management	WaterContStruc	Water Control Structures
CarSeqAltCrop	Carbon Sequestration	Cropirrmgmt	Crop Irrigation Management
ConPlan	Conservation Plans	EffNutManEnhanceVA	Enhanced Nutrient Application Management
ComCovCrop	Commodity Cover Crop	NonUrbStrmRest	NonUrban Stream Restoration
WetlandRestore	Wetland Restoration	LoafLot	Loafing Lot Management
DecisionAg	Decision Agriculture	OSWnoFence	Pasture Alternative Watering
PastFence	Stream Access Control with Fencing	ConserveTillom	Conservation-Till Specialty Crops
GrassBuffersTrp	Grass Buffers on Fenced Pasture Corridor	TreePlantTrp	Tree Planting on Fenced Pasture Corridor
DairyPrecFeed	Dairy Precision Feeding	PoultryPhytase	Poultry Phytase
PoultryInjection	Poultry Injection	SwinePhytase	Swine Phytase
TreePlant	Tree Planting	BioFilters	BioFilters
CaptureReuse	Capture & Reuse	HorsePasMan	Horse Pasture Management
ManureTransport	Manure Transport	LagoonCovers	Lagoon Covers
ContinuousNT	Continuous NoTill	NutMan	Nutrient Application Management on Crop
BarnRunoffCont	Barnyard Runoff Control	Alum	Ammonia Emission Reductions (Alum)
LiquidInjection	Liquid Injection		

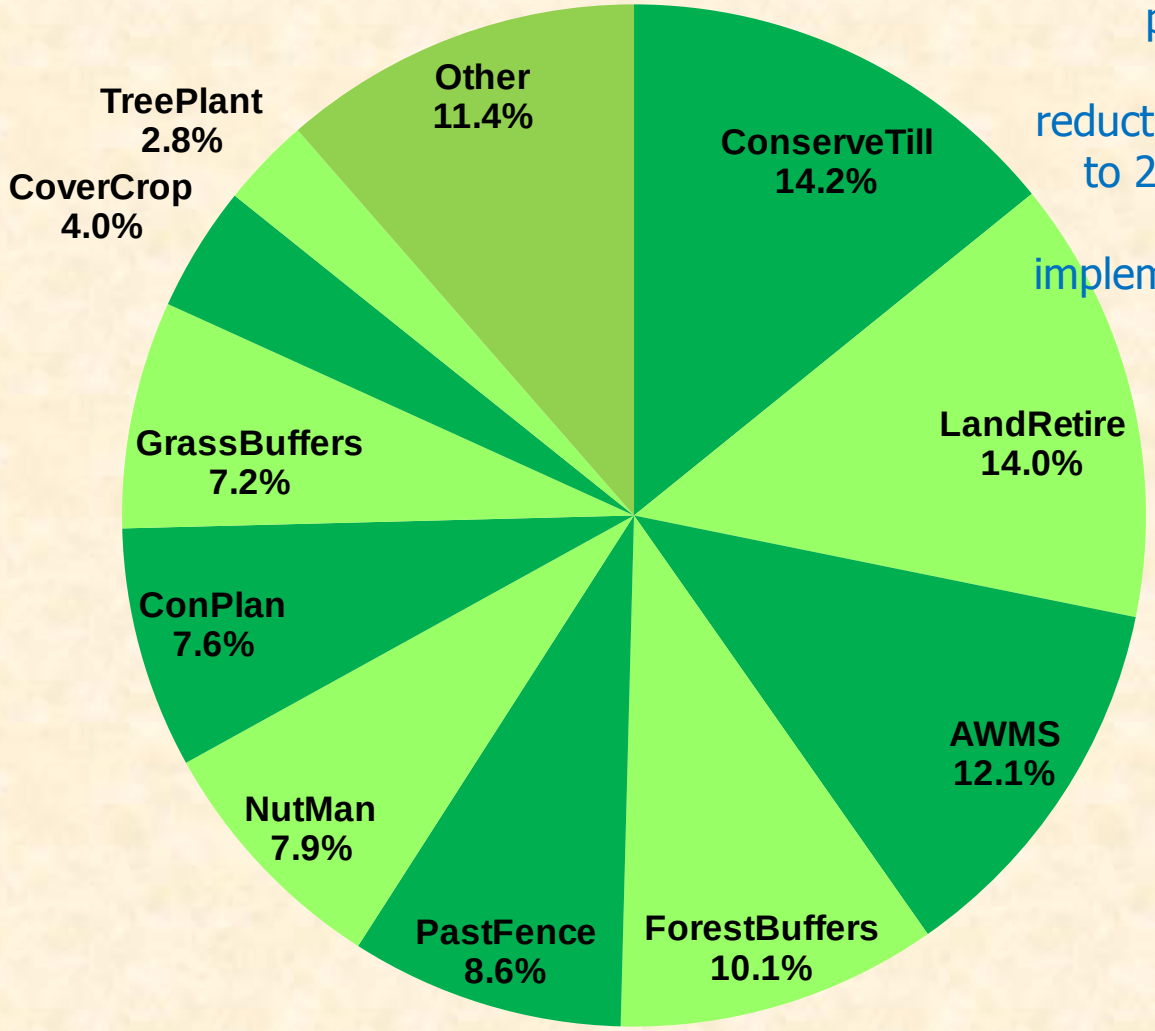
Agricultural Nitrogen Reductions

Relative influence of 2013 Progress BMPs on load reductions

Agriculture Nitrogen Load Reduction by BMP

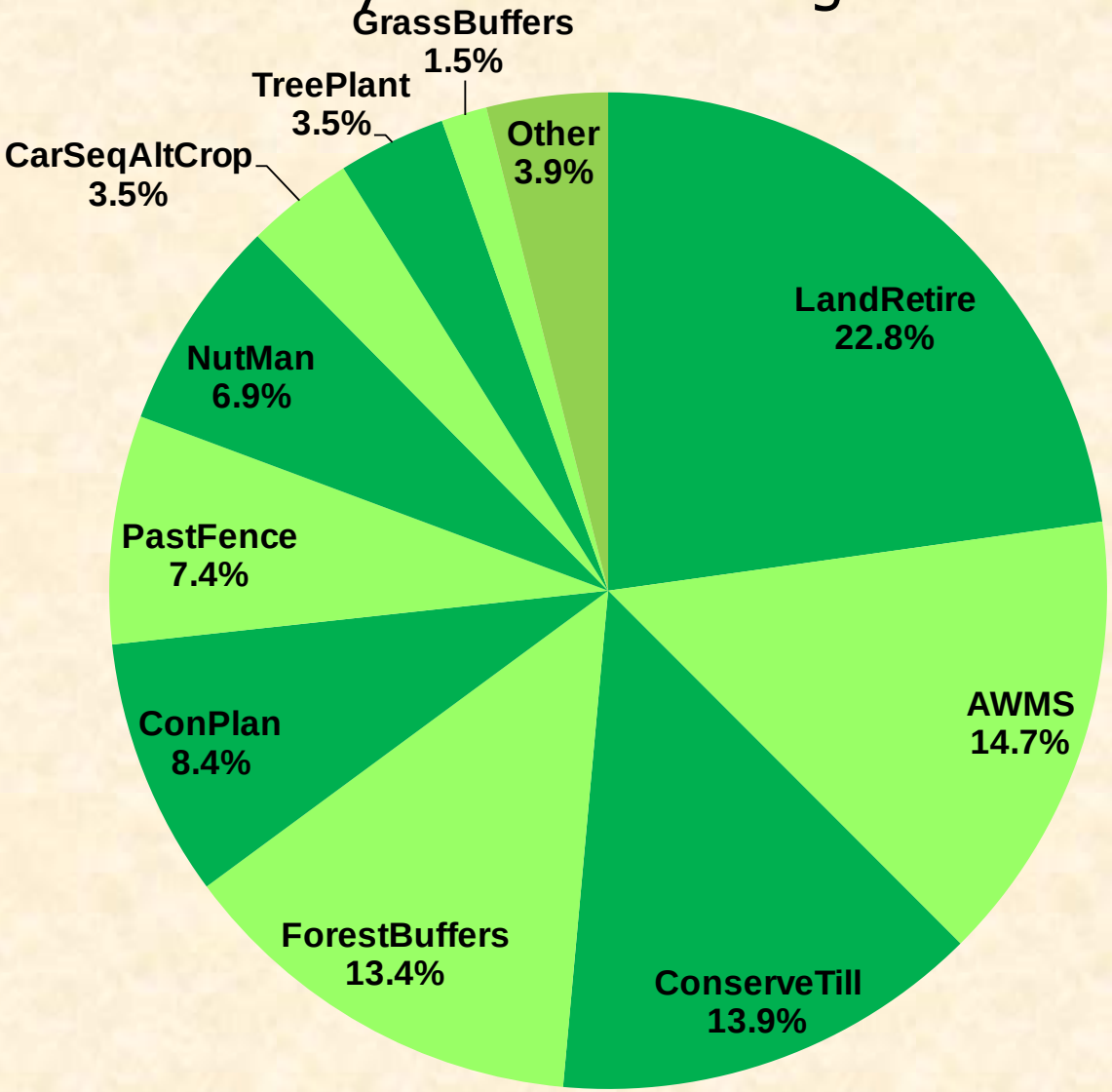
All Jurisdictions' – 2013 Progress

Each slice represents the percent of the total agricultural load reduction from No-Action to 2013 attributable to state-reported implementation levels for that BMP.



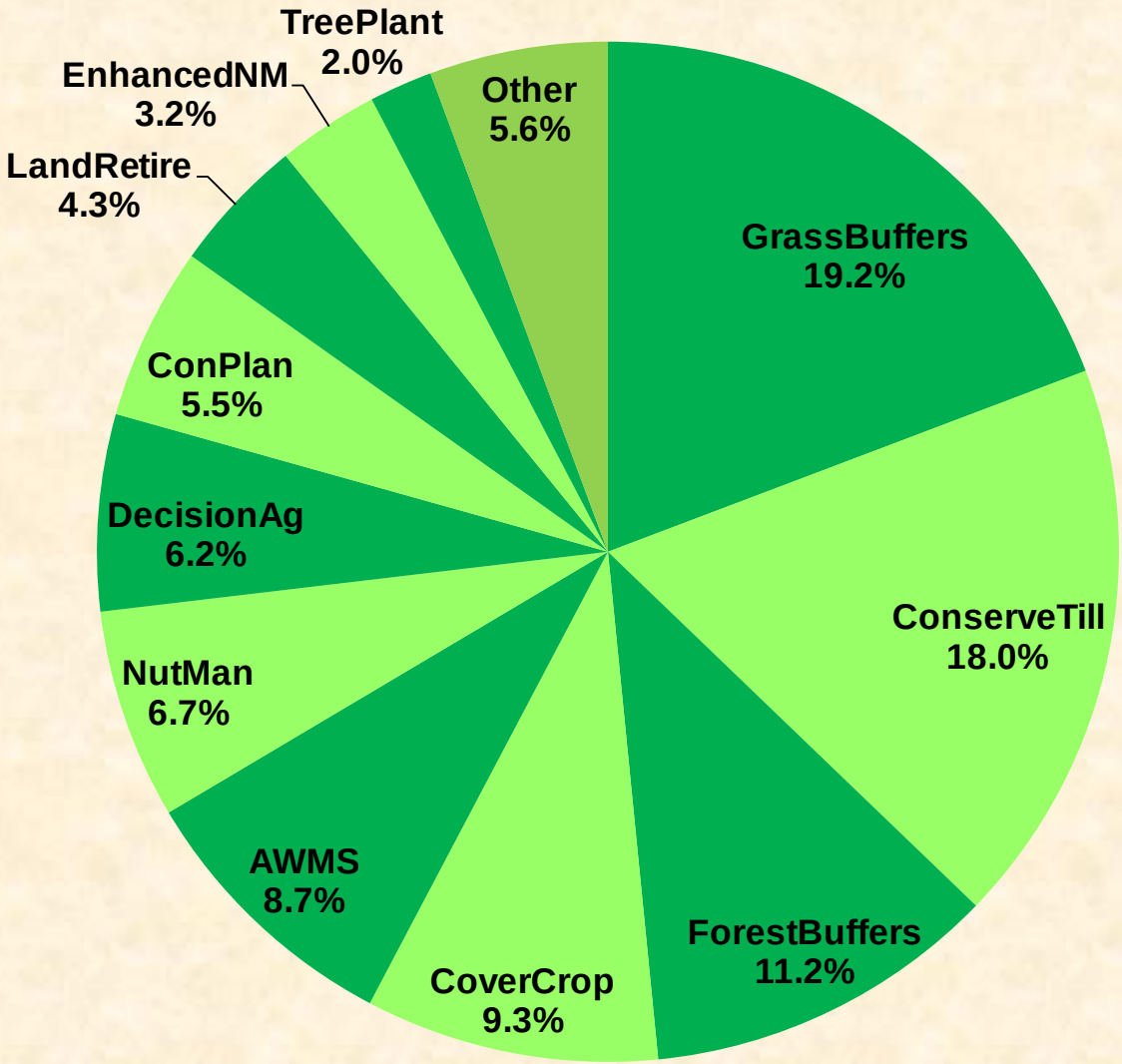
Agriculture Nitrogen Load Reduction by BMP

Pennsylvania 2013 Progress



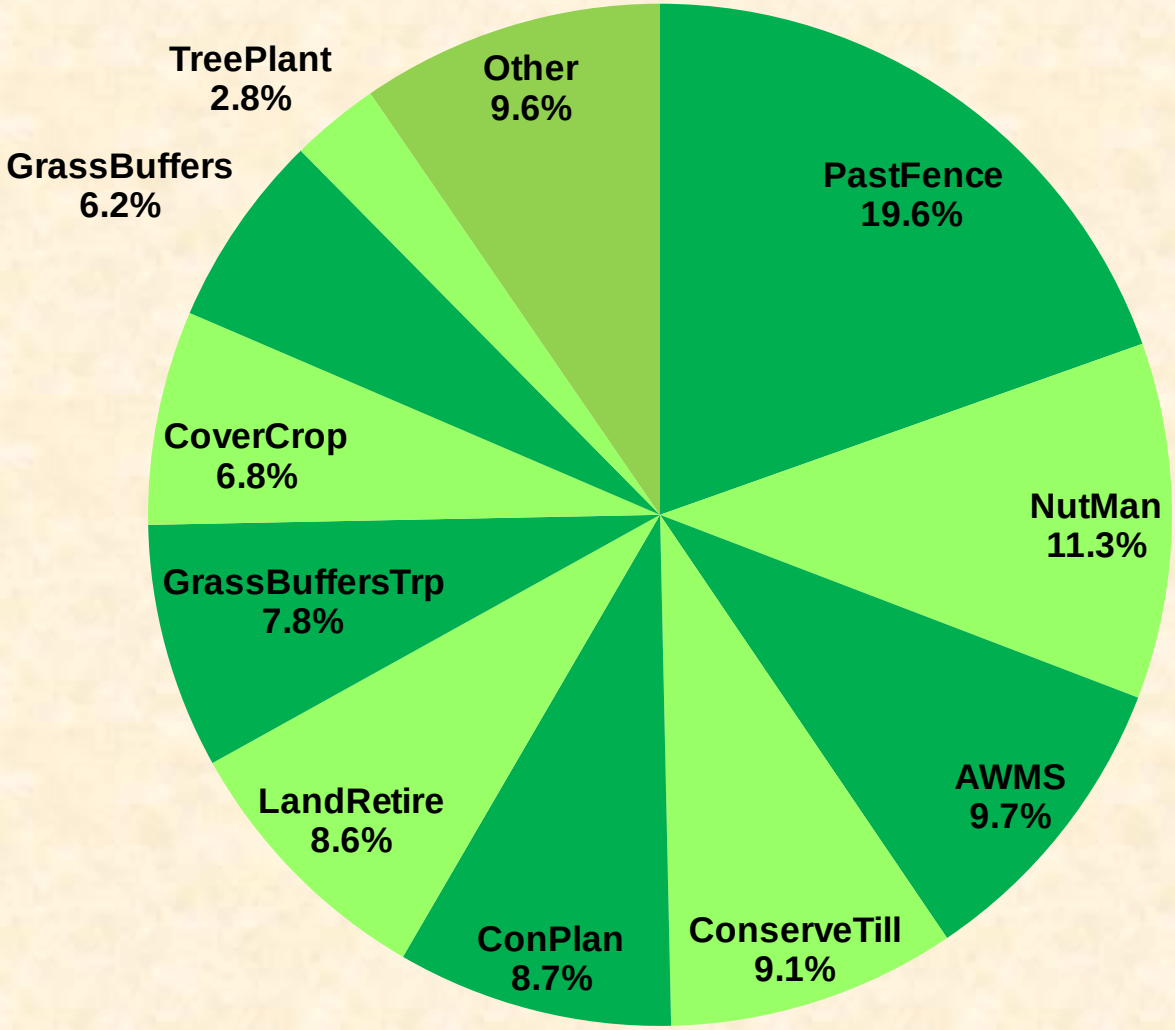
Agriculture Nitrogen Load Reduction by BMP

Maryland 2013 Progress



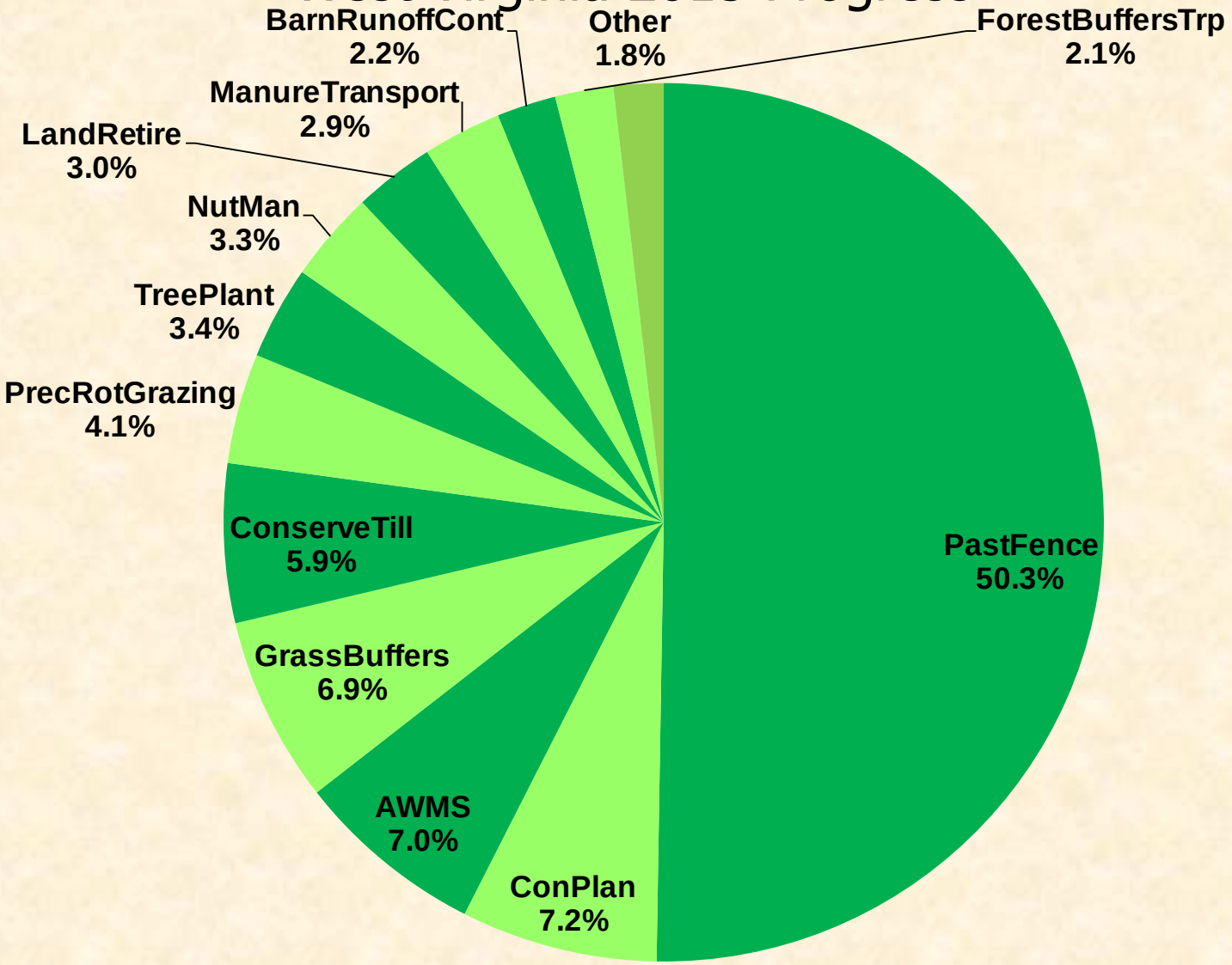
Agriculture Nitrogen Load Reduction by BMP

Virginia 2013 Progress



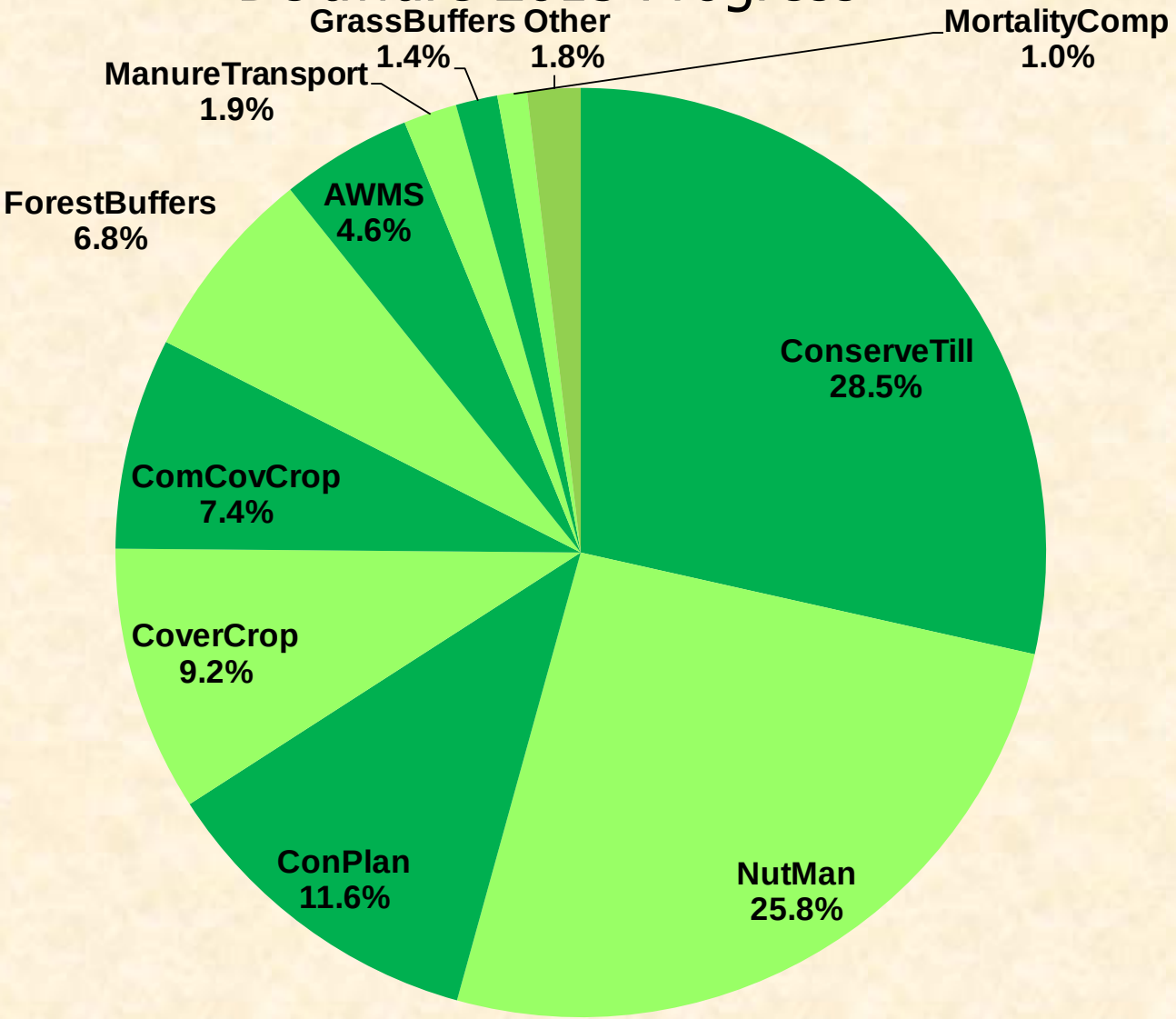
Agriculture Nitrogen Load Reduction by BMP

West Virginia 2013 Progress



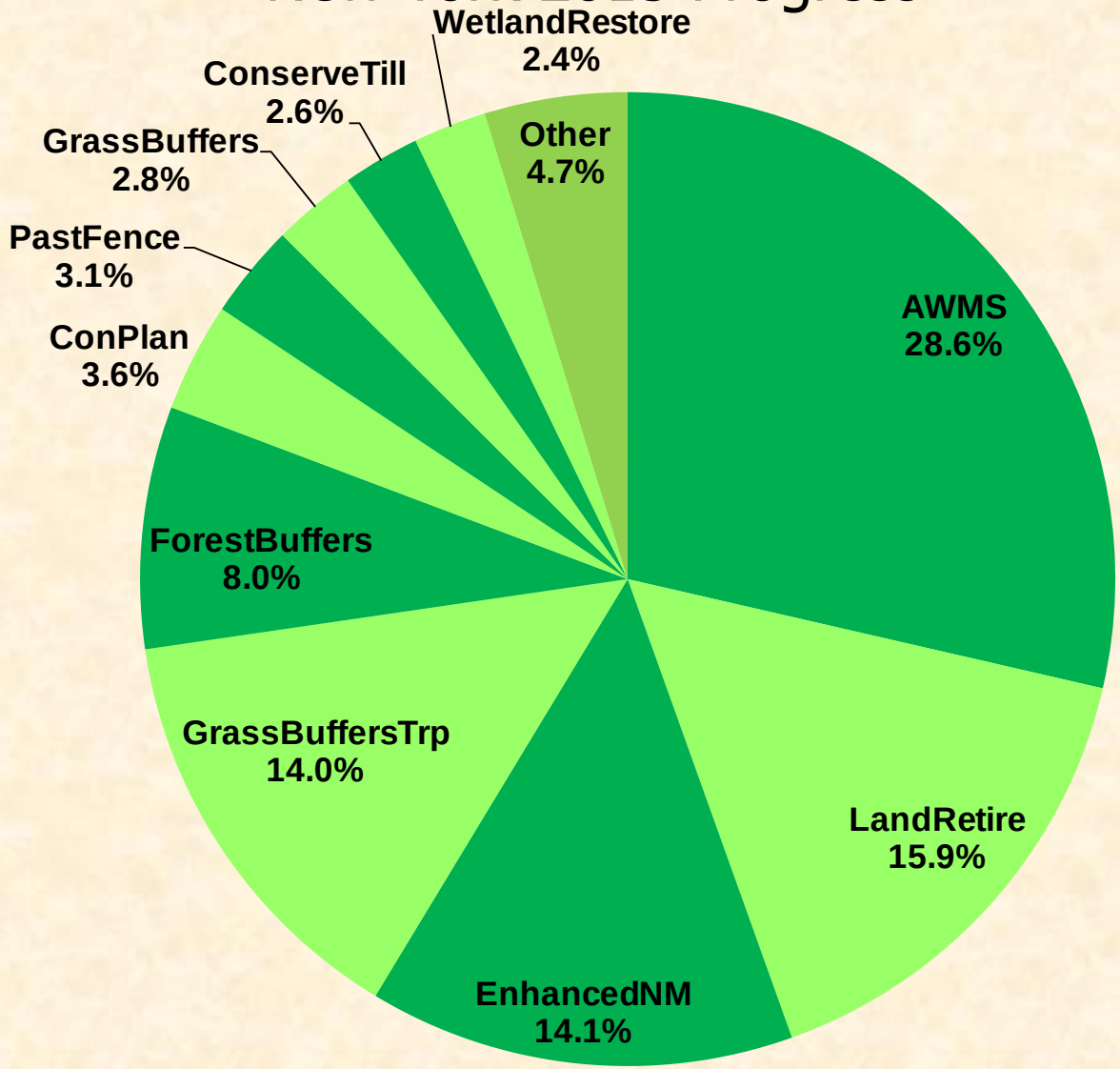
Agriculture Nitrogen Load Reduction by BMP

Delaware 2013 Progress



Agriculture Nitrogen Load Reduction by BMP

New York 2013 Progress

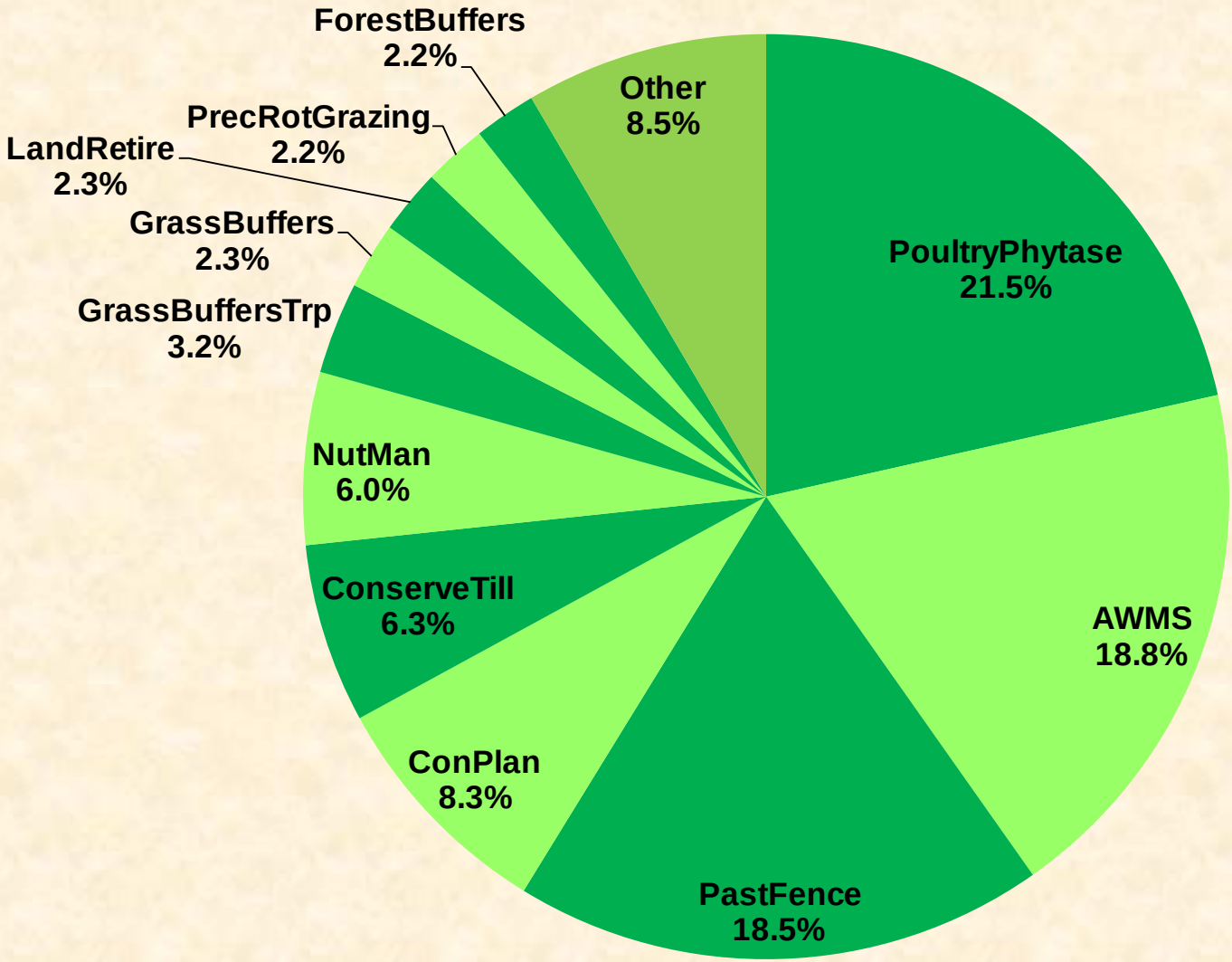


Agricultural Phosphorus Reductions

Relative influence of 2013 Progress BMPs on load reductions

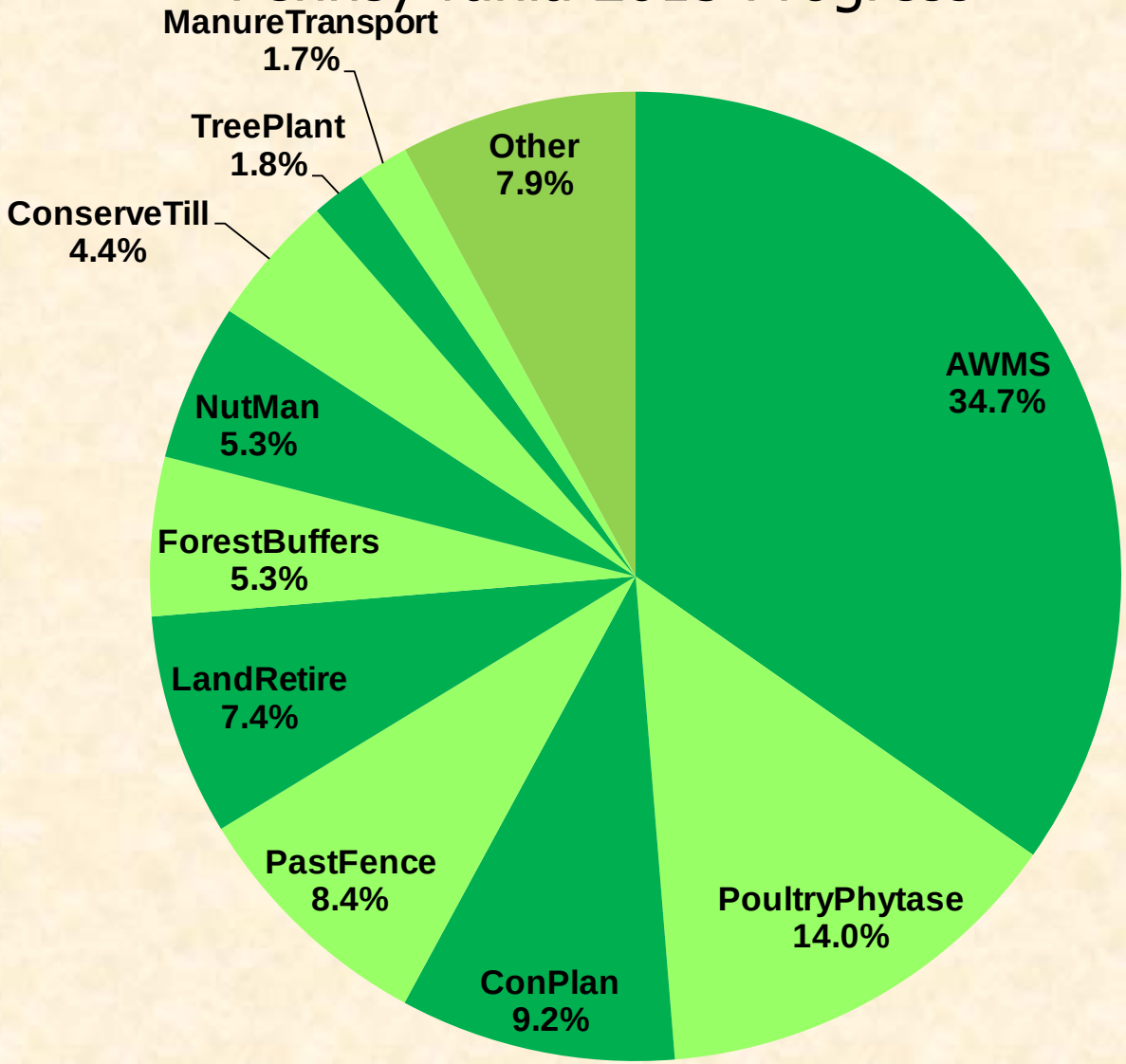
Agriculture Phosphorus Load Reduction by BMP

All Jurisdictions' – 2013 Progress



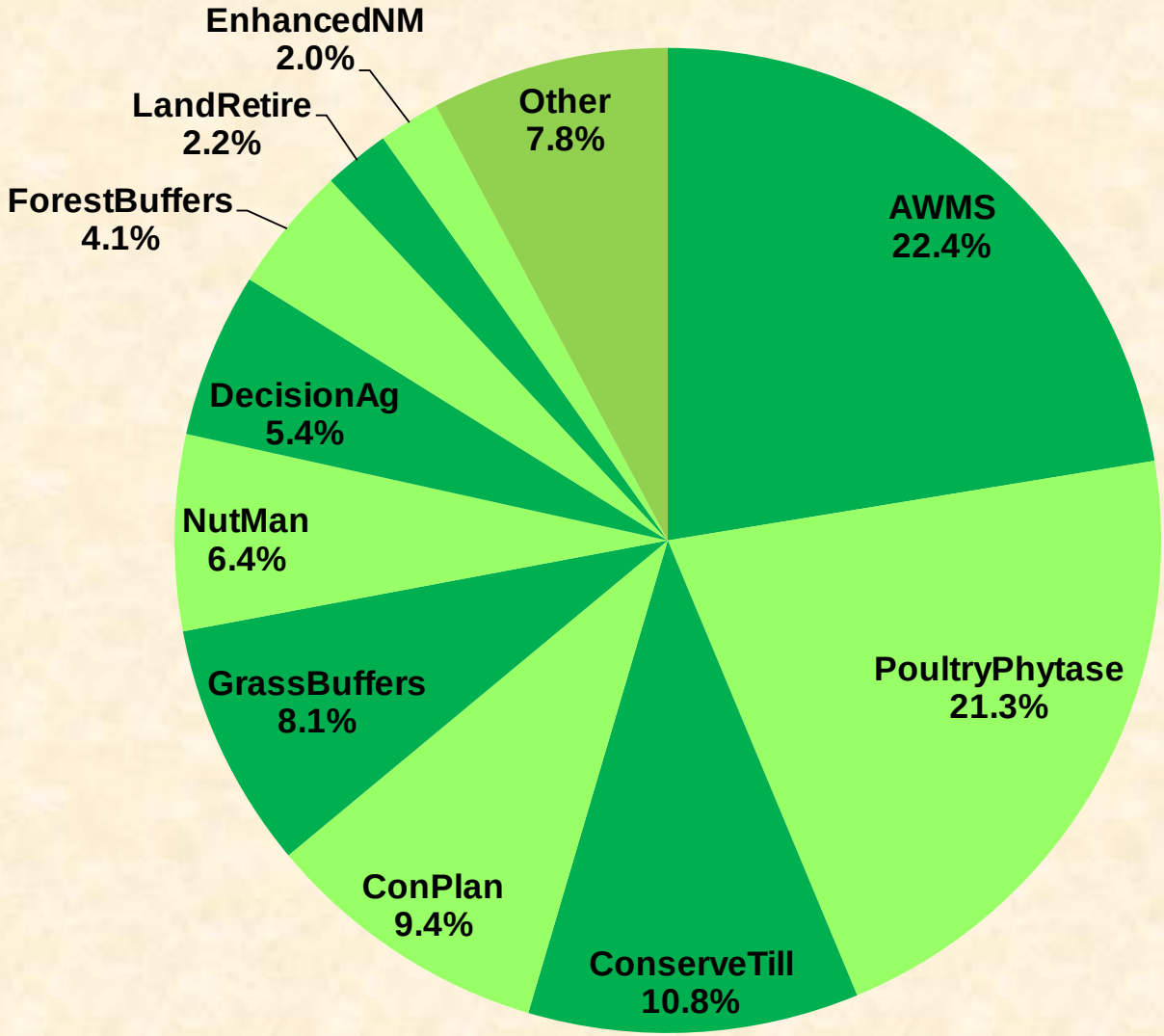
Phosphorus Relative Load Reductions

Pennsylvania 2013 Progress



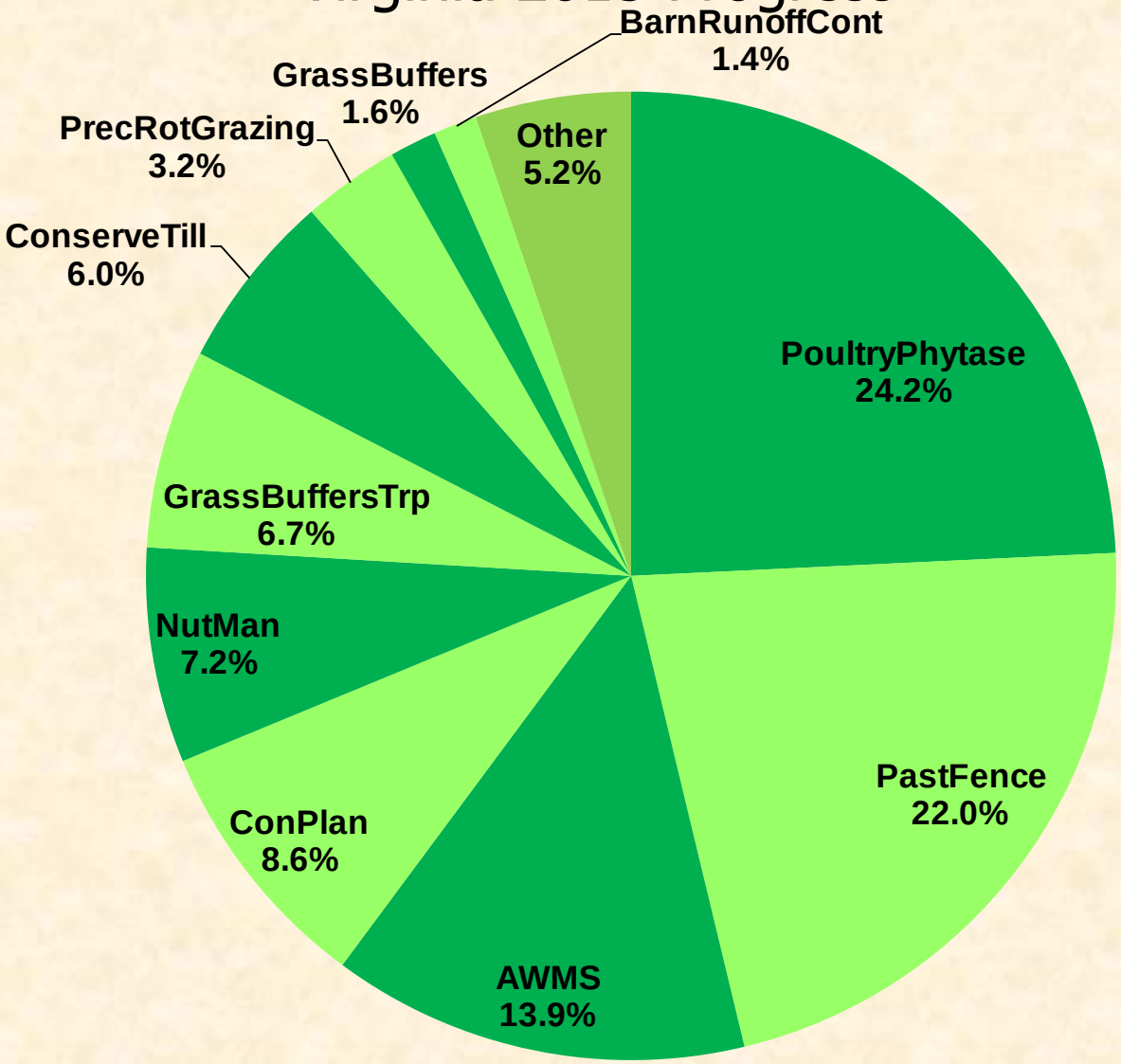
Agriculture Phosphorus Load Reduction by BMP

Maryland 2013 Progress



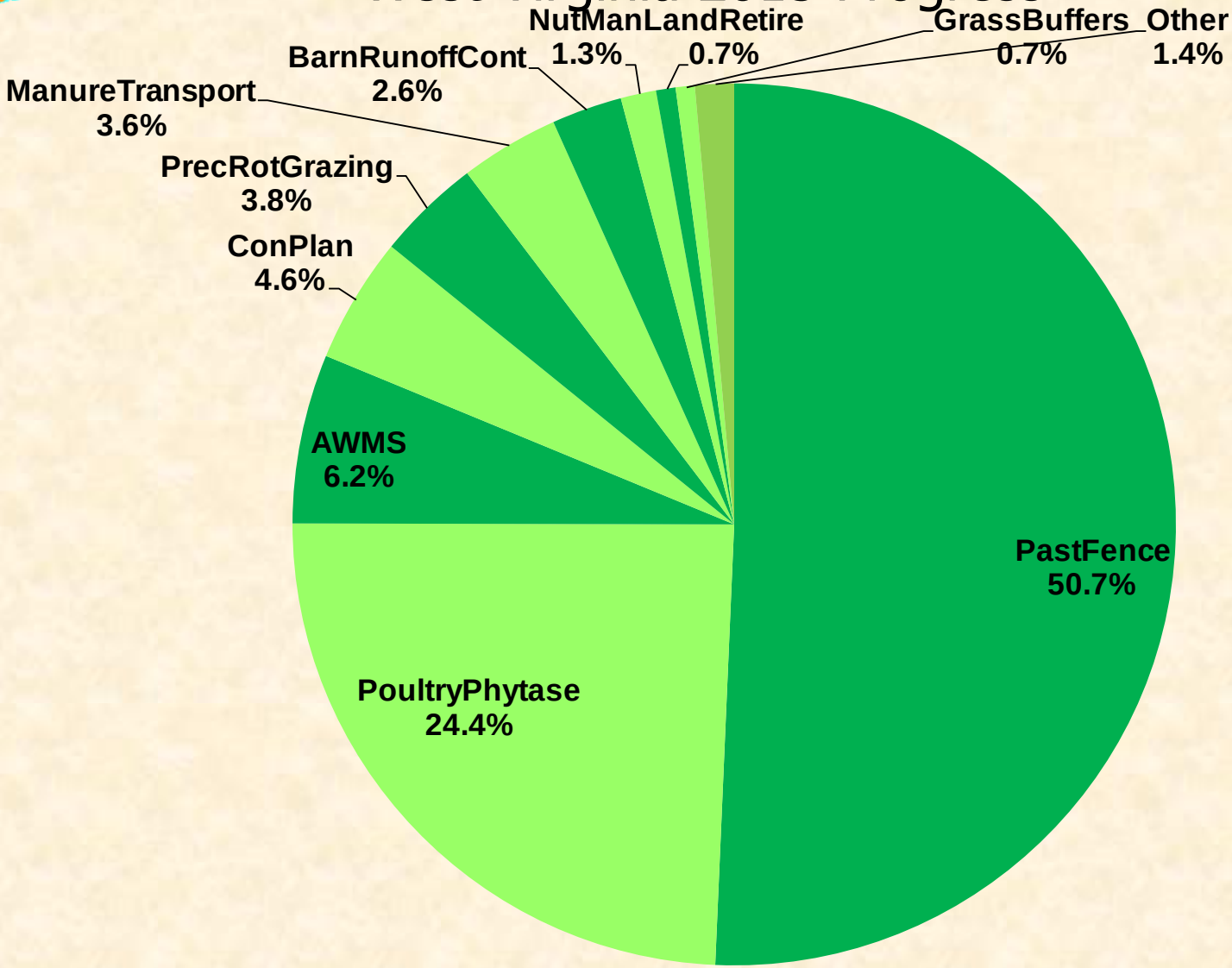
Agriculture Phosphorus Load Reduction by BMP

Virginia 2013 Progress



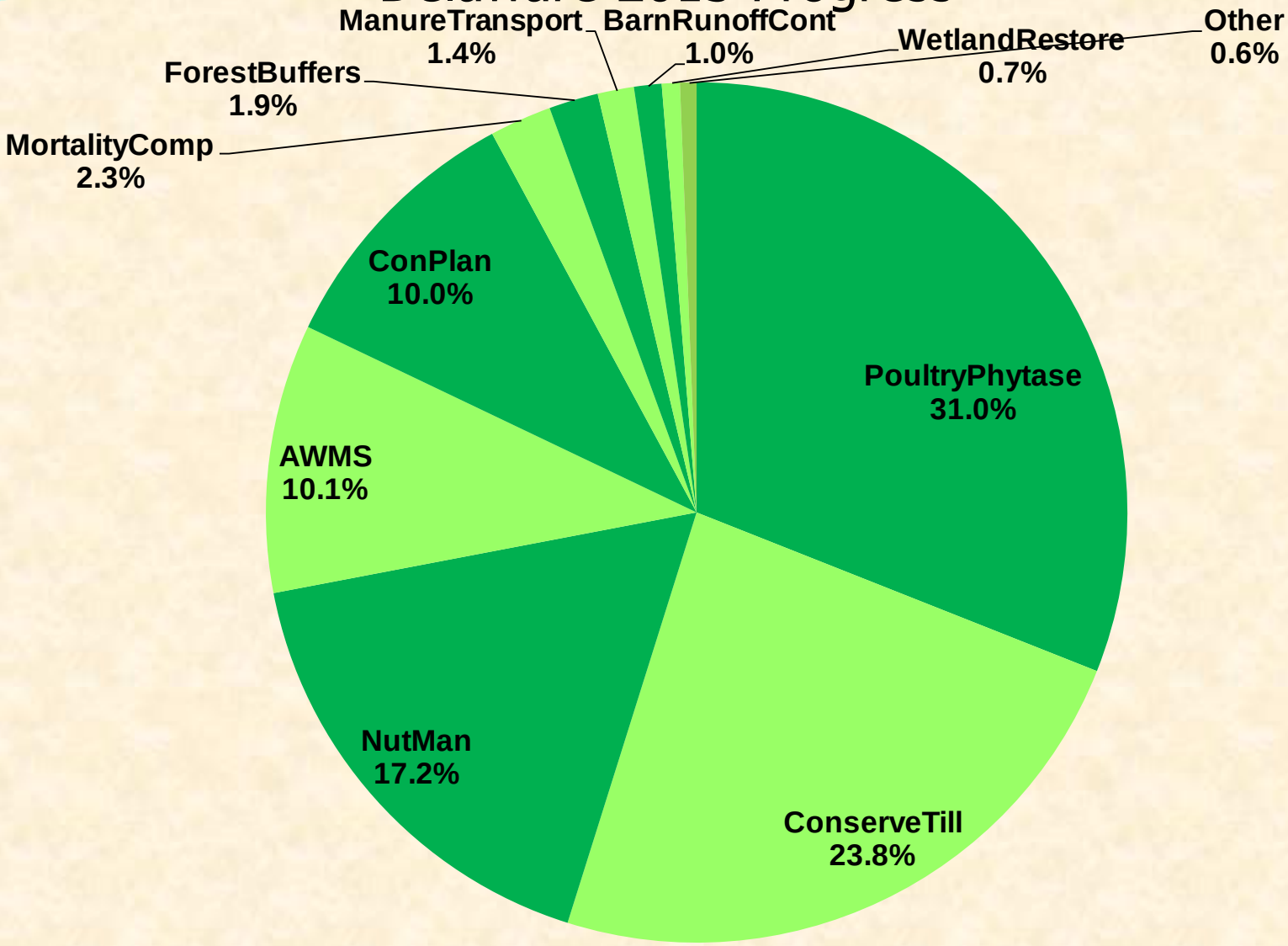
Agriculture Phosphorus Load Reduction by BMP

West Virginia 2013 Progress



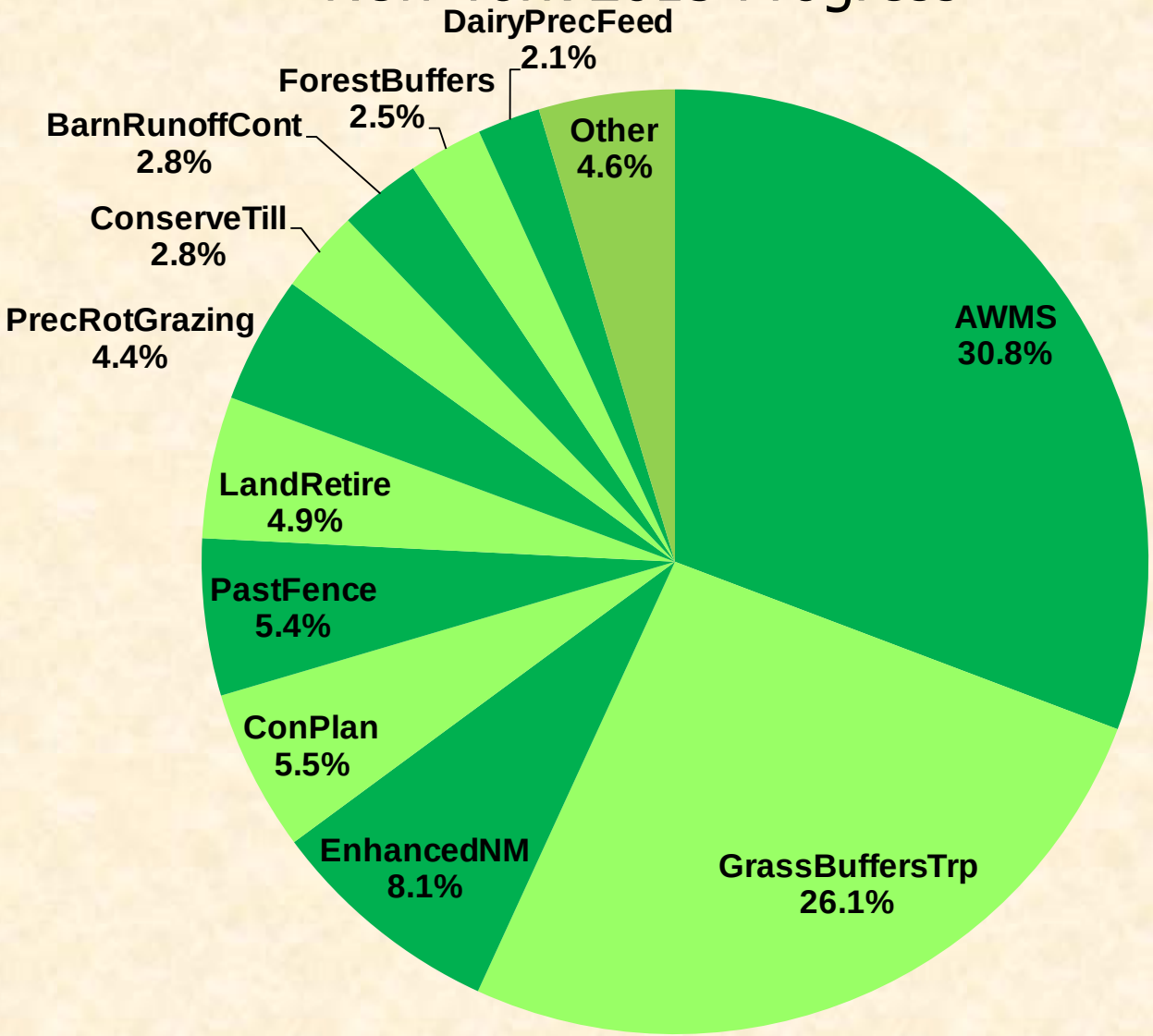
Agriculture Phosphorus Load Reduction by BMP

Delaware 2013 Progress



Agriculture Phosphorus Load Reduction by BMP

New York 2013 Progress

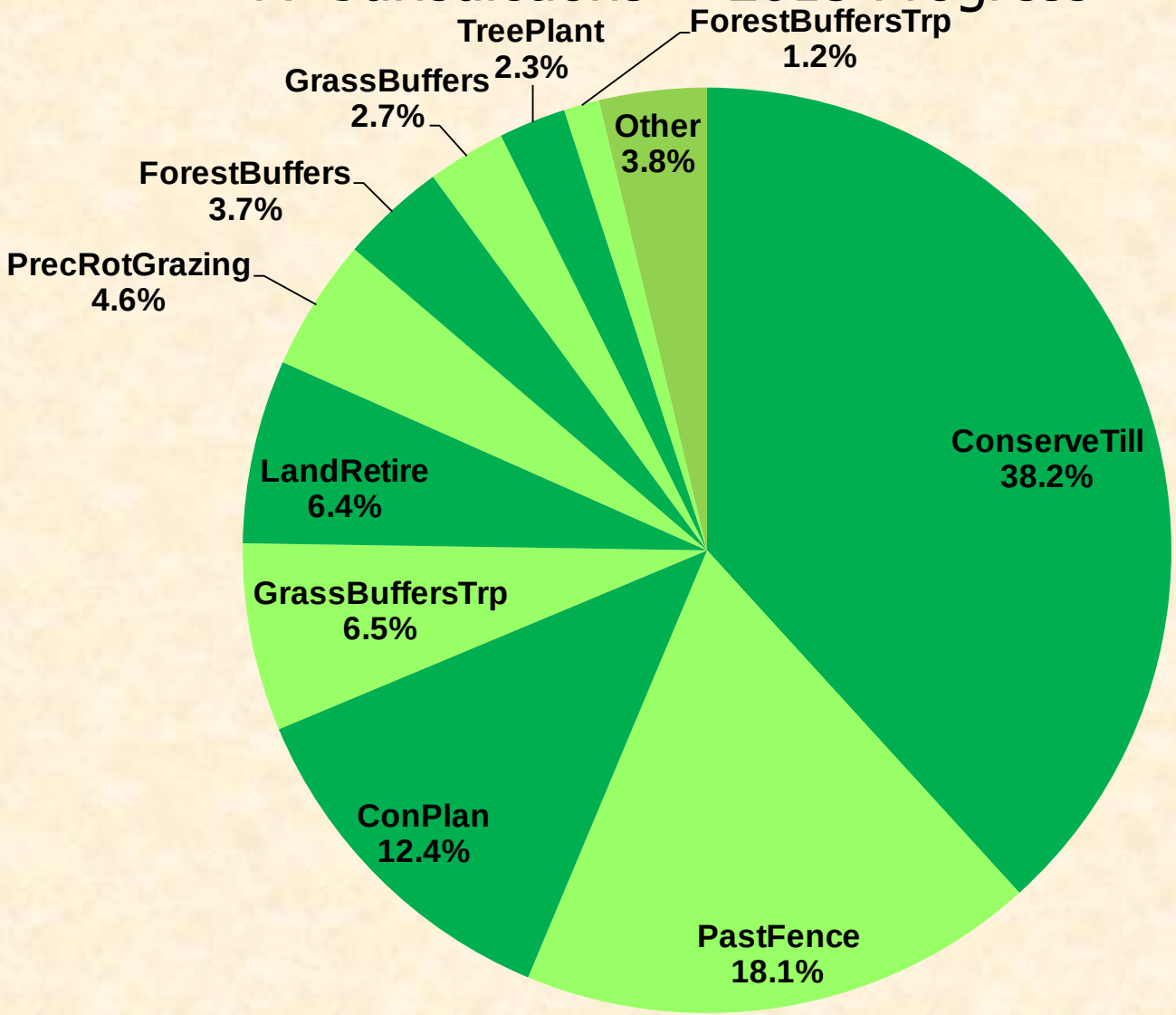


Agricultural Sediment (Total Suspended Solids) Reductions

Relative influence of 2013 Progress BMPs on load reductions

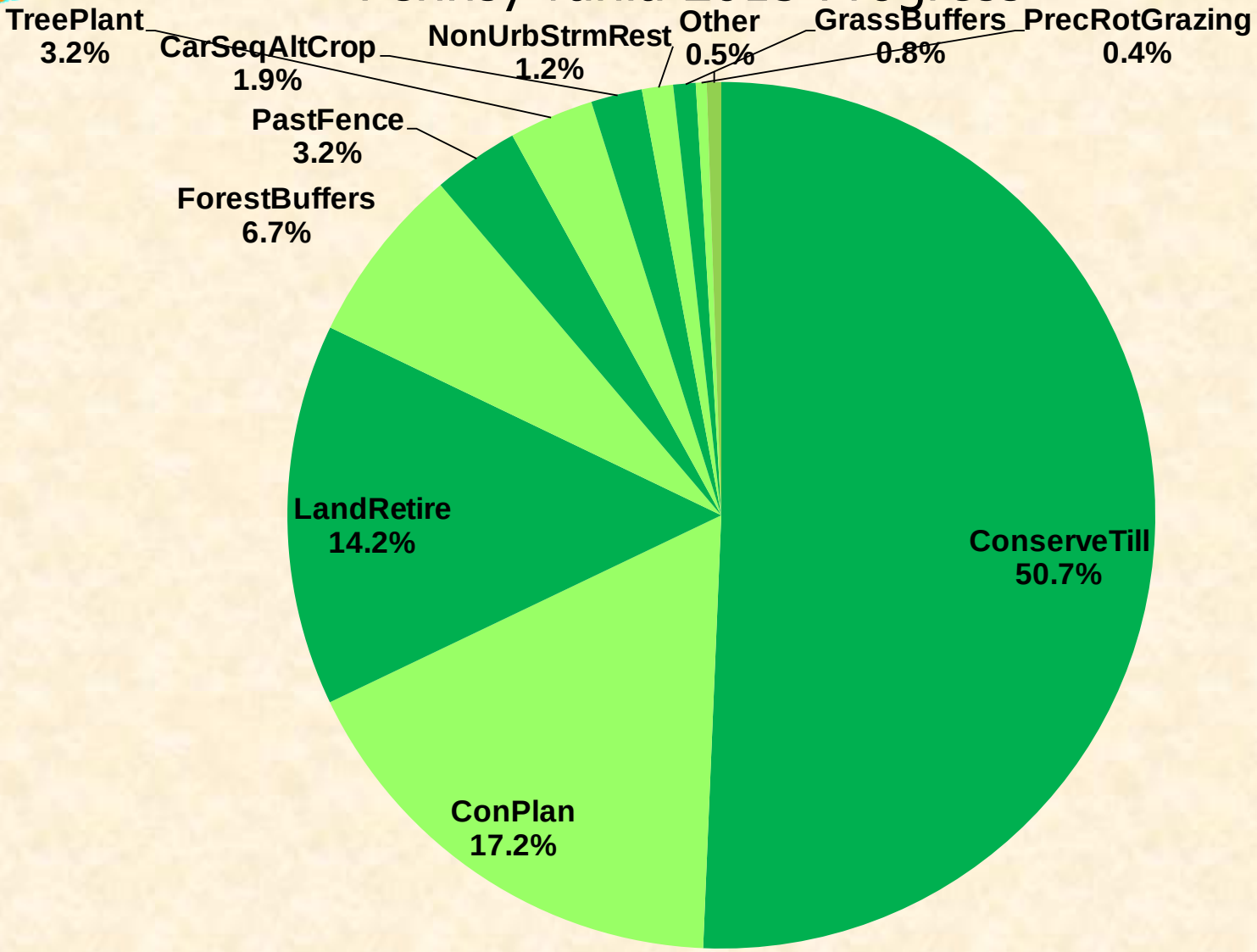
Agriculture Sediment Load Reduction by BMP

All Jurisdictions' – 2013 Progress



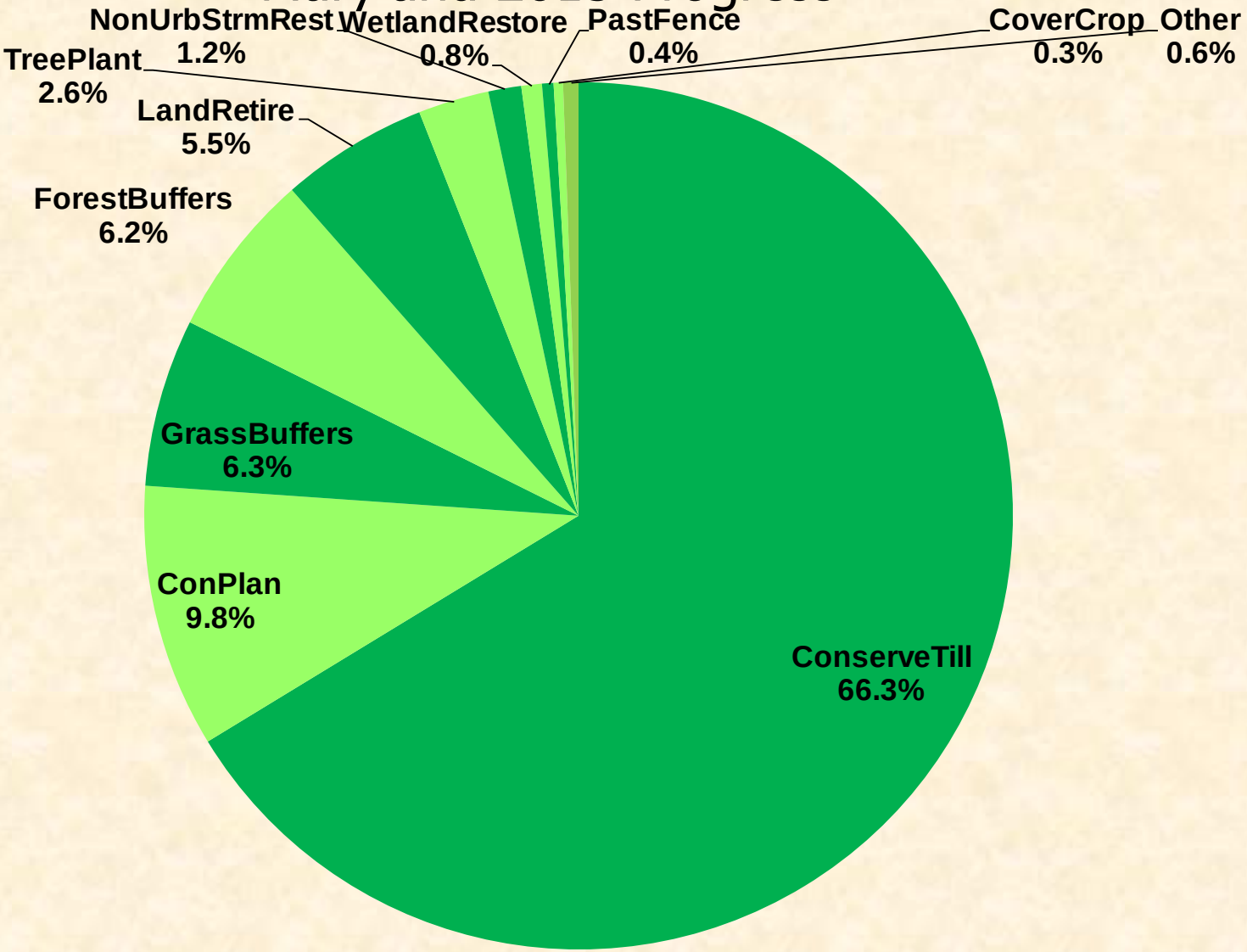
Agriculture Sediment Load Reduction by BMP

Pennsylvania 2013 Progress



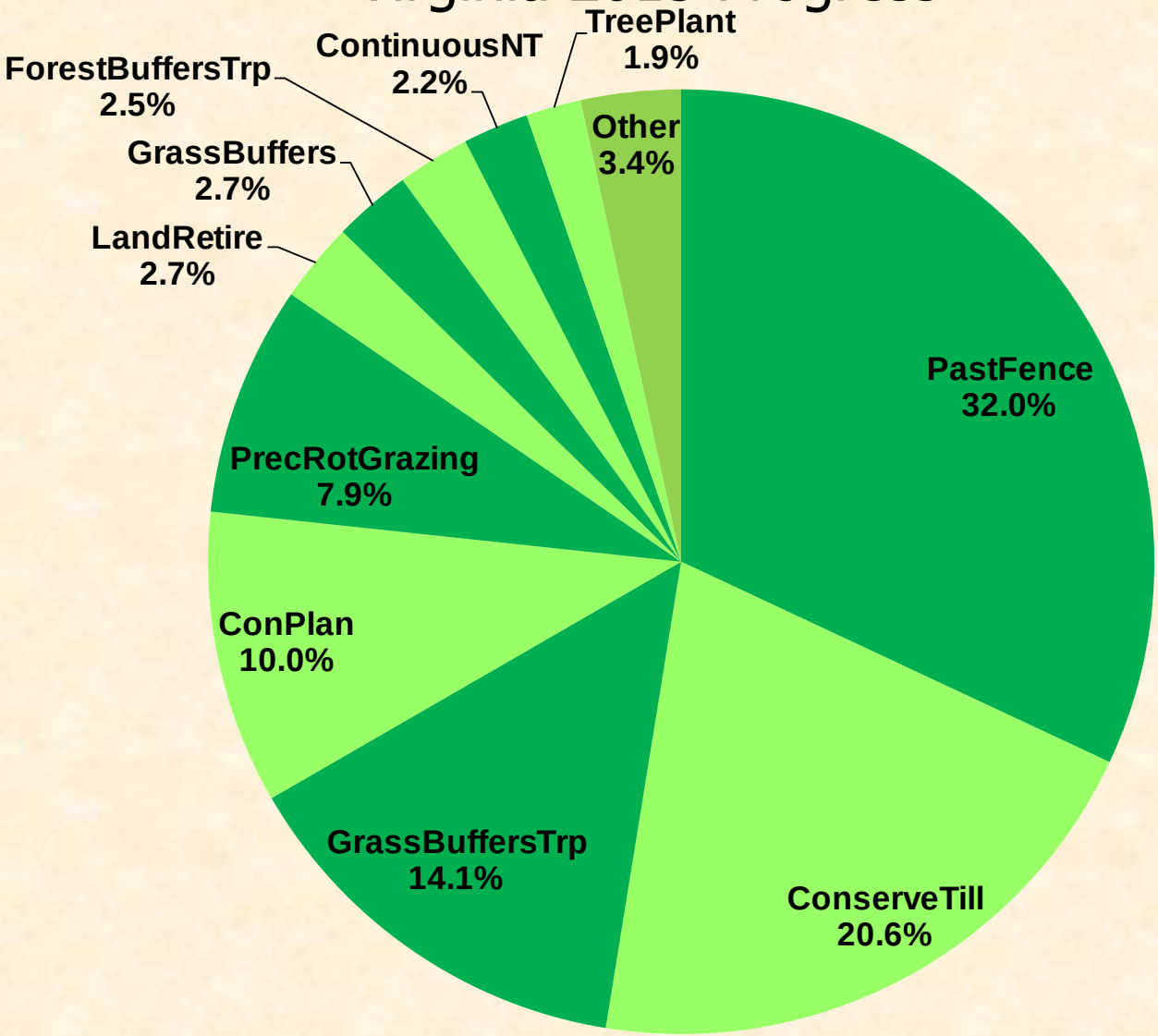
Agriculture Sediment Load Reduction by BMP

Maryland 2013 Progress



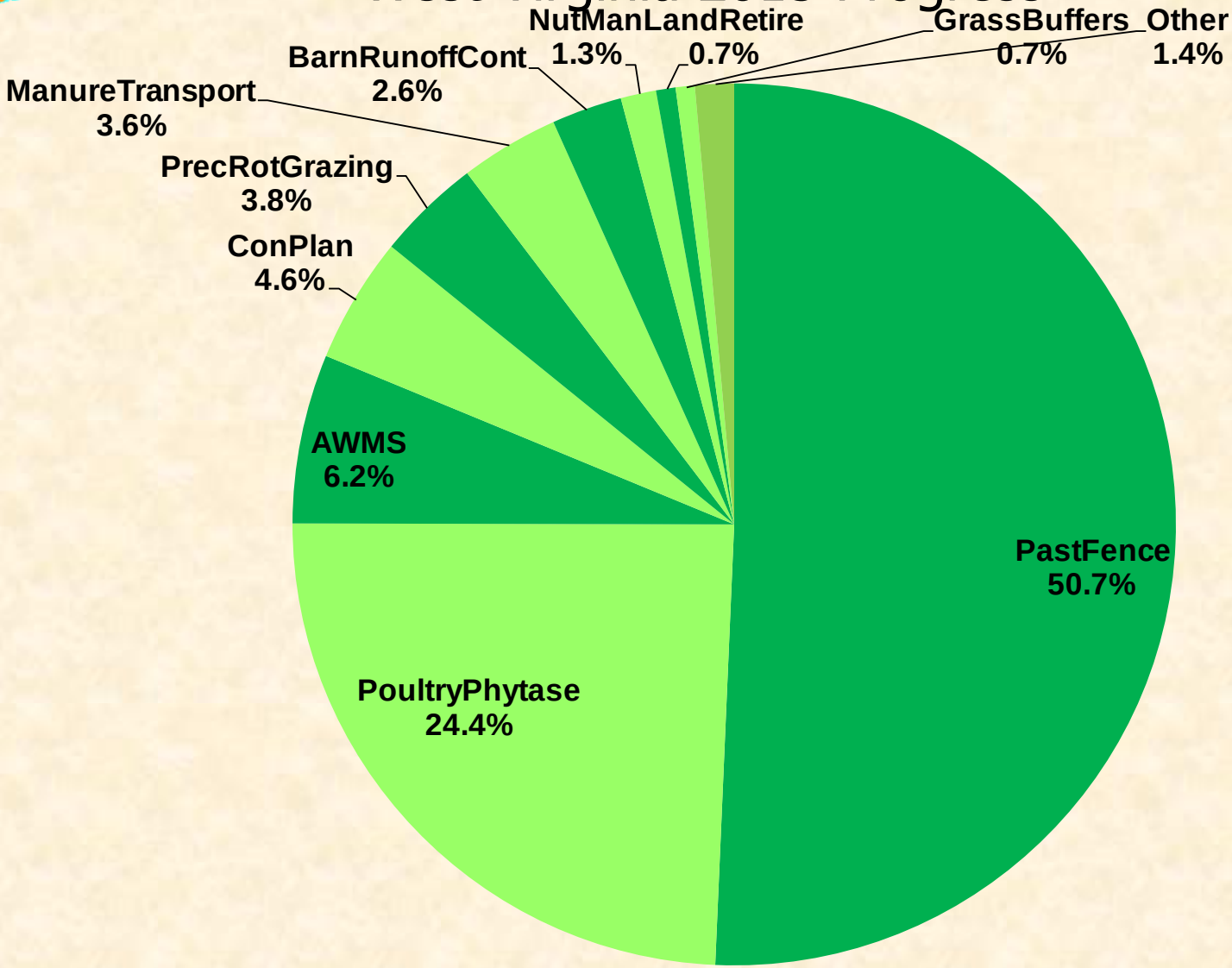
Agriculture Sediment Load Reduction by BMP

Virginia 2013 Progress



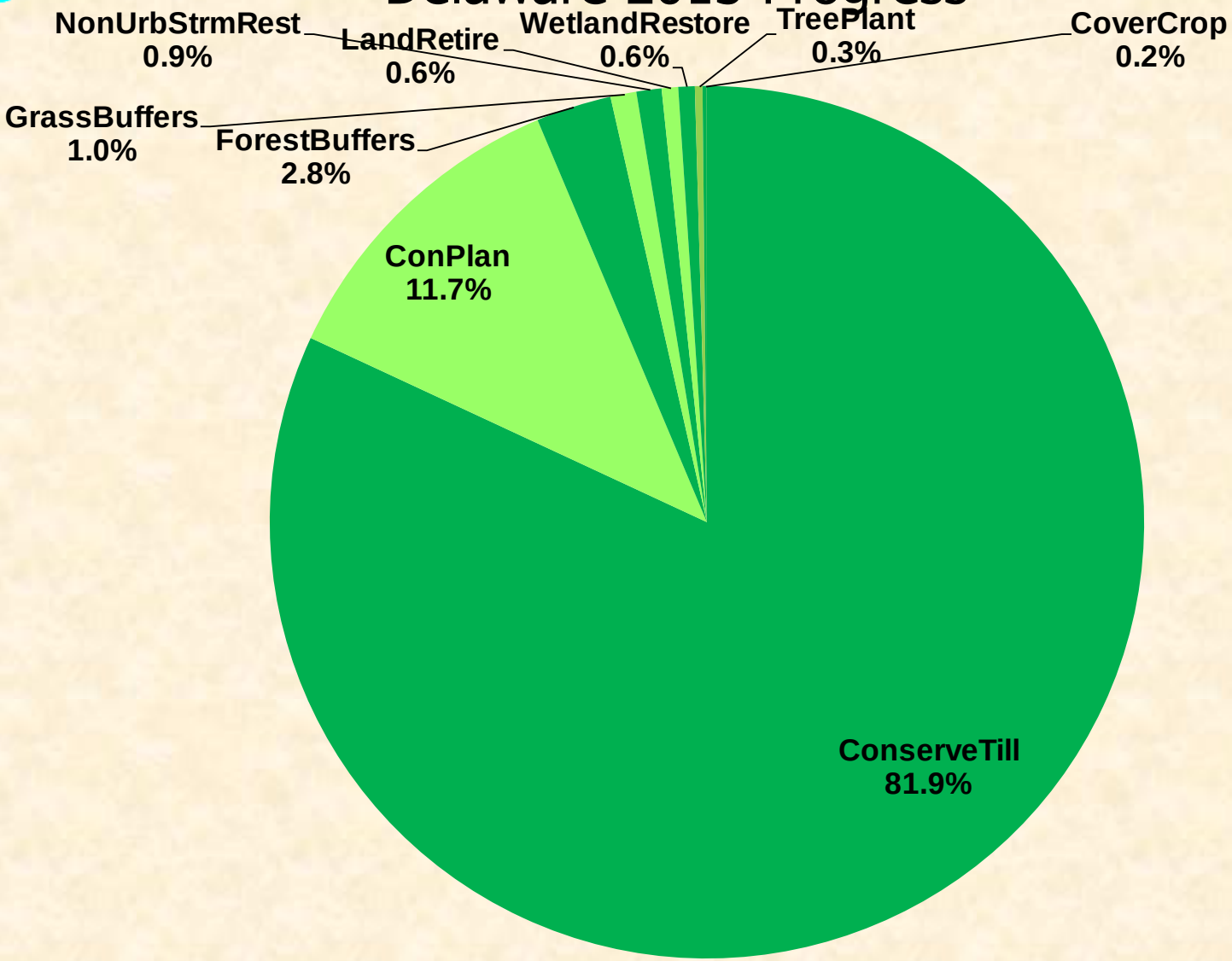
Agriculture Sediment Load Reduction by BMP

West Virginia 2013 Progress



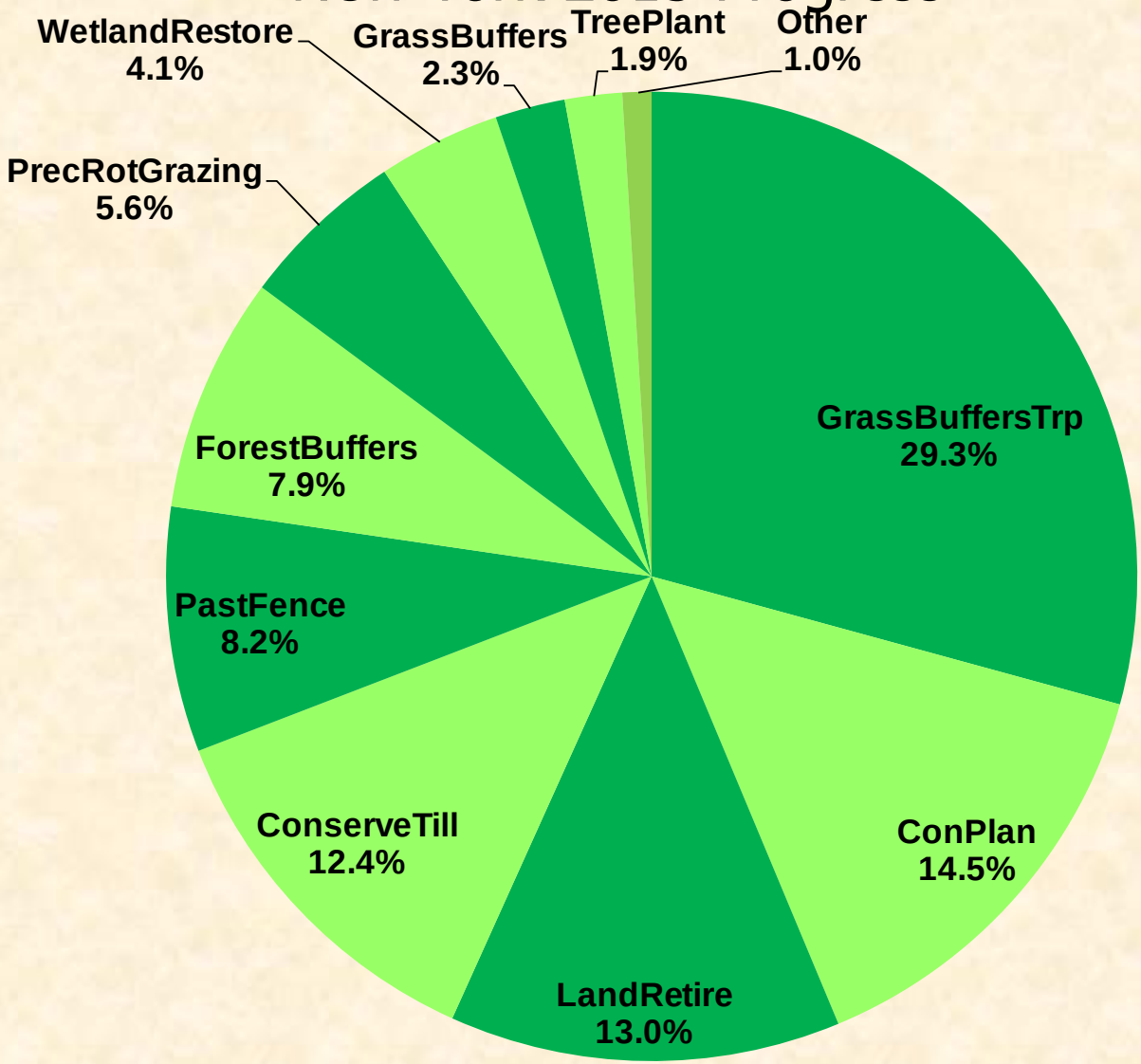
Agriculture Sediment Load Reduction by BMP

Delaware 2013 Progress



Agriculture Sediment Load Reduction by BMP

New York 2013 Progress



Statistical Sampling Approach for Initial and Follow-Up BMP Verification

Purpose

This document provides a statistics-based approach for selecting sites to inspect for verification that BMPs are on the ground (or otherwise continue to be implemented) and performing as expected based on engineering specifications or other applicable criteria. Verification on a BMP-by-BMP basis is emphasized here to both simplify the approach and reflect the need for practical methods to address this large undertaking.

While the agricultural BMP verification guidance (*Chesapeake Bay Program Partnership Agriculture Workgroup's Agricultural BMP Verification Guidance*) developed by the Chesapeake Bay Program Agriculture Workgroup (2014) calls for 100% verification of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers for most practices, it does allow for statistical sub-sampling to verify single-year BMPs such as tillage practices. The guidance also states that for follow-up BMP verification, states may propose using a sub-sampling approach with documentation as an alternative strategy for review and approval. The statistical sampling approach described here can be used for both single-year BMP verification and in an alternative follow-up BMP verification approach for multiple-year BMPs.

Selection of appropriate verification methods at sites selected using this approach is addressed in the agricultural BMP verification guidance. Regardless of the sampling approach used initially for agricultural BMP verification, states should do a post-evaluation of the results and process, updating as necessary.

Background

The need for verification that BMPs are implemented properly and remain functional is documented in the agricultural BMP verification guidance. That guidance also provides information on defining and categorizing agricultural BMPs, defining implementation mechanisms for agricultural BMPs, agricultural BMP verification methods and priorities, and how to develop an agricultural practice verification protocol. In addition, it provides streamlined guidance and an overview of the default verification levels for agricultural BMP verification.

This document supplements the agricultural BMP verification guidance by providing specific information on a statistically-based sampling approach that can be used as part of state efforts to meet verification requirements. The measure of choice for this approach is the proportion (percentage) of implemented BMPs (1) still in place or (2) still performing in accordance with expectations. The approach described here addresses how to compute the sample size necessary to estimate these proportions (i.e., "p" or proportion of "Yes" responses and "q" or proportion of "No" responses) with the desired degree of confidence and a specified acceptable error (±d%) using simple random sampling. No hypothesis testing, comparison of proportions, or trend analysis is considered.

Probabilistic Sampling

Overview

Probabilistic approaches are appropriate for ground verification of agricultural BMPs because they can yield accurate information without having to visit each site. In a probabilistic approach, individuals are randomly selected from the entire group. The selected individuals are evaluated, and the results from the individuals provide an unbiased assessment about the entire group. Applying the results from randomly selected individuals to the entire group is *statistical inference*. Statistical inference enables one to determine, in terms of probability, for example, the percentage of implemented multi-year BMPs that are still in place without visiting every site.

The group about which inferences are made is the population or *target population*, which consists of *population units*. The *sample population* is the set of population units that are directly available for measurement. Statistical inferences can be made only about the target population available for sampling. For example, if only a certain class of BMPs can be ground verified (e.g., cost-shared BMPs), then inferences cannot be made about other classes of BMPs that could not be ground verified (e.g., voluntarily implemented BMPs with no cost-share). States will need to consider carefully how they define their population units for each BMP. See “Defining Population Units” for addition information regarding this very important task.

The most common types of sampling that should be used are either simple random sampling or stratified random sampling. *Simple random sampling* is the most elementary type of sampling. Each unit of the target population has an equal chance of being selected. This type of sampling is appropriate when there are no major trends, cycles, or patterns in the target population. If the pattern of BMP presence or performance is expected to be uniform across the geographic area of interest (e.g., state), simple random sampling is appropriate to estimate the proportion of BMP presence or performance. If, however, implementation is homogeneous only within certain categories (e.g., region of state, cost-shared vs. non-cost-shared), stratified random sampling should be used. See “Sample Size Calculation with Simple Random Sampling” for additional details.

In *stratified random sampling*, the target population is divided into groups called strata for the purpose of obtaining a better estimate of the mean or total for the entire population. Simple random sampling is then used within each stratum. Stratification involves the use of categorical variables to group observations into more units (e.g., cost-shared vs. non-cost-shared), thereby reducing the variability of observations within each unit. In general, a larger number of samples should be taken in a stratum if the stratum is more variable, larger, or less costly to sample than other strata. See “Stratified Sampling” for additional information.

If the state believes that there will be a difference between two or more subsets of the sites, the sites can first be stratified into these subsets and a random sample taken within each subset. The goal of stratification is to increase the accuracy of the estimated mean values over what could have been obtained using simple random sampling of the entire population. The method makes use of prior information to divide the target population into subgroups that are internally homogeneous. There are a number of ways to "select" sites to be certain that important information will not be lost, or that results will not be misrepresented. One current approach is Generalized Random Tessellation Stratified (GRTS) survey design (Stevens and Olsen 2004).

Sample Size Calculation with Simple Random Sampling

The following are data requirements for the sample size (n) calculations described in this document:

- An initial estimate of both the percent of BMPs still in place and the percent of BMPs still performing as expected. This can be based on previous studies or assumed to be 50% (p=0.5) for a conservative (high) estimate of sample size.
- An allowable error (e.g. ±5% or 0.05). This error (d) can be different for different BMPs based on considerations of BMP importance, risk of BMP abandonment, failure, cost, or other factors.
- A confidence level (e.g., 90% or α=0.10). This is used to determine the 2-sided Z score from the standard normal distribution ($Z_{1-\alpha/2}$), e.g., $Z_{1-\alpha/2}$ is equal to 1.645 for α = 0.10. For example, an α=0.10 indicates that the actual proportion of BMPs still in place has a 10 percent chance of being outside the allowable error or calculated confidence interval.
- An estimate of the total population (N) from which the sample is taken (e.g., how many BMPs were installed). This can be based on records of BMP implementation.

In simple random sampling, we presume that the sample population is relatively homogeneous and we would not expect a difference in sampling costs or variability. If the cost or variability of any group within the sample population were different, it might be more appropriate to consider a stratified random sampling approach.

To estimate the proportion of BMPs still in place or still performing as expected (p), such that the allowable error, *d*, meets the study precision requirements (i.e., the true proportion lies between *p-d* and *p+d* with a *1-α* confidence level), a preliminary estimate of sample size (n_0) can be computed with the following equation assuming a large population from which to sample (Snedecor and Cochran, 1980):

$$n_o = \frac{(Z_{1-\alpha/2})^2 pq}{d^2} \quad (1)$$

In many applications, the number of population units in the sample population (*N*) is large in comparison to the population units sampled (*n*) and the *finite population correction term* (*1-φ*) can be ignored. However, depending on the number of units (e.g., expensive or unique BMPs) in a particular population, *N* can become quite small. *N* is determined by the definition of the sample population and the corresponding population units. If φ is greater than 0.1, the finite population correction factor should not be ignored (Cochran, 1977). Thus, the final sample size (n) can be estimated as (Snedecor and Cochran, 1980)

$$n = \begin{cases} n_0 & \\ 1+\varphi & for\ \varphi > 0.1 \\ n_o & otherwise \end{cases} \quad (2)$$

where φ is equal to n_o/N.

Terms:

N = total number of population units in sample population

n = number of samples

p = proportion of "yes" responses

q = proportion of "no" responses (i.e., 1-p)

n_0 = preliminary estimate of sample size

$\varphi = n_0/N$ unless otherwise stated

$Z_{1-\alpha/2}$ = value corresponding to cumulative area of 1-α/2 using the normal distribution

d = allowable error

Practical Sampling Considerations

The best sampling approach will be one that meets statistical objectives and can be performed with maximum ease at minimum cost. Success requires that the information to be used in the equation described above is unambiguous and obtainable within logistical, programmatic, and budgetary constraints.

Defining Population Units

Population units should be defined in a manner that makes enumeration simple. The most promising options for population units are structures (e.g., lagoons), contracts, and plans (e.g., nutrient management plans). States should have access to counts of these population units through federal or state permit programs (e.g., CAFO), federal/state/local cost-share programs, or other sources. In some cases, counts or a portion of counts may need to be obtained from private-sector sources (e.g., nutrient management plans). The use of acreage as a population unit for the purposes of this sampling approach is not considered although acreage might be a useful variable to stratify BMPs (see "Stratified Sampling"). Acreage of practices (e.g., cover crops) inspected through a sampling effort based on contracts can be recorded, however, to provide an additional measure of the extent to which existing practices were inspected. For example, A% of contracts that include cover crops were sampled, covering a total B acres, or C% of existing cover crop acreage in the state.

States will need to choose population units that make the most sense for those BMPs they verify. Structural BMPs, for example, could be enumerated on the basis of actual structural units or contracts with the structure. If contracts are used as the population unit it is recommended that the total number of structural BMP units inspected on the sampled farms is recorded as well (e.g., if contracts can include more than one structure).

Stratified Sampling

Because some BMPs provide a greater pollutant load reduction than others, states may want to place priority on verification of those BMPs. If, for example, nutrient management plans (NMPs) have yielded the greatest nitrogen and phosphorus load reductions, it might be appropriate to emphasize these practices in the BMP verification program to provide results with better precision. For example, a smaller confidence interval (e.g., ±5%) and greater confidence level (e.g., 95%) might be appropriate for these BMPs. Less important BMPs, with respect to nutrient reduction, could be verified with a larger confidence interval (e.g., ±15%) and/or lower confidence level (e.g., 80%).

Alternatively, if state reports have indicated that livestock operations, for example, yield a greater load reduction than cropland farms (or vice versa) for a particular BMP, the state may want to use a stratified random sampling approach. A separate population for livestock operations and cropland farms would be developed for the BMP, with perhaps even a different confidence interval or confidence level applied to the two strata. The intent of this approach would be to provide the best verification data on a targeted basis within the resource constraints of the state. The same logic would apply to stratification by

geographic region, BMP delivery program (e.g., permits, cost-share, voluntary), farm size (e.g., large vs. small), or risk (e.g., BMPs most likely to be abandoned or implemented poorly vs. BMPs that are more reliably implemented and maintained).

Grouping

If the count for a specific BMP is so low that it would be difficult to achieve a reasonably precise estimate of verification via sampling, a state may consider combining similar BMPs to increase the number of population units and increase the precision of the verification estimate. Similarity of BMPs could be judged on the basis of nutrient reduction credits provided by the Bay model. For example, if BMP A is credited with a 10% reduction in nitrogen load and BMP B is credited with a 12% reduction in nitrogen load (per unit applied), it may be reasonable to combine the two BMPs for the purpose of verification. This approach would be most appropriate for BMPs that account for a smaller share of the state's load reductions attributed to agricultural BMPs. Additional guidance on BMP grouping can be found in Part 6 of the agricultural BMP verification guidance.

Field Verification Methods

States will need to establish field protocols that address the type of information to be collected and consistency between different field technicians or groups collecting the data. Specific verification methods and the need for quality assurance procedures are discussed in the agricultural BMP verification guidance. Essential to the statistical approach described in this document is determination and documentation of how "yes" and "no" responses will be assigned for the two basic questions:

- Is the BMP there?
- Is the BMP functioning properly?

States may have existing verification programs that go beyond simple yes/no determinations. For example, a state may have a third, gray area response between yes and no indicating that the BMP is partially functional or could be functional after tweaking by the landowner. This may be very important information for purposes other than verification using this statistical approach, but the data will need to be reduced down to yes/no to apply the method described here. A simple approach to reducing data down to yes/no responses is that anything not "yes" is "no." Using this approach, BMPs checked off as "gray area" BMPs would be added to the "no" tally.

States should consider performing initial field testing as part of their overall plan for agricultural BMP verification. This will help identify issues that can be resolved before the program is launched.

Timeframe for Sampling

Field inspections should be scheduled to provide the best opportunity to observe the features of a BMP that best indicate its presence and whether it is functioning properly. Cover crops, for example, may need to be observed both at planting and later to determine if seeds have germinated and cover has been established. The number of sites to be examined would remain the same, but the number of site visits would double in this case. States will need to consider when each BMP should be examined to establish a cost-efficient inspection schedule that can be achieved with existing resources.

Level of Effort

Resources committed to verification will most likely come from resources that could be used for other purposes such as technical and financial assistance for BMP implementation. Scheduling of staff activities will be an essential element to ensure that verification and other program functions are carried out successfully. The efficiency with which staff are deployed may be increased if states can find opportunities to piggyback verification work with other tasks while visiting individual farms. The

establishment of standard operating procedures for verification site visits, creative use of modern technology, and other innovative approaches may help reduce the time required for inspections and the recording and management of verification data.

Application to Chesapeake Bay Program

There are currently 47 agricultural BMPs and interim BMPs subject to verification under the Chesapeake Bay Program, and this number will increase over time. States may track even more BMPs before having them translated into BMPs recognized by the Bay model. While there may be interest in designing a single, comprehensive sampling approach that addresses all BMPs that must be verified at specified levels of precision and confidence, such an approach is not recommended because it might become logistically impractical. Keep it simple.

A simple approach to sampling is to:

1. Estimate sample sizes for the priority BMPs,
2. Choose the largest "n" value from the set of priority BMPs,
3. Randomly select the farms to inspect for the priority BMPs,
4. Check records for the non-priority BMPs at the selected farms to determine the respective "n" values for non-priority BMPs,
5. Estimate confidence intervals for the non-priority BMPs based on the "n" values
6. Do either:
    - Increase random sample size for priority BMPs as needed to reach suitable confidence intervals for the non-priority BMPs and repeat steps 3-5 until a suitable confidence interval is reached for all BMPs of interest, or
    - Develop a separate sampling approach for non-priority BMPs by carrying out steps 1-3 for the non-priority BMPs. This creates two sampling approaches, but there may be overlap on sites visited.

This approach is illustrated with an example featuring five priority BMPs (Table B-9) and five non-priority BMPs (Table B-10) that must be verified by the state. Equations 1 and 2 are applied to the data in Table B-9 to estimate sample sizes required for each priority BMP.

Table B-9. Example: Priority agricultural BMPs for verification.

BMP	Population Unit	N	d	α	P (a priori)	n	% Sampled
Nutrient Management Plans	plan	350	.05	.10	.70	139	40
Cover Crops	contract	750	.05	.10	.65	186	25
Conservation Tillage	contract	2,000	.05	.10	.90	98	5
Prescribed Grazing	contract	155	.05	.10	.85	74	48
Grass Buffers	contract	900	.05	.10	.90	89	10

In this case, the state would need to inspect 186 farms to satisfy the precision and confidence level requirements for cover crops (Table B-9). The state would then randomly select 186 farms from the set of farms with contracts including cover crops. Next, the state would check the contracts for those 186 farms to see if they also included nutrient management plans, conservation tillage, prescribed grazing,

or grass buffers. For illustrative purposes, assume that the state found that the 186 farms selected based on cover crop contracts had the following counts for the other four priority BMPs:

- Nutrient Management Plans: 145 plans
- Conservation Tillage: 132 contracts
- Prescribed Grazing: 55 contracts
- Grass Buffers: 93 contracts

With the exception of prescribed grazing, sample sizes are also adequate for the other four priority BMPs. A sample size of 55 for prescribed grazing would yield a confidence interval of ±7% at α=.10.

The state can now choose to:

- Accept the slightly larger confidence interval for prescribed grazing, or
- Increase the sample size for cover crops and see if the prescribed grazing "n" value reaches the target of 74 (this would likely require an increase of at least another 60 farms based on the ratio of prescribed grazing to cover crop contracts), or
- Randomly select an additional 19 sites with prescribed grazing contracts from the 100 (155-55) prescribed grazing contract sites not captured in the cover crops sample. The total sample size would now be 205, a slight over-sampling for cover crops.

Assuming the state decides to add 19 sites for prescribed grazing contracts, the state now estimates the required sample sizes for non-priority BMPs, assuming a larger confidence interval (d=.10) and same confidence level (α=.10).

Equations 1 and 2 are also applied to the data in Table B-10 to estimate sample sizes needed for each non-priority BMP. Note that the value of d is greater than used for Table B-9 while the value for α is kept at 0.10. These choices and those made for Table B-9 are judgment calls that the state must make.

Table B-10. Example: Non-priority agricultural BMPs for verification.

BMP	Population Unit	N	d	α	P (a priori)	n	% Sampled
Land Retirement	contract	65	.10	.10	.90	19	29
Barnyard Runoff Control	contract	125	.10	.10	.95	12	10
Poultry Phytase	contract	475	.10	.10	.95	13	3
Crop Irrigation Management	contract	33	.10	.10	.85	17	52

Reviewing the contracts for the 205 farms selected based on cover crop and prescribed grazing contracts yielded the following counts for the non-priority BMPs:

- Land Retirement: 47 plans
- Barnyard Runoff Control: 15 contracts
- Poultry Phytase: 2 contracts
- Crop Irrigation Management: 27 contracts

Comparing these numbers with the results in Table B-10 it can be seen that in this case all but poultry phytase would be adequately sampled. The simplest approach at this point would be to randomly select 11 additional contracts (13-2) from the 473 (475-2) poultry phytase contracts not captured in the cover

crops/prescribed grazing sample, yielding 216 farms to inspect to meet statistical requirements for all tracked BMPs included in this example.

Currently, we do not have any information to suggest that selecting BMPs in this way (i.e., based on largest n value for priority BMPs) would result in a biased sampling of other BMPs. However, it should be an issue that is discussed within states based on knowledge of BMP implementation patterns.

Generalized Example

By executing Equations 1 and 2 over a wide range of scenarios we are able to construct generalized tables that indicate appropriate sample sizes within the established constraints. This begins with forming a precision statement that includes an allowable error term, ±d, and a confidence level. For example, a state may want to estimate the percentage of manure sheds passing the verification process to within ±10% at the 95% confidence level. Here is where the state might think about identifying different goals for different types of programs or BMPs. For example, some practices might be of a higher or lower importance to the Bay model in terms of loading while other practices might be of higher or lower risk of meeting the implementation requirements.

The state would also want to use a priori knowledge about the likely proportion of "yes" responses. One way to factor in this knowledge might be to establish a few categories or levels of expected implementation. For example, states may choose to set an "excellent" level of expected maintenance at 85%. Similarly, a 70% level could be set for "good," and 50% could be used if no information is available. These would essentially be the starting point assumptions of p to be used in equation 1. We can then combine these levels of BMP maintenance with a few choices of allowable error and confidence levels. In this example, we chose allowable error values of ±5, 10, 15, 20 and 25 percent and confidence levels of 90 and 95 percent.

Table B-11 shows the results of those calculations. The top panel is for a 95% confidence level and the bottom panel is for 90% confidence level. The left-most columns show the expected level of BMP maintenance and allowable error, respectively. The Large N column represents the sample size without correction for finite populations; and the remaining six columns represent the adjusted sample sizes for a variety of population sizes. For example, to estimate the proportion of 200 BMPs successfully passing through the validation process assuming a 90% confidence level, assuming a likely percentage of BMPs equal to 85%, and an allowable error of ±10%, results in a sampling requirement of 30 as shown by the orange star. The blue bars represent a histogram of sample size.

Table B-11. Generalized example: calculation of n.

95% Confidence Level

p		±d	Large N	100	200	600	1000	1,500	2,000
No Information	50%	5%	385	80	132	235	278	307	323
	50%	10%	97	50	66	84	89	92	93
	50%	15%	43	31	36	41	42	42	43
	50%	20%	25	20	23	24	25	25	25
	50%	25%	16	14	15	16	16	16	16
Good Maintenance	70%	5%	323	77	124	210	245	266	279
	70%	10%	81	45	58	72	75	77	78
	70%	15%	36	27	31	34	35	36	36
	70%	20%	21	18	20	21	21	21	21
	70%	25%	13	12	13	13	13	13	13
Excellent	85%	5%	196	67	99	148	164	174	179
	85%	10%	49	33	40	46	47	48	48
	85%	15%	22	19	20	22	22	22	22
	85%	20%	13	12	13	13	13	13	13
	85%	25%	8	8	8	8	8	8	8

90% Confidence Level

p		±d	Large N	100	200	600	1000	1,500	2,000
No Information	50%	5%	271	74	116	187	214	230	239
	50%	10%	68	41	51	62	64	66	66
	50%	15%	31	24	27	30	31	31	31
	50%	20%	17	15	16	17	17	17	17
	50%	25%	11	10	11	11	11	11	11
Good Maintenance	70%	5%	228	70	107	166	186	198	205
	70%	10%	57	37	45	53	54	55	56
	70%	15%	26	21	24	25	26	26	26
	70%	20%	15	14	14	15	15	15	15
	70%	25%	10	10	10	10	10	10	10
Excellent	85%	5%	138	58	82	113	122	127	130
	85%	10%	35	26	30	34	34	35	35
	85%	15%	16	14	15	16	16	16	16
	85%	20%	9	9	9	9	9	9	9
	85%	25%	6	6	6	6	6	6	6

Recognizing that sampling percentage can be the focal point for verification efforts, we can take Table 3 and divide through by the population size. Table B-12 contains the same results as Table 3 but we display the results based on sampling percentage and use a 4-color stop light coding scheme. Sampling levels greater than 20% are coded black, 10 to 20% are coded red, 5-10% are coded yellow, and less than 5% are coded green. Table B-12 therefore provides a quick visual assessment of sampling percentages needed to meet verification expectations. For example, where N is small (e.g., 100), nearly all sampling levels need to be greater than 20% for an allowable error of ±15% or smaller at the 90 and 95% confidence levels.

Table B-12. Generalized example: calculation of sampling percentage.

95% Confidence Level

p		±d	Large N	100	200	600	1000	1,500	2,000
No Information	50%	5%	385	80%	66%	39%	28%	20%	16%
	50%	10%	97	50%	33%	14%	9%	6%	5%
	50%	15%	43	31%	18%	7%	4%	3%	2%
	50%	20%	25	20%	12%	4%	3%	2%	1%
	50%	25%	16	14%	8%	3%	2%	1%	1%
Good Maintenance	70%	5%	323	77%	62%	35%	25%	18%	14%
	70%	10%	81	45%	29%	12%	8%	5%	4%
	70%	15%	36	27%	16%	6%	4%	2%	2%
	70%	20%	21	18%	10%	4%	2%	1%	1%
	70%	25%	13	12%	7%	2%	1%	1%	1%
Excellent	85%	5%	196	67%	50%	25%	16%	12%	9%
	85%	10%	49	33%	20%	8%	5%	3%	2%
	85%	15%	22	19%	10%	4%	2%	1%	1%
	85%	20%	13	12%	7%	2%	1%	1%	1%
	85%	25%	8	8%	4%	1%	1%	1%	0.4%

90% Confidence Level

p		±d	Large N	100	200	600	1000	1,500	2,000
No Information	50%	5%	271	74%	58%	31%	21%	15%	12%
	50%	10%	68	41%	26%	10%	6%	4%	3%
	50%	15%	31	24%	14%	5%	3%	2%	2%
	50%	20%	17	15%	8%	3%	2%	1%	1%
	50%	25%	11	10%	6%	2%	1%	1%	1%
Good Maintenance	70%	5%	228	70%	54%	28%	19%	13%	10%
	70%	10%	57	37%	23%	9%	5%	4%	3%
	70%	15%	26	21%	12%	4%	3%	2%	1%
	70%	20%	15	14%	7%	3%	2%	1%	1%
	70%	25%	10	10%	5%	2%	1%	1%	1%
Excellent	85%	5%	138	58%	41%	19%	12%	8%	7%
	85%	10%	35	26%	15%	6%	3%	2%	2%
	85%	15%	16	14%	8%	3%	2%	1%	1%
	85%	20%	9	9%	5%	2%	1%	1%	0.5%
	85%	25%	6	6%	3%	1%	1%	0.4%	0.3%

Summary

A robust sampling effort begins with clear identification of the target population and enumeration of the population units (i.e., N). States will need to define the appropriate population unit for a large number of agricultural BMPs. Use of structural units, contracts, or plans is recommended.

Appropriate sample size for verification is driven by N, the desired margin of error (e.g., ±10%), the desired level of confidence (e.g., 95%), and the proportion of the sampled population that will have a positive result (p). States will need to apply their judgment in making decisions on the values for d and α. Improved precision (smaller d) or greater confidence (smaller α) will require increased sampling, while reduced sampling levels will result in lower confidence levels or increased allowable errors.

A priori knowledge is important in setting sample sizes; 50% is a conservative value with respect to sample size calculations. That is, absent knowledge of the likely proportion of positive responses, a p value of 0.5 is used in the calculation, resulting in a larger sample size than would result from using

values of p greater or smaller than 0.5. It will benefit states to check for records on BMP compliance to use in the calculation of sample sizes.

The error associated with setting sample sizes for small populations can be large. In these cases it might be appropriate to group BMPs into classes rather than accept margin of errors that are too large to be helpful.

Field assessments of BMPs will require "yes" or "no" determinations for this statistical approach to be applicable. This may involve performing an additional step for states with existing verification approaches, but should not interfere with achievement of other objectives the state may have. States will need to strive for consistency among field staff making these assessments.

Finally, with limited resources states will need to seek optimal scheduling for field visits by considering appropriate timing to inspect different types of BMPs, multiple site visits for some BMPs, other staff commitments, and the potential for achieving multiple objectives during each site visit. Development and application of standard protocols for field assessments may also save time.

References

Agriculture Workgroup. 2014. *Chesapeake Bay Program Partnership Agriculture Workgroup's Agricultural BMP Verification Guidance*, approved August 8, 2014, as amended. Chesapeake Bay Program, 40 p.

Cochran, W.G. 1977. *Sampling Techniques*. 3rd ed. John Wiley and Sons, New York, New York.

Snedecor, G.W. and W.G. Cochran. 1980. *Statistical methods*. 7th ed. The Iowa State University Press, Ames. Iowa.

Stevens, D. L., Jr. and A. R. Olsen. 2004. *Spatially balanced sampling of natural resources*. Journal of the American Statistical Association 99:262-278.