Statistical Sampling Approach for Follow-Up Agricultural BMP Verification

Purpose

This document outlines an adaptive management approach for selecting sites to inspect for verification that agricultural BMPs are on the ground (or otherwise continue to be implemented) and performing as expected based on engineering specifications or other applicable criteria. Techniques used to inspect BMPs at selected sites and record and track findings are described in *Upper Susquehanna Coalition (USC) Quality Assurance Project Plan for New York Work Plan for the Chesapeake Bay Program* (2015)**.**

Background

The expected coverage of BMPs for agricultural verification protocols described in the agricultural verification guidance (Appendix B of *Strengthening Verification of Best Management Practices Implemented in the Chesapeake Bay Watershed: A Basinwide Framework*, October 2014) is summarized in Table 1.

Table 1. Summary of verification coverage requirements.

Program Type	Practice Type	Initial Verification	Follow-Up or Re-Verification
Non-Cost-Shared BMPs	Annual	100% BUT sub-sampling allowed for single year BMPs (e.g., tillage practices) that are visually assessed	
Non-Cost-Shared BMPs	Multi-Year	100%	10% of those multi-year BMPs which account for >5% of agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario
Cost-Shared BMPs	Annual	100% BUT sub-sampling allowed for single year BMPs (e.g., tillage practices) that are visually assessed	
Cost-Shared BMPs	Multi-Year	100%	10% of those multi-year BMPs which account for >5% of agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario
Permit-Based BMPs	Annual	100% BUT sub-sampling allowed for single year BMPs (e.g., tillage practices) that are visually assessed	
Permit-Based BMPs	Multi-Year	100%	20% BUT sub-sampling allowed for nonfederal state permit-issuing program BMPs

The overall approach for meeting the targets in Table 1 is summarized in Table 2. New York State performs initial verification of all agricultural BMPs on farms participating in its Agricultural Environmental Management program (AEM), farms with contracts, and CAFO permitted facilities. This

document focuses on how the follow-up checks described in Table 2 will be used to meet the re-verification targets in Table 1.

Table 2. Summary of proposed verification approach.

Verification Element	BMP Implementation Mechanism			
	Non Cost Shared BMPs	*Cost Shared BMPs*	*Regulatory Programs*	*Permit Issuing Programs*
Initial Inspection				
Method	Farm Inventory: On Site Visual Assessment	Farm Inventory: On Site Visual Assessment		Farm Inventory: On Site Visual Assessment
Frequency	100% of farms participating in AEM	100% of All farms under contract		100% of all CAFO permitted facilities
Who Inspects	County Conservation Districts, NRCS Staff and Certified AEM Planners			County Conservation Districts, NRCS Staff and Certified AEM Planners, NYSDEC inspectors
Documentation	BMPs meet appropriate government and/or CBP practice standard (PE sign off and/or SWCD evaluation)	BMP certification and or PE sign off		BMP certification and or PE Sign off
Follow-Up Check				
Follow-Up Inspection	Multi-year: Farm Inventory: On-site Visual Assessment	Multi-year: Farm Inventory: On-site Visual Assessment		Multi-year: Farm Inventory: On-site Visual Assessment
Statistical Sub-Sample[1]	>10% of all Farms participating in AEM	>10% of Farms with active contracts		67% of all farms w/ active permits
Response if Problem	Bring into compliance within one year or remove from reported BMPs	Cost Share Program Contract Compliance Policy		NYSDEC CAFO Permit Compliance Policy
Lifespan/Sunset	Re-verification by SWCD personnel and/or AEM planners. If practice sunsets within 2 years of on-site visual inspection a farm inventory will be conducted			Re-verification by SWCD personnel and/or DEC staff during inspections.
[1]Sub-sampling will be designed to achieve ≥10% of farms overall.				

The AEM program is the umbrella agricultural program in New York supporting farmers in their efforts to protect water quality and conserve natural resources, while enhancing farm viability. State and

Federal programs are coordinated through AEM to work together to efficiently provide technical and financial assistance to priority farms and priority environmental issues.

New York's Concentrated Animal Feeding Operation (CAFO) and AEM programs cover 95% of the dairies in the New York portion of the Chesapeake Bay watershed. This includes permitting of 65 CAFOs (11 large, 54 medium) with over 45 percent of the total dairy animals. New York does not have significant numbers of poultry or swine. There are currently 2,832 farms included in Tier 1 of the AEM database. Tier 1 consists of basic information such as farm contact information, farm inventories, and potential environmental concerns and opportunities. A subset of these farms has BMPs.

A comparison of Tables 1 and 2 shows that the coverage planned for follow-up inspections of BMPs at CAFOs will be three times (67% vs. 20%) that required by the Chesapeake Bay Program. Planned coverage for both cost-shared and non-cost-shared BMPs should meet program requirements but will be assessed through testing of the approach. The difference between the sampling rates specified in Table 2 and Table 1 for cost-shared and non-cost-shared BMPs derives from New York State's proposal to sample on a farm basis rather than on a BMP basis. An adaptive management approach described below will allow adjustments to the sampling scheme over time to ensure that the expectations summarized in Table 1 are met over time.

Selecting Sites to Inspect

The first step in the site selection process is to identify the multi-year BMPs that account for >5% of agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario. The agricultural verification guidance illustrates this with Attachment A in Appendix B (*Relative Influence of BMPs in Agriculture Sector*). In Appendix B of the agricultural verification guidance document, load reductions were compared between a 2013 progress scenario and a *No-Action* scenario. The results for New York are summarized in Table 3.

Table 3. BMP-specific load reductions for 2013 vs. no-action scenarios for New York.

BMP	Share of Total Agricultural Load Reduction for 2013 vs. No-Action		
	N (%)	P (%)	Sediment (%)
Animal Waste Management Systems	28.6	30.8	-
Land Retirement	15.9	4.9	13.0
Enhanced Nutrient Management	14.1	8.1	-
Grass Buffer Strips	14.0	26.1	29.3
Forest Buffers	8.0	2.5	7.9
Conservation Plans	3.6	5.5	14.5
Pasture Fencing	3.1	5.4	8.2
Grass Buffers	2.8	-	2.3
Conservation Tillage	2.6	2.8	12.4
Wetland Restoration	2.4	-	4.1
Precision Rotation Grazing	-	4.4	5.6
Barnyard Runoff Control	-	2.8	-
Dairy Precision Feeding	-	2.1	-
Tree Planting	-	-	1.9

While this analysis would indicate that the nine (9) BMPs highlighted in Table 3 would require re-verification at a 10 percent rate, the approach to be used initially by New York State may differ to address factors such as the risk of BMPs not being maintained and the relative importance of BMPs beyond 2013.

The next step is to determine how to inspect the BMPs. New York State will perform re-verification on a farm-by-farm basis rather than on a BMP-by-BMP basis, so the challenge will be to ensure that site selection on a farm basis will yield satisfactory re-verification rates on a BMP basis.

New York inspects two-thirds of CAFOs each year. The one-third not sampled during a year will be rolled into the two-thirds sampled the next year to ensure that 100 percent of CAFOs is inspected every two years. This approach to CAFO re-verification will result in easily meeting the target of 20 percent for permit-based BMPs (Table 1). CAFO inspections will also contribute significantly to the number of animal waste management system that is re-verified.

Coverage of the other highlighted BMPs in Table 3 (e.g., grass buffer strips) will be determined by selection of non-CAFO farms to inspect. A random 10 percent sample of these farms would be suitable if each farm implemented these BMPs, but this is unlikely for the complete set of BMPs that need to be re-verified. For this reason, more than 10% of the farms would likely be targeted.

The sampling approach described in *Statistical Sampling Approach for Initial and Follow-Up BMP Verification* provides an equation for determining sample size based on the following variables:
- 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. ±10% or 0.10). 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.

Using available data and reasonable assumptions, the sampling size equation for binary distributions (pass/fail) will be tested to determine the best sampling approach for New York farms within the Chesapeake Bay Watershed. The best approach will satisfy the requirements summarized in Table 1 and address the following additional important factors:

- Work load balance across all counties involved
- Re-verification of sunsetting BMPs
- Time period over which sampling approach is evaluated (e.g., 2 yr, 5 yr, 10 yr)
- BMP lifespans
- Independent verification requirements
- Inspection methods (e.g., visual)
- Other logistics constraints

It should be noted that New York will inspect all BMPs at every farm included in the re-verification effort. This will result in coverage of additional BMPs beyond the minimum requirements in Table 1.

Adaptive Management Approach

Regardless of the initial sampling scheme used, an adaptive management approach to re-verification will be applied to ensure that sampling rates remain on or within reasonable range of the targets in Table 1. As implementation of BMPs in the watershed progresses, BMP goals may be exceeded in some cases and not achieved in others. This would result in different projections of the relative load reductions expected for each BMP, potentially creating a need to shift the focus of re-verification to a slightly different set of BMPs. Similarly, an improvement or decline in compliance rates may result in a need to change the sample size.

The AEM Data Management System provides opportunities for tracking important information such as the geographic distribution and age of re-verified BMPs. This and other information will be used to help assess the need to alter the sampling approach. Adjustments will be made as necessary to ensure that re-verification goals are met.

Next Steps

Existing data extracted from the AEM Data Management System will be used to test various sampling scenarios to determine the best approach for meeting the targets in Table 1 within the logistical and resource constraints of USC and its partners. The recommended approach will be incorporated within an updated QAPP and fully documented for review by the Verification Committee.