Pennsylvania
Department of
Environmental Protection

MEMO

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RE Response to Tetra Tech Evaluation of the "Methodology Guidance for Remote Sensing Verification of Conservation Tillage BMPs"

MESSAGE:

The Pennsylvania Department of Environmental Protection (PA DEP) acknowledges Tetra Tech's independent review of *Methodology Guidance for Remote Sensing Verification of Conservation Tillage BMPs* ("Methodology"), provided on March 10, 2025, and coordinated by the Chesapeake Bay Program Office. We are pleased that the findings of Tetra Tech's Evaluation concluded that the proposed Methodology generally aligns with existing Chesapeake Bay Program (CBP) guidance. Additionally, we appreciate that Tetra Tech provided constructive suggestions for CBP to consider in development of future guidance for remote sensing verification of BMPs. This memo addresses two comments from Tetra Tech designated as "Note 1" and "Note 2" (see Figures 1 and 2).

NOTE 1

2017 CBP Guideline Element	PA 2025 Method Compliance	Notes
Use of standard accuracy metrics – Utilize confusion-matrix statistics (e.g. Hit Rate (producer's accuracy), False Alarm Rate, overall accuracy) for performance evaluation.	Yes	The PA methodology uses a confusion matrix to derive Producer's Accuracy (Hit Rate), False Alarm Rate (User's accuracy), and overall classification accuracy, consistent with CBP's standard accuracy metrics.
Minimum accuracy threshold (71% overall) – Demonstrate that the remote sensing model achieves 71% or higher overall accuracy (as a minimum acceptable level for BMP identification) and a lower confidence limit of at least 70%	No	The PA methodology applies a lower confidence limit of 50%; however, this is derived from the Roadside Transect Surveys verification guidelines and is not consistent with the Remote Sensing verification guidelines. Using the verification guidelines from another method is not appropriate and the values from the 2017 Remote Sensing Guidelines need to be applied.

Figure 1. Screen capture of Tetra Tech Evaluation (March 10, 2025) highlighting the comment addressed below

Based on expert input and established guidance, we maintain that the proposed Methodology provides reasonable and specific acceptability criteria for using remote sensing to monitor conservation tillage BMPs by establishing an accuracy floor in which the lower confidence limit estimate of the overall accuracy exceeds 50%. PA DEP assembled the following contextual and technical information to provide a better understanding of the accuracy metrics identified in the Methodology.

The PA DEP and Resolve Hydro Team consulted with a Project Advisory Committee and reviewed available CBP guidance (see citations below) in development and review of the overall accuracy metrics proposed in the Methodology. We contend that the new Methodology should match the existing standards for verification of conservation tillage BMPs established in the March 2017 report cited below.

Applicable CBP Guidance

Recommendation Report for the Establishment of Uniform Evaluation Standards for Application of Remote Sensing to Identify and Inventory Agricultural Conservation Practices for the Chesapeake Bay Program Partnership's Watershed Model[1] - January 2017

- Does not directly establish standard or clear acceptance criteria for remote sensing BMP verification results.
- Notes that a remote sensing method with an overall accuracy of 71% to 78% is acceptable, but again, does not clearly establish acceptance or rejection criteria.
- Provides more general guidance for the application of remote sensing of agricultural conservation practices.

[1] https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/recommendation_report_draft_final.pdf

Recommendation Report for the Establishment of Uniform Evaluation Standards for Application of Roadside Transect Surveys to Identify and Inventory Agricultural Conservation Practices for the Chesapeake Bay Program Partnership's Watershed Model[2] - March 2017

- Concludes that results from roadside transect surveys are acceptable if the lower confidence limit on the overall accuracy exceeds 50%.
- Specific to conservation tillage BMP verification.
- References January 2017 Report.

Understanding Accuracy in Context

The proposed Methodology states that jurisdictions are encouraged to strive for the highest level of accuracy attainable. However, multiple factors affect the overall accuracy of a specific remote sensing method as determined through this process. Accordingly, the proposed Methodology set acceptability criteria considering historical, practical, and technical factors.

- The remote sensing methodology relies upon standards set by the roadside transect survey separating tillage within the four percentile categories.
    - CBP guidance regarding how to estimate conservation tillage BMP implementation should be consistent through methods and reliant upon data.
    - Both the roadside transect survey and the proposed remote sensing methods call for the lower limit value of the ≥90% confidence interval around the estimate of the overall accuracy to exceed 50%. In constructing the ≥90% confidence interval, we constrain the estimate's allowable error to within +/- 10%. These measures in the proposed Methodology directly match the March 2017 report recommendations, which has served as the accepted standard for conservation tillage BMP implementation reporting for nearly a decade.
- All models have uncertainty and comparing model results obtained through different methods can obfuscate accuracy interpretation. For example, remote sensing models generally report data with higher spatial resolution than roadside transect surveys, complicating direct comparisons of the results from each method. Remote sensing models rely upon field-collected data for both development and verification, but there are inherent differences in how field data and remote sensing data reported.
    - Compounding accuracy metrics are accounted for and contribute to lower the decision to use a minimum of 50% for the lower limit estimate of overall accuracy.
- A strength of remote sensing is that it provides global consistency over space and time. Remote sensing algorithms will perform the same year after year, county to county, and field to field, thereby overcoming some of the limitations associated with having multiple different human-observers identifying conservation tillage BMP implementation. Further, multi-temporal and spectrally based methods provide additional information and utility than traditional field methods.

[2] https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/Transect_Survey_Recommendations_Report_3-16-17.pdf

Based on the factors and input described above, the Methodology – which applies exclusively to conservation tillage BMP remote sensing – recommends that to use the proportions resulting from the analysis described, the lower confidence limit estimate of the overall accuracy should exceed 50%. The proposed method aligns with the existing industry and CBP standards for verification of conservation tillage BMPs, including those established in the March 2017 report.

NOTE 2

2017 CBP Guideline Element	PA 2025 Method Compliance	Notes
Separate verification for each BMP type (no "composite" BMP credit) – Verify and report each BMP type independently. If multiple BMPs are assessed, each must meet accuracy and confidence criteria on its own; results for different practices should not be combined into a single aggregate credit or accuracy measure.	Unclear	It is unclear whether the three conservation tillage BMPs are being treated as separate BMPs and evaluated separately within the analysis. Each BMP needs to be treated independently (e.g., independent sampling data for validation, statistical confidence intervals, and overall accuracy assessment. *Applicable if the method is expanded beyond conservation tillage BMPs.* If Pennsylvania applies this remote sensing approach to multiple BMPs in the future, it will need to evaluate each practice separately. The CBP does not recognize composite or pooled credit for multiple BMP categories – for example, a combined accuracy for "tillage + cover crops" together would not be acceptable. Each BMP (e.g. tillage, cover crops, etc.) would require its own verification statistics and must individually meet the guidance criteria. PA's methodology should be prepared to maintain distinct accuracy assessments for each practice type to remain compliant with CBP requirements.

Figure 2. Screen capture of Tetra Tech Evaluation (March 10, 2025) highlighting the comment addressed below

The proposed Methodology was revised to explicitly state that the three conservation tillage BMPs are treated separately under Model Selection – Performance evaluation section. See page 11 of the Methodology.