

## Conservation Evaluation and Monitoring Activity

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### Edge-of-Field Water Quality Monitoring - Data Collection and Evaluation CEMA 201

#### Definition

Water quality monitoring and evaluation under this conservation evaluation and monitoring activity (CEMA) are the actions and activities, using acceptable tools and protocols, by which a Qualified Individual will measure the effectiveness of conservation practices and systems.

The purposes of this CEMA include:

- Evaluating the effectiveness of a practice or system of practices in reducing concentrations and/or loads of targeted water quality constituents.
- Using evaluation techniques to acquire insight about existing land management and where applicable, institute change to achieve a future desired condition.
- Collecting site specific edge-of-field water quality data to calibrate, validate, and verify planning and assessment tools and predictive models and inform practice standard criteria.

Evaluation of conservation practice effectiveness through edge-of-field monitoring will lead to a better understanding of the efficacy of conservation practices intended to address water quality resource concerns. It will also assist Natural Resources Conservation Service (NRCS) and the participant in adapting and/or validating the application of conservation practices and managements.

#### Applicable Land Uses

This conservation activity applies to all land uses where conservation practices are or will be addressing surface and subsurface drainage water quality. There is a need to determine the effects and performance of applied conservation practices. The pollutant(s) to be measured at the edge-of-field must be tied to a water quality constituent of concern for the associated receiving stream or water body. This ties the activity to addressing a resource concern using the NRCS conservation planning process and promotes a systems approach to conservation.

### REQUIREMENTS

#### Qualified Individual Requirements

NRCS strongly encourages participants to know the following Qualified Individual (QI) Requirements to ensure the person they hire is a good match for their needs and objectives.

A QI for this CEMA meets all the qualifications listed below:

- 1) Has demonstrated successful management of at least two relevant edge-of-field water quality monitoring projects that acquired flow, precipitation, and water quality sample data collection – including operation and maintenance of the monitoring system(s).
- 2) Demonstrated proper sample collection and preservation and oversight of the laboratory analysis.
- 3) Completed statistical analysis of the data collected.

- 4) Has documented prior system installation and is prepared to provide a copy of a previous installation report, including photographs, with personally identifiable information redacted.

Non-qualified individuals are allowed to collect data under the guidance and oversight of a QI.

## General Requirements

- 1) This CEMA includes the performance of work and documentation of the tasks, results, interpretations, and other activities described herein by a QI.
- 2) Prior to initiation of the CEMA, the QI must arrange a pre-work conference with all parties involved to ensure all parties understand the participant's objectives, required deliverables, and characteristics of the CEMA tasks.
  - a) The parties in the pre-work conference must include the participant, the QI, the associated NRCS State Edge-of-Field POC, field office staff, and a representative from the Water Quality Monitoring Team (WQMT – [sm.nrcs.wqmt@usda.gov](mailto:sm.nrcs.wqmt@usda.gov)). The parties should agree whether they will join in-person or join via phone, web-meeting, etc.
  - b) If the participant will employ a Technical Service Provider (TSP) to implement a Conservation Planning Activity (CPA) or Design and Implementation Activity (DIA) that will be supported by results of this CEMA, it is recommended to invite them to the pre-work conference, too.
- 3) A QI may use any reference information, resource concerns, conservation practice standards and related documents in the NRCS Field Office Technical Guide (FOTG) for the state where this CEMA is performed. The FOTG home page hyperlink is: <https://efotg.sc.egov.usda.gov/#/>

## Technical Requirements Applicable to Edge-of-Field Monitoring

### Monitoring Design

Selection of the appropriate monitoring design is critical to collect data for evaluating the effectiveness of a practice or a system of practices and other desired monitoring objectives. The monitoring design must specify three factors: site configuration, sampling approach, and parameters to monitor.

All water quality monitoring activities must be developed and implemented in consultation with the WQMT. Tools and templates for all required data, analysis, and reports will be made available upon activity initiation.

### Monitoring Design Criteria Required for All Edge-of-Field Monitoring Activities

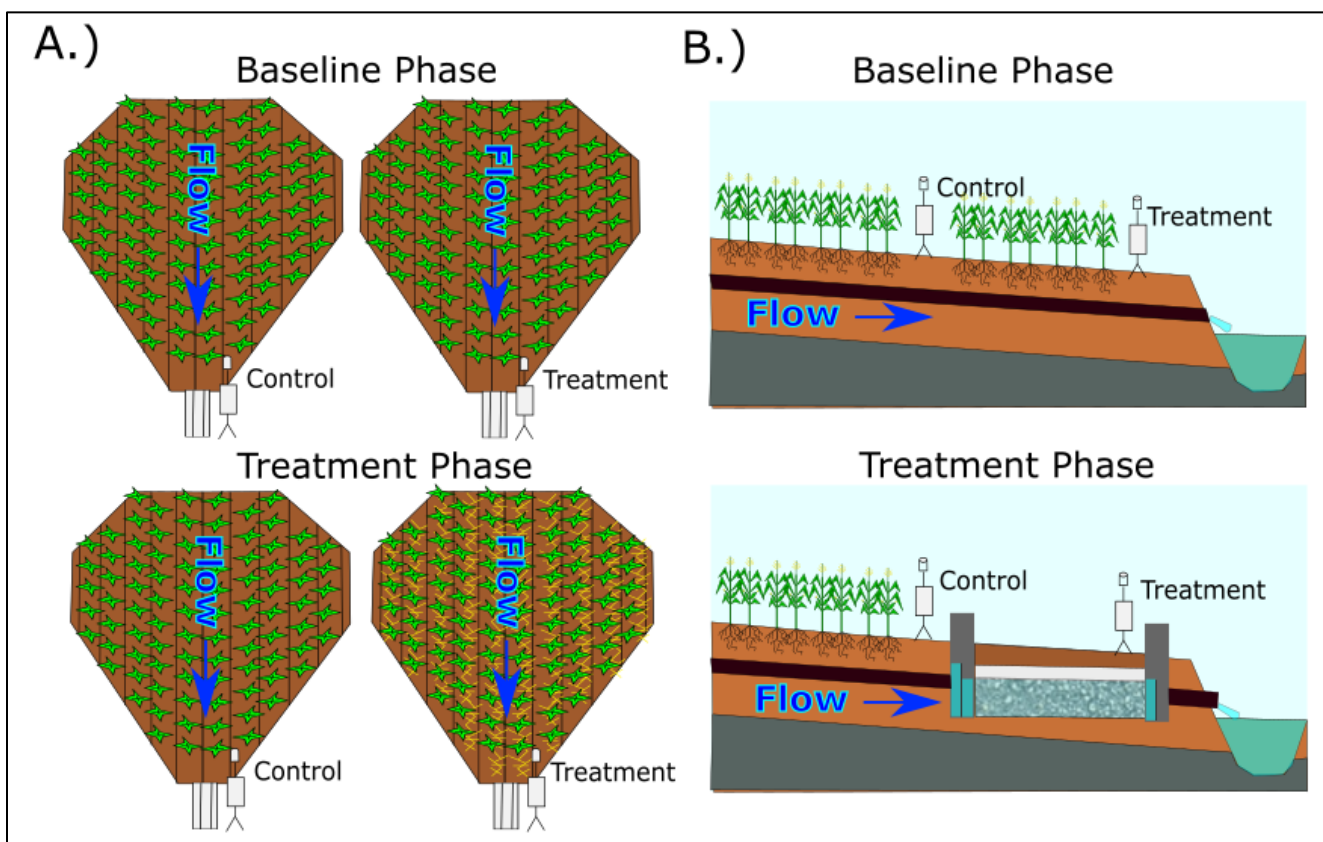
- 1.) The QI must develop and obtain WQMT approval of a Monitoring Plan (MP) before starting the activity. After approval of the MP, a Quality Assurance Project Plan (QAPP) must be developed by the QI and approved by the WQMT prior to commencement of monitoring activities. The requirements for the MP and QAPP and document templates will be provided by the WQMT to the QI upon request. These documents specify basic information on the objectives of the monitoring activity, monitoring design, and protocols that will be used through the duration of the activity to ensure activity objectives are met.
- 2.) Changes to land management or practice implementation beyond those described in the MP or QAPP within a monitored field require consultation and pre-approval from the WQMT.

### Monitoring Site Configuration

One of two site configurations must be selected for continuous monitoring sites: paired sites or an above- and below-site configuration.

- A “paired site” (i.e., side by side) monitoring site configuration provides for a determination of conservation practice effectiveness by comparing a control site without conservation practices and a treatment site with conservation practices (Clausen and Spooner 1993). A single field area with split drainage areas may simplify the paired site approach. This approach requires a baseline period before the treatment is implemented. Note: This paired site configuration must be evaluated using continuous sampling.
- In an above- and below-site configuration, the evaluation of a conservation practice is done by monitoring flow and water quality before it enters and after it exits a conservation practice or an area treated with a conservation practice or system of conservation practices. In this type of monitoring site configuration, the above site is considered the ‘control’ and the below site is considered the ‘treatment’. Note: this above- and below-site configuration may be evaluated using either continuous or discrete sampling.

Figure 1: Monitoring site configurations A.) Plan view schematic of paired, side-by-side monitoring site configuration with a treatment of reduced tillage (CPS 345). B.) Profile view schematic of before and after, above and below, monitoring site configuration with a treatment of denitrifying bioreactor (CPS 605).



### Monitoring Site Configuration Criteria for all Sites

- 1.) The participant must have control of the land comprising the entire contributing drainage areas and the management thereof for the duration of the required monitoring period.
- 2.) Contributing drainage areas should have homogeneous land use and management throughout, provide for wet weather travel access, and the assurance that sampling and any instrumentation will not interfere with normal management operations or conservation practice implementation. Ideally, access should be limited, such that monitoring will

proceed without interference, theft, or vandalism.

3.) Delineation of contributing drainage areas:

- a) To delineate contributing areas and outlets for surface water runoff monitoring sites use topographic analysis with hi-resolution LiDAR (<=1m) or on-site, hi-res, GPS surveying to locate the catchment outlet and to delineate the drainage area. Berm construction may be necessary to direct runoff to the inlet of the monitoring system.
- b) To delineate contributing areas and outlets of drain system monitoring sites obtain a map with locations and properties of the drainage system and soil properties in conjunction with analytical or numerical sub-surface flow analysis to determine the zone of influence of the drainage system (USDA-NRCS, 2003).

4.) Monitoring activities and monitoring sites must be name identified using the following convention:

5.) Unique Monitoring Activity ID (UMAID): ST+COFIPS+ACTNUM

6.) Unique Monitoring Station ID (UMSID): ST+COFIPS+ACTNUM+STANUM

Where:

- a) ST – two-digit state abbreviation.
- b) COFIPS – three-digit FIPS code.
- c) ACTNUM – two-digit activity number code, county level sequential value, assigned by WQMT at onset of activity.
- d) STANUM – two-digit station code, beginning on 00 increment code assigning values to all control sites then treatment sites for an activity.

**Additional Criteria for a Paired Monitoring Site Configuration**

- 1.) Monitoring sites must be adjacent to, or as close as possible and not exceed 3 miles of distance between them (to receive similar environmental conditions).
- 2.) The contributing drainage areas for individual paired sites must be hydrologically isolated from each other.
- 3.) The contributing drainage areas of the control site and the treated site must be similar in size (i.e., differ by less than 10 percent).
- 4.) Contributing drainage areas to monitoring sites must be no smaller than 3 acres.

**Additional Criteria for an Above and Below Monitoring Site Configuration**

- 1.) Total flow entering the treatment from the contributing area above must be measured and sampled and, if applicable, the flow bypassing the treatment must be measured.
- 2.) The below site must quantify all inflow from the above site, plus any additional runoff and drainage generated internally within the practice area.

**Monitoring Approach**

Flow and water quality parameters may be obtained by one of two general monitoring approaches: continuous monitoring via automated sampling equipment or discrete monitoring via grab sampling and on-site observations obtained at pre-defined intervals.

Continuous monitoring involves the installation of automated monitoring stations at the control and treatment sites that allow for continuous data acquisition of precipitation, flow, and water quality samples. Continuous monitoring provides a comprehensive data set (including baseline data before installation) that in addition to demonstrating the effect of the conservation practice may elicit insights to unanticipated phenomena (e.g., environmental interactions, management trade-offs) with respect to nutrients, sediment, and hydrology.

Discrete monitoring entails manual acquisition of paired water quality grab samples at above and below the conservation practice during specified events or intervals throughout the monitoring period. Discrete sampling provides a practical, efficient assessment of a conservation practice with respect to the water quality constituents directly tied to the resource concern it was designed to address.

### **Operational Requirements for All Edge-of-Field Monitoring Approaches**

- 1.) Paired samples must be collected from both control and treatment sites throughout the duration of the monitoring period.
- 2.) Sample acquisition, handling, preservation, storage, and transport will be performed as specified in the QAPP.

Laboratory analysis of water quality samples must use standard protocols outlined in the National Environmental Methods Index (NEMI, 2012). The QAPP must document a detailed description or procedure reference number of the laboratory analysis. It must also document the use of duplicate and blank samples (typically 10 percent of the samples) and instruct laboratories to perform analysis only when there is sufficient volume present in the sample to analyze all water quality constituents.

### **Additional Operational Requirements for Discrete Edge-of-Field Monitoring Approaches**

- 1.) Practice(s) being monitored with the discrete monitoring approach must have concentrated flows amenable to grab sampling entering and exiting the practice being evaluated. All flows entering, exiting and if applicable, bypassing the practice, must be able to be measured or reliably estimated at all times. Practices such as denitrifying bio-reactors (CPS 605) and waste separation facilities (CPS 632) are examples of practices fulfilling these requirements. Application of discrete monitoring to other practices requires consultation and approval by the WQMT.
- 2.) Site configuration must be above and below type configuration.
- 3.) Collect samples for one to three years.
- 4.) Paired-event samples at all control and treatment sites must be collected within a half hour period for a sampling event.
- 5.) A corresponding instantaneous flow rate or total flow for an event must be recorded with each sample at each site.
- 6.) Analyze water quality samples for one to three of the following constituents in all samples. One constituent should be an indicator for the primary resource concern of which the conservation practice is being applied to address:
  - a. NH<sub>4</sub>-N (Ammonium Nitrogen only required when animal waste is land applied)
  - b. NO<sub>2</sub>-N + NO<sub>3</sub>-N (Nitrite plus Nitrate Nitrogen)
  - c. TKN (Total Kjeldahl Nitrogen)
  - d. Soluble Reactive P (Orthophosphate Phosphorus)
  - e. TP (Total Phosphorus)
  - f. SSC (Suspended Sediment Concentration) or TSS (Total Suspended Solids)
- 7.) Ensure flow paths to and from sampling sites (as well as the bypass) are free of unintended obstructions and debris that may influence flow or water quality.

### **Additional Operational Requirements for Continuous Edge-of-Field Monitoring Approaches**

- 1.) The monitoring duration should be based on the number of years in the crop rotation. The minimum recommended durations are found in table 1. Typically this is one crop rotation for baseline and two crop rotations for post conservation practice application. If after the

second crop rotation, statistically significant data have been collected and the effectiveness of the monitored practice(s) is established, a third crop rotation may be used to evaluate an additional practice(s) at this site. The participant may request a different monitoring duration in writing from the state water quality monitoring point of contact to seek approval through the WQMT and the NRCS National Water Quality Specialist.

Table 1. Monitoring Period Duration Based on Crop Rotation for Continuous Monitoring of Avoid and Control Practices

Years in Rotation	Baseline Duration	Treatment Duration
1 year	Minimum of 1 years	Minimum of 2 years
2 year	Minimum of 2 years	Minimum of 4 years
3 year	Minimum of 3 years	Minimum of 6 years

- 2.) Analyze all water quality samples for all of the following constituents.
  - a. NH<sub>4</sub>-N (Ammonium Nitrogen only required when animal waste is land applied)
  - b. NO<sub>2</sub>-N + NO<sub>3</sub>-N (Nitrite plus Nitrate Nitrogen)
  - c. TKN (Total Kjeldahl Nitrogen)
  - d. Soluble Reactive P (Orthophosphate Phosphorus)
  - e. TP (Total Phosphorus)
  - f. SSC (Suspended Sediment Concentration) or TSS (Total Suspended Solids)
- 3.) Required Site Visits
  - a. Retrieve samples from all sites as soon as possible (as determined by guidelines listed in the QAPP) after sampling events, inspect flow measurement and automated sampler function, and make necessary repairs.
  - b. Conduct bi-weekly inspections and maintenance of all sites. These inspections may be performed simultaneously with sample retrieval.
 

General inspection and maintenance tasks:

    - i. Inspect power sources, stage recorders, pumps, sample tubes, sample intakes, and desiccant strength.
    - ii. Check and/or calibrate stage recorders to ensure flow measurement accuracy.
    - iii. Retrieve collected data bi-weekly (or after a major precipitation event) to limit the amount of data potentially lost due to equipment failure or logger capacity limitations.
    - iv. Remove debris, snow, and ice upstream and downstream from the flow control structure. Clean site and assure unimpeded flow through the structure(s).

### **Data Management, Analysis, and Reporting**

Proper data management ensures that data are secure and organized. Observations from monitoring sites and site management data are required to be stored and submitted in standardized formats. This facilitates subsequent analyses and archiving. All data should be summarized in such a way that it is meaningful to the participant and protect personally identifiable information (PII).

For all data management, analysis, and reporting requirements, the WQMT will provide tools, templates, and guidance for analyses, reports, and factsheets.

### **Data Management, Data Analysis, and Reporting Requirements for All Edge-of-Field Monitoring Approaches**

## Data Management

- 1.) Data files must be named with following conventions:
  - a. File Name for Activity Level Files: UMAID\_YR\_FID.FEXT
  - b. File Name for Monitoring Station Level Files: UMSID\_YR\_FID.FEXT

Where:

UMAID – Unique Monitoring Activity ID

UMSID – Unique Monitoring Station ID

YR – Four-digit year

FID -- File Type Identifier from table

FEXT – File type extension e.g. .doc, xlsx, txt.

Table 2. File type identifiers and scope of file for all activity required files

File Type	FID	File Scope
interim annual report	IAR	activity
baseline report	BLR	activity
installation report	INR	activity
final comprehensive report	FNR	activity
fact sheet	FSH	activity
water quality data	WQD	site
management data	MGD	site
site check data	CHD	site

- 2.) Documentation of analyses of water quality samples will be submitted for each site-event.
- 3.) Paired water quality and flow observations must be recorded in the specified data format for the type of monitoring design.
- 4.) Annual site management and conservation practice data will be recorded and submitted in the approved format.

## Data Analysis

- 1.) Statistical analysis of data across control and treatment sites must be performed using an approved analysis for the type of monitoring design.

## Reporting

- 1.) Summary Factsheet: Factsheet produced at the culmination of the activity describing results of sampling, analysis, and efficacy of the conservation practice that was evaluated.

## **Data Management, Analysis, and Reporting Requirements Discrete Edge-of-Field Monitoring**

### Reporting

- 1.) Annual summary data report: Brief annual report describing sampling and analysis activities and results.

## **Data Management, Analysis, and Reporting Requirements Continuous Edge-of-Field Monitoring**

### Reporting

- 1.) System Installation Report: The Monitoring Conservation Evaluation and Monitoring Activity Installation Report will be submitted. An approved Water Quality Monitoring Plan and a QAPP must be submitted and approved as a part of the installation. NRCS must complete a quality assurance check of existing practice management known as the Annual Field Check form. These forms, along with digital photo documentation, serve as documentation for system installation.
- 2.) Reporting Requirements for All Years: For each water quality station, raw continuous rainfall and flow data for the year will accompany electronic (.pdf) copies of the laboratory analysis for each event sampled throughout the year. Descriptions of data gaps and associated causes and measures will be undertaken to remedy them. Bi-weekly site checklists should provide information about the performance of the monitoring systems. Monthly photos of the field and the system will be provided digitally. The latest version of the management operations data form completed up through the reporting period and water quality data form containing all water quality data for all the events up through the reporting period will be submitted. The data forms and all digital files will follow the naming convention specified above.
- 3.) Baseline Monitoring Report: In addition to the annual reporting requirements for all years, upon completion of the baseline monitoring phase this report will summarize the findings and will include a status review with the participant. The report will establish the correlation between the control and treatment sites under the baseline management regime.
- 4.) Final Comprehensive Report: A comprehensive report with an executive summary is required at the end of the monitoring period. This report will summarize site management, observations, and analysis conducted throughout the implementation of the activity. The report must include statistical and graphical analyses to evaluate the effectiveness of the conservation practice(s) being evaluated and implications for the broader resource concerns, watershed water quality, and recommendations for practice improvement.

## **DELIVERABLES**

The QI must provide documentation showing all the tasks indicated in the **General Requirements** section, the **Technical Requirements** section, and the following sections:

### **Cover Page**

Cover page reporting the technical services provided by the QI. Cover page(s) must include the following:

- 1) CEMA name and number.
- 2) Participant information: Name, farm bill program name, contract number (QI obtains contract number from participant), land identification (e.g., state, county, farm, and tract number).
- 3) QI name, address, phone number, email.
- 4) A statement by the QI explaining how they currently meet the Qualified Individual Requirements for this CEMA. Attaching or enclosing a copy of documentation for how the QI requirements are met is encouraged. Examples include:



- Certification Name and Number,
- License Name and Number,
- Agricultural Retailer Business Name, or
- Other brief written statement indicating how the requirements of a QI for this CEMA are met.

5) A statement by the QI that services provided meet NRCS requirements, such as:

*I certify the work completed and delivered for this CEMA:*

- *Complies with all applicable Federal, State, Tribal, and local laws and regulations.*
- *Meets the general requirements, technical requirements and deliverables for this CEMA.*
- *Is consistent with and meets the conservation objectives for which the program contract was entered into by the participant.*
- *Addresses the participant's conservation objectives for this CEMA.*

*QI Signature:* \_\_\_\_\_ *Date:* \_\_\_\_\_

6) A Participant's acceptance statement, such as:

*I accept the completed CEMA deliverables as thorough and satisfying my objectives*

*Participant Signature:* \_\_\_\_\_ *Date:* \_\_\_\_\_

7) A space for an NRCS reviewer to certify the agency's acceptance of the completed CEMA, such as:

*NRCS administrative review completion by:*

*Signature:* \_\_\_\_\_ *Title:* \_\_\_\_\_ *Date:* \_\_\_\_\_

## Notes and Correspondence

- 1) Document each site visit, its participants, the activity completed in the field, and results of each site visit.
- 2) Copies of correspondence between the QI and the participant relating to decision-making and completion of this CEMA.
- 3) Copies of observations, data, technology tool output, or test results prepared during completion of this CEMA.

## Maps

1) At a minimum, all maps developed for the CEMA will include:

a) Title block showing:

- i) Map title.
- ii) Participant's name (individual or business).
- iii) Prepared with assistance from [QI Name].
- iv) Date prepared.
- v) Map scale.
- vi) North arrow
- vii) Appropriate map symbols and a map symbol legend

## **Deliver Completed Work**

- 1) The QI must prepare and provide the participant two sets of all the items listed in the **General Requirements**, the **Technical Requirements** and the **Deliverables** sections of this document.
- 2) One set is for the participant to keep.
- 3) The other set is for the local NRCS Office.
- 4) The QI may transmit a set of the completed work to the local NRCS Office, if their participant has authorized it.

It is recommended to provide the NRCS field office an opportunity to review the CEMA deliverables, prior to asking for their acceptance.

## **References**

NEMI. 2012. National Environmental Methods Index: Methods and Data Comparability Board chartered under the National Water Quality Monitoring Council. Available at: <http://www.nemi.gov>