Conservation Evaluation and Monitoring Activity

Soil Health Testing

CEMA 216

Definition

Quantitative testing for physical, biological, or chemical characteristics of soil and constraints of soil using approved laboratory methods.

Applicable Land Uses

Crop, Forest, Range, Pasture, Farmstead, Associated Agriculture Lands, Other Rural Land, and Developed Land.

REQUIREMENTS

Qualified Individual Requirements

The Natural Resources Conservation Service (NRCS) strongly encourages Conservation Evaluation and Monitoring Activity (CEMA) participants to know the Qualified Individual (QI) requirements in order to ensure the person they employ to provide the CEMA is fully qualified to meet the objectives of the activity.

A QI for Soil Health Testing CEMA 216 meets one of the following:

- Certified Crop Advisor (CCA) or Certified Professional Agronomist (CPAg) through the American Society of Agronomy or a Certified Professional Soil Scientist (CPSS) or Associate Professional Soil Scientist (APSS) through the Soil Science Society of America.
- Technical Service Providers (TSP) certified for Soil Health Management Plan Conservation Practice Activity (116) or Soil Health Management Design and Implementation Activity (162).
- Associates degree or higher in an agricultural or soil science with at least 2 years of experience collecting soil for laboratory analysis.

Individuals working under the guidance or management of a QI are allowed to collect soil samples for this CEMA.

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 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, and the NRCS field office staff. 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 served 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

This CEMA includes details to collect and analyze soil based on soil health resource concerns and planning objective. Soil samples will be collected in the Soil Health Management Unit (SHMU) and submitted to commercial laboratories for analysis using standardized methods.

Plans and specifications for soil health testing shall be consistent with this activity and the referenced Soil Health Technical Note (TN 450-TCH-3), Recommended Soil Health Indicators and Associated Laboratory Procedures.

All Soil Testing

1) Record the purpose and strategy for testing the soil. Design the soil sampling strategy based on goals, available tools, and other applicable guidance. Analyze the soil type, topography, and management information to determine appropriate sampling locations within a Soil Health Management unit.

2) Use the following sampling strategies, or combination of strategies, when applicable:

   a) Random - Soil in management unit is homogeneous and there are few problem areas. Sampling locations are chosen by assigning random numbers to areas on a grid overlay.

   b) Stratified - Soil in management unit is heterogenous and contains different soil types across different landscape positions. Sampling locations are chosen randomly within delineated subareas (or strata) in proportion to the size of the subarea in relation to the management unit.

   c) Composite - Soil is subsampled from many locations in a larger management unit and combined into one homogenous sample.

   d) Problem - Distinct areas with uneven crop performance are strategically sampled.

   e) Dynamic Soil Properties (DSP) Protocol – Follow DSP Guide.

3) Ensure all equipment is relatively clean and free from residue prior to collection. Remove vegetation or debris from the soil surface.

4) Collect soil prior to beginning growing season activities, throughout the growing season or after harvest, providing it is done when soil moisture and temperature are not extreme and there have not been any recent physical disturbances, additions of soil amendments, or other chemical inputs.

5) Avoid collecting or combining soil samples under the following conditions, unless a sampling strategy is used to specifically address the variability (e.g. stratified sampling):

   a) Wheel tracks or drive lanes, field borders, depressions, or other odd areas within the field

   b) Areas with historically lower or higher productivity

c) Different landscape positions

d) Fields with different crops or rotations, or the same crops with a different management

e) Row versus inter-row areas

f) Eroded versus non-eroded areas

g) Saturated soil

6) When using this activity to monitor practice effects over multiple years, it's recommended to remain consistent in the following ways: use the same georeferenced locations, employ the same sampling strategy, collect soil under similar soil conditions, collect soil at the same time of year, utilize the same lab tests and methods, and utilize the same laboratory.

7) Follow all USDA-APHIS regulations for prohibited, regulated, or quarantined soils.

8) Ensure laboratories maintain current certification for one of the following:

a) The Performance Assessment Program (PAP) from The North American Proficiency Testing Program (NAPT) under the auspices of the Soil Science Society of America, or

b) The American National Standards Institute (ANSI) National Accreditation Board (ANAB), or

c) The International Organization for Standardization (ISO/IEC 17043:2010) for ISO 10694:1995

d) State-approved certification program that considers laboratory performance and proficiency to assure accuracy of soil test results.

Soil Health Testing

1) Collect soil in the same locations where resource concern assessments for the appropriate land use were already completed. Within the SHMU, collect soil from at least 3 representative locations (main locations). At each main location, collect soil from the main location and 4 subsamples about 20 to 50 feet from the main location (5 subsamples per location). Combine all 15 subsamples to create 1 composite sample. Gently break up any large clods, and remove stones, roots, or debris from the soil. Gently and thoroughly mix the samples.

2) Use a tile spade, sharpshooter, or straight shovel to collect soil, when practical. Dig a hole 8 inches deep and remove a 2-inch thick vertical, rectangular slice of soil 6-8 inches in depth. Sampling a soil slice in this way preserves the structure and aggregates better than sampling with a probe. If it is impractical to sample a slice of soil, then a soil probe that is 1-inch or more in diameter may be used.

3) Follow all laboratory recommendations (soil temperature, soil moisture content, storage, shipping times, etc.) for the indicator(s) being analyzed. Store soil for soil health testing in a cooler or refrigerator if samples are not immediately sent to the laboratory.

4) Test soil for indicators referenced in Soil Health Technical Note No. 450-03, Recommended Soil Health Indicators and Associated Laboratory Procedures.

5) Participants choose among the following combinations:

a) Basic Soil Health Testing

b) Basic Soil Health Testing, plus Comprehensive Chemical Analysis

c) Basic Soil Health Testing, according to Dynamic Soil Properties Protocol

d) Basic Soil Health Testing, plus one or more Single Indicator Testing

e) Single Indicator Testing for one or multiple indicators.

Basic Soil Health Testing

The basic soil health test includes all five of the following indicators by the methods below:

1) Soil organic carbon content measured by dry combustion
2) Wet macro-aggregate stability measured using ARS or NRCS methods or by sprinkle infiltrometer
3) Respiration using 1, 2, 3 or 4-day incubation
4) Active carbon measured by permanganate oxidation
5) Bioavailable nitrogen measured by ACE Protein method

Single Indicator Testing

Use any recommended indicator or method listed in Table 1 of Soil Health Technical Note No. 450-03, or other tests approved at the State level. Single Indicator tests include, but are not limited to:

1) Individually, the indicators listed under Basic Soil Health Testing
2) Microbial diversity using phospholipid fatty acid (PLFA)
3) Enzyme activity of β-glucosidase, N-acetyl-β-D-glucosaminidase (NAG), arylsulfatase, protease, or acid or alkaline phosphatase.

Additional Comprehensive Chemical Analysis

1) If soil fertility testing is not completed under another activity (for example, as part of a Nutrient Management Plan or through Soil and Source Testing for Nutrient Management CEMA 217) then comprehensive chemical analysis may be included to provide information on soil nutrient content as it relates to healthy soil function and nutrient cycling.
2) Follow Land Grant University (LGU) or industry guidance to collect, prepare, store and ship soil samples. Ensure sampling and nutrient extraction methods are the same as those required by the State-adapted NRCS Nutrient Management Code 590 practice standard.
3) Comprehensive chemical analysis must include testing for phosphorus, potassium, calcium, magnesium, pH, sulfur, iron, manganese, copper, zinc, boron, cation exchange capacity, and total nitrogen.
4) When applicable to local conditions, test for additional analytes such as molybdenum, aluminum, sodium, and soluble salts (electrical conductivity).

Additional Testing for Dynamic Soil Properties

Follow the requirements for sampling design in the current Dynamic Soil Properties Guide (see reference list).

1) Identify two SHMUs or sampling units on a single soil series/component. A comparative sampling location for two soil conditions (i.e., different management) will provide insight for planning purposes.
2) Collect soil samples at 0-5 cm, 5-10 cm, and 10-15 cm depths at a main location and two satellite locations.

3) Sample collection is completed by a Qualified Individual in consultation with NRCS staff as needed.
4) Laboratory analysis includes the Basic Soil Health Tests identified above. Include the completed the DSP Land Use and Management Questionnaire (Appendix I in DSP Guide).

Definitions

1) *ACE Protein (Autoclaved Citrate Extractable Protein)* is a soil health indicator method that measures the amount of protein-like substances in soil organic materials, which indicates the amount of nitrogen potentially available for plants and microorganisms.
2) *Active Carbon*, also known as POXC when measured by permanganate oxidation, is a soil health indicator that indicates available carbon and represents the amount of microbial food available.
3) *Respiration* is analyzed as a soil health indicator of microbial activity and measured by the amount of carbon dioxide gas released from a soil sample over a period of 1 to 4 days.
4) *Soil health* is the continued capacity for soil to function as a vital living ecosystem to support plants, animals, and humans.
5) *Soil Health Management System* (SHMS) is a collection of NRCS conservation practices that focuses on maintaining or enhancing soil health by addressing soil health management principles: minimize disturbance, maximize soil cover, maximize biodiversity and maximize the presence of living roots.
6) *Soil Health Management Unit* (SHMU) is one or more planning land units with similar soil type, land use, and management that can vary in size or acreage depending on soil texture, topography, and cropping system. SHMU is like a conservation management unit but designed to assess soil health status and potential limitations on soil health indicators.
7) *Soil Organic Carbon* is a soil health indicator that indicates the carbon storage and soil organic matter cycling and is analyzed by high-temperature, dry combustion of soil.
8) *Wet aggregate stability* is a method of testing how well soil aggregates resist breaking apart under water pressure, which indicates the size and amount of water-stable aggregates.

DELIVERABLES

The QI must provide documentation showing all the tasks indicated in the **General Requirements** section, the **Technical Requirements** section are complete, 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 and, 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, or test results prepared during completion of this CEMA.

Maps

1) Maps to include, but not be limited to:
   a) General location map to locate the sampling area, such as geographic coordinates, public land survey coordinates, roads to access the site, etc.
   b) Soil Sampling map showing the SHMUs polygon data, GPS point data (WGS84 latitude, longitude) for sampling locations, SHMU.
   c) maps, as needed, with appropriate interpretations.
2) All maps developed for the CEMA will include:
   a) Map title.
   b) Client's name (individual or business).

c) Assisted By [QI name].

d) Date prepared.

e) Map scale.

f) North arrow.

g) Appropriate map unit symbols and a map symbol legend on the map or as an attachment.

Testing Results

At a minimum, the following are required:

1) Sampling and testing strategy used.
2) Aerial imagery with GPS point data (WGS84 latitude, longitude) for sampling locations and GPS polygon data for the management unit.
3) Sample identification code(s).
4) Laboratory test results.
5) Schedule of additional testing or monitoring at recommended frequency.
6) For DSP scenario, include the completed Land Use and Management Questionnaire.

Deliver Completed Work

1) The QI must prepare and provide the participant two sets of all of the items listed in the **General Requirements**, the **Technical Requirements** and the **Deliverables** sections of this document.
   a) One set is for the participant to keep.
   b) The other set is for the local NRCS Office.
2) If the participant has pre-authorized it, the QI may transmit a set of the completed work to the local NRCS Office. It is recommended to provide the NRCS field office an opportunity to review the CEMA deliverables, prior to asking for their acceptance.

Post Testing Analysis

After testing results are supplied, participants will submit raw data and sampling location(s) coordinates to SoilHealthTest@usda.gov.

Raw data will be used to improve and strengthen the Soil Health Assessment Protocol and Evaluation process, procedures, and results.

Appropriate waivers to release participant information may be used to grant permission for the QI, or NRCS field office to submit the test results.

References

USDA Natural Resources Conservation Service. 2022. Dynamic Soil Properties (DSP) Guide. https://new.cloudvault.usda.gov/index.php/s/HB84Lw7EkKAyMC7#pdfviewer

USDA Natural Resources Conservation Service. 2019. Soil Health Technical Note No. 450-03. Recommended Soil Health Indicators and Associated Laboratory Procedures. https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=43637

USDA Natural Resources Conservation Service. 2019. Soil Health Technical Note No. 450-04. The Basics of Addressing Resource Concerns with Conservation Practices within Integrated Soil Health Management Systems on Cropland. https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=44292

USDA Natural Resources Conservation Service. 2014. Kellogg Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42. Version 5.0. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054247

US Environmental Protection Agency. 2002. Guidance on Choosing a Sampling Design for Environmental Data Collection. EPA QA/G-5S. https://www.epa.gov/quality/guidance-choosing-sampling-design-environmental-data-collection-use-developing-quality

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