



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES

All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

CRITERIA

General Criteria Applicable to All Purposes

Develop a nutrient management plan (see Plans and Specifications section of this standard for required content and development methods of 'traditional' and precision ag-type plans) including recommended application rates for nitrogen (N), phosphorus (P), and potassium (K) that accounts for all known measurable sources and removal of these nutrients.

Sources of nutrients may include, but are not limited to, commercial fertilizers (including starter and in-furrow starter/pop-up fertilizer), animal manures, legume fixation credits, green manures, plant or crop residues, compost including on site mortality compost, organic by-products, municipal and industrial biosolids, wastewater, organic materials, soil carbon amendments, plant available soil nutrients, and irrigation water.

When irrigating, apply irrigation water in a manner that reduces the risk of nutrient loss to surface and ground water.

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at <https://www.nrcs.usda.gov/> and type FOTG in the search field.

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Follow all applicable State requirements and regulations when applying nutrients near areas prone to contamination, such as designated water quality sensitive areas, (e.g., lakes, ponds, rivers and streams, sinkholes, wellheads, classic gullies, ditches, or surface inlets) that run unmitigated to surface or groundwater.

The 4Rs of nutrient stewardship

For all nutrient sources, manage nutrients based on the 4Rs of nutrient stewardship—apply the right nutrient source at the right rate at the right time in the right place—to improve nutrient use efficiency by the crop and to reduce nutrient losses to surface and groundwater and to the atmosphere.

Nutrient source

Choose nutrient sources compatible with application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

Determine nutrient values of all nutrient sources (e.g. commercial fertilizers, manure, organic by-products, biosolids) prior to land application.

Determine nutrient contribution of cover crops, previous crop residues, and soil organic matter.

For operations following USDA's National Organic Program – either already certified or in the transition period -- apply and manage nutrient sources according to program regulations.

For enhanced efficiency fertilizer (EEF) products, use products defined by the Association of American Plant Food Control Officials as EEF and recommended for use by the State LGU. In North Carolina, enhanced efficiency products have not been proven to be effective for nutrient use efficiency or increased yields.

In areas where soil salinity levels are a concern on a planned field, select nutrient sources that limit the buildup of soil salts, or engage in other LGU supported salinity management techniques. When manures are applied, and soil salinity is a concern, monitor salt concentrations to prevent potential plant or crop damage and reduced soil quality. Apply manure or organic by-products on legumes at rates no greater than the LGU estimated N removal rates in harvested plant biomass, not to exceed P risk assessment limitations.

For any single application of nutrients applied as liquid (e.g., liquid manure, nutrients in irrigation water, fertigation)—

- Do not exceed the soil's infiltration rate or water holding capacity.
- Apply so that nutrients move no deeper than the current crop rooting depth.
- Avoid runoff or loss to subsurface tile drains.

When manure or other organic by-product (such as compost) is a primary nutrient source, see “Manure, organic-by product, and biosolids testing and analysis for plan development and implementation” Section of this standard for additional criteria and NC-specific guidance to develop and implement a Nutrient Management Plan or NMP component of an NC Certified Animal Waste Management Plan (CAWMP)/NRCS Comprehensive Nutrient Management Plan (CNMP).

Nutrient application timing and placement

Consider the nutrient source, management and production system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment to develop optimal timing of nutrients. For N, time the application as closely as practical with plant and crop uptake. For P, time planned surface application when runoff potential is low. Time the application of all nutrients to minimize potential for soil compaction.

For crop rotations or multiple crops grown in one year, do not apply additional P if it was already added in an amount sufficient to supply all crop nutrient needs.

To avoid salt damage, follow available NCDA C&S/NCSU recommendations for the timing, placement, and rate of applied N and K in starter fertilizer or follow industry practice recognized by the LGU.

Do not surface apply nutrients when there is a high risk of runoff, including when—

- Soils are frozen.
- Soils are snow-covered.
- The soil surface is saturated.
- Precipitation is occurring.
- For permitted animal feeding operations, when weather conditions occur that prohibit waste application per permit conditions.

Nutrient Application Rates: See “Planned Nutrient Application Rates and Implementation of Recommended Rates” Section (page 6-7) for criteria on developing appropriate nutrient application rates to be included in a Nutrient Management Plan.

Soil and tissue testing and analysis

Base the nutrient management plan and recommended nutrient application rates on current soil test results in accordance with NCDA & CS Agronomic Division and NCSU Dept of Crop and Soil Science interpretation guidance, or industry practice when recognized by NCDA C&S/NCSU. Use soil tests no older than 2 years when developing new or updating existing nutrient management plans, including for new fields added to existing plans. For animal waste management plans certified and permitted by the NC water quality regulatory authority, required soil testing intervals will be provided by the permit. Soil testing may also be completed more frequently as recommended by NCDA C&S/NCSU soil and crop specialists, or per state laws and applicable permits. Use tissue testing, when applicable, for monitoring or adjusting the nutrient management plan in accordance with NCDA & CS/NCSU guidance, or industry practice when recognized by the NCDA & CS/NCSU.

Collect, prepare, store, and ship all soil and tissue samples following NCDA & CS Agronomic Division guidance. The test analyses must include pertinent information for monitoring or amending the annual nutrient plan. Standards and recommendations for collection and preparation of soil samples, NC soil testing methodologies and crop specific fertility notes are provided in pertinent NCSU Dept of Crop & Soil Science *Soil Facts* publications and on the NCDA & CS Agronomic Division website. Additional information on interpreting NC soil test results for crop fertilization is available on the NCDA C&S Agronomic Division website.

For soil test analyses, use laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing (NAPT) Program under the auspices of the Soil Science Society of America and NRCS or use an alternative NRCS- or State-approved certification program that considers laboratory performance and proficiency to assure accuracy of soil test results. Soil test analyses for the purposes of compliance or plan development for a permitted animal operation facility shall be conducted by a laboratory certified by the [Laboratory Certification Branch](#) of the Division of Water Resources (DWR), NC Department of Environmental Quality (DEQ). Alternative certification programs must have solid stakeholder support (e.g., State department of agriculture, LGU, water quality control entity, NRCS State staff, growers, and others) and be State or regional in scope.

Producers who utilize non-NCDA Agronomic Division soil testing labs must obtain nutrient recommendations made using Mehlich-3 methodology or NCDA-equivalent conversion equations. This is to ensure laboratories provide consistent soil test-based nutrient rate recommendations made using

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guidelines and methodologies similar to NCDA&CS Agronomic Division, supported by available NC field research and reference information, and are compatible with North Carolina nutrient management planning tools and nutrient risk assessment tools.

Soil and tissue testing shall include analyses for any nutrients for which specific information is available and/or needed to develop the nutrient plan. Request analyses pertinent to monitoring or amending the annual nutrient budget, e.g. pH, electrical conductivity (EC), soil organic matter, nitrogen, phosphorus and potassium.

Maintain soil pH within ranges which enhance the adequate level for plant or crop nutrient availability and utilization. Refer to NCDA/NCSU documentation for guidance.

Manure, organic by-product, and biosolids testing and analysis for plan development and implementation

Collect, prepare, store, and ship all manure, compost (plant or animal based), organic by-products, and biosolids following NCDA & CS/NCSU guidance or industry practice when recognized by NCDA & CS/NCSU. In the absence of such guidance, test at least annually, or more frequently if needed to account for operational changes (e.g., feed management, animal type, manure handling strategy, etc.) impacting manure nutrient concentrations or by NC state law and applicable permits. If no operational changes occur and operations can document a stable level of nutrient concentrations for the preceding 3 consecutive years, manure may be tested less frequently, unless Federal, State, or local regulations require more frequent testing. For permitted animal operations, NC General Statutes require waste analyses of representative waste samples to be completed within 60 days of land application of waste materials. Follow NCDA/NCSU guidelines regarding required analyses and test interpretations. Analyze, as a minimum, total N (may be TKN), total P or P₂O₅, total K or K₂O, and percent solids.

When developing nutrient management plans for new, expanded, or production phase modified livestock operations where specific operation-based manure analysis information is not yet available, current standardized information, recognized by NRCS, and accepted by the NC Interagency Nutrient Management Committee (INMC) as meeting all technical criteria and any applicable permitting requirements – such as manure nutrient content, production, and plant availability coefficient values posted on NCSU Nutrient Management in NC website tables (<https://nutrientmanagement.wordpress.ncsu.edu/manures/>) must be used in initial planning activities. Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the NCDA & CS Agronomic Division. For significant plan modifications to existing operations – such as plan ‘revisions’ per SB 1217 Interagency Group guidance -- utilize current operation-based specific manure analysis information to the extent practicable, based upon a planning specialist determination that operation specific manure nutrient analysis values will provide the most accurate nutrient content and quantity of total nutrients generated by the operation.

USDA CNMP Nutrient Management Plan Component. For nutrient management plans developed as a component of a comprehensive nutrient management plan (CNMP) for an animal feeding operation (AFO), follow policy in NRCS directive General Manual (GM) 190, Part 405, “Comprehensive Nutrient Management Plans.” These plans must include quantification documentation and accounting of all nutrients produced and/or applied by the AFO -- nutrient imports, exports, and on-farm transfers, in addition to AFO facility generated manure and/or compost nutrients. Manure and/or compost exported quantities such as those land applied by third party manure haulers to ‘off site’ land not owned or controlled by the AFO operation must be documented in the 590 Implementation Requirements (Job Sheet) or equivalent. Manure and/or compost nutrient quantities produced by the AFO and not accounted for as hauled off site by the Implementations Requirements or equivalent must be accounted for in the nutrient management plan component of the CNMP or non CNMP nutrient management plan. Where the source of land applied compost is through the implementation of animal mortality management compost options, then all NCDA & CS State Veterinary Division and NC DEQ requirements for compost production, storage, management, off site hauling, and land application must be followed.

Nutrient loss risk assessments (see additional information on N and P loss risk assessments and plan development criteria below)

When applicable (see sections below on Nitrogen and Phosphorus Loss Risk Assessments), use current NRCS-approved nitrogen (in NC the Nitrogen Leaching Index per RUSLE 2 software that may be obtained at https://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm), phosphorus (in NC, the current version of the Phosphorus Loss Assessment Tool contained in the NC Nutrient Management Software or equivalent), and soil erosion (RUSLE 2 for PLAT soil loss data input purposes) risk assessment tools to assess the site-specific risk of nutrient and soil loss. Field specific, annual erosion estimation results, as can be obtained per RUSLE 2 assessments, for the application crop are essential to completion of an accurate PLAT assessment. When multiple annual crops produced in sequence on a specific field are included in a Nutrient Management Plan developed to reflect nutrient application for the entire crop system, use the highest annual erosion value as the soil loss data input value in PLAT. When manure is applied on crops that are permanent grasses or the crop application area clearly meets NRCS planning criteria thresholds for low soil erosion occurring (eg very flat topography, permanent/dense grass or crop cover), PLAT soil loss data input may be based on a best estimate of average annual soil loss provided by a qualified planner. When erosion concerns are visually evident, RUSLE 2 erosion estimation results are required for use in PLAT.

NITROGEN LOSS RISK ASSESSMENTS -- Nitrogen Leaching Index (NLI) and Plan Criteria

During the plan development process, complete an NRCS-approved nutrient risk assessment for Nitrogen (N) by obtaining the Nitrogen Leaching Index (NLI) value. To obtain the NLI value via RUSLE 2, only the county location and soil map unit is needed, not a complete sheet and rill erosion loss estimation assessment. **For addition instructions/information on obtaining the NLI from RUSLE 2, see reference instructions posted in the NC FOTG Sec2 Nitrogen Leaching Index folder, or here: <https://efotg.sc.egov.usda.gov/#/state/NC/documents/section=2&folder=49772>.** In situations where NLI is not determined as part of the Nutrient Management Plan, then the plan must include recommended practices and management techniques that will minimize nitrate loss risk as specified below for the planned field(s).

When the NLI > 10 for the predominant soil map unit in the planned field, recommended practices and management techniques that will minimize risk of nitrate losses must be included in the conservation plan and/or Nutrient Management Plan per the 590 Implementation Requirements or plan narrative. Additional information on Nitrogen management techniques to maintain and protect water quality when appropriate per application techniques and/or NLI are included in NRCS practice standard “Purposes”, resource concern information references, and in NC, NCSU Soils Facts publications such as “Nitrogen Management and Water Quality”, located at: <https://content.ces.ncsu.edu/nitrogen-management-and-water-quality>, and “Best Management Practices for Agricultural Nutrient”, located at: <https://content.ces.ncsu.edu/best-management-practices-for-agricultural-nutrients>. In addition to the NCSU Soil Facts references, additional information about NRCS water quality-based resource concerns and conservation treatment solutions potentially connected to land application of agricultural nutrients may be found in NRCS Resource Concerns Fact Sheets, located within National Instruction 450-309 in the NRCS eDirectives system.

PHOSPHORUS LOSS RISK ASSESSMENTS -- NC Phosphorus Loss Assessment Tool (PLAT) and Plan Criteria

Complete an NRCS-approved nutrient risk assessment (in NC, the approved assessment is the Phosphorus Loss Assessment Tool, or PLAT) for P for planned fields, when any of the following conditions are met—

- The planned phosphorous (P) application rate exceeds NCDA C&S/NCSU fertility rate guidelines for

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the planned crop system (this is typical where animal waste is applied per the approved plan at an N-based rate), **and** a PLAT assessment has not been completed in last 5 years on the planned field(s).

- The planned area is within a P-impaired watershed. In North Carolina, 303(d) impaired watersheds are not typically connected to specific nutrient causes, so this condition is unlikely to result in necessary PLAT assessment.

PLAT assessments are not necessary on planned fields in the NMP when recommended P application rates do not exceed soil test P and crop-based NCDA C&S/NCSU fertility guidelines.

In North Carolina, the regulatory authority may require a PLAT assessment to be completed on land application fields included in the Waste Utilization Plan component of a Certified Animal Waste Management Plan at any time per NC permit criteria and conditions.

For planned fields where **manure application** is to take place per the nutrient management plan, **planning criteria for P application must be based on PLAT results**, and are as follows:

- LOW NRCS national risk (NC PLAT “Low” total rating score 0-25 OR “Medium” total rating score 26-50) —Manure can be applied at rates to supply P at greater than crop requirement not to exceed the N requirement for the succeeding crop. Manure may be applied at N-based rates established through NC Realistic Yield Expectations (RYEs), appropriately verified yield records, or expert analysis of likely yields where RYEs do not exist for planned application crop(s). In NC, RYEs and recommended N rates are available on the NCSU Nutrient Management site at: <https://realisticyields.ces.ncsu.edu/>.
- MODERATE NRCS national risk (NC PLAT “High” total rating score 51-100) —Manure can be applied at rates not to exceed crop P removal rate or the soil test P recommended rate for the planned crops in rotation. In NC, P available crop P removal rates are available on the NCSU Nutrient Management in NC site with RYEs and recommended N rates at: <https://realisticyields.ces.ncsu.edu/>.
- HIGH NRCS national risk (NC PLAT “Very High total rating score > 100) -- In NC, no additional P application, including manure, is to be specified in the nutrient management when the PLAT rating is “Very High”.

Regardless of PLAT categorical risk results, when concerns exist about potential P losses from any site receiving land application of agricultural nutrients, additional information about potentially applicable conservation practice treatments and nutrient management techniques is available in NCSU Soil Facts publications and NRCS Resource Concern Fact Sheets referenced in the previous section on Nitrogen Loss Risk Assessments and Plan Criteria.

Planned nutrient application rates and implementation of recommended rates

Planned nutrient application rates for nitrogen, phosphorus, and potassium must not exceed NCSU-recommended guidelines, NCSU recognized industry practice, or criteria based on P risk assessment results.

Determination of planned nutrient application rates must consider crop/cropping sequence, current NCDA or similarly based soil test results, NC Realistic Yield Expectations (RYEs), crop yield response to applied nutrients, nutrient risk assessment results, and producer management objectives and capabilities. Sufficiently documented actual yield information per NCSU/NCDA guidelines may be utilized by a qualified specialist to develop a crop RYE for planned fields. Established RYE data for common crops in each NC county, based on soil productivity information, yield data, and research with NC soils and cropping systems is available at the NCSU Nutrient Management in NC website: <https://realisticyields.ces.ncsu.edu/>

If established RYE values or sufficiently documented yield information do not exist for a crop, a nitrogen fertilization rate recommended by NCSU or NCDA & CS agronomy and nutrient management specialists may be developed in coordination with NC INMC guidance and included in the nutrient management plan. In the absence of this recommendation, or until documented yield information has been collected, the nutrient management planner may infer a realistic yield from a similar crop on a soil with similar physical and

chemical features. The same procedure applies when establishing a RYE for a new crop. The nutrient management plan should document the source of the RYE.

Estimates of yield response must consider factors such as low soil crop yield potential, drainage, pH, salinity, etc., prior to assuming that nitrogen and/or phosphorus are deficient.

Nutrient application rates lower than those recommended are permissible if the grower's objectives are met.

Liming material shall be applied as needed to adjust soil pH to the specific range required by the crop or crops in the rotation for optimum availability and utilization of nutrients.

The recommended rates of Nitrogen(N)/Phosphorous(P)/Potassium(K) application from all sources, as documented in the planned nutrient budget, must be determined based on the following guidance:

- **Nitrogen Application** – Planned nitrogen application rates from all sources must match the RYE-based (when available) or specialist recommended (when RYE-based rates are not available) rates as closely as possible for the predominant soil map unit in each planned field or management zone.
- **Phosphorus Application** - Planned phosphorus application rates for planned fields must match the soil test recommended rates as closely as possible. When manure or organic by-products are a source of land applied nutrients, see “Phosphorus Loss Risk Assessments -- PLAT and Plan Criteria” section of this standard (page 5-6) for further guidance on P rates. For ‘variable rate’ nutrient management plan recommended rates, see “Plans and Specifications” section of this practice standard for further guidance.
- **Potassium Application** – Planned potassium application rates for planned fields must match the soil test recommended rates as closely as possible except in manure application situations. *For ‘variable rate’ nutrient management plan recommended rates, see “Plans and Specifications” section of this practice standard for further guidance.* Potassium shall not be applied in situations in which excess (greater than soil test potassium recommendation) causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, state standards when available shall be used to set forage quality guidelines.
- **Other Plant Nutrients** - The planned rates of application of other nutrients shall be consistent with NCSU/NCDA C&S guidance recommendations. High levels of soil Copper and Zinc may be toxic to production crops. Copper and zinc soil test index levels must be monitored, and planned land application of copper and zinc must be in accordance with NCSU/NCDA C&S crop toxicity guidelines.
- **Legume Cover Crops** – When legume cover crops are grown to serve as a nitrogen source for the subsequent production crop, appropriate nitrogen credit must be given to the production crop in accordance with available NCSU, CES, or NCDA & CS recommendations. Planners should note that residual N availability from legume cover crops is highly variable and site condition dependent.
- **Starter Fertilizers** - When starter fertilizers are used, they shall be included in the overall nutrient budget, and applied in accordance with NCSU/NCDA recommendations. Current NCSU/NCDA C&S recommendations are that no starter P is to be applied to soils with > 100 Soil Test P index or have a ‘very high’ categorical PLAT risk rating.

Implementation of Planned/Recommended Nutrient Application Rates

Actual nutrient application rates for nitrogen, phosphorous, and potassium must match recommended rates (for manure land application plans, overall N application rates are not to exceed annual Plant Available Nitrogen (PAN)-based amounts) in the nutrient management plan as closely as possible, and may not exceed those established through criteria attributed to risk assessment results.

Actual nitrogen application rates may not consequentially exceed planned/recommended rates, especially important for meeting requirements of a permitted NC Certified Animal Waste Management Plan, where no exceedance of planned/recommended rates is allowed. Therefore, it is critical to properly calibrate application equipment on a regular basis or as required by the operation permit.

Actual Phosphorous or potassium application rates for commercial fertilizer may exceed planned/recommended rates by a minimal amount, or when custom blended fertilizers and precision application technology are not available. Actual application rates for manure or other organic by-products

used as a nutrient source must be in accordance with P risk assessment results as described in standard criteria.

Exceeding the recommended nutrient rates or NCDA & CS/NCSU crop and soil fertility rate guidelines using manure or inorganic fertilizer on a long term basis is potentially harmful to crop production and water quality.

Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater

Apply conservation practices to avoid nutrient loss and control and trap nutrients before they can leave the field(s) by surface, leaching, or subsurface drainage (e.g., tile, karst) when there is a significant risk of transport of nutrients.

Additional Criteria to Reduce the Risk of Potential Pathogens From Manure, Biosolids, or Compost Application From Reaching Surface and Groundwater

When applicable, follow proper biosecurity measures as provided in NRCS directives GM-130, Part 403, Subpart H, "Biosecurity Preparedness and Response."

Follow all applicable Federal, Tribal, State, and local laws and policies concerning the application of manure, biosolids, or compost in the production of fresh, edible crops.

Apply manure, biosolids, or compost with minimal soil disturbance or by injection into the soil unless it is being applied to an actively growing crop, a minimum of 30 percent residue exists, or there is a living cover that has a fibrous root system with 75 percent or more cover. Do not surface apply manure if a storm event is forecast within 24 hours.

Additional Criteria to Reduce Emissions of Objectionable Odors, PM and PM Precursors, and GHG and Ozone Precursors

To address air quality concerns caused by odor, N, sulfur, and particulate emissions; adjust the source, timing, amount, and placement of nutrients to reduce the negative impact of these emissions on the environment and human health.

Do not surface apply solid nutrient sources, including commercial fertilizers, manure, or organic by-products of similar dryness/density when there is high risk that wind will blow the material and emissions offsite. Do not surface apply liquid nutrient sources when there is high risk that wind will blow the liquid droplets applied from sprinklers or other applicable methods offsite.

Consult appropriate, currently available NCSU Fact Sheets and NC DEQ Odor Control Checklist documents for additional guidance for minimizing air emissions and odors when manure is applied.

Additional Criteria to Improve or Maintain Organic Matter

Design the plant or crop management systems so the soil conditioning index (SCI) organic matter subfactor is positive.

Apply manure, compost, soil carbon amendments, or other organic nutrient sources at a rate and with minimal disturbance that will improve soil organic matter without exceeding acceptable risk of N or P loss.

For low residue plant or cropping systems, apply adequate nutrients to optimize plant or crop residue production to maintain or increase soil organic matter.

CONSIDERATIONS

General Considerations

Updates to 590 Nutrient Management conservation practice standard criteria that follow NRCS policy guidelines for timing and content of national standard revisions are not meant to necessitate retroactive modifications to existing nutrient management plans that meet guidelines accepted by the NC Interagency Nutrient Management Committee (INMC) and NC DEQ regulatory authority.

Documenting AFO Waste Materials applied by third parties or “manure haulers”

General information on manure and/or compost waste generated by an AFO to be applied to land not owned or controlled by the AFO owner or operator may be recorded as specified in the NC 590 Implementation Requirement, nutrient management plan narrative, or other supplemental documentation to the nutrient management plan. NRCS CNMP technical criteria require documentation of manure/compost nutrient exports off the farm. The AFO owner/operator should provide the third party applicator with a current waste/compost analysis in order to facilitate agronomic crop application of the facility’s generated waste – this is a requirement for NC-permitted animal feeding operations. Should land not owned or controlled by the AFO owner or operator be included in a nutrient management plan, the complete plan must meet 590 criteria. In North Carolina, third party applicators must register as a Manure Hauler as required by NC Administrative Code 15A NCAC 02T Section .1400.

Consider development of nutrient management plans by conservation management unit (CMU). A CMU is a field, group of fields, or other land units of the same land use and having similar treatment needs and planned management. A CMU is a grouping by the planner to simplify planning activities and facilitate development of conservation management systems. A CMU has definitive boundaries such as fencing, drainage, vegetation, topography, or soil lines.

Develop site-specific yield maps using a yield monitoring system, multispectral imagery or other methods. Use the data to further delineate low- and high-yield areas, or zones, and make the necessary management changes. Use variable rate nutrient application based on site-specific factor variability. See NRCS directive Agronomy Technical Note (TN) 190, AGR.3, “Precision Nutrient Management Planning.”

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in NRCS’ national nutrient policy in GM-190, Part 402, “Nutrient Management.” Consider using an adaptive approach to adjust nutrient rate, timing, form, and placement as soil biologic functions and soil organic matter changes over time. See NRCS directive Agronomy Technical Note (TN) 190, AGR.7, “Adaptive Nutrient Management Process.”

When developing new nutrient management plans, consider using soil test information no older than 1 year rather than 2 years.

Develop a whole farm nutrient budget (nutrient mass balance), including all imported and exported nutrients. Imports may include feed, fertilizer, animals and bedding, while exports may include crop removal, animal products, animal sales, manure, and compost.

Modify animal feed diets to reduce the nutrient content of manure following guidance contained in Conservation Practice Standard (CPS) Feed Management (Code 592).

Provide a nutrient analysis of all nutrient source exports (manure or other materials).

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, (e.g., high soil test P levels can result in zinc deficiency in corn).

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient deficiencies or toxicity that may impact plant growth or availability of the primary nutrients.

Do not apply K in situations where an excess (greater than soil test K recommendation) causes nutrient imbalances in crops or forages.

Use bioreactors and multistage drainage strategies to mitigate nutrient loss pathways, as applicable.

Use legume crops and cover crops to provide N through biological fixation. Cover crops with a carbon to nitrogen ratio below 20:1 can release a large amount of soluble N after being plowed or tilled into the soil when an actively growing crop is not present to take up nutrients, leading to increased risks of nitrate movement and nitrous oxide emissions. The nitrous oxide emissions often occur in high soil moisture conditions, such as when a legume cover crop is plowed down in fall or early spring. To avoid these losses, use grass-legume or grass-legume-forbs mixtures with a more balanced carbon to nitrogen ratio.

Use winter hardy grass cover crops to take up excess N after the cash crop growing season and promote contribution of the nitrogen to next plant or crop.

Use conservation practices that slow runoff, reduce erosion, and increase infiltration (e.g., filter strip, contour farming, or contour buffer strips).

Use application methods, timing, technologies or strategies to reduce the risk of nutrient movement or loss, such as—

- Split nutrient applications.
- Banded applications.
- Injection of nutrients below the soil surface.
- Incorporate surface-applied nutrient sources when precipitation capable of producing runoff or erosion is forecast within the time of a planned application.
- High-efficiency irrigation systems and technology.

Enhanced efficiency fertilizers are only recommended when accepted as effective for production value, nutrient use efficiency, and/or water quality protection by NCDA & CS/NCSU. See NCSU Soil Facts publication “Alternative Synthetic Nitrogen Fertilizer Products for Row Crop Production”, located at (<https://content.ces.ncsu.edu/alternative-synthetic-nitrogen-fertilizer-products-for-row-crop-production>) for most current information available on performance of alternative nitrogen fertilizer products in assessed field production crops.

- Slow or controlled release fertilizers
- Nitrification inhibitors
- Urease inhibitors.
- Drainage water management.
- Tissue testing, chlorophyll meters, or real-time sensors.
- Pathogen management considerations.

When a recycled product (e.g., compost) is to be used as a nutrient source on food crops or as food for humans or animals, make sure that pathogen levels have been reduced to acceptable levels (reference the Food and Drug Administration’s Food Safety Modernization Act). www.fda.gov/FSMA When the recycled product has come from another farming operation, implement biosecurity measures and evaluate the risk of pathogen transfer that could cause plant or animal diseases.

Use manure treatment systems that reduce pathogen content from manure.

Implementing a soil health management system that reduces tillage or other soil disturbance, includes a diverse rotation of crops and cover crops, keeps roots growing throughout the year, and keeps the soils covered to reduce nutrient losses, and improves—

- Nutrient use efficiency, rooting depth, and availability of nutrients.
- Soil organic matter levels.
- Availability of nutrients from organic sources.
- Aggregate stability and soil structure.
- Infiltration, drainage, and aeration of the soil profile.
- Soil biological activity.
- Water use efficiency and available moisture.

Use targeted or prescribed livestock grazing to enhance nutrient cycling and improve soil nutrient cycling functions.

Elevated soil test P levels may lead to reduced mycorrhizal fungal associations and immobilize some micronutrients, such as iron, zinc, and copper.

Apply manure, compost, or other nutrient sources with minimal soil disturbance and at a rate that will improve soil organic matter without exceeding acceptable risk of N or P loss.

PLANS AND SPECIFICATIONS

For NC-permitted animal operations, the Nutrient Management Plan (may also be called the “Waste Utilization Plan”) must include all elements required by the Permit and Certified Animal Waste Management Plan (CAWMP).

In the nutrient management plan, document—

- Aerial site photograph(s), imagery, topography, or site map(s).
- Soil survey map of the site.
- Soil information including: soil type, surface texture, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and ponding frequency.
- Location of designated sensitive areas and the associated nutrient application restrictions and setbacks.
- Location of nearby residences, or other locations where humans may be present on a regular basis, that may be impacted if odors or PM are transported to those locations.
- Results of approved risk assessment tools for N, P, and erosion losses.
- Current and planned plant production sequence or crop rotation.
- All available test results (e.g. soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient budget and management plan are based.
- When soil P levels are increasing above an agronomic level, include notification of the loss risk associated with soil surface P accumulation and possible P draw-down strategy
- Realistic yield goals for the crops (where applicable for developing the nutrient management plan).
- Nutrient recommendations for N, P, and K for the entire plant production sequence or crop rotation.
- Listing, quantification, application method and timing for all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports, and onsite transfers.
- Guidance for implementation, operation and maintenance, and recordkeeping.

For variable rate (‘precision ag’ type plans) nutrient management plans, also include—

- Planned N rate based in NC RYEs, sufficient on farm records, or qualified crop specialist recommendations. P & K planned rates do not have to be 'documented' in a typical pre-developed nutrient management 'plan', but will be based in zone based soil test results and verified after implementation with soil test results and application maps provided for practice certification.
- Geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations per management zone. Must include site-specific yield maps using soils data, current soil test results, and a yield monitoring system with GPS receiver to correlate field location with yield.
- Nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- After implementation, provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all nutrient or soil amendment applications. Actual application rates must match prescribed N rate and soil test based P & K rates as closely as possible.
- Where 'chlorophyll' reader technology is utilized for real time, crop-need based nitrogen application, application records that nitrogen rates match RYE-based N rates or documented crop needs as closely as possible.
- For non variable rate 'zone based' application of P & K, provide applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all applications that resulted from use of the precision agriculture process for nutrient or soil amendment applications.

If increases in soil P levels are expected above an agronomic level (i.e., when N-based rates are used), use the NC 590 Implementation Requirements 'job sheet' or Nutrient Mgmt Plan narrative to document --

- Soil P levels or PLAT categorical risk assessment results at which it is desirable to convert to P-based planning. In NC, P based planning must commence at a PLAT 'High' risk assessment level.
- A long-term strategy and proposed implementation timeline for soil test P drawdown from the production and harvesting of crops. Should a P drawdown be desired or necessary, the only proven method of reducing soil P is to **not** apply P fertilizer of any type **and** to plant and harvest crops that utilize P currently present in the soil surface.
- Management activities or techniques used to reduce the potential for P transport and loss.
- For AFOs, a quantification of manure produced in excess of crop nutrient requirements, if applicable.

OPERATION AND MAINTENANCE

Review or revise plans periodically to determine if adjustments or modifications are needed. At a minimum, review plans with each soil test cycle and revised if needed when changes in manure management, volume or analysis, plants and crops, or plant and crop management occur. In NC, animal operations subject to state permitting requirements may have different review periods. For NPDES permitted animal operations, plan revisions could trigger a permit revision process that includes public review of the plan. Planning requirements for Plan "Amendments" (minor modifications) and "Revisions" (Major Modifications) are clarified by SB 1217 Interagency Group Guidance Sections 1.4, 1.5, and 1.6.

Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and P in accordance with NCSU guidance and State law.

For animal feeding operations, significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a nutrient content value representative of actual land application amounts.

Calibrate application equipment to ensure accurate distribution of material at planned rates. Calibration

frequency for animal feeding operations is specified in permits. All animal feeding operations under NPDES permits must calibrate application equipment annually.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation to explain the difference.

Protect workers from and avoid unnecessary contact with nutrient sources. Take extra caution when handling anhydrous ammonia or when managing organic wastes stored in unventilated tanks, impoundments, or other enclosures.

Use material generated from cleaning nutrient application equipment in an environmentally safe manner. Collect, store, or field apply excess material in an appropriate manner.

Recycle or dispose of nutrient containers in compliance with State and local guidelines or regulations.

Maintain records for at least 5 years or for a period required by NC Administrative Code and/or permitting provisions to document plan implementation and maintenance. Records must include—

- All test results (soil, water, compost, manure, organic by-product, and plant tissue sample analysis upon which the nutrient management plan is based.
- and quantification of all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports and onsite transfers.
- Date(s), method(s), and location(s) of all nutrient applications.
- Precipitation records as required by the NMP and/or permit conditions.
- Plants and crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and plant or crop residues removed.
- Dates of plan review, name of reviewer, and recommended adjustments resulting from the review.
- Dates, methods, and land application locations of all manure transfers to third party applicators/manure haulers.

For variable rate nutrient management plans, also maintain —

- Maps identifying the variable application location, source, timing, amount, and placement of all plant and crop nutrients applied.
- GPS-based yield maps for crops where yields can be digitally collected.

REFERENCES

NCSU Nutrient Management In North Carolina website: <https://nutrientmanagement.wordpress.ncsu.edu/>.

NCSU Nutrient Management in NC Manure Nutrient Summary: <https://nutrientmanagement.wordpress.ncsu.edu/manures/>

NCSU Nutrient Management in NC Realistic Yield Expectations (RYEs): <https://realisticields.ces.ncsu.edu/>.

The North Carolina Phosphorus Loss Assessment Tool (PLAT): <https://content.ces.ncsu.edu/the-north-carolina-phosphorus-loss-assessment-tool-plat>.

The NC PLAT – A Guide for Technical Specialists: <https://content.ces.ncsu.edu/the-north-carolina-phosphorus-loss-assessment-tool-plat-a-guide-for-technical-specialists/>

NC Interagency Nutrient Management Committee technical guidance: <https://nutrientmanagement.wordpress.ncsu.edu/resources/>.

SB 1217 Interagency Group information and guidance: <http://www.ncagr.gov/SWC/tech/1217committee.html>

NC DENR DWR Animal Feeding Operations website: <https://deq.nc.gov/about/divisions/water-resources/water-quality-permitting/animal-feeding-operations>.

NC State University Cooperative Extension Service Soil Facts publications: <https://content.ces.ncsu.edu/catalog/series/104/soilfacts>.

Association of American Plant Food Control Officials (AAPFCO). 2017. AAPFCO Official Publication no. 70. AAPFCO Inc., Little Rock, AR.

Follett, R.F. 2001. Nitrogen transformation and transport processes. In Nitrogen in the environment; sources, problems, and solutions, (eds.) R.F. Follett and J. Hatfield, pp. 17–44. Elsevier Science Publishers. The Netherlands. 520 pp.

Schepers, J.S., and W.R. Ruan, (eds.) 2008. Nitrogen in agricultural systems. Agron. Monogr. no. 49, American Society of Agronomy (ASA), Crop Science Society of America (CSSA), Soil Science Society of America (SSSA). Madison, WI.

Sims, J.T. (ed.) 2005. Phosphorus: Agriculture and the environment. Agron. Monogr. no. 46. ASA, CSSA, and SSSA, Madison, WI.

Stevenson, F.J. (ed.) 1982. Nitrogen in agricultural soils. Agron. Series 22. ASA, CSSA, and SSSA, Madison, WI.

USDA, NRCS. Agronomy Technical Note 3, Precision Nutrient Management Planning. 2010. Washington, DC. NRCS eDirectives under Technical Notes, Title 190 <https://policy.nrcs.usda.gov/>.

USDA, NRCS. Agronomy Technical Note 7, Adaptive Nutrient Management Process. 2013. Washington, DC. NRCS eDirectives under Technical Notes, Title 190 <https://policy.nrcs.usda.gov/>.

USDA, NRCS. Nutrient Management Technical Note 7, Reducing Risk of E. coli O157:H7. 2007. Washington, DC. NRCS eDirectives under Technical Notes, Title 190 <https://policy.nrcs.usda.gov/>.

USDA, NRCS. Title 190, General Manual, (GM), Part 402, Nutrient Management. 2011. Washington, DC. NRCS eDirectives under General Manual, Title 190 <https://policy.nrcs.usda.gov/>.

USDA, NRCS. Title 190, National Instruction (NI), Part 313, Nutrient Management Policy Implementation. 2017. Washington, DC. NRCS eDirectives under National Instruction, Title 190 https://policy.nrcs.usda.gov