

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical, and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and

irrigation water.

Enhanced efficiency fertilizers, used in the state must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by NCSU and NCDA experts with responsibility for verification of product guarantees, ingredients (by AAPFCO definition) and label claims.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with NCSU/NCDA & CS guidelines, or industry practice recognized by NCSU/NCDA & CS specialists.

For nutrient risk assessment policy and procedures see Title 190, General Manual (GM), Part 402, Nutrient Management, and Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation.

To assess the risk of **nitrogen** leaching loss, the nitrogen Leaching Index, obtained through use of current Soil Hydrologic Group (SHG)-based LI index maps in Section II of the NC FOTG OR RUSLE 2 field-specific soil loss calculations, must be completed on all planned fields.

In North Carolina, the Phosphorus Loss Assessment Tool (PLAT) is utilized to assess P loss risk on a field specific basis.

To assess the field specific risk of **phosphorus** loss, PLAT evaluations are applicable to planned fields that meet either of the following conditions:

- Condition 1: the phosphorus application rate for manure or commercial nutrients—including applied starter P--exceeds soil test report rate guidelines for the planned crop(s), **or**
- Condition 2: the planned area is within the watershed for a 303d-listed water body, and

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service [State Office](#) or visit the [Field Office Technical Guide](#).

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ag-related P loss is identified by NC DENR DWR as a likely contributor to the impairment. (A current parameter indicating potential nutrient-related impairment is Chlorophyll A.) The most current version of the NC 303d list is available on the NC DWR website at:

<http://portal.ncdenr.org/web/wq/ps/mtu/assessment>.

PLAT is not required when neither Condition 1 nor Condition 2 applies to the planned field.

When PLAT is determined applicable to the planned field by meeting Condition 1 or Condition 2, it will not be required when NRCS, through coordination with the NC Interagency Nutrient Management Committee (INMC), has determined conditions where the risk of phosphorus loss in a planned field is low.

PLAT is not required if all of the following 'low risk' conditions apply to the planned field(s):

- 5 years old or less PLAT field assessment
- Manure sludge (as is typical with lagoon sludge maintenance or lagoon closures) has not been applied since the last PLAT field assessment;
- The previous PLAT Total P rating score is 45 or less for the planned field(s).
- The planned field is not to be included in land application of lagoon sludge through closure or maintenance

NC PLAT rating categories commensurate with national 590 P-loss risk categories are noted in the "Manure Nutrient Application Rates" section of this standard, (See Table 590-1), and are considered to have equivalent criteria for purposes of P application planning.

State or Federally permitted animal operations are required to complete PLAT assessments at intervals required by the regulatory entity.

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program.

Areas contained within minimum application setbacks (e.g., sinkholes, wellheads, gullies,

ditches, or surface inlets) must receive nutrients consistent with the setback restrictions, such as those described by current Senate Bill 1217 Committee Guidance and state law for manure.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater.

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization.

Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing).

Nutrient management plans must be developed utilizing current soil test results, no more than 3 years old.

Soil samples shall be collected and prepared in accordance with North Carolina State University or the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Agronomic Division standards or recommendations. Standards and recommendations for collection and preparation of soil samples are outlined in pertinent NCSU Dept of Soil Science *Soil Facts* publications.

Current soil tests are those that are no older than 3 years, but may be taken on an interval recommended by NCSU/NCDA crop and soils specialist guidance or as required by state law. The area represented by a soil test must be consistent with soil testing procedures recommended by NCSU and/or NCDA & CS.

Soil test analyses can be performed by any laboratory or program that is certified by the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Water Quality, Laboratory Section. NCDA&CS Agronomic Division uses the Mehlich-3 extractant process for soil testing.

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 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

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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.

Nutrient values of manure, organic by-products and biosolids must be determined prior to land application. In North Carolina, the most current nutrient values of manure are posted on the NCSU Nutrient Management in North Carolina website

(<http://nutrients.soil.ncsu.edu/index.htm>).

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P₂O₅, total potassium (K) or K₂O, percent solids, Copper (Cu), and Zinc (Zn), or follow NCSU and/or NCDA & CS guidance regarding required analyses.

Samples must be collected, prepared, stored, and shipped following NCSU and NCDA & CS recommended procedures, outlined in the NCSU Dept of Soil Science *Soil Facts* publication *Waste Analysis*.

When planning for new or modified livestock operations, available standard information, recognized by NRCS, such as manure nutrient source and production values posted on the NCSU Nutrient Management in NC website, and those included in NC nutrient management planning software, may be used if they accurately estimate nutrient output from the proposed operation. Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the NCDA & CS Agronomic Division.

Planned Nutrient Application Rates

Planned nutrient application rates for nitrogen, phosphorus, and potassium must not exceed NCSU-recommended guidelines or NCSU recognized industry practice.

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:

<http://nutrients.soil.ncsu.edu/yields/index.php>

If established RYE values or sufficiently documented yield information does 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 the NC INMC. 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 RYEs, 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.

Applications of biosolids or pop-up fertilizers must be accounted for in the nutrient budget.

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 N/P/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 for must match the RYE-based or specialist recommended rates as closely as possible for the predominant soil

map unit in each planned field or management zone.

Where manure or organic by-products is a source of land applied nutrients, see “*Additional Criteria to Properly Utilize Manure and Organic By-Products—Manure Nutrient Application Rates*” for further guidance on N rates.

Where intensely managed prescribed grazing systems facilitate enhanced manure nitrogen recycling, see the “Considerations” section of this standard for further guidance on N rates.

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 is a source of land applied nutrients, see “*Additional Criteria to Properly Utilize Manure and Organic By-Products—Manure Nutrient Application Rates* for further guidance on P rates.

- **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. 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 shall be used to set forage quality guidelines.
- **Other Plant Nutrients** - The planned rates of application of other nutrients shall be consistent with NCSU or NCDA&CS 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 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 NC State University or NCDA&CS recommendations. Current NCSU recommendations are that no starter P is to be applied to soils or sites that rate Very High through NCDA Soil Tests or PLAT.

Implementation of Recommended Nutrient Application Rates

Actual nutrient application rates for nitrogen, phosphorous, and potassium must match planned/recommended rates as closely as possible, and may not exceed those established through criteria attributed to risk assessment results

Actual nitrogen application rates may not exceed planned/recommended rates.

Actual Phosphorous or potassium application rates may exceed planned/recommended rates when custom blended fertilizers and precision application technology are not available, and when manure or other organic by-products are used as a nutrient source in accordance with Planned Manure Nutrient Application Rates criteria in this standard.

Exceeding the recommended nutrient rates (from soil test/RYE) using manure or inorganic fertilizer on a long term basis is potentially harmful to crop production and water quality.

Nutrient Sources.

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

Nutrient Application Timing and Placement.

Timing and placement of all nutrients must correspond as closely as practical with plant nutrient uptake (utilization by crops), and consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results.

Nutrients must not be surface-applied if nutrient losses offsite are likely, such as with frozen and/or snow covered soils, and saturated soils.

controlled by the producer must be accounted for in a nutrient management plan.

Nutrient Management Plan Development

In addition to NCDA soil test recommendations, the nutrient management plan must be based on approved values for RYEs, nitrogen factors, phosphorus removal rates, default nutrient values for animal waste, plant availability coefficients for N, P, and K, animal waste generation volumes, and for manure, application timing windows per SB 1217 Interagency Group guidance. Appropriate values, including nutrient application rates, are those approved by the N.C. Interagency Nutrient Management Committee (INMC) based on NCSU-recommended guidelines. NC RYEs are found at:

<http://nutrients.soil.ncsu.edu/yields/index.php>.
Historic farm records may also be used through use of a procedure provided in SB 1217 Interagency Group guidance.

Historically accepted and approved NCSU manure nutrient values can continue to be utilized in existing nutrient management plans unless a 'major modification' of the plan as defined in current SB 1217 Interagency Group guidance, is required or requested by the producer (see Operation & Maintenance section of this standard for more information).

The most current values must be utilized for newly developed nutrient management plans, for new application fields added to existing plans, for existing plans with SB 1217 guidance-defined major modification revisions, or upon producer request.

For livestock classes or other types of waste without default information on the NCSU website, use available values from the USDA Agricultural Waste Management Field Handbook, Chapter 4 – Agricultural Waste Characteristics, available at: <ftp://ftp.wcc.nrcs.usda.gov/wntsc/AWM/handbook/ch4.pdf>

All manure waste applied on land owned by or controlled by an Animal Feeding Operation (AFO) owner or operator must be included in a nutrient management plan. The volume difference in total manure waste generated by the AFO and waste applied to land not owned or

Concentrated feeding area acreage in land application fields, where vegetation has been destroyed or severely damaged, should not be included in the nutrient management plan for land application of additional nutrients.

In development of the nutrient management plan, planners must correctly identify the land application crop in order to ensure that proper nutrient application rates are specified in the plan.

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

Planners must use the current NRCS-approved nitrogen, phosphorus, and soil erosion risk assessment tools to assess the risk of nutrient and soil loss. Identified resource concerns must be addressed to meet current planning criteria (quality criteria).

When PLAT categorical field ratings are HIGH, OR when the Nitrogen LI > 10 for the planned field, appropriate conservation practices and/or application techniques must be included in the conservation plan and/or Comprehensive Nutrient Management Plan (CNMP) to control or trap nutrients before they can leave the field via surface or subsurface drainage (if present). The number of applications and the application rates must also be considered to limit the transport of nutrients to tile. See the document "Soil Rating for Nitrate and Soluble Nutrients" in Section II of the FOTG for further technical guidance.

When nutrients are applied to fields where erosion exceeds soil loss tolerance ("T"), a site assessment must be conducted to determine need for mitigation practices that reduce sediment delivery and surface runoff. If site assessment concludes that mitigation practices are needed, appropriate practices must be included in the conservation plan.

Nutrients must be applied with the right placement, in the right amount, at the right time, and from the right source to minimize nutrient losses to surface and groundwater. The following nutrient use efficiency strategies must be considered in accordance with NCSU and NCDA recommendations:

- slow and controlled release fertilizers; and nitrification and urease inhibitors (for NC specific information, see NCSU Soil Facts publication *Alternative Synthetic Nitrogen Fertilizer Products for Row Crop Production*, available at: <http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-74April7.pdf>).
- incorporation or injection
- timing and number of applications
- coordinate nutrient applications with optimum crop nutrient uptake
- tissue testing, chlorophyll meters, and spectral analysis technologies
- adaptive nutrient management techniques as recommended by NCSU
- other NCSU and NCDA supported technologies that improve nutrient use efficiency and minimize surface or groundwater resource concerns.

Additional Criteria Applicable to Properly Utilize Manure or Organic By-Products as a Plant Nutrient Source

The total single irrigation event application of liquid manure:

- must not exceed the soil’s infiltration or water holding capacity
- must be based on crop rooting depth, utilizing available information in the NRCS NC Irrigation Guide
- must be adjusted to avoid runoff or loss to subsurface tile drains.
- must meet conditions of the applicable permit for the animal operation.

Crop production activities and nutrient use efficiency technologies as recommended by NCSU and NCDA must be coordinated to take advantage of mineralized plant-available nitrogen losses due to denitrification or ammonia volatilization.

Planned Manure Nutrient Application Rates

Manure nitrogen application rates must be planned based on RYE-based nitrogen needs of the application crop, or NCSU/NCDA &CS specialist recommendation in the absence of RYE information. The plan must include the Leaching Index value. Nitrogen-based rates

may result in an application rate for other nutrients that exceeds the soil test recommendation.

Manure phosphorus application rates must be planned based on criteria attributed to risk assessment results as determined by the most recent field-specific PLAT risk evaluation. The specific field conditions that require PLAT use is detailed in the General Criteria of this standard. **Manure P application criteria are shown in Table 590-1.**

Where PLAT is utilized, the total rating will be calculated using the most erosive projected crop in the P application planning period in order to ensure manure P is not applied at a rate above the risk rating in the highest erosion year of the crop rotation where manure is applied. The soil erosion data input for the most erosive crop must be derived from RUSLE 2 and stated as tons/ac/year.

Table 590-1, PLAT Rating Categories and Manure Nutrient Application Criteria

PLAT RATING (Total PLAT rating score)	Equivalent National 590 P-loss risk category	NC Manure Nutrient Application Criteria
LOW (0-25)	LOW	Nitrogen-based manure application
MEDIUM (26-50)	LOW	Nitrogen-based manure application
HIGH (51-100)	MODERATE	P-based manure application (limited to P uptake in harvested biomass).
VERY HIGH (>100)	HIGH	No additional manure OR starter P application to be specified in plan

For planning requirements and documentation where PLAT is completed, see “Post PLAT

Planning Requirements” section included in “Planning and Specifications” part of this standard.

Single event manure phosphorus applications

A single event application of phosphorus applied in manure (such as when lagoon sludge is applied during a lagoon closure or lagoon storage maintenance) or organic by-product may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence.

When such single manure-based applications of phosphorus are made for multiple-year crop sequence P needs, the rate must:

- not exceed the recommended nitrogen application rate during the year of application, or
- not exceed the estimated nitrogen removal in harvested plant bio-mass during the year of application when there is no recommended nitrogen application, and
- not exceed the application criteria required by PLAT rating table 590-1, and not be made on sites with a Very High PLAT risk rating.

On PLAT “High” fields, where P application criteria requires manure P to be applied at a rate not to exceed crop P uptake rate, single multi-year based crop sequence P manure applications may be made. However, no additional P can be applied until crop P uptake for the multi-year crop sequence equals the amount of manure P applied in the single year application.

Manure or organic by-products must not be applied more than 30 days prior to planting of the crop or forages breaking dormancy, and for NC permitted animal operations, must be applied within approved crop application windows as noted in the Certified Animal Waste Management Plan. Also, manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass, not to exceed NCSU recommendations.

When land receiving manure is predominantly pine forest, refer to NC INMC Issue Guidance “Animal Waste Application on Forest Land” (<http://nutrients.soil.ncsu.edu/interagency/techni>

cal.guidance/forestry_application_guidance.pdf) for application criteria.

Heavy Metal Monitoring for Biosolids and Manures. When sewage sludge (biosolids) is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil must be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations.

Additional information on heavy metal criteria for sewage sludge and biosolids may be found at: <http://water.epa.gov/polwaste/wastewater/treatment/biosolids/index.cfm>

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates

To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impact of these emissions on the environment and human health. One or more of the following may be used:

- slow or controlled release fertilizers; and nitrification and urease inhibitors (see “Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater” section of this standard for more information)
- nutrient enhancement technologies
- incorporation
- injection
- stabilized nitrogen fertilizers
- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Do not apply poultry litter, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material offsite. Operators will handle and apply poultry litter or other dry types of animal manures when the potential for wind-driven loss is low and there is less potential for transport of particulates into the atmosphere.

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

Time the application of nutrients to avoid periods when field activities will result in soil compaction.

In areas where salinity is a concern, select nutrient sources that minimize the buildup of soil salts.

CONSIDERATIONS

Third Party Applicators/Manure Haulers

General information on manure 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 CNMP Certification Sheet and Documentation Checklist* or other supplemental documentation to the nutrient management plan. NRCS CNMP technical criteria require documentation of manure exports off the farm. The AFO owner/operator should provide the third party applicator with a current waste analysis in order to facilitate agronomic crop application of the facility's generated waste. 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.

Nitrogen application rates in intensely managed prescribed grazing systems

For pasture fields implementing an intensely managed prescribed grazing system, additional applied nitrogen recommendations to meet RYE-based crop needs or producer yield objectives may be based on an estimated quantity of recycled livestock manure nitrogen. This recommendation may be made upon producer requested grazing specialist analysis of grazing system efficiency and manure nutrient distribution. The recycled manure nitrogen portion of the overall RYE-based N recommended rate will not exceed an amount attributed to crop nitrogen availability through a determined level of manure distribution uniformity in prescribed grazing systems.

Consider using documented actual yield data from the planned site to determine nitrogen

application rates. To identify a RYE based on actual yield data, determine the average of the highest three yields of the last five consecutive specific crop or forage harvests.

Use no-till/strip-till in combination with cover crops to sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency.

Use nutrient management strategies such as cover crops, crop rotations, and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Use variable-rate phosphorus and potassium application rates based on site-specific variability in crop yield, soil characteristics, soil test values, and other soil productivity factors.

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high- yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Use manure management conservation practices to manage manure nutrients to limit losses prior to nutrient utilization.

Apply manure at a rate that will result in an "improving" Soil Conditioning Index (SCI) without exceeding acceptable risk of nitrogen or phosphorus loss.

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

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

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus 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.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on

farms as outlined in the NRCS' National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Potassium should not be applied in situations where an excess (greater than soil test potassium recommendation) causes nutrient imbalances in crops or forages.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater.

Use conservation practices that slow runoff, reduce erosion, and increase infiltration, e.g., filter strip, contour farming, or contour buffer strips. These practices can also reduce the loss of nitrates or soluble phosphorus.

NCSU research indicates that acidic soil conditions contribute to high levels of water solubility of soil P reactive products when organic waste P is applied. Thus, when soil tests show that pH is below soil target pH and lime is recommended, soils should be limed to increase soil pH to soil target levels prior to application of organic waste materials. Target pHs as established by NCDA Agronomic Division are 5.0 for Organic soil class (ORG), 5.5 for Mineral-Organic soil class (M-O), and range from 6.0 to 6.5 for Mineral soil class (MIN) depending on the crop.

Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as:

- split applications of nitrogen to deliver nutrients during periods of maximum crop utilization,
- banded applications of nitrogen and/or phosphorus to improve nutrient availability,
- drainage water management to reduce nutrient discharge through drainage systems, and
- incorporation of surface-applied manures or organic by-products if precipitation capable of producing runoff or erosion is forecast within the time of planned application.

Use bioreactors and multistage drainage strategies when approved by the land-grant university.

When land application fields are grazed by livestock, consider development of a prescribed

grazing plan balancing forage produced with herd nutritional need, while preserving the grass forage stands included in the nutrient management plan as a land application receiving crop.

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere.

Avoid applying manure and other by-products upwind of inhabited areas.

Use high-efficiency irrigation technologies (e.g., reduced-pressure drop nozzles for center pivots) to reduce the potential for nutrient losses.

For manure applications, consider location of nearby residences, or other locations where humans may be present on a regular basis, and any identified meteorological (e.g., prevailing winds at different times of the year), or topographical influences that may affect the transport of odors to those locations,

PLANS AND SPECIFICATIONS

For NC DWR or NPDES permitted animal operations, the plan and specifications must include all elements required by the Certified Animal Waste Management Plan and Permit.

The following components must be included in a nutrient management plan typical of 'conventional' fertilizer and manure application methods. Where precision ag/variable rate application technology is utilized, see next section for additional guidance.

- aerial site photograph(s)/imagery or site map(s), and a soil survey map of the site
- A listing of nutrient application land application areas, ie 'fields' or 'management zones'.
- Planned nitrogen application rates based on the RYE where available.
- The Nitrogen Leaching Index for planned fields.
- Planned P & K application rates based on soil test results (not applicable where P & K applied through variable rate technology).
- Sufficient soils information—such as dominant soil map unit for each planned

field—needed to apply nutrients at RYE and Soil Test Report determined rates as appropriate; and to not exceed rates determined by nutrient risk assessment planning criteria.

- location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- results of any applicable approved risk assessment tools for nitrogen, phosphorus, and erosion losses. In NC, most recent PLAT results are a required part of the nutrient management plan where manure is applied.
- current and/or planned plant production sequence or rotation,
- soil, water, compost, manure, organic by-product, and plant tissue sample analyses applicable to the plan,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation
- land application timing specifications based on crop needs and growth response. For manure, land application must be based on approved crop specific waste application windows
- listing and quantification of all nutrient sources and form,
- in accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount (except for precision/variable rate applications specify method used to determine rate), and placement of plant nutrients for each field or management unit, and
- guidance for implementation, operation and maintenance, and recordkeeping as specified by the CNMP or applicable NC DWR or NDPEs permit.
- On intensely managed grazed pasture fields where quantity of assessed recycled N is included in the N recommendation, a RYE-based complete nitrogen budget that includes

estimated recycled and planned additional nitrogen application amount. Documentation method used to assess manure distribution uniformity and then determine recycled N included in the overall nitrogen rate recommendation must be included in the nutrient management plan.

When determining actual application rates, a laboratory analysis is the preferred method to determine nutrient values of manure and organic by-products to be applied, and is required by state laws or rules for regulated operations. Waste reports from the NCDA & CS Agronomic Division, or equivalent, are acceptable sources of information for determining applied nutrient amounts for recordkeeping or crop budgeting purposes.

Precision/Variable Rate Nutrient Application Planning and Verification

In precision ag/variable rate nutrient application situations, some required planning components of the preceding section, such as aerial photos, site maps, and soils information may be provided by the overall conservation plan.

The following components must be included in precision/variable rate nutrient management planning and/or verification that actual application rates for nitrogen, phosphorus, and potassium application match the recommended rates as closely as possible.

PLANNING

- RYE-based nitrogen application rate recommendations must be provided to the producer on each planned field. Planned application rates may be made per soil testing 'zone' or per more conventional crop management field.
- The Nitrogen Leaching Index value for each planned field. .
- The 590 Nutrient Management Job Sheet/Supplemental Information
- In non-variable rate situations, planned P & K rates based on soil test results as specified in Soil Testing section of this standard must be provided to the producer for each planned field. P & K soil test-based rate recommendations may be provided to the producer by NRCS or a producer consultant. The source of the

recommendation must be retained by NRCS as part of overall nutrient management planning documentation.

VERIFICATION

- Documentation per field nitrogen application rates do not exceed RYE-based recommended rates
- Documentation of the 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.
- Documentation of the 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.
- Documentation if a variable rate nutrient or soil amendment application was made.
- Where variable rate application is done, documentation that phosphorous and potassium application rates do not exceed rates specified by soil sampled zone based test results. Application records per management/soil sampled zone and geo-referenced field must be provided.
- 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.
- Maintain the electronic records of the GIS data layers and nutrient applications for at least 5 years.
- Where 'chlorophyll' reader technology is utilized for real time, crop-need based nitrogen application, application records that nitrogen rates match RYE-based N rates as closely as possible.

Post PLAT Planning Requirements

When PLAT field evaluations are completed, the nutrient management plan must include:

- ◆ a record of the PLAT assessment rating

for each field or sub-field, and

- ◆ information about conservation practices and management activities that can reduce the potential for phosphorus movement from the site.

Where increases in Soil Test P levels are expected (typically where manure is applied with Nitrogen as the limiting nutrient), the nutrient management plan must document:

- Information on the NC PLAT rating categories that will require P-based manure application (HIGH) AND where no additional manure can be applied (VERY HIGH) will be specified in the plan. Future manure P application within 590 criteria will be based on site specific resource conditions, which will facilitate data input into PLAT.
- Information on a P drawdown strategy (reduction in soil phosphorus) for the manure application site. Should a P drawdown be desired or necessary, the only proven method of reducing soil P is to **not** apply manure-based P **and** to plant and harvest crops that utilize P currently present in the soil surface.
- When phosphorus is applied in excess of crop requirement, and where a PLAT assessment is **not** conducted in conjunction with providing assistance in applying this standard, documentation establishing the application site meets 'low risk' conditions as approved by the NC INMC and detailed in General Criteria.
- Conservation practices and/or management activities or techniques used to reduce the potential for P transport and loss must be documented in the conservation plan.
- for AFOs, a quantification of manure produced in excess of crop nutrient requirements if applicable.

OPERATION AND MAINTENANCE

The owner/client is responsible for safe operation and maintenance of this practice, including all equipment. Operation and

maintenance guidance provided to the client must address the following:

1. The producer is encouraged to review the plan periodically to determine if adjustments or modifications to the plan are needed. In NC, animal operations permitting provisions may specify more frequent 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. .
2. Protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
3. Proper calibration of application equipment to ensure uniform distribution of material at planned rates.
4. Maintaining records to document plan implementation. Records should be maintained for five years, or for a period as required by NC DWR General or NPDES Permits. To ensure adequate information exists to support sound nutrient management, NRCS recommends the following records be included:
 - soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,
 - quantities, analyses and sources of nutrients applied,
 - dates, and method(s) of nutrient applications, source of nutrients, and rates of application,
 - weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event,
 - crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and crop residues removed,
 - dates of plan review, name of reviewer, and recommended changes resulting from the review, and
 - all enhanced efficiency fertilizer products used.
 - Additional records for precision/variable rate sites must include:
 - maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied, and
 - GPS-based yield maps for crops where yields can be digitally collected.
5. State laws or regulations may define record-keeping requirements for some operations.
6. Workers should be protected from and avoid unnecessary contact with inorganic fertilizers and organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with organic wastes stored in unventilated enclosures.
7. The disposal of material generated by the cleaning of nutrient application equipment should be accomplished properly. Excess material should be collected and stored or field applied in an appropriate manner. Excess material should not be applied on areas of high potential risk for runoff or leaching.
8. The disposal or recycling of nutrient containers should be done according to state and local guidelines or regulations.
9. Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation for the change.
10. Changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content.
11. Field receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with NCSU guidance and NC law.

REFERENCES

NCSU Nutrient Management In North Carolina website: <http://nutrients.soil.ncsu.edu/index.htm>

North Carolina Agricultural Nutrient Assessment Tool (NCANAT) supporting literature:
<http://nutrients.soil.ncsu.edu/index.htm>

NC Interagency Nutrient Management Committee technical guidance:
<http://nutrients.soil.ncsu.edu/guidance/>

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

NC DENR DWR Animal Feeding Operations website: <http://portal.ncdenr.org/web/wq/aps/afo>

United States Department of Agriculture, Agricultural Research Service, 2006. Best Management Practices to Minimize Agricultural Phosphorus Impacts on Water Quality:
<http://www.ars.usda.gov/is/np/BestMgmtPractices/BestMgmtPracticesIntro.htm>

USDA NRCS Agricultural Waste Management Field Handbook online:
<http://www.info.usda.gov/viewerFS.aspx?hid=21430>

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