

# Section III - Field Office Technical Guide

## COMPREHENSIVE NUTRIENT MANAGEMENT PLANNING TECHNICAL GUIDANCE

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## COMPREHENSIVE NUTRIENT MANAGEMENT PLANNING TECHNICAL GUIDANCE

### 1.0 INTRODUCTION

USDA's goal is for animal feeding operation (AFO) owners/operators to take voluntary actions to minimize potential water pollutants from confinement facilities and land application of manure and organic by-products. To accomplish this goal, it is a national expectation that all AFOs should develop and implement technically sound, economically feasible, and site-specific Comprehensive Nutrient Management Plans (CNMP)

In general terms, a CNMP identifies management and conservation actions that will be followed to meet clearly defined soil and water conservation goals, including nutrient management, at an agricultural operation. Defining soil and water conservation goals and identifying measures and schedules for attaining the goals are critical to reducing threats to water quality and public health from AFOs. The CNMP should fit within the total resource management objectives of the entire farm/animal feeding operation.

The Comprehensive Nutrient Management Planning Technical Guidance is a document intended for use by those individuals (both public and private) who develop or assist in the development of CNMPs. The purpose of this document is to provide technical guidance for the development of CNMPs, whether they are developed for USDA's voluntary programs or as a means to help satisfy the United States Environmental Protection Agency's (USEPA) National Pollutant Discharge Elimination System (NPDES) permit requirements.

This technical guidance is not intended as a sole-source reference for developing CNMPs. Rather, it is to be used as a tool in support of the conservation planning process (see Appendix A), as contained in the USDA Natural Resources Conservation Service (NRCS) National Planning Procedures Handbook (NPPH) and NRCS Technical References, Handbooks, and Policy Directives (see Appendix B).

### 2.0 DEFINITION

A CNMP is a conservation system that is unique to animal feeding operations. A CNMP is a grouping of conservation practices and management activities which, when implemented as part of a conservation system, will help to ensure that both production and natural resource protection goals are achieved. It incorporates practices to utilize animal manure and organic by-products as a beneficial resource. A CNMP addresses natural resource concerns dealing with soil erosion, manure, and organic by-products and their potential impacts on water quality, that may derive from a animal feeding operation. A CNMP is developed to assist an AFO owner/operator in meeting all applicable local, tribal, State, and Federal water quality goals or regulations. For nutrient impaired stream segments or water bodies, additional management

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activities or conservation practices may be required by local, tribal, State, or Federal water quality goals or regulations.

The conservation practices and management activities planned and implemented as part of a CNMP must meet NRCS technical standards. For those components included in a CNMP where NRCS does not currently maintain technical standards (i.e., feed management, vector control, air quality, etc.), producers must meet criteria established by Land Grant Universities, Industry, or other technically qualified entities. Within each state, the NRCS State Conservationist has the authority to approve non-NRCS criteria established for use in the planning and implementation of CNMP components.

## **2.1 Conservation Planning Process**

Conservation planning is a natural resource problem-solving process. The process integrates ecological (natural resource), economic, and production considerations in meeting both the owner's/operator's objectives and the public's resource protection needs. This approach emphasizes identifying desired future conditions, improving natural resource management, minimizing conflict, and addressing problems and opportunities.

The NRCS' NPPH provides guidance in the application of effective conservation planning procedures in the development of conservation plans. This Comprehensive Nutrient Management Planning Technical Guidance does not replace the NRCS NPPH requirements, rather, it provides complementary guidance in applying the NRCS planning process specific to the development of CNMPs. (See Appendix A, Conservation Planning Process and CNMP Development.)

## **3.0 OBJECTIVES**

The objective of a CNMP is to provide AFO owners/operators with a plan to manage manure and organic by-products by combining conservation practices and management activities into a conservation system that, when implemented, will protect or improve water quality. The elements of a CNMP should be developed by certified specialists.

## **4.0 CRITERIA**

This section establishes the minimum criteria to be addressed in the development and implementation of CNMPs.

### **4.1 General Criteria**

Comprehensive Nutrient Management Plans will meet the following criteria:

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- Provide documentation that addresses the outlined items provided in Appendix C (Comprehensive Nutrient Management Plan Format and Content).
- Document the consideration of the following CNMP elements (It is recognized that a CNMP may not contain all of the six following elements; however, all six elements need to be considered by the owner/operator during plan development, and the owner/operators decisions concerning each must be documented):
  - 1) Manure and Wastewater Handling and Storage
  - 2) Land Treatment Practices
  - 3) Nutrient Management
  - 4) Record Keeping
  - 5) Feed Management
  - 6) Other Utilization Activities
- CNMPs will contain actions that address soil erosion and water quality criteria for the feedlot, production area, and land on which the manure and organic by-products will be applied (i.e., as a minimum the plan would address CNMP elements 1, 2, 3, and 4 listed above). For AFO owners/operators who do not land apply any manure or organic by-products, the CNMP would only address the feedlot and production areas (i.e., address CNMP elements 1, 4, and 6 listed above).
- Meet requirements of NRCS Field Office Technical Guide (FOTG) conservation practice standards for practices contained in the CNMP.
- Meet all applicable local, Tribal, State, and Federal regulations.
- When applicable, ensure that USEPA NPDES or State permit requirements (i.e. minimum standards and special conditions) are addressed.

## **4.2 Element Criteria**

Each of the CNMP's elements will address specific criteria. The degree to which these elements are addressed in the development and implementation of a site-specific CNMP is determined by the General Criteria in Section 4.1 and the specific criteria provided for each element. The elements will address the following specific criteria:

### **4.2.1 Manure and Wastewater Handling and Storage**

This element addresses the components and activities associated with the production facility, feedlot, manure and wastewater storage and treatment structures and areas, and any areas used to facilitate transfer of manure and wastewater. In most situations, addressing this element will require a combination of conservation practices and management activities to meet

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the production needs of the AFO owner/operator and environmental concerns associated with the production facility.

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#### 4.2.1.1 Criteria for Manure and Wastewater Handling and Storage

- Provide for adequate collection, storage, and/or treatment of manure and organic by-products that allows application during favorable weather conditions and at times compatible with crop management. Collection, storage, treatment, and/or transfer practices shall meet the minimum requirements as addressed in the following NRCS conservation practice standards (See Appendix D), contained in Section IV of the NRCS FOTG, as appropriate:
  - *Waste Storage Facility* (Code 313)
  - *Waste Treatment Lagoon* (Code 359)
  - *Manure Transfer* (Code 634)
  - *Heavy Use Protection* (Code 561)
- Comply with existing federal, Tribal, State, and local regulations, associated with the following activities:
  - Disposal of dead animals
  - Disposal of animal medical wastes
  - Spoiled feed or other contaminants that may be regulated by other than a NPDES or State concentrated animal feeding operation (CAFO) permitting program

NRCS does not have national conservation practice standards that address all these activities. Generally, federal, Tribal, State and local regulations dictate acceptable procedures; however, NRCS in some States has developed standards that address the disposal of dead animals by incineration or freezing.

- Documentation of the following:
  - Types of animals and phases of production that exist at the facility.
  - Numbers of each animal type, average weight, and period of confinement for each phase of production.
  - Total estimated manure and wastewater volumes produced at facility. Where historical manure and wastewater production volumes are not documented, an estimate may be made using the procedures and table data provided in the NRCS Agricultural Waste Management Field Handbook (AWMFH), Chapter 4, "Waste Characteristics".
  - Manure storage type, volume, and length of storage. For more information on storage and treatment systems, how they function, their limitations, and design guidance see NRCS AWMFH, Chapter 9, "Animal Waste Management Systems", and Chapter 10, "Component Design".
  - Existing transfer equipment, system and procedures.

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- Operation and maintenance activities that address the collection, storage, treatment and transfer of manure and wastewater, including associated equipment, facilities and structures.
- Nutrient content and volume of manure, if transferred to others.
- An emergency action plan that addresses spills and catastrophic events.

#### **4.2.1.2 Considerations for Manure and Wastewater Handling and Storage**

There are additional considerations associated with CNMP development and implementation that should to be addressed. However, NRCS does not have specific technical criteria for these considerations that are required for CNMPs.

##### Air Quality

AFO operators/owners need to consider the impact of selected conservation practices on air quality during the CNMP development process. Air quality in and around structures, waste storage areas and treatment sites may be impaired by excessive dust, gaseous emissions such as ammonia, and odors. Poor air quality may impact the health of workers, animals and persons living in the surrounding areas. Ammonia emissions from animal operations may be deposited to surface waters, increasing the nutrient load to these regions. Proper siting of structures and waste storage facilities can enhance dispersion and dilution of odorous gases. Enclosing waste storage or treatment facilities can reduce gaseous emissions from AFOs in areas with residential development in the region. Background information on the current state of the knowledge, research gaps, and on-going research projects being carried out on air quality at USDA are provided in Appendix F.

##### Pathogens

AFO operators/owners need to consider the impact of selected conservation practices on pathogen control during the CNMP development process. Pathogenic organisms occur naturally in animal wastes. Exposure to some pathogens by humans and animals can cause illness, especially for immune-deficient populations. Many of the same conservation practices used to prevent nutrient movement from animal operations, such as leaching, runoff and erosion control are likely to prevent the movement of pathogens. Background information on the current state of the knowledge, research gaps, and on-going research projects being carried out on pathogens at USDA are given in Appendix F.

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## 4.2.2 Land Treatment Practices

This element addresses evaluation and implementation of appropriate conservation practices on sites proposed for land application of manure and organic by-products from an AFO. On fields where manure and organic by-products are applied as beneficial nutrients, it is essential that runoff and soil erosion be minimized to allow for plant uptake of these nutrients. An understanding of the present land use of these fields is essential in developing a conservation system to address runoff and soil erosion.

### 4.2.2.1 Criteria for Land Treatment Practices

- An on-site visit is required to identify existing and potential natural resource concerns, problems, and opportunities for the conservation management unit (CMU).
- Identification of the potential for nitrogen or phosphorus losses from the site.
- As a minimum, the conservation system developed for this element will address water quality and soil erosion NRCS Quality Criteria, found in Section III of the FOTG. (See Appendix A for an example of how a conservation system is developed within the framework of the NRCS conservation planning process.) Typical NRCS conservation practices, and their corresponding NRCS conservation practice standard code number, used as part of a conservation system to minimize runoff and soil erosion are:
  - *Conservation Crop Rotation* (Code 328)
  - *Residue Management, No Till and Strip Till* (Code 329A)
  - *Residue Management, Mulch Till* (Code 329B)
  - *Residue Management, Ridge Till* (Code 329C)
  - *Contour Buffer Strips* (Code 332)
  - *Cover Crop* (Code 340)
  - *Residue Management, Seasonal* (Code 344)
  - *Diversion* (Code 362)
  - *Windbreak/Shelterbelt Establishment* (Code 380)
  - *Riparian Forest Buffer* (Code 390)
  - *Filter Strip* (Code 393)
  - *Grassed Waterway* (Code 412)
  - *Prescribed Grazing* (Code 528A)
  - *Contour Stripcropping* (Code 585)
  - *Stripcropping, Field* (Code 586)

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- *Pest Management* (Code 595)
- *Terrace* (Code 600)

Notes:

The FOTG, Section IV, contains a complete list of NRCS conservation practices and the criteria associated with their design and implementation.

The conservation practice physical effects of individual practices on the natural resources (soil, water, air, plants, and animals) are found in the FOTG, Section V.

- Comply with existing, federal, Tribal, State and Local regulations or ordinances associated with soil erosion and runoff.
- Document the following:
  - Aerial maps of land application areas
  - Individual field maps with marked setbacks, buffers, waterways, and other conservation practices planned
  - Soils information associated with fields (i.e., features, limitations)
  - Design information associated with planned and implemented conservation practices
  - Identification of sensitive areas such as sinkholes, streams, springs, lakes, ponds, wells, gullies, and drinking water sources
- Other site information features of significance, such as property boundaries.
- Identification of operation and maintenance (O&M) practices/activities.

### **4.2.3 Nutrient Management**

This element addresses the requirements for land application of all nutrients and organic by-products (e.g., animal manure, wastewater, commercial fertilizers, crop residues, legume credits, irrigation water, etc.) that must be evaluated and documented for each CMU.

Land application of manure and organic by-products is the most common method of manure utilization due to the nutrients and organic matter content of the material. Land application procedures must be planned and implemented in a way that minimizes potential adverse impacts to the environment and public health.

#### **4.2.3.1 Criteria for Nutrient Management**

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- Meet the NRCS Nutrient Management Policy as contained in the NRCS General Manual, Title 190, Part 402, dated May 1999. (See Appendix B)
- Meet criteria in NRCS conservation practice standard *Nutrient Management* (Code 590) and, as appropriate, *Irrigation Water Management* (Code 449). (See Appendix D)
- Develop a nutrient budget for nitrogen, phosphorus, and potassium that includes all potential sources of nutrients.
- Document the following:
  - Planned crop types, cropping sequence, and realistic yield targets
  - Current soil test results (nitrogen, phosphorus, potassium, heavy metals, and sodic condition)
  - Manure and organic by-product source testing results
  - Form, source, amount, timing and method of application of nutrients, by field
  - Description of application equipment and method used for calibration

#### **4.2.3.2 Considerations for Nutrient Management**

There are additional considerations associated with CNMP development and implementation that should to be addressed. However, NRCS does not have specific technical criteria for these considerations that are required for CNMPs.

##### Air Quality

AFO operators/owners should consider the impact of selected conservation practices on air quality during the CNMP development process. Air quality on land application sites may be impaired by excessive dust, gaseous emissions such as ammonia, and odors. Poor air quality may impact the health of workers, animals and persons living in the surrounding areas. Ammonia emissions from animal operations may be deposited to surface waters, increasing the nutrient load to these regions. Soil incorporation of manure and organic by-products on land application sites can reduce gaseous emissions. Background information on the current state of the knowledge, research gaps, and on-going research projects being carried out on air quality at USDA are given in Appendix F.

##### Pathogens

AFO operators/owner should consider the impact of selected conservation practices on pathogen control during the CNMP development process. Pathogenic organisms occur naturally in animal waste. Exposure to some pathogens by humans and animals can cause illness, especially for immune-deficient populations. Many of the same conservation practices used to prevent nutrient movement from animal operations, such

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as leaching, runoff and erosion control, are likely to prevent the movement of pathogens. Background information on the current state of the knowledge, research gaps, and on-going research projects being carried out on pathogens at USDA are given in Appendix F.

#### Salt and Heavy Metals

Build up of salt and heavy metals (i.e., arsenic, selenium, cadmium, molybdenum, zinc) in soils can create a potential for human and animal health problems and threaten soil productivity and crop marketability. Federal and State regulations do not address the heavy metal content associated with agricultural by-products. In developing a CNMP, the build-up of salt and heavy metals should be tracked through soil testing. Additional guidance on salt and heavy metal contamination from manure is available in the following:

NRCS Agricultural Waste Management Field Handbook, Sections 651.1103 and 651.0604(b), deal with the salt content of agricultural waste.

NRCS Agricultural Waste Management Field Handbook, Sections 651.0603(g) and 651.0605(a and b), deal with the heavy metal content of agricultural waste.

USEPA Title 40 Part 503 – Standards for the Use or Disposal of Sewage Sludge, Section 503.13, contains pollutant limits for biosolids heavy metal content and cumulative loading rates. This rule does not address resident levels of metals in the soil.

#### **4.2.4 Record Keeping**

It is important that records are kept to effectively document and demonstrate implementation activities associated with CNMPs. Documentation of management and implementation activities associated with a CNMP provides valuable benchmark information for the AFO owner/operator that can be used to adjust his/her CNMP to better meet production objectives. It is the responsibility of AFO owners/operators to maintain records that document the implementation of CNMPs.

Documentation will include:

- Annual manure tests for nutrient contents for each manure storage containment.
- Application records for each application event, including (this also applies to commercial fertilizers that are applied to supplement manure):
  - Containment source or type and form of commercial fertilizer
  - Field(s) where manure or organic by-products are applied
  - Amount applied per acre
  - Time and date of application

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- Weather conditions during nutrient application
- General soil moisture condition at time of application (i.e., saturated, wet, moist, dry)
- Application method and equipment used
- Crops planted and planting/harvesting dates, by field.
- Records that address storage containment structures:
  - Dates of emptying, level before emptying, and level after emptying
  - Discharge or overflow events, level before and after event
- Transfer of manure off-site or to third parties:
  - Manure nutrient content
  - Amount of manure transferred
  - Date of transfer
  - Recipient of manure
- Activities associated with emergency spill response plan.
- Records associated with any reviews by NRCS, third-party consultants, or representatives of regulatory agencies:
  - Dates of review
  - Name of reviewer and purpose of the review
  - Recommendations or follow-up requirements resulting from the review
  - Actions taken as a result of the review
- Records of maintenance performed associated with operation and maintenance Plans.
- Nutrient application equipment calibration.
- Changes made in CNMP.

#### **4.2.5 Feed Management**

Feed management activities may be used to reduce the nutrient content of manure, which may result in less land being required to effectively utilize the manure. Feed management activities may be dealt with as a planning consideration and not as a requirement that addresses specific criteria; however, AFO owners/operators are encouraged to incorporate feed management as part of their nutrient management strategy. Specific information and recommendations should be obtained from Land Grant Universities, industry, the Agricultural Research Service, or professional societies such as the Federation of Animal Science Societies (FASS) or American Registry of Professional Animal Scientists (ARPAS), or other technically qualified entities.

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An example of the effective use of feed management is presented as follows:

*“If a dairy cow is fed 0.04 percent above recommended levels of dietary phosphorus she will excrete an additional six pounds of phosphorus annually. For a herd of 500 cows, this is an additional 3,000 pounds of phosphorus per year. In a single cropping system, corn silage is about 0.2 percent phosphorus on a dry matter basis. For a field yielding 30 tons of silage per acre, at 30 percent dry matter, this is 36 pounds of phosphorus in the crop. If an additional 3,000 pounds of phosphorus are recovered in manure it takes considerably more land for application if manure is applied on a phosphorus basis.” Dr. Deanne Meyer, Livestock Waste Management Specialist, Cooperative Extension, University of California.*

Specific feed management activities to address nutrient reduction in manure may include phase feeding, amino acid supplemented low crude protein diets, and the use of low phytin phosphorus grain and enzymes, such as phytase or other additives.

Feed management can be an effective approach to addressing excess nutrient production and should be encouraged; however, it is also recognized that feed management may not be a viable or acceptable alternative for all AFOs. A professional animal nutritionist should be consulted before making any recommendations associated with feed ration adjustment.

#### **4.2.6 Other Utilization Activities**

Using environmentally-safe alternatives to land application of manure and organic by-products could be an integral part of the overall CNMP. Alternative uses are needed for animal manure in areas where nutrient supply exceeds available land and/or where land application would cause significant environmental risk. Manure use for energy production, including burning, methane generation and conversion to other fuels, is being investigated and even commercially tested as a viable source of energy. Methods to reduce the weight, volume, or form of manure, such as composting or pelletizing, can reduce transportation cost, and create a more valuable product. Manure can be mixed or co-composted with industrial or municipal by-products to produce value-added material for specialized uses. Transportation options are needed to move manure from areas of over supply to areas with nutrient deficiencies (i.e., manure brokering).

More efficient and cost-effective methods are needed for manure handling, treatment, and storage. Areas in need of targeting include: (1) improved systems for solids removal from liquid manure; (2) improved manure handling, storage, and treatment methods to reduce ammonia volatilization; (3) treatment systems that transform and/or capture nutrients, trace elements, and pharmaceutically active chemicals from manure; (4) improved composting and other manure stabilization techniques; and, (5) treatment systems to remediate or replace anaerobic lagoons.

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As many of these alternatives to conventional manure management activities have not been fully developed or refined, industry standards do not always exist that provide for their consistent implementation. Except for the NRCS conservation practice standard *Composting Facility* (Code 317), NRCS does not have conservation practice standards that address these other utilization options.

This element of a CNMP should be presented as a consideration for the AFO owner/operator in his/her decision-making process. No specific criteria need to be addressed unless an alternative utilization option is decided upon by the AFO owner/operator. When an AFO owner/operator implements this element, applicable industry standards and all federal, Tribal, State, and local regulations must be met.

## **5.0 CERTIFICATION**

Providing conservation planning and other technical assistance to AFO owners/operators through voluntary programs or to help satisfy regulatory requirements presents a potentially tremendous workload. NRCS traditionally has been the primary provider of conservation planning and other technical assistance to agricultural producers. In an effort to build capacity to meet this potential workload, NRCS will establish a process for certifying approved sources of conservation assistance. An individual who is appropriately certified through an USDA-recognized certification organization is referred to as either a “certified specialist” or a “certified conservation planner.”

Certifying organizations (approved sources) can come from the private or public sectors. Private consultants, employees of agribusiness, and others who hold appropriate certifications through an approved independent certification organization or state licensing agency can be approved as certified specialists. Employees of natural resource conservation agencies, departments, or other entities organized under federal, Tribal, State, or local law who have planning and technical assistance functions as part of their assigned responsibilities can also be approved as certified specialists. Other non-commercial sources, as determined by the NRCS state conservationist, also can be approved.

Individuals can be recognized as providers of conservation planning assistance by obtaining a certified conservation planner designation, or as providers of technical assistance for developing components of a conservation plan by obtaining a certified specialist designation. An individual that is qualified to develop a complete CNMP would be designated as a certified conservation planner. To develop a specific element of a CNMP would require a certified specialist designation. (For specific requirements associated with establishing a certification process, and the minimum national demonstrated competencies associated with obtaining a certified specialist designation, see the NRCS General Manual 180 Part 409.)

In the development of a CNMP, as a minimum, the elements Manure and Wastewater Handling and Storage, Land Treatment Practices, and Nutrient Management must be developed by certified specialists. Because of the diversity and complexity of specific skills associated with each element of the CNMP, most individuals will pursue “certification” for only one of the

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elements. Therefore, to achieve a CNMP could require the interaction of three separate certified specialists, each addressing only one of the three elements.

It is envisioned that a certified conservation planner, assisting the AFO owner/operator, would facilitate the CNMP development process, with “certified specialists” developing the more detailed specifics associated with the element they are certified to help produce.

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## APPENDIX A

### THE NRCS CONSERVATION PLANNING PROCESS AND CNMP DEVELOPMENT

This Appendix describes the NRCS conservation planning process and shows how a comprehensive nutrient management plan (CNMP) is developed using this established planning process.

Conservation planning is a natural resource problem-solving process. The process integrates ecological (natural resource), economic, and social considerations to meet both the owner's/operator's objectives and public resource protection needs. This approach emphasizes identifying desired future conditions, improving natural resource management, minimizing conflict, and addressing problems and opportunities. The NRCS National Planning Procedures Handbook (NPPH) provides guidance in the application of effective conservation planning procedures in the development of conservation plans.

The conservation planning process has not been changed by the introduction of CNMPs. However, public scrutiny of the conservation planning process has increased as a result of the introduction of CNMPs. It is essential that individuals providing technical assistance to develop CNMPs be well versed in the conservation planning process, have the skill to recognize resource concerns, and have the tools necessary to develop and evaluate treatment alternatives.

The Comprehensive Nutrient Management Planning Technical Guidance does not replace the NRCS NPPH, nor does it relieve the planner from offering conservation alternatives that address all of the resource concerns: soil, water, air, plants, and animals. Development of CNMPs will rely on the planning process and established conservation practice standards.

Conservation plans are developed with individual clients or with a group of individuals functioning as a unit. These plans are site-specific, comprehensive, and action-oriented. A conservation plan contains natural resource information and a record of decisions made by the client. It describes the schedule of operations and activities needed to solve identified natural resource problems and take advantage of opportunities. A conservation system (CS) addresses treatment needs that meet the NRCS Field Office Technical Guide (FOTG), Section III, Quality Criteria, for each identified natural resource concern.

Quality criteria, in Section III of the FOTG, are quantitative or qualitative statements of treatment levels required to prevent resource degradation and enable sustained use for identified resource considerations for a particular land area. Quality criteria are established in accordance with local, State, Tribal, and federal programs and regulations in consideration of ecological, economic, and social effects. Table 1 contains typical quality criteria as presented in the FOTG, Section III, for soil and water resources, specifically soil erosion and surface water quality.

The scale of planning associated with the development of a CNMP is the Conservation Management Unit (CMU). A CMU is a field, group of fields, or other land units of the same land

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use and having similar natural resource conditions, treatment needs, and planned management. A CMU is defined by the planner, to simplify planning activities and to facilitate CS development. A CMU has definite boundaries, usually natural resource boundaries, such as drainage ways, vegetation, topography, or soils, but also can be based on land use.

Table 1. Example Quality Criteria		
Resource	Resource Problem	Quality Criteria
Soil	Erosion: Sheet and Rill – soil erosion caused by overland water flow.	The soil loss is reduced to tolerance “T” for the soil map unit, as listed in Section II of the FOTG.
Water	Quality: Surface – pollution problems that result from the handling and use of applied nutrients, especially nitrogen, phosphorus, and total organic carbon.	Collection, transfer and storage of agricultural waste and fertilizers do not contribute contaminants that adversely affect surface water. Application of nutrients and organics are in balance with plant requirements -- considering all nutrient sources, soil characteristics, optimum yields and runoff loss potential of nutrients dissolved in the runoff and/or attached to soil particles transported by water and wind.

A CNMP is a CS for animal feeding operations that addresses water quality as the primary resource concern. For AFOs that will land apply manure, the CNMP also will need to address soil erosion, condition, and deposition as a primary resource concern.

In working with an AFO owners/operators, alternatives are developed that address various treatment levels of the resources of concern. Alternatives developed for a CNMP will meet the FOTG quality criteria for soil and water concerns within all CMUs impacted by the collection, storage, and application of animal waste and organic by-products. The AFO owner/operator, as decision-maker, selects from these alternatives to create a CNMP that best meets his/her management objectives and environmental concerns.

Figure 1 is a typical representation of the conservation effects of alternative resource management systems for cropland on the key soil and water resource concerns. The rating system used is a relative impact representation. A plus (+) sign indicates a positive impact in addressing the resource concern; a negative (-) sign indicates a negative impact in addressing the resource concern; a zero (0) indicates no significant impact, either positive or negative. The accompanying numeric representation (+3) serves to indicate how much of a positive or negative influence the conservation practice has on addressing the resource concern. The effect of each conservation practice on each of the resource concerns is found in the NRCS

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FOTG, Section V, "Conservation Practice Physical Effects." The numeric representations of each of the conservation practices in an alternative system are not additive in determining the overall effect of the system; rather, they are to be used as a qualitative tool by the certified conservation planner in deciding if the overall effect of the system is positive or negative. In order for a system to be an acceptable alternative, its overall impact on the resource concerns must not only be positive, but it must also satisfy the quality criteria for the RMS level, as described in the FOTG, Section III.

A broad range of technically feasible alternatives should be developed with the client. It is not merely enough to ask the producer what is being done and make a record of that as a CNMP. Alternatives need to achieve the objectives of the client, solve identified problems, and treat the resources to defined quality criteria. Alternatives may include a mix of structural and/or management practices, within restrictions defined by ordinances or regulations. It is important that the client be actively involved in the formulation of these alternatives.

CNMP implementation may require additional design, analysis or evaluations. This is particularly true for structural practices and nutrient management. Dynamics of operations, nature, infusion of real-time measurements or other unknowns may cause changes in amount, size, timing, or distribution of nutrients. These inputs may even cause complete revisions to planned alternatives. It is important for the certified conservation planner to maintain a relationship with the producer throughout CNMP implementation to address changes or new challenges.

Evaluation of the effectiveness of the CNMP may begin during the implementation phase and not end until several years after the last practice is applied. Follow-up and evaluation determines whether the implemented alternative is meeting the client needs and solving the conservation problems in a manner beneficial to the resources. If the evaluation determines that this is not taking place, adjustments to the CNMP probably will be needed.

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**Figure 1. CROPLAND RESOURCE MANAGEMENT SYSTEMS (RMS)**

<p><b>Soil</b></p> <p>These soils are best for production of common field crops. They are deep to very deep, nearly level to gently sloping [0-8%] soils on uplands. Drainage classes are well, moderately well, and excessively well drained. The soils have loam, slit loam, loamy sand, fine sandy loam, and sandy loam textures. They can erode easily if not managed properly. Land capability Classes are 1, 2E, 2S, and 2W.</p> <p>Major soils include: Adelhia, Butlertown, Matapeak, Sassafra, Bourne, Croom, Rumford, Woodstown</p>	<p><b>Resource Concerns</b></p> <p>The resource concerns found on the landscape are:</p> <ul style="list-style-type: none"> <li>-sheet and rill erosion</li> <li>-ground contaminants - nutrient and pesticides</li> <li>-ephemeral gully erosion</li> <li>-surface water contaminants - nutrients</li> <li>-soil compaction</li> <li>-plant pests</li> <li>-offsite sediment deposition</li> <li>-wildlife cover</li> <li>-water</li> </ul>
---	--

Resource Management System Alternative	Resource Concerns and Effects of RMS Implementation						
	Soil				Water		
	Erosion		Condition	Deposition	Quality		
	Sheet and Rill	Ephemeral gully	Compaction	Offsite Sediment	Groundwater Contaminants		Surface Water Contaminants
				Nutrients	Pesticides	Nutrients	
<b><u>Present Farm Systems</u></b>							
328-Continuous Corn Soybeans							
Conventional tillage & no crop residues	-1	-1	-1	-1	-1	-1	-2
- Up/down slop farming	-3	-3	0	-3	+2	+2	-3
- No nutrient testing	+1	0	+1	+1	-2	0	-3
- Pesticides use when insects seen	0	0	-1	0	0	-3	0
<b>Present System - General Effects:</b>	<b>-3</b>	<b>-3</b>	<b>-1</b>	<b>-3</b>	<b>-1</b>	<b>-1</b>	<b>-3</b>
<b><u>Alternative 1 RMS</u></b>							
328-Conservation Cropping Sequence:							
Continuous Corn / Soybeans	-1	-1	-1	-1	-1	-1	-2
329- Conservation Tillage	+2	+1	+3	+2	-1	0	+2
585-Contour stripcropping	+2	+1	+1	+2	+1	-1	+2
342-Critical Area Planting	+1	+3	+0	+3	+1	+1	+2
412-Grassed Waterway	+0	+3	+1	+2	0	-1	-1
590-Nutrient Management	+1	+1	+1	+1	+3	0	+3
595-Pest Management	0	0	+1	0	0	+3	0
<b>Alternative 1 – General Effects:</b>	<b>+3</b>	<b>+1</b>	<b>+3</b>	<b>+3</b>	<b>+1</b>	<b>+1</b>	<b>+2</b>

<b>Alternative 2 RMS</b>							
328-Conservation Cropping Sequence:							
Continuous Corn/soybeans	-1	-1	-1	-1	-1	-1	-2
329- Conservation Tillage	+3	+2	+3	+2	-1	0	+2
412-Grassed Waterway	+1	+3	+1	+2	0	+1	+1
590-Nutrient Management	+1	+1	+1	+1	+3	0	+3
595-Pest Management	0	0	+1	0	0	+3	0
600-Terraces	+3	+2	0	+1		-2	- 1
<b>Alternative 2 - General Effects:</b>	<b>+2</b>	<b>+1</b>	<b>+1</b>	<b>+1</b>	<b>+1</b>	<b>+0</b>	<b>+1</b>

## APPENDIX B

### TECHNICAL REFERENCES, HANDBOOKS, AND POLICY DIRECTIVES

#### Technical References and Handbooks

The Natural Resource Conservation Service has numerous technical references and handbooks that it uses to assist in the development of conservation plans and its various components. Listed below are those technical references and handbooks generally associated with the development of comprehensive nutrient management plans (CNMPs):

United States Department of Agriculture, Natural Resource Conservation Service, **Comprehensive Nutrient Management Planning Technical Guidance** is available on the NRCS website at <http://www.nhq.nrcs.usda.gov/PROGRAMS/ahcwpd/AFO.html>.

United States Department of Agriculture, Natural Resource Conservation Service (NRCS), National Engineering Handbook, Part 651, **Agricultural Waste Management Field Handbook**. This handbook is available on the NRCS website at [http://www.ncg.nrcs.usda.gov/tech\\_ref.html](http://www.ncg.nrcs.usda.gov/tech_ref.html) or a paper copy of this publication can be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA. 22161, telephone: 1-800-553-6847. Order NTI Publications Numbers: PB230819 and PB97167753.

United States Department of Agriculture, Natural Resource Conservation Service, **National Agronomy Manual**. The National Agronomy Manual establishes policy for agronomy activities and provides technical procedures for uniform implementation of agronomy tools and applications. This manual is presently under revision and is scheduled for release in the fall of 2000. The draft version is available on the USDA server in Ft. Worth, Texas at <ftp://ftp.ftw.nrcs.usda.gov/pub/NAM/>.

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**National Planning Procedures Handbook (NPPH).** The purpose of this handbook is to provide guidance on the planning process the Natural Resources Conservation Service (NRCS) uses to help develop, implement, and evaluate conservation plans for individuals, and areawide conservation plans or assessments for groups. This handbook is available on the NRCS website at <http://policy.nrcs.usda.gov/scripts/lpsiis.dll/EDS/RTFList.html>, or from the NRCS, Conservation Operations Division, by contacting the Director, Conservation Operations Division, Natural Resources Conservation Service, 12<sup>th</sup> and Independence SW, Washington, D.C. 20013.

United States Department of Agriculture, Natural Resource Conservation Service, “**Conservation Planning Course.**” The Conservation Planning Course consists of nine modules. Part 1 of the Conservation Planning Course contains Modules 1 - 5, which cover the background and framework for conservation planning. These modules are included in a computer-based, self-paced version of the course. Part I of the course is available on the NRCS website at <http://www.ncg.nrcs.usda.gov/start.htm>. Part 2 of the course contains Modules 6 – 8, which are a hands-on field application of the conservation planning process, that involves classroom and field exercises. Part 3, Module 9, is the individual application of the conservation planning process utilizing the information learned in Parts 1 and 2. Part 3 is to be completed at the participant’s work location with the assistance of a coach. For more information on the availability of training on Parts 2 and 3 of the Conservation Planning Course , contact your NRCS State Conservationist.

United States Department of Agriculture, Natural Resource Conservation Service, “**CORE 4 Conservation Practices Training Guide.**” The purpose of this workbook is to enhance the technical knowledge of individuals that will assist landowners in effectively using conservation tillage, nutrient management, pest management, and conservation buffers. This training guide is available on the NRCS website at <http://www.nhq.nrcs.usda.gov/BCS/agro/CORE4.PDF>.

United States Department of Agriculture, Natural Resource Conservation Service, “**Agronomy Technical Notes.**” These technical notes address a wide variety of agronomy issues and are available on the NRCS website at [http://www.ncg.nrcs.usda.gov/tech\\_notes.html](http://www.ncg.nrcs.usda.gov/tech_notes.html). Following is a list of the Agronomy Technical Notes found at this website:

- |  |   |
|--|---|
| Note 1: Cover Crops  | Note 6: Legumes and Soil Quality                                      |
| Note 2: Conservation Crop Rotation Effects on Soil Quality     | Note 7: Effects of Soil Erosion on Soil Productivity and Soil Quality |
| Note 3: Effects of Residue Management, No-Till on Soil Quality | Note 8: Liming to Improve Soil Quality in Acid Soils                  |
| Note 4: Effect of Soil Quality on Nutrient Efficiency          | Note 9: Managing Conservation Tillage                                 |
| Note 5: Herbicides   | Note 10: Sunn Hemp, a Cover Crop for                                  |

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Southern and Tropical Farming  
Systems.

United States Department of Agriculture, Natural Resource Conservation Service (NRCS), **National Range and Pasture Handbook**. The National Range and Pasture Handbook constitutes NRCS basic policy and procedures for assisting farmers, ranchers, groups, organizations, units of government, and others working through conservation districts in planning and applying resource conservation on non-Federal grazing lands throughout the United States. This Handbook is available on the NRCS website at **[http://www.ncg.nrcs.usda.gov/tech\\_notes.html](http://www.ncg.nrcs.usda.gov/tech_notes.html)**, or a paper copy of this publication can be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA. 22161, telephone: 1-800-553-6847. Order NTI Publication Number: PB2000105483.

### Policy Directives

NRCS policy is contained in Natural Resources Conservation Service **General Manual**. The index for the entire manual can be found at NRCS website **<http://policy.nrcs.usda.gov/national/gm/index.htm>**. Listed below are those policy directives, contained in the **General Manual**, generally associated with the development of comprehensive nutrient management plans:

Natural Resources Conservation Service, **General Manual**, Title 450, Technology, Part 401, “**Technical Guides**”. This part of the General Manual is available at the NRCS website at **<http://policy.nrcs.usda.gov/national/gm/title450/part401/index.htm>**.

Natural Resources Conservation Service, **General Manual**, Title 190, Ecological Sciences, Part 402, “**Nutrient Management**”. This part of the General Manual is available at the NRCS website at **<http://www.nhq.nrcs.usda.gov/BCS/nutri/gm-190.html>**. Following is the NRCS Nutrient Management, as of, November 24, 2000:

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#### PART 402 - NUTRIENT MANAGEMENT

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**Field Office Technical Guide  
Section III  
Resource Management Systems**

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402.01 Policy.

(a) The guidance and procedures contained in this section are applicable to all technical assistance that involves nutrient management and/or the utilization of organic by-products, including animal manure, where nutrients are applied to the land. All NRCS employees will follow these procedures when providing such technical assistance. Third party vendors and other non-NRCS employees will use these procedures when assisting with the implementation of Federal conservation programs for which NRCS has national technical responsibility and that include plans for nutrient management.

(b) Plans for nutrient management are developed in compliance with all applicable Federal, state, and/or local regulations. Federal, State, and/or local regulations take precedence over NRCS policy when more restrictive.

(c) NRCS at the State level will supplement this guidance to make it applicable to local conditions as appropriate.

402.02 Definitions.

(a) The following definitions apply to terms used in this section.

(1) Conservation Management Unit (CMU): 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 definite boundaries, such as fence, drainage, vegetation, topography, or soil lines.

(2) Nutrient: Any of the elements considered essential for plant growth, particularly the primary nutrients; nitrogen, phosphorus, and potassium.

(3) Nutrient Management: Managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments to ensure adequate soil fertility for plant production and to minimize the potential for environmental degradation, particularly water quality impairment.

(4) Nutrient Management Plan: A documented record of how nutrients will be used for plant production prepared for reference and use by the producer or landowner.

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(5) **Nutrient Management Specialist:** A person who provides technical assistance for nutrient management and has the appropriate certification.

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402.02(6)

(6) **Nutrient Source:** Any material (i.e. commercial fertilizer, animal manure, sewage sludge, irrigation water, etc.) that supplies one or more of the elements essential for plant growth.

(7) **Other Organic By-product:** Any organic material other than animal manure, sewage sludge, or urea applied to the land (e.g. food processing waste).

(8) **Resource Management System (RMS):** A prescribed combination of conservation practices and management identified by land or water uses that, when implemented, prevents resource degradation and permits sustained use by meeting quality criteria established in the FOTG for the treatment of soil, water, air, plant, and animal resources.

(9) **Third Party Vendor:** An individual (excluding NRCS employees, extension specialists, and conservation district employees) who has been certified by an approved certification organization as being qualified to provide specified types of conservation assistance, and whose certifying organization participates in the USDA Approved Vendor Process outlined in Part 504, "Conservation Assistance from Third Party Vendors" of the NRCS Conservation Programs Manual. Third Party Vendor certification programs may include, but are not limited to:

- (i) Certified Crop Advisor (CCA) Program of the American Society of Agronomy.
- (ii) Land Grant University certification programs.
- (iii) National Alliance of Independent Crop Consultants (NAICC).

402.03 Certification.

(a) All persons who review or approve plans for nutrient management will be certified through a certification program accepted by NRCS in the State involved.

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(b) NRCS should identify all certification programs, available within the State, it judges to be acceptable methods for becoming certified.

(c) USDA recognized programs for certifying third party vendors are recommended for use in states that have or use no other recognized certification program.

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402.04(d)

#### 402.04 Nutrient Management Plans.

(a) Plans for nutrient management may be stand alone or be elements of a more comprehensive conservation plan. When plans for nutrient management are part of a more comprehensive conservation plan, the provisions for nutrient management are compatible with other provisions of the plan.

(b) Plans for nutrient management are developed in accordance with technical requirements of the NRCS Field Office Technical Guide (FOTG), policy requirements of the General Manual (GM), procedures contained in the National Planning Procedures Handbook (NPPH), and technical guidance contained in the National Agronomy Manual (NAM).

(c) Plans for nutrient management will include the following components, as applicable:

- (1) Aerial site photographs or maps and a soil map.
- (2) Current and/or planned plant production sequence or crop rotation.
- (3) Soil test results and recommended nutrient application rates.
- (4) Plant tissue test results, when used for nutrient management.
- (5) A complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production system.
- (6) Realistic yield goals and a description of how they were determined.

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(7) Quantification of all important nutrient sources (this could include but not be limited to commercial fertilizer, animal manure and other organic by-products, irrigation water, etc.).

(8) Planned rates, methods, and timing (month & year) of nutrient application.

(9) Location of designated sensitive areas or resources (if present on the conservation management unit).

(10) Guidance for implementation, operation, maintenance, and record keeping.

(d) When applicable, plans for nutrient management should include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

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402.04(e)

(e) States are encouraged to adopt protocol for the format and appearance of nutrient management plans that is in accordance with the National Planning Procedures Handbook (NPPH) and other State developed guidance.

(f) If the Conservation Management Unit lies within a hydrologic unit area that has been identified or designated as having impaired water quality associated with nitrogen or phosphorus, plans for nutrient management include an assessment of the potential for nitrogen or phosphorus transport from the field. The Leaching Index (LI) and/or Phosphorus Index (PI), or other assessment tools accepted by NRCS, may be used to make these assessments.

(1) When such assessments are made, nutrient management plans will include:

(i) A record of the site rating for each field.

(ii) Information about conservation practices and management actions that can reduce the potential for phosphorus movement from the field.

(2) The results of such assessments and recommendations are discussed with the producer as a normal part of the planning process.

(g) Review and Revision of Nutrient Management Plans.

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(1) Plans for nutrient management should be reviewed periodically to determine if adjustments or modifications are needed. Annual reviews are highly recommended. The results of such reviews should be documented in the plan, as well as the identification of the person who made the review.

(i) States are encouraged to develop procedures for periodic reviews so that they may be completed by the producer or the representative of the producer.

(ii) When a review indicates that a revision of the plan is needed, the revised plan is approved by a certified nutrient management specialist.

(2) A thorough review of nutrient management plans is done on a regular cycle not to exceed 5 years. This review should coincide with the soil test cycle.

#### 402.05 Soil and Plant Tissue Testing.

(a) Current soil test information is used in the development of all plans for nutrient

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402.05(c)(3)

management. As a minimum, tests should include information for pH, phosphorus, and potassium. Tests for other elements may be required when needed to develop plans for nutrient management or to comply with State or local requirements.

(1) Current soil tests are those no older than 5 years, or

(2) Are less than 5 years old if required by the State.

(b) Soil Sampling.

(1) Soil samples are taken and handled in accordance with Land Grant University guidance or standard industry practice if accepted by the Land Grant University within the State.

(2) In situations where there are special production or environmental considerations, the use of other sampling techniques is encouraged. For example:

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- systems.
- (i) Sub-soil sampling for residual nitrate in irrigated crop production
  - (ii) Pre-sidedress Nitrogen Test (PSNT) and/or Pre-Plant Soil Nitrate test.
  - (iii) Sampling of the surface layer (0-2 inches) for elevated soil phosphorus or soil acidity when there is permanent vegetation, non-inversion tillage, or when animal manure or other organic by-products are broadcast or surface applied and not incorporated.

(c) Soil test analysis is performed by laboratories that are accepted in one or more of the following programs:

- (1) State Certified Programs.
- (2) The North American Proficiency Testing Program (Soil Science Society of America).
- (3) Laboratories participating in other programs whose tests are accepted by the Land Grant University in the State in which the tests are used as the basis for nutrient application.

402-5

402.05(d)

(d) The use of tissue analysis and other such tests should be recommended when needed to ensure acceptable nutrient management.

(e) The nutrient content of animal manure and other organic by-products is based on:

- (1) Laboratory analysis of the material.

(2) Accepted book values recognized by NRCS in the absence of laboratory analysis.

(3) Historic records for the operation if they exist and give an accurate estimate of the nutrient content of the manure.

402.06 Nutrient Application Rates.

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(a) Soil amendments are recommended, as needed, to adjust and maintain soil pH at the specific range of the crop for optimum availability and utilization of nutrients.

(b) Recommended nutrient application rates are based upon Land Grant University guidance or standard industry practice if recognized by the Land Grant University. Current soil test results, realistic yield goals, producer management capabilities, and other pertinent information are considered when determining recommended nutrient application rates.

(c) The planned and actual rates of nutrient application shall not normally exceed recommended rates when commercial fertilizer is the only source of nutrients being applied. When site specific conditions require that either planned or actual rates of application differ from or exceed recommended rates, the records for the plan shall document the reason.

(d) Producers shall be advised that the planned rates of nutrient application (nitrogen, phosphorus, and potassium) may exceed recommended rates when custom blended commercial fertilizers are not available, or when animal manures or other organic by-products are used as a nutrient source. When custom blended commercial fertilizers are not available, the planned rates of application shall match recommended rates as closely as possible. When animal manure or other organic by-products are applied, the following guidance shall be used for determining planned application rates:

(1) Nitrogen Application. Manure may be applied to legume crops at a rate equal to the estimated nitrogen removal in harvested plant biomass.

(2) Phosphorus application will be in accordance with one of the following options.

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402.06(d)(2)(iii)

(i) Phosphorus Index (PI): When the PI is used, phosphorus may be applied at rates consistent with Table 1.

(ii) Phosphorus Threshold: When soil specific Phosphorus Threshold (TH) values are available, phosphorus may be applied at rates consistent with Table 2.

(iii) Soil Test Phosphorus: When soil test phosphorus levels are used, phosphorus may be applied at rates consistent with Table 3 or Figure 1.

Table 1 \*

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<u>Phosphorus Index Rating</u>	<u>Phosphorus Application</u>
Low Risk	Nitrogen Based
Medium Risk	Nitrogen Based
High Risk	Phosphorus Based (e.g. crop removal)
Very High Risk	Phosphorus Based (e.g. no application)

---

\* See 402.06(d)(2)(v)

Table 2 \*

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<u>Soil Phosphorus Threshold Level</u>	<u>Phosphorus Application</u>
< 3/4 TH	Nitrogen Based
=> 3/4 TH, < 1 1/2 TH	Phosphorus Based (e.g. crop removal)
=> 1 1/2 TH, < 2 TH	Phosphorus Based (e.g. 1/2 crop removal)
=> 2 TH	Phosphorus Based (e.g. no application)

---

\* See 402.06(d)(2)(v)

Table 3 \*

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<u>Soil Test Phosphorus Level</u>	<u>Phosphorus Application</u>
Low	Nitrogen Based
Medium	Nitrogen Based
High	Phosphorus Based (e.g. 1.5 times crop removal)
Very High	Phosphorus Based (e.g. crop removal)
Excessive	Phosphorus Based (e.g. no application)

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\* See 402.06(e)(2)(v)

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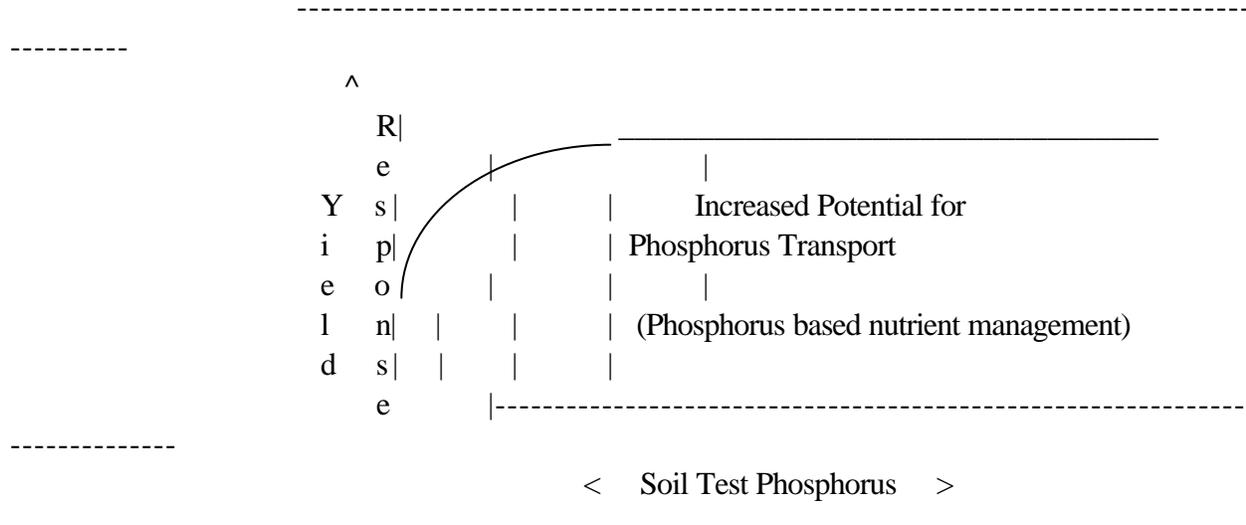
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402.06(d)(2)(iii)(iv)

Figure 1 \*\*



\*\* See 402.06(d)(2)(vi)

(iv) State developed guidance for using Tables 1, 2, and 3 and Figure 1 will be used to establish criteria for a Resource Management System (RMS) level of nutrient management. State developed guidance will include input from the State Technical Committee and be coordinated across State lines to ensure compatibility and consistency with guidance developed in adjoining States.

(v) When using Tables 1, 2, or 3, States determine acceptable phosphorus based application rates as a function of estimated phosphorus removal in harvested plant biomass. Rates of application should decrease as soil phosphorus levels or the risk of transport increase. Guidance may include recommendations for no application. The application rates shown in the tables are provided as guidance. Both the State Technical Committee and Land Grant University should be involved in developing these rates.

(vi) When using Figure 1, States determine soil phosphorus levels at which nitrogen based manure application is acceptable and when phosphorus based manure application is recommended. Phosphorus based manure application rates shall be developed as a function of estimated phosphorus removal in harvested plant biomass. Phosphorus application rates should decrease as available soil phosphorus levels increase. Guidance may include a recommendation of no

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application. Both the State Technical Committee and Land Grant University should be involved in developing this guidance.

(vii) Accommodation may be made for a single application of phosphorus applied as manure at a rate equal to the recommended phosphorus application rate or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence. Multi-year phosphorus applications will not be at rates which exceed the annual nitrogen recommendation of the year of application or on sites considered vulnerable to

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402.07(a)(3)(i)

off-site transport of phosphorus unless the appropriate conservation practices, best management practices, or management activities are used to reduce vulnerability.

(3) Potassium Application.

(i) Excess potassium will not be recommended in situations in which it causes unacceptable nutrient imbalances in crops or forages.

(ii) When forage quality and animal health are issues associated with excess potassium application, State standards will be used to set forage quality guidelines.

(e) Other plant nutrients should be applied as needed.

(f) Starter fertilizers containing nitrogen, phosphorus, and potassium may be recommended in accordance with Land Grant University guidance or industry practice if recognized by the Land Grant University within the State.

402.07 Special Considerations.

(a) Plans developed for nutrient management that include the use of manure or other organic by-products will:

(1) Identify the size of the land base needed to enable plan implementation based on phosphorus, even when initial implementation will be based on nitrogen, unless other provisions that do not involve land application are made for utilizing the manure.

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(2) Document the soil phosphorus level at which plan implementation on a phosphorus standard would be desirable.

(3) Include a field-by-field assessment of the potential risk for phosphorus transport from the field. This assessment may be made using the Phosphorus Index (PI) or other assessment tool recognized and accepted by NRCS.

(i) When a phosphorus assessment is completed, the plans will describe:

A record of the ratings for each field.

Information about conservation practices and management activities that can reduce the potential for phosphorus transport from the field.

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402.07(3)(ii)

(ii) The results of a phosphorus assessment and recommendations will be discussed with the producer as a normal part of the planning process.

(4) Recognize that some manures contain heavy metals and should be accounted for in the plan for nutrient management.

(b) Progressive Planning.

(1) The National Planning Procedures Handbook, Part 600.1, provides guidance for progressive planning designed to assist producers who cannot initially plan for a Resource Management System (RMS).

(2) The progressive planning process may be used to help existing producers achieve an RMS level system when an RMS cannot be immediately implemented. Such plans shall include:

(i) A description of the RMS level system which the producer will be working to achieve.

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(ii) Conservation practices, management activities, and milestones (installation schedules) that demonstrate movement toward an RMS.

(3) Annual review of nutrient management systems being implemented through the progressive planning process is highly encouraged to determine progress.

(c) When plans for nutrient management are developed and implemented in a way that results in expected increases in soil phosphorus levels, the plans will include:

(1) Discussion about the potential for phosphorus accumulation in the soil and how such accumulation increases the potential for transport, animal health, or crop production problems.

(2) Discussion of the potential for soil phosphorus draw-down from the production and harvesting of crops.

(d) In areas with specially protected water bodies, plans will be developed incorporating any special requirements that are applicable within these areas.

(e) Land application of sewage sludge

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402.08(a)(8)

(1) When sewage sludge is applied to agricultural land, the accumulations of potential pollutants from such sources (including: Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc) in the soil is monitored in accordance with the U.S. Code Reference 40 CFR Parts 403 and 503, applicable State laws, and/or local ordinances. States may determine if such provisions should also be required for the land application of animal manure and other organic by-products that contain any of these metals.

(2) Sewage sludge is analyzed prior to land application to determine its nutrient value, heavy metals, and salt content.

(3) Acceptable application rates of sewage sludge are determined using guidelines in this policy, and applicable Federal, State, or local regulations.

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(f) Producers will be reminded that when producing “fresh, edible crops for the produce market, such as vegetables, root, or tuber crops” and using sewage sludge, animal manure, or other organic materials as a source of nutrients, applications should be in accordance with provisions of all applicable Federal, State, or local laws or policies.

402.08 Record Keeping.

(a) It is the responsibility of producers, or the agents of producers, to maintain records which document the implementation of plans for nutrient management. Records include:

- (1) Soil test results and recommended nutrient application rates.
- (2) Quantities and sources of nutrients applied; and heavy metals if applicable.
- (3) Dates (month and year) on which nutrients were applied.
- (4) Methods by which nutrients were applied (e.g. broadcast, incorporated after broadcast, injected, or fertigation).
- (5) Crops planted and dates of planting.
- (6) Harvest dates and yields of crops.
- (7) Where applicable, results of water quality tests (including irrigation water), plant tissue, or other organic by-products tests.
- (8) The results of reviews including the identification of the person completing the review and any recommendations that resulted from the review.

402-11

402.08(b)

(b) Records which document implementation of the plan should be retained for a period of 5 years; or for a period longer than 5 years if specified by other Federal or State agencies or local ordinances, or program or contract requirements.

(c) National Instruction No. 120-310, Amendment No. 4, dated June 17, 1998, provides guidance for responding to requests for access to these records.

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## APPENDIX C

# COMPREHENSIVE NUTRIENT MANAGEMENT PLAN FORMAT AND CONTENT

## INTRODUCTION

A conservation plan is developed by the landowner/operator for his/her use to record decisions for natural resource protection, conservation, and enhancement.

Decisions and resource information needed during implementation and maintenance of the plan are recorded. The plan narrative and supporting documents provide guidance for implementation and may serve as a basis for compliance with regulations and/or program funding through federal, State, or local financial support initiatives.

A comprehensive nutrient management plan (CNMP) is to include all land units on which manure and organic by-products will be generated, handled, or applied, and that the animal feeding operation (AFO) owner/operator either owns or has decision-making authority over.

The following guidance helps to maintain quality and provide appropriate documentation of a CNMP. The list shows the suggested items to be given to the AFO owner/operator. However, the CNMP content should be tailored to the meet the AFO owner's/operator's needs.

### Contents of a Comprehensive Nutrient Management Plan

#### 1. Site information

- Names, phone numbers, and addresses of the AFO owner(s) and manager(s).
- Location of production site: legal description, driving instructions from nearest post office, and the emergency 911 coordinates.
- Farmstead sketch.
- Plat map or local proximity map (Optional).
- Emergency action plan covering: fire, personal injury, manure storage and handling, and land application operations.
- Operation procedures specific to the production site and practices.

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- Existing documentation of present facility components that would aid in evaluating existing conditions, capacities, etc. (i.e., as-built plans, year installed, number of animals a component was originally designed for, etc.)

## **2. Production information**

- Animal types, phases of production, and length of confinement for each type at this site.
- Animal count and average weight for each phase of production on this site.
- Calculated manure and wastewater volumes for this site.
- Manure storage type, volume, and approximate length of storage.

## **3. Applicable permits or certifications**

- Federal, Tribal, State or local permits and/or ordinances.
- Operator or manager certifications.
- Manure applicator certifications.
- Record of inspections or site assessments.
- Changes made to CNMP.

## **4. Land application site information**

- Date plan prepared.
- Written manure application agreements. (Where Applicable)
- Aerial maps of land application area.
- Individuals field maps with marked setbacks, buffers, and waterways, and environmentally sensitive areas, such as sinkholes, wells, gullies, tile inlets, etc.
- Landowner names, addresses, and phone numbers.
- Legal description of land sites, including watershed codes.
- Specific and unique field identification codes.
- Land use designation.
- Soil map, with appropriate interpretations
- Risk assessments for potential nitrogen or phosphorus transport from fields. (See NRCS GM – 190, Part 402, “Nutrient Management”, Section 402.07)
- Land treatment practices planned and applied, and level of treatment they provide.

## **5. Manure application plans**

- Crop types, realistic yield targets, and expected nutrient uptake amounts.
- Application equipment descriptions and methods of application.
- Expected application seasons and estimated days of application per season.
- Estimated application amounts per acre (volume in gallons or tons per acre, and pounds of plant available nitrogen, phosphorous as P205, and potassium as K20 per acre)
- Estimated of acres needed to apply manure generated on this site respecting any guidelines published for nitrogen or phosphorous soil loading limits.

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## **6. Actual activity records**

- Soil tests -- not more than 5 years old.
- Manure test annually for each individual manure storage containment.
- Planned and applied rates, methods of application, and timing (month and year) of nutrients applied. (Include all sources of nutrients – manure, commercial fertilizers, etc.)
- Current and/or planned crop rotation.
- Weather conditions during nutrient application (Optional)
- General soil moisture condition at time of application (i.e., saturated, wet, moist, dry) (Optional)
- Actual crop and yield harvest from manure application sites.
- Record of internal inspections for manure system components.
- Record of any spill events.

## **7. Mortality disposal**

- Plan for mortality disposal.
- Methods and equipment used to implement the disposal plan.

## **8. Operation and Maintenance**

- Detailed operation and maintenance procedures for the conservation system, holding facility, etc., contained in the CNMP. This would include procedures such as calibration of land application equipment, storage facility emptying schedule, soil and manure sampling techniques, etc.

## APPENDIX D

### CONSERVATION PRACTICE STANDARDS

Natural Resources Conservation Service (NRCS) conservation practice standards provide guidance for applying technology on the land, and set the minimum level for acceptable application of the technology.

NRCS issues national conservation practice standards in its National Handbook of Conservation Practices (NHCP). National standards for each practice are available at the NRCS website [http://www.ncg.nrcs.usda.gov/nhcp\\_2.html](http://www.ncg.nrcs.usda.gov/nhcp_2.html). Each State Conservationist determines which national standards will be used in his/her state.

State Conservationists that choose to use national standards, without changes, adapt them for use in their state and issue them as state conservation practice standards. State Conservationists add the technical detail needed to effectively use the standards at the field office level. Also, State Conservationists can make their conservation practice standards more restrictive, but not less restrictive. State conservation practice standards are contained in Section IV of the Field Office Technical Guide.

Copies of NRCS state conservation practice standards are not currently available from the NRCS Homepage, but may be available later. Copies presently can be obtained by contacting the appropriate NRCS State Office. (see Appendix G)

On the following pages are the three most commonly considered conservation practice standards that may be used when developing a comprehensive nutrient management plan (CNMP):

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**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**NUTRIENT MANAGEMENT**

(Acre)

**CODE 590**

**DEFINITION**

Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

**PURPOSES**

- ◆ To budget and supply nutrients for plant production.
- ◆ To properly utilize manure or organic by-products as a plant nutrient source.
- ◆ To minimize agricultural nonpoint source pollution of surface and ground water resources.
- ◆ 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.

**CRITERIA**

**General Criteria Applicable to All Purposes**

Plans for nutrient management shall comply with all applicable Federal, state, and local laws and regulations.

Plans for nutrient management shall be developed in accordance with policy requirements of the NRCS General Manual Title 450, Part 401.03 (Technical Guides, Policy and Responsibilities) and Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy); technical requirements of the NRCS Field Office Technical Guide (FOTG); procedures contained in the National Planning Procedures Handbook (NPPH), and the NRCS National Agronomy Manual (NAM) Section 503.

Persons who review or approve plans for nutrient management shall be certified through any

certification program acceptable to NRCS within the state.

Plans for nutrient management that are elements of a more comprehensive conservation plan shall recognize other requirements of the conservation plan and be compatible with its other requirements.

A nutrient budget for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to animal manure and organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water.

Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soil, cropping systems, and soil and manure/organic by-products tests. For new crops or varieties, industry yield recommendations may be used until documented yield information is available. Plans for nutrient management shall specify the form, source, amount, timing and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and/or phosphorus movement to surface and/or ground waters.

Erosion, runoff, and water management controls shall be installed, as needed, on fields that receive nutrients.

### Soil Sampling and Laboratory Analysis (Testing)

Nutrient planning shall be based on current soil test results developed in accordance with Land Grant University guidance or industry practice if recognized by the Land Grant University. Current soil tests are those that are no older than five years.

Soil samples shall be collected and prepared according to the Land Grant University guidance or standard industry practice. Soil test analyses shall be performed by laboratories that are accepted in one or more of the following programs:

- ◆ State Certified Programs,
- ◆ The North American Proficiency Testing Program (Soil Science Society of America), or
- ◆ Laboratories whose tests are accepted by the Land Grant University in the state in which the tests will be used.

Soil testing shall include analysis for any nutrients for which specific information is 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.

### Plant Tissue Testing

Tissue sampling and testing, where used, shall be done in accordance with Land Grant University standards or recommendations.

### Nutrient Application Rates

Soil amendments shall be applied, as needed, to adjust soil pH to the specific range of the crop for optimum availability and utilization of nutrients.

Recommended nutrient application rates shall be based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities. If the Land Grant University does not provide specific recommendations, application shall be based on realistic yield goals and associated plant nutrient uptake rates.

The planned rates of nutrient application, as documented in the nutrient budget, shall be determined based on the following guidance:

- ◆ **Nitrogen Application** - Planned nitrogen application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- ◆ **Phosphorus Application** - Planned phosphorus application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- ◆ **Potassium Application** - Excess potassium shall not be applied in situations in which it 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 Land Grant University guidance or industry practice if recognized by the Land Grant University in the state.
- ◆ **Starter Fertilizers** - Starter fertilizers containing nitrogen, phosphorus and potassium may be applied in accordance with Land Grant University recommendations, or industry practice if recognized by the Land Grant University within the state. When starter fertilizers are used, they shall be included in the nutrient budget.

### Nutrient Application Timing

Timing and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, and field accessibility.

### Nutrient Application Methods

Nutrients shall not be applied to frozen, snow-covered, or saturated soil if the potential risk for runoff exists.

Nutrient applications associated with irrigation systems shall be applied in accordance with the requirements of Irrigation Water Management (Code 449).

### Additional Criteria Applicable to Manure or Organic By-Products Applied as a Plant Nutrient Source

Nutrient values of manure and organic by-products (excluding sewage sludge) shall be determined prior to land application based on laboratory analysis, acceptable "book values" recognized by the NRCS and/or the Land Grant University, or historic records for the operation, if they accurately estimate the nutrient content of the material. Book values recognized by NRCS may be found in the Agricultural Waste Management Field Handbook, Chapter 4 - Agricultural Waste Characteristics.

### Nutrient Application Rates

The application rate (in/hr) for material applied through irrigation shall not exceed the soil intake/infiltration rate. The total application shall not exceed the field capacity of the soil. The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

- ◆ **Nitrogen Application** - When the plan is being implemented on a phosphorus standard, manure or other organic by-products shall be applied at rates consistent with the phosphorus standard. In such situations, an additional nitrogen application, from non-organic sources, may be required to supply the recommended amounts of nitrogen.

Manure or other organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass.

- ◆ **Phosphorus Application** - When manure or other organic by-products are used, the planned rates of phosphorus application shall be consistent with any one of the following options:
  - **Phosphorus Index (PI) Rating.**  
Nitrogen based manure application on

Low or Medium Risk Sites, phosphorus based or no manure application on High and Very High Risk Sites.\*\*

- **Soil Phosphorus Threshold Values.** Nitrogen based manure application on sites on which the soil test phosphorus levels are below the threshold values. Phosphorus based or no manure application on sites on which soil phosphorus levels equal or exceed threshold values.\*\*
- **Soil Test.** Nitrogen based manure application on sites on which there is a soil test recommendation to apply phosphorus. Phosphorus based or no manure application on sites on which there is no soil test recommendation to apply phosphorus.\*\*  
\*\* Acceptable phosphorus based manure application rates shall be determined as a function of soil test recommendation or estimated phosphorus removal in harvested plant biomass. Guidance for developing these acceptable rates is found in the NRCS General Manual, Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy), and the National Agronomy Manual, Section 503.

A single application of phosphorus applied as manure 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 applications are made, the application rate shall:

- not exceed the recommended nitrogen application rate during the year of application, or
- not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when there is no recommended nitrogen application.
- not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices, best

**NRCS, NHCP**

management practices, or management activities are used to reduce the vulnerability.

### **Field Risk Assessment**

When animal manures or other organic by-products are applied, a field-specific assessment of the potential for phosphorus transport from the field shall be completed. This assessment may be done using the Phosphorus Index or other recognized assessment tool. In such cases, plans shall include:

- ◆ a record of the 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.

When such assessments are done, the results of the assessment and recommendations shall be discussed with the producer during the development of the plan.

### **Heavy Metals Monitoring**

When sewage sludge is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall 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 Criteria to Minimize Agricultural Non-point Source Pollution of Surface and Ground Water Resources**

In areas with an identified or designated nutrient-related water quality impairment, an assessment shall be completed of the potential for nitrogen and/or phosphorus transport from the field. The Leaching Index (LI) and/or Phosphorus Index (PI), or other recognized assessment tools, may be used to make these assessments. The results of these assessments and recommendations shall be discussed with the producer and included in the plan.

Plans developed to minimize agricultural nonpoint source pollution of surface or ground water resources shall include practices and/or management activities that can reduce the risk of nitrogen or phosphorus movement from the field.

### **Additional Criteria to Improve the Physical, Chemical, and Biological Condition of the Soil.**

Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition. Use of nutrient sources with high salt content will be minimized unless provisions are used to leach salts below the crop root zone.

Nutrients shall not be applied to flooded or saturated soils when the potential for soil compaction and creation of ruts is high.

### **CONSIDERATIONS**

Consider induced deficiencies of nutrients due to excessive levels of other nutrients.

Consider additional practices such as Conservation Cover (327), Grassed Waterway (412), Contour Buffer Strips (332), Filter Strips (393), Irrigation Water Management (449), Riparian Forest Buffer (391A), Conservation Crop Rotation (328), Cover and Green Manure (340), and Residue Management (329A, 329B, or 329C, and 344) to improve soil nutrient and water storage, infiltration, aeration, tillage, diversity of soil organisms and to protect or improve water quality.

Consider cover crops whenever possible to utilize and recycle residual nitrogen.

Consider application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere. Suggestions include:

- ◆ split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- ◆ avoiding winter nutrient application for spring seeded crops,
- ◆ band applications of phosphorus near the seed row,
- ◆ applying nutrient materials uniformly to application areas or as prescribed by precision agricultural techniques, and/or
- ◆ immediate incorporation of land applied manures or organic by-products,
- ◆ delaying field application of animal manures or other organic by-products if precipitation capable of producing runoff and erosion is

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forecast within 24 hours of the time of the planned application.

Consider minimum application setback distances from environmentally sensitive areas, such as sinkholes, wells, gullies, ditches, surface inlets or rapidly permeable soil areas.

Consider the potential problems from odors associated with the land application of animal manures, especially when applied near or upwind of residences.

Consider nitrogen volatilization losses associated with the land application of animal manures. Volatilization losses can become significant, if manure is not immediately incorporated into the soil after application.

Consider the potential to affect National Register listed or eligible cultural resources.

Consider using soil test information no older than one year when developing new plans, particularly if animal manures are to be a nutrient source.

Consider annual reviews to determine if changes in the nutrient budget are desirable (or needed) for the next planned crop.

On sites on which there are special environmental concerns, consider other sampling techniques. (For example: Soil profile sampling for nitrogen, Pre-Sidedress Nitrogen Test (PSNT), Pre-Plant Soil Nitrate Test (PPSN) or soil surface sampling for phosphorus accumulation or pH changes.)

Consider ways to modify the chemistry of animal manure, including modification of the animal's diet to reduce the manure nutrient content, to enhance the producer's ability to manage manure effectively.

### **PLANS AND SPECIFICATIONS**

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan:

- ◆ aerial photograph or map and a soil map of the site,

- ◆ current and/or planned plant production sequence or crop rotation,
- ◆ results of soil, plant, water, manure or organic by-product sample analyses,
- ◆ realistic yield goals for the crops in the rotation,
- ◆ quantification of all nutrient sources,
- ◆ recommended nutrient rates, timing, form, and method of application and incorporation,
- ◆ location of designated sensitive areas or resources and the associated, nutrient management restriction,
- ◆ guidance for implementation, operation, maintenance, recordkeeping, and
- ◆ complete nutrient budget for nitrogen, phosphorus, and potassium for the rotation or crop sequence.

If increases in soil phosphorus levels are expected, plans shall document:

- ◆ the soil phosphorus levels at which it may be desirable to convert to phosphorus based implementation,
- ◆ the relationship between soil phosphorus levels and potential for phosphorus transport from the field, and
- ◆ the potential for soil phosphorus drawdown from the production and harvesting of crops.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

In addition to the requirements described above, plans for nutrient management shall also include:

- ◆ discussion about the relationship between nitrogen and phosphorus transport and water quality impairment. The discussion about nitrogen should include information about nitrogen leaching into shallow ground water and potential health impacts. The discussion about phosphorus should include information about phosphorus accumulation in the soil, the increased potential for phosphorus transport in soluble form, and the types of water quality

impairment that could result from phosphorus movement into surface water bodies.

- ◆ discussion about how the plan is intended to prevent the nutrients (nitrogen and phosphorus) supplied for production purposes from contributing to water quality impairment.
- ◆ a statement that the plan was developed based on the requirements of the current standard and any applicable Federal, state, or local regulations or policies; and that changes in any of these requirements may necessitate a revision of the plan.

### **OPERATION AND MAINTENANCE**

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

- ◆ periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle.
- ◆ protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- ◆ calibration of application equipment to ensure uniform distribution of material at planned rates.
- ◆ documentation of the actual rate at which nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences.
- ◆ Maintaining records to document plan implementation. As applicable, records include:

- soil test results and recommendations for nutrient application,
- quantities, analyses and sources of nutrients applied,
- dates and method of nutrient applications,
- crops planted, planting and harvest dates, yields, and crop residues removed,
- results of water, plant, and organic by-product analyses, and
- dates of review and person performing the review, and recommendations that resulted from the review.

Records should be maintained for five years; or for a period longer than five years if required by other Federal, state, or local ordinances, or program or contract requirements.

Workers should be protected from and avoid unnecessary contact with chemical 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.

The disposal of material generated by the cleaning 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 and leaching.

The disposal or recycling of nutrient containers should be done according to state and local guidelines or regulations.

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**WASTE STORAGE FACILITY**

(No.)

**CODE 313**

**DEFINITION**

A waste impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

**PURPOSE**

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a function of an agricultural waste management system.

**CONDITIONS WHERE PRACTICE APPLIES**

The storage facility is a component of a planned agricultural waste management system.

Temporary storage is needed for organic wastes generated by agricultural production or processing.

The storage facility can be constructed, operated and maintained without polluting air or water resources.

Soils, geology, and topography are suitable for construction of the facility.

The practice applies to facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads. Fabricated structure facilities applies to tanks, stacking facilities, and pond appurtenances.

**CRITERIA**

**General Criteria**

**Storage period.** The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering

the climate, crops, soil, equipment, and local, state, and Federal regulations.

**Design storage volume.** The design storage volume shall consist of the total of the following as appropriate:

- a. Manure, wastewater, and other wastes accumulated during the storage period.
- b. Normal precipitation less evaporation on the surface area of the facility during the storage period.
- c. Normal runoff from the facility's drainage area during the storage period.
- d. 25-year, 24-hour precipitation on the surface of the facility.
- e. 25-year, 24-hour runoff from the facility's drainage area.
- f. Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks.
- g. Additional storage as may be required to meet management goals or regulatory requirements.

The design storage volume for a waste storage facility is equal to its required volume.

**Inlet.** Inlets shall be of any permanent type designed to resist corrosion, plugging, and freeze damage incorporating erosion protection as necessary. Inlets from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings or other confined spaces.

**Safety.** Design shall include appropriate safety features to minimize the hazards of the facility.

**Protection.** Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

**Flexible membranes.** Flexible membranes shall meet or exceed the requirements of flexible membrane linings specified in NRCS Practice Standard Pond Sealing.

#### **Pond Criteria**

**Location.** Waste storage ponds, if located within floodplains, shall be protected from inundation or damage from a 25-year flood event.

**Soil and foundation.** The pond shall be located in soils with acceptable permeabilities, or the pond shall be lined. Information and guidance on controlling seepage from waste storage ponds can be found in the Agricultural Waste Management Field Handbook (AWMFH), Chapter 7. The pond shall have a bottom elevation that is a minimum of 2 feet above the high water table.

**Outlet.** No outlet shall automatically release storage from the required storage volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

**Embankments.** The minimum elevation of the top of the settled embankment shall be 1 foot above the required storage volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top width shall be 8 feet. The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical.

**Emptying facilities.** Some type of facility shall be provided for emptying the pond. It may be a dock, a pumping platform, a retaining wall, or a ramp. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter. Steeper slopes may be used if special traction surfaces are provided.

Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the size and shape of the pond and type of seal, if any.

**Safety.** The pond shall be fenced and warning signs posted to prevent children and others from using it for other than its intended purpose.

#### **Fabricated Structure Criteria**

**Foundation.** The foundations of waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 1 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Table 1 - Presumptive allowable bearing stress values<sup>1</sup>

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf
<sup>1</sup> Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)	

**Structural loadings.** Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 2 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

- \* Rigid frame or restrained wall. Use the values shown in Table 2 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.
- \* Flexible or yielding wall. Use the values shown in Table 2 under the column "Freestanding Wall," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lbs/ft<sup>2</sup> where the stored waste is not protected from precipitation. A value of 60 lbs/ft<sup>2</sup> may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to

be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structure Due to Use, and in ASAE EP393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

**Structural design.** The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties and construction quality. Design assumptions and construction requirement shall be indicated on the plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety, and for odor and vector control.

All structures shall be underlain by free draining material or shall have footing located below the anticipated frost depth.

Minimum requirements for fabricated structures are as follows:

- \* Steel. "Manual of Steel Construction", American Institute of Steel Construction.
- \* Timber. "National Design Specifications for Wood Construction", American Forest and Paper Association.
- \* Concrete. "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute.

- \* Masonry. "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute.
  - \* Slabs on grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a minimum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.
  - \* For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade".
  - \* When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360 shall be used.
- Safety provisions.** Entrance ramps shall be no steeper than 10 horizontal to 1 vertical. Warning signs, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings.

Table 2 - Lateral earth pressure values<sup>1</sup>

Soil		Equivalent fluid pressure (lb/ft <sup>2</sup> /ft of depth)			
Description <sup>4</sup>	Unified Classification <sup>4</sup>	Above seasonal high water table <sup>2</sup>		Below seasonal high water table <sup>3</sup>	
		Free standing wall	Frame tanks	Free standing wall	Frame tanks
Clean gravel, sand or sand-gravel mixtures (maximum 5% fines) <sup>5</sup>	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and/or clay (less than 50% fines)	All gravel/sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50) <sup>6</sup>	CH, MH	-	-	-	-

- 1 For lightly compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
- 2 Also below seasonal high water table if adequate drainage is provided.
- 3 Includes hydrostatic pressure.
- 4 All definitions and procedures in accordance with ASTM D 2488 and D 653.
- 5 Generally, only washed materials are in this category
- 6 Not recommended. Requires special design if used.

## **CONSIDERATIONS**

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable. In addition, they should be located considering prevailing winds and landscape elements such as building arrangement, landform, and vegetation to minimize odors and visual resource problems.

An auxiliary (emergency) spillway and/or additional embankment height should be considered to protect the embankment. Factors such as drainage area, pond size, precipitation amounts, downstream hazards, and receiving waters should be evaluated in this consideration.

Non-polluted runoff should be excluded to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Freeboard for waste storage structures should be considered.

Solid/liquid separation of runoff or wastewater entering pond facilities should be considered to minimize the frequency of accumulated solid removal and to facilitate pumping and application of the stored waste.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

## **PLANS AND SPECIFICATIONS**

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

## **OPERATION AND MAINTENANCE**

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, for ponds, the plan shall include the requirement that following storms, waste shall be removed at the earliest environmentally safe period to ensure that sufficient capacity is available to accommodate subsequent storms.

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**WASTE UTILIZATION**

(Acre)

**CODE 633**

**DEFINITION**

Using agricultural wastes such as manure and wastewater or other organic residues.

**PURPOSES**

- Protect water quality
- Provide fertility for crop, forage, fiber production and forest products
- Improve or maintain soil structure;
- Provide feedstock for livestock
- Provide a source of energy

**CONDITIONS WHERE PRACTICE APPLIES**

This practice applies where agricultural wastes including animal manure and contaminated water from livestock and poultry operations; solids and wastewater from municipal treatment plants; and agricultural processing residues are generated, and/or utilized.

**CRITERIA**

**General criteria applicable to all purposes**

All federal, state and local laws, rules and regulations governing waste management, pollution abatement, health and safety shall be strictly adhered to. The owner or operator shall be responsible for securing any and all required permits or approvals related to waste utilization, and for operating and maintaining any components in accordance with applicable laws and regulations.

Use of agricultural wastes shall be based on at least one analysis of the material during the time it is to be used. In the case of daily spreading, the waste shall be sampled and analyzed at least once each year. As a

minimum the waste analysis should identify nutrient and specific ion concentrations.

Where the metal content of municipal wastewater, sludge, septage, and other agricultural waste is of a concern, the analysis shall also include determining the concentration of metals in the material.

Where agricultural wastes are to be spread on land not owned or controlled by the producer, the waste management plan, as a minimum, shall document the amount of waste to be transferred and who will be responsible for the environmentally acceptable use of the waste.

Records of the use of wastes shall be kept a minimum of five years as discussed in OPERATION AND MAINTENANCE, below.

**Additional criteria to protect water quality**

All agricultural waste shall be utilized in a manner that minimizes the opportunity for contamination of surface and ground water supplies.

Agricultural waste shall not be land-applied on soils that are frequently flooded, as defined by the National Cooperative Soil Survey, during the period when flooding is expected.

When liquid wastes are applied, the application rate shall not exceed the infiltration rate of the soil, and the amount of waste applied shall not exceed the moisture holding capacity of the soil profile at the time of application. Wastes shall not be applied to frozen or snow-covered ground.

**NRCS, NHCP**

**April, 1999**

**Additional criteria for providing fertility for crop, forage, fiber production and forest products**

Where agricultural wastes are utilized to provide fertility for crop, forage, fiber production, and forest products, the practice standard Nutrient Management (590) shall be followed.

Where municipal wastewater and solids are applied to agricultural lands as a nutrient source, the single application or lifetime limits of heavy metals shall not be exceeded. The concentration of salts shall not exceed the level that will impair seed germination or plant growth.

**Additional criteria for improving or maintaining soil structure**

Wastes shall be applied at rates not to exceed the crop nutrient requirements or salt concentrations as stated above, and shall be applied at times the waste material can be incorporated by appropriate means into the soil within 72 hours of application.

**Additional criteria for providing feedstock for livestock**

Agricultural wastes to be used for feedstock shall be handled in a manner to minimize contamination and preserve its feed value. Chicken litter stored for this purpose shall be covered. A qualified animal nutritionist shall develop rations which utilize wastes.

**Additional criteria for providing a source of energy**

Use of agricultural waste for energy production shall be an integral part of the overall waste management system.

All energy producing components of the system shall be included in the waste management plan and provisions for utilization of residues of energy production identified.

Where the residues of energy production are to be land-applied for crop nutrient use or soil conditioning, the criteria listed above shall apply.

**CONSIDERATIONS**

The effect of Waste Utilization on the water budget should be considered, particularly where a shallow ground water table is present or in areas prone to runoff. Limit waste application to the volume of liquid that can be stored in the root zone.

Minimize the impact of odors of land-applied wastes by making application at times when temperatures are cool and when wind direction is away from neighbors.

Agricultural wastes contain pathogens and other disease-causing organisms. Wastes should be utilized in a manner that minimizes their disease potential.

Priority areas for land application of wastes should be on gentle slopes located as far as possible from waterways. When wastes are applied on more sloping land or land adjacent to waterways, other conservation practices should be installed to reduce the potential for offsite transport of waste.

It is preferable to apply wastes on pastures and hayland soon after cutting or grazing before re-growth has occurred.

Reduce nitrogen volatilization losses associated with the land application of some waste by incorporation within 24 hours.

Minimize environmental impact of land-applied waste by limiting the quantity of waste applied to the rates determined using the practice standard Nutrient Management (590) for all waste utilization.

**PLANS AND SPECIFICATIONS**

Plans and specifications for Waste Utilization shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The waste management plan is to account for the utilization or other disposal of all animal wastes produced, and all waste application areas shall be clearly indicated on a plan map.

**OPERATION AND MAINTENANCE**

Records shall be kept for a period of five years or longer, and include when appropriate:

- Quantity of manure and other agricultural waste produced and their nutrient content
- Soil test results
- Dates and amounts of waste application where land applied, and the dates and amounts of waste removed from the system due to feeding, energy production, or export from the operation
- Waste application methods
- Crops grown and yields (both yield goals and measured yield)
- Other tests, such as determining the nutrient content of the harvested product
- Calibration of application equipment.

The operation and maintenance plan shall include the dates of periodic inspections and maintenance of equipment and facilities used in waste utilization. The plan should include what is to be inspected or maintained, and a general time frame for making necessary repairs.

## APPENDIX E

### NRCS FIELD OFFICE TECHNICAL GUIDE

The Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) is an essential tool for resource planning. The FOTG contains five Sections:

- I. **General Resource References** – References, maps, cost lists, typical crop budgets, and other information for use in understanding the field office working area, or in making decisions about resource use and resource management.
- II. **Soil and Site Information** – Soils are described and interpreted to help make decisions about land use and management. In most cases, this will be an electronic database.
- III. **Resource Management Systems** – Guidance for developing resource management systems. A description of the resource considerations and their acceptable levels of quality or criteria are included in this section. This section contains the Comprehensive Nutrient Management Planning Technical Guidance.
- IV. **Practice Standards and Specifications** – Contains standards and specifications for conservation practices used in the field office. Conservation practice standards contain minimum quality criteria for designing and planning each practice; specifications describe requirements necessary to install a practice.
- V. **Conservation Effects** – Contains Conservation Practices Physical Effects matrices that outline the impact of practices on various aspects of the five major resources – soil, air, water, plants, and animals.

The FOTG is a document that is being updated continuously to reflect changes in technology, resource information, and agency policy. The FOTG contains information that is unique to states and local field offices within states. To obtain information contained within the FOTG, contact a United States Department of Agriculture NRCS State Office (See Appendix G for a listing).

## APPENDIX F

### BACKGROUND INFORMATION AND CURRENT RESEARCH ON RESOURCE CONCERNS

The information presented here was obtained from the USDA Agricultural Research Service (ARS) Manure and Byproduct Utilization National Program Action Plan. Additional Research is also being conducted under the ARS Air Quality National Program. The action plans describe, in detail, the research goals in these areas over the next five years. For the complete action plan and the most up-to-date information on ARS National programs see:

*<http://www.nps.ars.usda.gov/>*.

#### AIR QUALITY

Air quality changes resulting from livestock operations are poorly defined because of lack of knowledge about the composition of emissions, emission rates, and dispersion of emissions across the landscape. However, the issue of air quality is one of the critical issues that must be addressed if animal feeding operations are to continue to exist in areas with increasing urban-rural populations.

There are three types of emissions from livestock operations that affect air quality: gases, particulates, and aerosols. Most gas emissions have not been examined or categorized. Known gases of particular interest include: ammonia, odorous compounds, and gases that adversely affect the atmosphere, such as methane, carbon dioxide and nitrous oxides. Ammonia emissions appear to have the greatest potential for adverse environmental and health impacts, while the generation and transport of malodorous compounds provokes the largest public concern.

Ammonia production is a consequence of bacterial activity involving organic nitrogen substrates. The primary source of ammonia production is the conversion of urea for livestock and uric acid for poultry. The process is extremely rapid, requiring only hours for substantial and days for complete conversion. A secondary source, which in this time frame can account for up to 35 percent of ammonia production, is organic nitrogen compounds in feces. In total, rapid processes convert about 35 percent of the total organic nitrogen initially in manure to ammonia. Over longer time periods, principally during storage, a total of 50 to 70 percent of the organic nitrogen can be converted to ammonia.

Odors are formed by the breakdown of manure via anaerobic digestion, and there are a wide range of volatile compounds that may potentially contribute to detection of odors by humans. Odorous compounds commonly associated with livestock facilities include: ammonia, volatile organic compounds including amines and fatty acids, and organic and inorganic sulfur containing compounds such as hydrogen sulfide and mercaptans.

The primary source of methane release in livestock production is ruminant animals. Release is a consequence of microbiological activity within the gastrointestinal tract necessary for breakdown of foodstuffs to compounds available for uptake by animals. Metabolic processes of methanogens can also result in significant methane release at all stages of manure handling. Methane production from agriculture has been estimated to be around 7.8 Tg/yr, with 70 percent of this amount produced by cattle that are grazed and not in confinement feeding operations. Swine manure is estimated to produce 1.1 Tg/yr, while beef and dairy produce 0.9 Tg/yr. This difference is attributed to the manure storage and handling process variations between swine and beef.

Carbon dioxide is the normal byproduct of animal and most bacterial metabolism. Nitrogen dioxide and NO<sub>x</sub> release are normally the result of nitrification and denitrification processes whereby ammonia is converted to inorganic forms of nitrogen which, in turn, are converted to nitrogen gas. In addition, significant quantities of these gases can be released as by-products of engineering processes designed to dispose of manure or reduce odors.

Particulates are generally a consequence of interactions of animals with their environment. In confined animal housing facilities, bedding, manure, litter, animal by-products such as feathers, and feed mixing and distribution can contribute to the generation of particulates. Activity of animals during transport or other husbandry activities can help particulates to become airborne. In external housing facilities, animal movement on dry soil and manure can produce significant dust problems. Aerosols can be generated anytime there is a water source and air movement. Numerous farm management procedures generate aerosols, including misting or spraying to cool animals, manure separation techniques, spray irrigation, and spraying to control dust. The current development and implementation of the U.S. Environmental Protection Agency's PM-2.5 and PM-10 air particulate matter standards add additional urgency to addressing the sources and amounts of particulate emission.

The goals of ARS researchers working in the area of atmospheric emissions from livestock operations are:

1. Develop certified methods to accurately measure emissions, e.g., ammonia, particulates, odors, volatile organic compounds, and other greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and NO<sub>x</sub>), related to livestock facilities. Develop robust methods that can be used across a wide range of environments and animal production systems.
2. Understand ecology of aerobic and anaerobic microorganisms that are associated with emissions. Identify mechanisms to change the ecology or metabolism of organisms to reduce undesirable emissions. Develop methods to promote favorable changes in ecology or metabolism of microorganisms.
3. Quantify the emission rates in relation to handling, storage, processing, and application practices commonly used in U.S. livestock production systems. Correlate emissions with management practices to allow identification of best management practices for adoption by producers.

4. Determine environmental impacts on generation processes elucidated from Goal #2. Determine the environmental impacts on transport and dispersion of gases and particulates from livestock production and manure application sites. Quantify the interactions of environment on generation, transport and dispersion processes. Quantify the interactions of emissions: gases, particulates, and aerosols, as factors influencing atmospheric transport and dispersion.
5. Determine the direct on-site impact of emissions on environment and health. Determine the local impact of emissions on environment and health. Determine the relative contribution of emissions from livestock facilities compared to regional and global emissions from other sources. Determine the net environmental cost of emissions related to livestock facilities and manure application.
6. Determine whether application of current best management practices can reduce emissions to acceptable on-site and off-site levels. Develop alternative management practices that can reduce emissions and achieve most efficient use of nutrients by animals. Determine the efficacy of various technologies and practices at a local, regional, and national scale.

## **PATHOGENS**

Utilization of contaminated irrigation water or manures containing pathogenic or parasitic agents are considered to be important factors in the occurrence and epidemiology of water- and food-borne diseases. Recycling of manure to the land without adequate pathogen reduction directly increases the risks of human illness via water- or food-borne contamination, as well as cycling pathogens back to animals on the farm. This is true for pathogens associated with foods of animal origin as well as produce that may have been contaminated during production. Techniques, such as composting or deep stacking, to reduce pathogen levels in manure are often not used by producers because they require extra time, attention, special equipment or structures, and impose additional costs.

Generally, soil that has not recently received raw manure (liquid, slurry, partially dried, or improperly composted) or inadequately treated sewage has not been found to harbor indigenous populations of enteric pathogens and parasites. Manure, however, is not the only on-farm source of pathogens and parasites. Other farm sources include: dust, aerosols, irrigation and runoff water, farm workers, plant residues, and the soil. For example, *Bacillus cereus*, *Clostridium* spp, and *Listeria monocytogenes*, can be readily found in many soils in association with plant material, vegetables, and decaying leaves and other plant parts. In addition, coliforms such as *Enterobacter* spp. and *Klebsiella* spp. are common inhabitants of soil and plant material, even in the absence of fecal material. This limits the use of traditional fecal coliform methods as indicators of fecal contamination, and reinforces the need for standard methods for the assessment of fecal contamination of produce.

It is well established that pathogen spread in the environment results from improper treatment and land application of sewage, slaughter offal, sludge, biosolids, slurry and manure, as well as

from wild and domesticated animals. This may lead, by way of contamination of surface waters and colonization of birds, rodents and insects, to the contamination of animal feeds or directly contribute to the re-colonization of farm animals. Despite what is known about potential vectors of pathogen contamination, many critical questions remain to be answered. The lack of knowledge about pathogen survival in manure and about the adequacy of various manure management techniques to reduce the levels of these pathogens clearly points to the need for research on these issues. The fate of pathogens in the environment (e.g., transport and survival) after manure and other by-products have been land applied or otherwise disposed is not adequately known. In addition, better estimates of human and animal exposure are required for risk assessment to adequately assess the benefit of manure and byproduct treatment strategies.

Many of the pathogens that have emerged over the past 10 years cannot be easily detected and quantified in complex environmental samples such as manure, compost, soil, and foods. Application of current standard methods to the variety of matrices involved in determining the exposure at the farm end of the farm-to-table continuum will require adaptation and possibly development of new methods for detection and quantification of viable microorganisms.

The specific goals of ARS researchers working in the area of pathogens from livestock operations are:

1. To develop new techniques and adapt existing techniques for the detection of pathogenic bacteria and protozoans in agricultural matrices such as manure and soil. To standardize techniques for sampling and detection of each pathogen in all environmental matrices encountered in agriculture (manure, soil, runoff water and ground water) with respect to sample size, limit of detection, storage, etc., so that studies can be compared. To develop sensors (biological, molecular, chemical) for the rapid detection of pathogens in agricultural systems.
2. Determine the survival and transport of enteropathogenic bacteria in agricultural soils managed under different agricultural practices. Determine the effect of soil structure, pH, temperature, etc. on pathogen survival. Determine the influence of cover crops on pathogen survival. Relate the survival of various pathogens under all these conditions to the survival of more easily measured indicator organisms. Determine the effect of manure composition on pathogen survival upon storage or on application to soil. Determine the role of biofilm formation by saprophytes and pathogens on plants, plant residues, and soil particles in the survival of pathogens derived from fresh manure and treated manures.
3. Determine pathogen/parasite levels in feces and estimate pathogen loading rates for different production systems. Develop functional relationships between vertical versus surface pathogen transport and soil, topographic, vegetation, rainfall, and organism parameters. Determine pathogen association with organic particulates and/or sediments and the impact on transport potential/dissemination. Assess the ability of vegetative buffer strips, riparian zones, and/or wetlands to reduce pathogen runoff. Integrate laboratory, field plot, and watershed scale data to describe pathogen transport in the context of hydrology. Assess the importance of wildlife/insect vectors and aerial transport. Quantify the role of on-farm

practices on inter- and intra-farm pathogen dissemination (e.g., vehicular transport of incompletely disinfected manures, birds, dust, etc.).

4. Determine rates of pathogen destruction for major existing treatments, i.e., deep stacks, compost (passive aerated, windrow, static piles, in-vessel), digestion, lagoon, air drying, heat drying, and new treatments, and include pathogens and parasites recently involved in the surge of food and waterborne illness outbreaks in the U.S. Determine what protectants in manures, composts, or soils affect survival of pathogens and parasites. Quantitatively relate rates of pathogen destruction to critical environmental factors associated with each of the various treatment processes; develop destruction functions for each of the major pathogens, manure types, and treatments. Develop process quality criteria to guide operators so that pathogen destruction is achieved to the extent possible for the treatment process selected. Develop and validate appropriate quality control tests or measures for pathogen destruction for each major treatment process. Determine which indicator or surrogate organisms are appropriate for use in assessing reduction of particular pathogens in manure from various animal species, and use them in on-farm tests. Improve microbial growth, survival and thermal death models for manure and soil matrices, including species and strain differences, and nonlinear declines. Develop concepts and models of microbial exposure and risk analysis for treated manure products and link to more general microbial risk assessment models. Incorporate pathogen reduction data for major treatment methods into cost-benefit analysis models. Compare actual and predicted destruction in various on-farm treatment processes. Evaluate the use of industrial by-products to improve effectiveness of pathogen reduction treatments. Develop new methods to reduce or eliminate contaminants from establishing on plants before harvest. Develop new cost-effective disinfection methods and equipment and systems modifications for processing manure that are also consistent with air and water quality and nutrient management concerns.
5. Establish assessment endpoints. Evaluate manure management strategies in the context of risk assessment.

## **NUTRIENT MANAGEMENT**

Animal manures, applied in solid, semisolid and liquid forms contain essential nutrients that can meet crop requirements if applied to land in the proper manner at the right time and in suitable amounts. The manure generated annually in the U.S. contains about 8.3 million tons of nitrogen (N) and 2.5 million tons of phosphorus (P). However, manure in general is underutilized as a nutrient source in high density animal production areas such as dairy farms in southern California, beef feedlots in the Southern Plains, hog operations in North Carolina and poultry houses in the Southeastern U.S. Manure can build soil organic matter reserves, resulting in improved water-holding capacity, increased water infiltration rates and improved structural stability. Manure can decrease the energy needed for tillage, reduce impedance to seedling

emergence and root penetration, stimulate growth of beneficial soil microbial populations and increase beneficial mesofauna such as earthworms.

Animal feed and animal nutrition are important components of manure management. Livestock and poultry diet directly influences the amount of manure produced; nutrient, trace element and pathogen concentrations in manure; and formation of volatile components. Research to increase feed use-efficiency emphasizes defining animal nutritional requirements, diet formulation, genetically altered crops, use of enzymes and alteration of intestinal microflora.

In the past, animal diets were oversupplied with nutrients to achieve maximum animal performance with little regard for nutrients excreted. As environmental concerns associated with excess manure nutrients have increased, research has turned toward more efficient use of feed and matching feed nutrient concentrations to animal requirements. This approach can reduce the volume of manure produced, reduce nutrients excreted and lower production costs.

Ineffective utilization of P, especially by monogastric animals such as poultry and swine, has resulted in excess levels of P in manure. Monogastric animals lack enzymes to effectively break down the phytic acid form of P normally found in grain. Producers routinely add inorganic P supplements to poultry and swine diets, resulting in even higher levels of P in manure. Two basic approaches are being used to increase P utilization efficiency: enzyme addition to animal feed and development of grain with P in forms more readily available to the animal.

Nitrogen is especially susceptible to losses through ammonia volatilization, denitrification, leaching, anaerobic decomposition in lagoons and during aerobic composting. Treatment technologies are being developed to control ammonia volatilization and to immobilize N and P. Management of liquid manure and wastewater from animal operations is a major concern. Research is being conducted to allow more effective use of manure resources from anaerobic and aerobic lagoons, to develop more efficient separation of manure liquids and solids, and to find improved ways to immobilize and capture manure nutrients. A combination of practices will be required to effectively manage nutrients during manure handling and storage.

A greater understanding of nutrient transformations and reactions in manure and soil treated with manure is required. Analytical methods are needed to give producers quick reliable estimates of bioavailable nutrient concentrations in manure and soil. This will allow manure application rates to be targeted to crop needs and will allow proper nutrient credits for manure.

Effective management of N and P from manure and fertilizer is essential to protect ground and surface water quality. In the past, animal manure application rates were based on crop N requirements to minimize nitrate leaching to groundwater. The mean N:P ratio (4:1) in manure is generally lower than the mean N:P ratio (8:1) taken up by major grain and hay crops. Therefore, if manure application based on N has occurred for many years, rapid build up of P levels in soils create the potential for P losses to surface waters through runoff. Although protecting groundwater from nitrate leaching and limiting ammonia volatilization are major concerns, the management emphasis has shifted to P in many areas of the U.S.

Irrigation, especially furrow irrigation, can significantly increase P losses by both surface runoff and erosion in irrigation return flows. In addition, researchers have shown that soil P moves

through the soil profile to shallow subsurface water in heavily-manured areas of the Delmarva Peninsula and through the soil profile to tile drains in the Midwest and Southeast U.S. Several states have established threshold soil test P levels that are perceived to protect surface waters from runoff that would cause eutrophication. These threshold levels are based on soil tests originally designed to predict crop response to nutrient additions. At soil test values above the threshold level, additional P cannot be added to the soil or application rates are limited to crop removal rates.

However, there are a number of limitations to a regulatory approach based on soil threshold P values. Also, it has been shown that 90 percent of the P runoff from an agricultural watershed may come from only 10 percent of the land area during a few relatively large storms. Therefore, the preferred approach to preventing P loss is to define, target and remediate source areas of P that combine high soil P levels, high surface runoff and erosion potentials, and proximity to P-sensitive bodies of water. This approach addresses P management at multi-field or watershed scales. A P index has been developed to rank the vulnerability of fields as sources of P losses in surface runoff. The index accounts for and ranks transport and source factors controlling P losses in surface runoff. The P index is being evaluated and refined in 14 states. When fully developed, the P index will allow producers to identify areas in a watershed that are susceptible to P losses and will suggest management options to correct the problem.

Alternative uses are needed for animal manure in areas where supply exceeds available land and land application would cause significant environmental risk. Manure use for energy production including burning, methane generation and conversion to other fuels is being investigated. Methods to reduce the weight, volume or form of manure such as composting or pelletizing will reduce transportation costs and create a more valuable product. Manure is being mixed, blended or co-composted with industrial or municipal byproducts to produce value-added material for specialized uses. Transportation subsidies are needed to move manure from areas of over supply to areas with nutrient deficiencies.

Changes in farming practices may be needed to address manure problems. Systems that balance nutrient inputs and outputs need to be developed at the whole-farm scale. These systems would emphasize a reduction of purchased nutrient inputs and more effective use and cycling of nutrients on the farm. Alternative production systems such as hoop houses for swine need to be evaluated and used where appropriate to reduce environmental threats from animal feeding operations. Benefits to be gained in terms of improved environmental quality would partially offset any additional expenses associated with these alternative manure uses and management practices.

The specific goals of ARS researchers working in the area of nutrient management from livestock manure are:

1. Determine the minimum nutrient requirements to support optimum production while minimizing nutrient losses for modern domestic livestock species under different production systems. Determine how nutrient requirements could be manipulated through changes in animal physiological processes. Determine the effects of diet formulation, environment, and feeding strategies on nutrient use and excretion by livestock and poultry. Develop procedures for use of dietary enzymes, supplements, and metabolic modifiers to improve nutrient utilization and decrease nutrient excretion. Determine the impact of gut micro flora on nutrient excretion. Modify feedstocks, livestock, and poultry for more efficient nutrient use by the animal and reduced nutrient excretion. Develop simple, inexpensive, rapid and reliable tests to reliably determine the bioavailability of nutrients in feeds. Determine the impact of diet and feeding strategies on nonpoint source water pollution.
2. Increase understanding of manure chemistry and microbiology to reduce nutrient losses during handling and storage and to improve treatment systems. Develop improved systems for solids removal from liquid manures. Develop improved manure handling, storage, and treatment methods to reduce ammonia volatilization. Develop treatment systems that transform and/or capture nutrients, trace elements, and pharmaceutically active chemicals from manure produced in confined animal production systems. Improve composting and other manure stabilization techniques. Develop treatment systems to remediate or replace anaerobic lagoons.
3. Develop techniques to identify and quantify the important compounds in animal manure and byproducts that contribute plant-available nutrients. Develop quick, accurate, and reliable methods for manure analysis. Develop techniques to assess the dynamics of nutrient availability from manures and byproducts in specific soil-crop-climate systems.
4. Develop best management practices for manure application rate, placement, and timing to synchronize manure nutrient availability with crop nutrient demand. Develop decision support tools and production practices that integrate manure and byproduct use and balance nutrient inputs and outputs at the whole-farm scale.
5. Determine the relationship between phosphorus in soil and the movement of soluble phosphorus to surface and shallow ground water. Develop predictive tools to identify areas susceptible to phosphorus losses in a landscape. Develop comprehensive watershed-scale nutrient management practices to protect water quality.
6. Determine the influence of agronomic practices such as tillage system, surface residue, crop rotations, on movement of manure nutrients to surface and ground water. Develop and evaluate methods such as vegetative buffer zones, grass filter strips, riparian zones, and/or other vegetative filters to prevent manure nutrient movement to surface waters.
7. Determine the long-term effects of manure and byproduct application on soil physical, biological, and chemical properties. Determine the long-term effects of manure and

byproduct application on crop, range, and livestock productivity. Determine the long-term effects of manure and byproduct application on adjacent ecosystems.

8. Develop soil and crop management systems that increase utilization of manure nutrients. Develop short-term remediation strategies (bio- and phyto-) to remove excess nutrients in the soil. Develop long-term soil amendments and crop management systems to remove excess nutrients from soil.
9. Develop effective methods to obtain energy from manure. Co-utilize animal manure with other organic and inorganic waste resources to produce value-added products for special uses.

## APPENDIX G

### STATE OFFICES

#### United States Department of Agriculture Natural Resources Conservation Service

**Alabama**

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Fax: 334/887-4552

**Connecticut**

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Fax: 860/871-4054

**Idaho**

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Suite C  
Boise, ID 83709  
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Fax: 208/378-5735

**Alaska**

800 West Evergreen  
Atrium Building, Suite 100  
Palmer, AK 99645-6539  
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Fax: 907/761-7790

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1203 College Park Drive  
Suite 101  
Dover, DE 19904-8713  
Phone: 302/678-4160  
Fax: 302/678-0843

**Illinois**

1902 Fox Drive  
Champaign, IL 61820-7335  
Phone: 217/353-6600  
Fax: 217/353-6676

**Arizona**

3003 North Central Avenue  
Suite 800  
Phoenix, AZ 85012-2945  
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2614 N.W. 43<sup>rd</sup> Street  
Gainesville, FL 32606-6611 or P.O.  
Box 141510,  
Gainesville, FL 32614  
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Fax: 352/338-9574

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Indianapolis, IN 46278-2933  
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Fax: 317/290-3225

**Arkansas**

Federal Building, Room 3416  
700 West Capitol Avenue  
Little Rock, AR 72201-3228  
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Fax: 501/301-3194

**Georgia**

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355 East Hancock Avenue  
Athens, GA 30601-2769  
Phone: 706/546-2272  
Fax: 706/546-2120

**Iowa**

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210 Walnut Street, Suite 693  
Des Moines, IA 50309-2180  
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Fax: 515/284-4394

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430 G Street  
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**Guam**

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FHB Building, Suite 301  
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Maite, GU 96927  
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Fax: 785/823-4540

**Colorado**

655 Parfet Street  
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Fax: 303/236-2896

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P.O. Box 50004  
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Fax: 808/541-1335

**Kentucky**

771 Corporate Drive  
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Lexington, KY 40503-5479  
Phone: 606/224-7350  
Fax: 606/224-7399

**Louisiana**

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Alexandria, LA 71302  
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Fax: 318/473-7626

**Mississippi**

Suite 1321, Federal Building  
100 West Capitol Street  
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Phone: 601/965-5205  
Fax: 601/965-4940

**New Jersey**

1370 Hamilton Street  
Somerset, NJ 08873-3157  
Phone: 732/246-1171 Ext. 120  
Fax: 732/246-2358

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967 Illinois Avenue  
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Bangor, ME 04401  
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**Missouri**

Parkade Center, Suite 250  
601 Business Loop 70 West  
Columbia, MO 65203-2546  
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Fax: 573/876-0913

**New Mexico**

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Fax: 505/761-4462

**Maryland**

John Hanson Business Center  
339 Busch's Frontage Road  
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Fax: 410/757-0687

**Montana**

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Fax: 406/587-6761

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Fax: 315/477-6550

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Fax: 413/253-4375

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Fax: 775/784-5939

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Bismarck, ND 58502-1458  
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Fax: 701/530-2110

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Fax: 651/602-7914 or 7915

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Fax: 405/742-1126

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Fax: 605/352-1280

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Nashville, TN 37203-3878  
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Fax: 615/277-2578

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