Chapter 3: Waste Management Plans

Current regulations require animal waste management plans for every animal operation involving 250 or more swine, 100 or more confined cattle, 75 or more horses, 1,000 or more sheep and 30,000 or more confined poultry that use a liquid waste management system. The animal waste management plan details the amount of waste generated, the fields and associated crops receiving the waste, and the BMPs specific to the operation. In addition, plans developed after January 1, 1997 are required to address the following eight components:

1. Odor Control
2. Insect Control
3. Animal Mortality Management
4. Riparian Buffers
5. Emergency Management
6. Waste and Soil Testing
7. Record Keeping
8. Waste Application Rates

Each of these items will be discussed in this and subsequent chapters.

ODOR CONTROL

On many operations, odor is likely to be the number one community issue for both producers and the general public. Because people can detect a smell they find offensive, they assume there is an environmental problem. The good news is that odor can be managed by reducing sources of odor. Decomposing manure is the most obvious source. Generally, decomposing manure that has undergone some type of anaerobic (without oxygen) breakdown has a more offensive odor than fresh manure. Factors that affect odor include feed source, animal metabolism, and environmental conditions in which manure is stored and spread. Decomposing feed and carcasses can also contribute to odor. A checklist of best management practices to control odor is included in Appendix D of this manual. As part of your animal waste management...
plan, a technical specialist will help you select practices from this list to be used on your farm to control odors. Once the checklist is completed it becomes your responsibility to follow those practices.

**INSECT CONTROL**

Insect control can also be a community issue for both producers and the general public. Usually insect problems can be found where feed has spilled or manure has accumulated. Again, the good news is that insects can be controlled using best management practices.

A checklist of best management practices to control insects is included in Appendix D of this manual. As part of your animal waste management plan, a technical specialist will help you select practices from this list to be used on your farm. Once the checklist is completed it becomes your responsibility to follow those practices.

**ANIMAL MORTALITY**

Animal mortality is regulated by the North Carolina Department of Agriculture Veterinary Division. Your animal waste management plan will address the requirements of these regulations.

The management of animal mortalities is a critical component of a farm’s animal waste management system. Improperly disposed animals will produce odor and disease problems as well as may contribute to the degradation of ground and surface water quality. Proper mortality disposal is part of an operations’ daily management responsibilities. The normal mortality of livestock and poultry facilities results in the need to dispose of large quantities of animals. In addition, the weight of carcasses that producers normally experience increases dramatically when animals get closer to maturity.

Common methods of mortality disposal include disposal pits, trench burial, incineration, rendering, and more recently composting. In many cases public landfills no longer accept animal carcasses. On-site burial and pit disposal are receiving close scrutiny in areas with high water tables or soils vulnerable to leaching of nutrients. Incineration is energy intensive, and contributes to air pollution.
Rendering is an option that recycles carcasses into safe, useful by-products such as meat and bone meal, animal fat, and paints and plastics. Rendering plants or livestock cooperatives provide bins to livestock operations for the collection of daily mortalities. Bins are then emptied depending on scheduled routes of rendering companies or the production needs of livestock operations in special cases.

Composting of animal mortalities is becoming more popular as a means of disposing of dead animals in an environmentally safe manner. Composting breaks down the dead animal into stable, safe humus-like material that can be spread on cropland. This process has been used successfully for years by the poultry industry. Initial trials have been conducted in several states for composting small pig carcasses (up to 30 pounds) and afterbirth with success similar to poultry mortality composters. Composting has also been successful in composting large hog carcasses (up to 400 pounds). Permits for mortality composters are required by the North Carolina Department of Agriculture Veterinary Division on a case-by-case basis. The Division can be contacted at (919) 733-3986 to obtain information on the compost permitting process.

The type of mortality management selected for use in your facility should be one that best fits your specific situation. The decision should be based on factors such as cost, environmental conditions, ability to meet design requirements, labor requirements, and how production methods match with animal numbers and the operation’s management system.

**Waste and Soil Sampling**

Periodic waste and soil analysis is now required. At a minimum, animal waste must be sampled within 60 days before or after land application, preferably before. Annual soil sampling for lime requirement and nutrient monitoring is also required for every field receiving animal waste. Both waste and soil sampling will be discussed in detail in Chapter 4.
Chapter 3: Waste Management Plans

**Record Keeping**

Records are required to be kept for five years. The records that must be kept include soil and waste analysis reports, as well as land application dates and rates for each application site. Regulations require the use of forms approved by the Department of Environment, Health, and Natural Resources. Chapter 6 will address record keeping and the required forms in detail.

**Waste Application Rates**

Waste application rates are a key factor in following a waste utilization plan. The primary goal of a waste utilization plan is to prevent accumulation of nutrients (such as nitrogen, phosphorus, potassium, calcium, magnesium, zinc, and copper) on your farm to the point where they threaten plant growth or the environment. Nutrients come to your farm as animal feeds and mineral additives. Animals transform these nutrients into body tissue, products (milk, eggs, etc.), and wastes. Unless these waste nutrients are transported off the farm, they will build up to levels that could harm crops, groundwater, and surface water. A land application system on the farm allows waste nutrients to be used to grow crops. The nutrients, in the form of crops, can then be exported off the farm to prevent buildup, or recycled back to the animals as a feed source.

A waste utilization plan begins as a tool to help you define the number of acres and types of crops to be grown based on the volume of waste produced and the nutrient requirements of your crops. The process requires estimating the volume of animal waste produced and the amount of plant-available nutrients the waste contains. Based on these factors, environmentally sound cropping systems are matched with your waste-handling systems to develop acceptable methods for land application.

Once waste begins to be produced on your farm, the plan must be implemented. A waste utilization plan requires careful attention to make it work properly. A properly implemented plan will let you use the waste nutrients as a fertilizer while ensuring that water quality on and off your farm is protected. You will need to understand how to use the information in your plan, along with monitoring information and equipment calibration to make the plan work.
Note: The waste utilization plan describes the amount of waste and other nutrient sources on the farm and a cropping plan to handle those nutrients. It is one specific component of the overall waste management plan.

In this chapter you will see how average waste generation volumes, waste storage times, and average nutrient contents are used to develop a cropping plan and to estimate the number of acres needed to properly land apply your waste. In the following chapter, you will learn how to use waste analysis, along with soil and plant analysis, to calculate and apply just the right amount of waste nutrients to your crops. You will also learn how to maintain waste application records properly.

Developing a waste utilization plan requires information on the source of nutrients, the amount of nutrients that can be safely land applied, the placement of nutrients on the field, and the timing of nutrient applications. Four components—source, amount, placement, and timing—must be considered together to ensure that the waste nutrients generated on your farm are applied in harmony with crop needs while maintaining enough animal waste storage to prevent a discharge. In addition, a waste utilization plan will identify best management practices (BMPs) that will help prevent the runoff of nutrients from fields. The four components will be reviewed briefly, then in greater detail to show how they are used in developing a waste utilization plan.

**SOURCE**

All sources of nutrients on the farm need to be considered when planning waste applications. Sources include nutrients already in the soil, commercial fertilizers, crop residues, and animal wastes. Legumes such as soybean, peanut, clover, and alfalfa can leave from 25 to 100 pounds of plant-available nitrogen (PAN) for the following crop. To account for some of these nutrients, you can use waste and soil analysis. For waste sources, you need to consider how much waste will be produced, the concentration of nutrients in the waste, and how readily available the nutrients are for plant uptake.
**AMOUNT**

To prevent misapplication of nutrients, which can result in negative environmental impacts, you should apply only the amount of nutrients needed by the cropping system. Insufficient applications will result in nutrient deficiencies, which can reduce crop yield and quality, and decrease utilization of waste nutrients. Excessive applications can negatively affect both the plant and the environment. The effect of too much fertilization on plant growth depends on the crop and nutrients involved. In most cases, too much phosphorus (P) and potassium (K) have little effect on plant growth and yield unless so much is applied that salt injury results. Too much nitrogen (N), however, can reduce yields by making plants more susceptible to diseases and insects, increasing lodging, and stimulating vegetative growth at the expense of fruit or grain production. Excess metals, such as copper and zinc, can be toxic to plants. In extreme cases, soil concentrations of these metals can be high enough to limit or prevent the growth of certain crops. An added concern of excessive nutrient applications is the potential for water pollution. Both nitrogen and phosphorus are known to enhance algal blooms in rivers and streams, which can lead to fish kills and reduced water quality.

**PLACEMENT**

Waste placement affects crop uptake or the likelihood of waste runoff from the site. Application to the soil surface typically results in greater potential for nutrient loss through volatilization (escape as a gas) and runoff than where wastes are incorporated (mixed with the topsoil) or injected. Uniformity of nutrient applications and distance from the root system can also influence crop response to nutrient applications. The method of application can also affect odor. Careful placement also means irrigating at rates that prevent runoff.

**TIMING**

All nutrient sources should be applied at times that will maximize crop use and minimize the possibility of loss. In general, waste nutrients should be applied to an actively growing crop or within 30 days of planting a crop. If crops for human consumption are to be grown, consult your general permit for specific requirements. Also, the last waste application to a crop used for fiber or further processing for human consumption must not be
within 30 days of harvest. Ideally, applications should be closely matched to crop nutrient demands. Timing is most important for nutrients applied to soils with a high leaching potential (leaching means movement of a nutrient or pollutant through the soil—past the crop rooting depth—and eventually into groundwater). Applying nitrogen to a sandy soil when there is no crop to remove it will almost certainly result in loss of nitrogen to the shallow groundwater. There are human health problems associated with excessive levels of nitrogen in groundwater used for drinking. Proper timing of animal waste application requires that pumping frequency be carefully matched with cropping sequences. Low storage capacity will require frequent applications and year round cropping systems, whereas larger storage volumes may allow less frequent applications to a single crop such as bermudagrass.

BEST MANAGEMENT PRACTICES (BMPs)

Practices that reduce the loss of nutrients and, thereby, reduce the potential for negative environmental impact, are considered BMPs. BMPs include erosion and sediment control (such as grassed waterways, buffer strips, and riparian buffers) to reduce movement of soil and nutrients into streams from field edges. Incorporation of wastes to reduce off-site movement, volatile losses, and odors may also be considered a best management practice. Using cover crops to scavenge nutrients remaining in the soil could also be an effective best management practice to reduce the loss of nutrients from a land application site. Conservation tillage, contour planting, crop residue management, and terraces may also be used to reduce soil and nutrient losses.

HOW MUCH WASTE IS PRODUCED ANNUALLY?

The number of crop acres needed for nutrient application increases with the amount of waste produced. In order to keep a lagoon or storage pond from overflowing, it is essential to estimate the amount of waste produced. As shown in Table 3-1, the average amount of waste produced annually is determined by the type of production facility and the animal unit capacity of the facility. Based on the volume of waste produced, a waste storage structure can be properly sized to meet the temporary storage needs of the operation. Most new lagoons are designed for 180 days of temporary storage. For existing facilities, the temporary storage volume should be

WHAT DO I NEED TO KNOW ABOUT SOURCES?

List ways in which best management practices protect water quality.
Chapter 3: Waste Management Plans

known, or can be calculated, and used to determine the number of days of
temporary storage. Because waste production and storage capacity
determine the maximum amount of time between waste applications, these
factors strongly influence crop selection.

Table 3-1. Average Animal Waste Generation Values for Different
Production Units

<table>
<thead>
<tr>
<th>Production Unit</th>
<th>Animal Unit Equivalent Live Weight</th>
<th>Lagoon Liquid</th>
<th>Lagoon Sludge</th>
<th>Slurry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pounds</td>
<td>gallons per animal unit/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Swine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weanling-to-feeder</td>
<td>per head capacity</td>
<td>30</td>
<td>191</td>
<td>6.7</td>
</tr>
<tr>
<td>Feeder-to-finish</td>
<td>per head capacity</td>
<td>135</td>
<td>927</td>
<td>33.0</td>
</tr>
<tr>
<td>Farrow-to-weanling</td>
<td>per active sow</td>
<td>433</td>
<td>3,203</td>
<td>78.0</td>
</tr>
<tr>
<td>Farrow-to-feeder</td>
<td>per active sow</td>
<td>522</td>
<td>3,861</td>
<td>94.0</td>
</tr>
<tr>
<td>Farrow-to-finish</td>
<td>per active sow</td>
<td>1,417</td>
<td>10,481</td>
<td>382.0</td>
</tr>
<tr>
<td><strong>Poultry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullet (nonlaying)</td>
<td>per bird</td>
<td>1.5</td>
<td>7.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Pullet (laying)</td>
<td>per bird</td>
<td>6.5</td>
<td>22.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Layer</td>
<td>per bird</td>
<td>4.0</td>
<td>25.2</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Dairy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>per head</td>
<td>350</td>
<td>1,946</td>
<td>395</td>
</tr>
<tr>
<td>Heifer</td>
<td>per head</td>
<td>1,000</td>
<td>6,570</td>
<td>1,387</td>
</tr>
<tr>
<td>Milk cow</td>
<td>per head</td>
<td>1,400</td>
<td>9,490</td>
<td>1,935</td>
</tr>
</tbody>
</table>

1 Estimated total lagoon liquid includes total liquid waste plus average annual rainfall surplus falling on lagoon.
2 No solids removal prior to lagoon input.
3 Six-month accumulation of waste, urine excess water usage; does not include fresh water for flushing or lot runoff.
4 Assumes 400-pound sow and boar on limited feed, 3-week old weanling, 50-pound feeder pig, 220-pound market hog, and 20 pigs/sow/year.

Values shown in Table 3-1 are averages that can be used for planning purposes. They cover a wide range of factors such as animal diet, age, usage, productivity, management, and location. Using average unit values, North Carolina’s animal industry generates approximately 27 million tons of manure each year.
Example:

You plan to start a feeder-to-finish operation to grow out 2,000 pigs a year. You will rely on pit storage and a pump and haul application system to deal with the waste produced. How much slurry must you land apply each year?

To answer this question, use the following formula:

\[
\text{Volume of wastewater generated} = \text{number of animals} \times \frac{\text{gallons of wastewater}}{\text{animal per year}}
\]

\[
2,000 \text{ animals} \times \frac{751 \text{ gal}}{\text{animal per year}} = 1,502,000 \text{ gal/year}
\]

Example:

You plan to expand your farrow-to-finish farm to include another 750 sows. How much additional liquid will you be putting into the anaerobic lagoon each year?

\[
750 \text{ sows} \times \frac{10,481 \text{ gal}}{\text{sow per year}} = 7,860,750 \text{ gal/year}
\]

Example:

You plan to expand your dairy operation by adding 30 calves and 10 milking cows. How much additional slurry will your operation generate per year?

\[
30 \text{ calves} \times \frac{1,611 \text{ gal}}{\text{calf per year}} = 48,330 \text{ gal/year}
\]

\[
10 \text{ milking cows} \times \frac{7,665 \text{ gal}}{\text{cow per year}} = 76,650 \text{ gal/year}
\]

Total additional slurry = 48,330 + 76,650 = 124,980 gal/year

Example:

You plan to start a layer operation with 50,000 birds. How much lagoon liquid will be generated per year from this operation?
WHAT NUTRIENT CONTENT AND FERTILIZER VALUE CAN YOU EXPECT FROM YOUR WASTE?

Once the total amount of waste is determined, you can estimate the amount of plant-available nutrients produced. The average total content of nitrogen (N), phosphorus ($P_2O_5$), and potassium ($K_2O$) found in several types of animal waste is shown in Table 3-2. These values are currently used for planning new facilities in North Carolina. The nutrient content of your animal waste can vary widely depending on diet, type of production facility, season, and recent rainfall. Where waste analyses are available for existing facilities, they should be used to develop waste utilization plans instead of the estimates.

Not all of the nutrients in animal waste are available to the plant during the first year they are applied. Organic nutrients must be broken down by soil microbes into mineral forms before they become available for plant uptake. Soil temperature can strongly affect the rate of breakdown. Availability is also influenced by the method of placement as you will see later. First year availability factors are shown in Table 3-3. The total nutrient content (in Table 3-2) is multiplied by the appropriate factor (in Table 3-3) to determine the amount of plant-available (PA) nutrient applied in the first year. Remember, these values are for planning purposes only. Applications should be based on recent waste analysis results to avoid under or over application of nutrients. Methods of sampling and how to use waste analysis will be described in Chapter 4. Sample results for waste analysis are typically given in plant-available nutrients, so the calculations for determining plant-availability are usually not required.
### Table 3-2. Nutrient Composition of Animal Manure

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Total N</th>
<th>Phosphorus P$_2$O$_5$</th>
<th>Potassium K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>12</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Scrapped</td>
<td>13</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Liquid slurry</td>
<td>31</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>22</td>
<td>49</td>
<td>7</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>136</td>
<td>53</td>
<td>133</td>
</tr>
<tr>
<td><strong>Poultry Layer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid slurry</td>
<td>62</td>
<td>59</td>
<td>37</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>26</td>
<td>92</td>
<td>13</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>179</td>
<td>46</td>
<td>266</td>
</tr>
<tr>
<td><strong>Dairy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot-scraped manure</td>
<td>10</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Liquid manure slurry</td>
<td>22</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>15</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>137</td>
<td>77</td>
<td>195</td>
</tr>
</tbody>
</table>

*Source: Abridged from North Carolina Agricultural Chemicals Manual.*
### Table 3-3. First-Year Availability Factors for Animal Waste

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Injection 1</th>
<th>Soil Incorporation 2</th>
<th>Soil Broadcast 3</th>
<th>Irrigation 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>All waste types</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Injection 1</th>
<th>Soil Incorporation 2</th>
<th>Soil Broadcast 3</th>
<th>Irrigation 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scraped paved surface</td>
<td>—</td>
<td>0.6</td>
<td>0.4</td>
<td>—</td>
</tr>
<tr>
<td>Liquid waste slurry</td>
<td>0.8</td>
<td>0.7</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>0.9</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Poultry Layer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid slurry</td>
<td>0.8</td>
<td>0.7</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>0.9</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Dairy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot-scraped manure</td>
<td>—</td>
<td>0.6</td>
<td>0.4</td>
<td>—</td>
</tr>
<tr>
<td>Liquid manure slurry</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid</td>
<td>0.8</td>
<td>0.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

1. Waste injected directly into soil and immediately covered.
2. Surface-spread waste plowed or disked into soil within two days.
3. Surface-spread waste uncovered for one month or longer.
4. Sprinkler-irrigated liquid uncovered for one month or longer.

### Consider All Sources

All other sources of nutrients need to be considered in your calculations. This would include starter fertilizers or other commercial sources. Soybeans and peanuts can leave 25 to 35 pounds of plant-available nitrogen (PAN) in the soil for the following crop. Clover and alfalfa can supply 60 to 100 pounds of PAN per acre.
To apply the waste nutrients produced in amounts that will not degrade water quality, you must know the crops to be grown, their nutrient requirements, and when they are actively taking up nutrients. You will also need to understand the terms agronomic rate, priority nutrient, and realistic yield expectation, and be able to calculate the amount of waste which can safely be applied in any one application.

The term **agronomic rate** is often used in reference to waste utilization. Agronomic rate means that nutrients will be applied in accordance with the needs of the crop. Thus, rates and timing of application must be made to optimize the uptake of nutrients. This can be fairly straightforward for commercial fertilizers, but waste application generally requires more planning.

Plants require 16 different plant nutrients in order to complete their lifecycle. Usually, only one of the many nutrients present in animal waste can be applied at a rate that meets the needs of a specific crop. If you have to choose one of the 16 essential elements to apply, how do you decide which one to base the amount on? One way is to pick the nutrient present in highest amounts, or the one most costly to purchase. From an environmental and crop production standpoint, however, it makes more sense to select the nutrient that is most likely to cause a problem either to the plant or to the environment when too much is applied. This nutrient is called the **priority nutrient**. For most animal waste utilization plans, nitrogen is the priority nutrient. Later, we will look at conditions where you may need to consider other nutrients as the priority nutrient, for the benefit of your crops and the environment.

**Crop Selection**

In order to determine the amount of waste to apply, the nutrient requirements of the crops to be planted must be known. Crops are an integral part of the treatment system. In a waste management system, the function of the crop is to:

- use the applied nutrients
- prevent soil erosion
- take up water
• provide food and habitat for organisms in the soil that further break down and use the waste products

Without a crop to actively utilize nutrients and prevent erosion, applied waste could be washed directly into surface streams or leached into the groundwater. The vegetative cover reduces the potential for runoff and erosion from an area. The root system in a cover crop holds soil together and provides a network of openings, or pores, for water to infiltrate (move into) the soil rather than run off.

Crops for waste utilization are often selected only for their ability to take up large amounts of nutrients. While this is very important, other factors should also be considered. These include:

• adaptation to the local climate
• ability to use nutrients when applications must be made
• ease of management
• harvest requirements
• marketability
• profitability

**Crop Nutrient Requirements**

Crops vary in their ability to use nutrients. Coastal bermudagrass has very high nutrient requirements, whereas a mature forest has much lower requirements. Some examples of the nutrient uptake by common crops are shown in Table 3-4.
### Table 3-4. Plant Food Removal at Harvest for Selected Southeastern Crops at Comparable Yield Levels

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average Yield</th>
<th>Nitrogen</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pounds per acre&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>4 tons/ac</td>
<td>184.0</td>
<td>(46.00)</td>
<td>48.0 (12.00)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200.0 (50.00)</td>
</tr>
<tr>
<td>Soybean</td>
<td>40 bu/ac</td>
<td>160.0</td>
<td>(4.00)</td>
<td>32.0 (0.80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56.0 (1.40)</td>
</tr>
<tr>
<td>Corn</td>
<td>100 bu/ac</td>
<td>75.0</td>
<td>(0.75)</td>
<td>44.0 (0.44)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29.0 (0.29)</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.5 bale/ac</td>
<td>46.5</td>
<td>(31.00)</td>
<td>18.0 (12.00)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.0 (14.00)</td>
</tr>
<tr>
<td>Wheat</td>
<td>50 bu/ac</td>
<td>57.5</td>
<td>(1.15)</td>
<td>27.5 (0.55)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.0 (0.34)</td>
</tr>
</tbody>
</table>

<sup>1</sup>Values in parenthesis indicate plant food removed per unit of yield.

From: Plant Food Uptake for Southern Crops, Potash and Phosphate Institute.

#### Realistic Yields

Because the amount of nitrogen required by a crop usually varies directly with the yield, there must be some way of estimating the yields expected on different fields. Yields vary with weather conditions, soils, cultivars, pest pressure, level of management, and many other factors; therefore, the best way to estimate yield potential is to use existing production records. Where records are available, you can average the three highest yields in five consecutive crop years for the field. Increased yields due to the use of new and improved varieties and hybrids should be considered when yield goals are set for a specific field. **Realistic yield expectations** (R.Y.E.) is the estimated crop yield for a given field.

Where records are not available, as with most new operations, some method of getting a ballpark figure is needed. A number of factors can affect the inherent realistic yield expectations (R.Y.E.) of a given site. One of the most obvious is the soil. Soil related factors that can influence yields include:

- depth to subsoil
- depth to rock or root-confining zone
- texture of surface soil and water-holding capacity
- organic matter content
- permeability—infiltration, runoff
- drainage—aeration, water availability

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*North Carolina State University*
Values of realistic yield expectations for agricultural soils have been put together by Natural Resource Conservation Service (NRCS) in conjunction with Cooperative Extension Service (CES) and other technical specialists. These values are based on inherent soil properties and long-term observations. They are intended to represent high levels of management, but should be viewed as estimates only, since they may not reflect irrigation, new cultivars, and improved management tools. Information on your soils may be obtained through the county field office of NRCS.

### Table 3-5. Nitrogen Fertilization Guidelines

<table>
<thead>
<tr>
<th>Commodity</th>
<th>lb N/Realistic Yield Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (grain)</td>
<td>1.0 to 1.25 lb N/bu</td>
</tr>
<tr>
<td>Wheat (grain)</td>
<td>1.7 to 2.4 lb N/bu</td>
</tr>
<tr>
<td>Rye (grain)</td>
<td>1.7 to 2.4 lb N/bu</td>
</tr>
<tr>
<td>Oats (grain)</td>
<td>1.0 to 1.3 lb N/bu</td>
</tr>
<tr>
<td>Barley (grain)</td>
<td>1.4 to 1.6 lb N/bu</td>
</tr>
<tr>
<td>Soybean (grain)</td>
<td>3.5 to 4.0 lb N/bu</td>
</tr>
<tr>
<td>Triticale (grain)</td>
<td>1.4 to 1.6 lb N/bu</td>
</tr>
<tr>
<td>Sorghum (grain)</td>
<td>2.0 to 2.5 lb N/cwt</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>10 to 12 lb N/ton</td>
</tr>
<tr>
<td>Sorghum-sudangrass (hay)</td>
<td>45 to 55 lb N/dry ton</td>
</tr>
<tr>
<td>Pearl millet (hay)</td>
<td>45 to 55 lb N/dry ton</td>
</tr>
<tr>
<td>Bermudagrass (hay)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Tall fescue (hay)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Orchard grass (hay)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Timothy (hay)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Small grain (hay)</td>
<td>50 to 60 lb N/dry ton</td>
</tr>
<tr>
<td>Cotton</td>
<td>0.06 to 0.12 lb N/lb lint</td>
</tr>
<tr>
<td>Pine trees</td>
<td>40 to 60 lb N/acre/year</td>
</tr>
<tr>
<td>Hardwood trees</td>
<td>70 to 100 lb N/acre/year</td>
</tr>
</tbody>
</table>

* Reduce N rate by 25 percent when grazing.

With values for plant-available nutrient content of the waste (from sampling), and realistic yield expectations for the crop, we can determine the crop nutrient requirement and the waste application rate for the field.
Using the values in Table 3-5, multiply the estimated crop yield or R.Y.E. by the N requirement to determine the crop requirement.

The plant-available nitrogen (PAN) application rate is determined by:

\[
\text{Application rate (lb PAN/acre)} = \frac{\text{realistic yield (tons, bushels, etc.)}}{\text{acre}} \times \frac{\text{lb PAN}}{\text{unit of yield}}
\]

\text{Formula 2}

Note: If for any reason you choose not to use nitrogen as your priority nutrient, the crop requirement is obtained directly from the soil test recommendations. In some cases, the soil test results will indicate no additional applications are required. When this happens, the amount of nutrient applied should not exceed the amount which will be removed in the harvested crop (see Table 3-4).

Determining the agronomic rate requires one additional consideration. The timing of application must match the period of crop uptake. Applications should not be made to a field unless an actively growing crop will be planted within 30 days.

Knowing your waste application rate allows you to calculate the total irrigation acreage needed for waste application. This is determined by:

\[
\text{Acres needed for waste application} = \frac{\text{gal (or tons) of waste produced annually}}{\text{waste application rate gallons (or tons)/acre}}
\]

\text{Formula 3}

If you do not have enough irrigation land, your options are:

1. obtain more acreage for irrigation
2. change cropping patterns to use more N per acre
3. utilize a custom applicator to totally remove the waste from your farm
4. reduce the N in your wastewater by further treating the waste prior to application (see Chapter 2).

\text{Maximum Uptake Period}

In most cases, waste storage capacity dictates that waste applications be made at least once every six months. If the same field is to be used, this...
means an actively growing crop must be present in both summer and winter. Double cropping or overseeding of perennial forages can be used to accomplish this, but a higher level of management is required to make this system work properly. Some common crops grown to use nutrients in waste products are shown in Table 3-6.

List cropping systems suitable for waste utilization in North Carolina.

<p>| Table 3-6. Crops Useful for Waste Utilization and Their Maximum Uptake Period |</p>
<table>
<thead>
<tr>
<th>Crop</th>
<th>Uptake Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (grain)</td>
<td>May–July</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>May–July</td>
</tr>
<tr>
<td>Sorghum (grain)</td>
<td>May–July</td>
</tr>
<tr>
<td>Small grains (grain)</td>
<td>Feb.–April</td>
</tr>
<tr>
<td>Small grains (hay, pasture)</td>
<td>Feb.–April</td>
</tr>
<tr>
<td>Soybean</td>
<td>July–Sept.</td>
</tr>
<tr>
<td>Cotton</td>
<td>June–August</td>
</tr>
<tr>
<td>Tobacco</td>
<td>May–July</td>
</tr>
<tr>
<td>Bermudagrass (hay, pasture)</td>
<td>April–Sept.</td>
</tr>
<tr>
<td>Tall fescue (hay, pasture)</td>
<td>Sept.–Nov. &amp; Feb.–April</td>
</tr>
<tr>
<td>Alfalfa (hay)</td>
<td>May–August</td>
</tr>
<tr>
<td>Annual ryegrass (hay, silage, pasture)</td>
<td>Feb.–April &amp; Sept.–Oct.</td>
</tr>
<tr>
<td>Millet (hay, silage)</td>
<td>May–August</td>
</tr>
</tbody>
</table>

1 Application should occur no more than 30 days before planting or green up of perennial forages.

Example:

Let’s assume that Farmer Jones wishes to grow corn grain for the first time in one of his fields. A brief look at the NRCS Soil Survey map shows that the field he wishes to use is primarily the Altavista soil series. Upon consultation with a technical specialist, Farmer Jones determines that he can produce approximately 125 bushels of corn per acre. Table 3-5 shows the range of nitrogen requirements for a bushel of corn grain (1.0 to 1.25 pounds nitrogen per bushel). Farmer Jones decides that based on his inexperience with corn he will only apply 1.0 pound of nitrogen per bushel of expected grain yield.
To find the amount of PAN per acre to be applied, use Formula 2:

\[
\text{Application rate (lb PAN/acre)} = \frac{\text{realistic yield (lb, tons, or bushels)}}{\text{acre}} \times \frac{\text{lb PAN}}{\text{unit of yield}}
\]

Farmer Jones needs:

\[
\frac{125 \text{ bushels of corn}}{\text{acre}} \times \frac{1.0 \text{ lb N}}{\text{bushel}} = 125 \text{ lb N/acre}
\]

**Example:**

Farmer Smith uses 50 acres of bermudagrass for waste application, and grazes cattle on the land in a rotational sequence. He expects to produce 5 tons of hay based on the soil type. How much PAN per acre must he apply to meet his needs for grazing? (He selects 50 lb N/dry ton from Table 3-5.)

To find the amount of PAN per acre to be applied, use Formula 2:

\[
\text{Application rate (lb PAN/acre)} = \frac{5 \text{ tons}}{\text{acre}} \times \frac{50 \text{ lb PAN}}{\text{ton of yield}} = 250 \text{ lb PAN/acre}
\]

Current regulations require that the PAN rate for grazed land be 75 percent of the hay PAN rate. The 250 pounds PAN per acre rate above must be adjusted for the grazing:

\[
\text{Application rate (lb PAN/acre)} = 250 \text{ lb PAN/acre} \times 0.75 = 187.5 \text{ lb PAN/acre}
\]

**Example:**

If Farmer Jones’ waste analysis shows 2.0 pounds PAN per 1,000 gallons of lagoon liquid, what is his waste application rate to apply 125 pounds of PAN per acre?

\[
\text{Application rate (gal/acre)} = \frac{\text{crop PAN requirement (lb)}}{\text{acre}} \times \frac{1,000}{\text{lb PAN per 1,000 gal}}
\]
Chapter 3: Waste Management Plans

Application rate (gal/acre) = \( \frac{125 \text{ lb PAN}}{\text{acre}} \times \frac{1,000}{2.0 \text{ lb PAN per 1,000 gal}} \)

Application rate (gal/acre) = \( \frac{125 \text{ lb PAN}}{\text{acre}} \times \frac{1,000}{2.0 \text{ lb PAN per 1,000 gal}} = 62,500 \text{ gal per acre} \)

This will supply the proper amount (agronomic rate) of N (the priority nutrient) to the corn crop.

Note: The application rate formula for dry wastes is:

Formula 5

\[
\text{Application rate (tons/acre)} = \frac{\text{crop PAN requirement (lb/acre)}}{\text{lb PAN/ton}}
\]

If Farmer Jones wishes to irrigate a certain amount of wastewater, the PAN applied can be calculated using the following formula:

Formula 6

\[
\text{lb PAN per acre applied} = \frac{\text{application rate (gal)}}{\text{acre}} \times \frac{\text{lb PAN per 1,000 gal}}{1,000}
\]

Example:

Farmer Jones wishes to apply 15,000 gallons per acre and the waste analysis shows 2.0 pounds PAN per 1,000 gallons. How much PAN per acre has been applied?

\[
\text{lb PAN per acre applied} = \frac{\text{15,000 gal}}{\text{acre}} \times \frac{\text{2.0 lb PAN per 1,000 gal}}{1,000} = 30 \text{ lb PAN per acre}
\]

Other Considerations

When selecting a crop there are numerous considerations other than nutrient requirement. Two such considerations are ease of management and economic value of the crop. Ease of management varies with cropping system. For example, when considering hay crops you must consider establishment of the crop and the labor required for each cutting, curing,
raking, and baling. You must also consider whether you plan to use the hay yourself or sell it. If you plan to sell it, you might choose a grass that has a higher market value. With regard to row crops, not only do you have to consider establishment but you must also consider insect and weed control as well as the cost and maintenance of harvest equipment or custom harvesting.

In summary, agronomic rates require that:

- Nutrient application rates are based on crop nutrient needs, as determined by realistic yield expectations, soil test results, and the amount of available priority nutrient present in the source.

- The timing and method of nutrient application maximizes crop uptake.

- Credit is given for the nutrients provided by previous crops, previously-applied organic wastes (such as manures), and commercial fertilizer applications.

Nutrient placement can affect the efficiency of crop use and the likelihood of nutrient loss from the soil. Surface-applied nutrients are more subject to loss by erosion from heavy rains, and under dry conditions will remain on the soil surface and be unavailable to plant roots. Surface-applied lagoon liquids contain ammonium-N, which can escape from the soil as ammonia gas. Incorporation into the soil improves crop utilization. Surface-applied phosphorus is not very mobile and is generally not available to plants and is easily lost in runoff unless adequate erosion control is achieved. Incorporation within the root zone increases plant availability.

The method of application can also affect nutrient availability. Placement often depends on the type of application equipment that is available or the method that is most cost or time effective. You should also review your farm conservation plan to see whether your fields should or should not be plowed. Many growers choose broadcast nutrient application because of time constraints or because it is cheaper. Broadcast applications can be made through a tank spreader or by irrigation. Where nutrient utilization is a prime consideration, the handling system may dictate the method of application. For example, solid or semisolid materials cannot be effectively injected into the soil or applied through an irrigation system,
whereas lagoon liquids are most economically applied through an irrigation system.

The application rate of the irrigation equipment will also determine whether the wastewater moves into the soil or runs off. This will be covered in detail in Chapter 5.

Typically, the annual rate of lagoon wastewater application will be dictated by the nutrient loading rate. This assumes that the site is capable of handling the wastewater without saturated soil conditions or runoff at the time of application. It also assumes that there is an actively growing crop to utilize the nutrients, or one will be planted within 30 days.

Crop growth rates and application conditions are not consistent throughout the year. Likewise, crop nutrient requirement is not consistent. Realizing this fact, you need to understand when it is or is not appropriate to land apply wastewater.

Ideally, nutrients should be applied to coincide with the crop uptake requirements shown in Figure 3-1. Unfortunately, it is not always practical to achieve an exact match between application and uptake. Even on well drained sites, soils may be “too wet” for liquid application during unseasonably wet periods. During these wet periods, land application may need to be delayed for a month or more. When poorly drained soils are included as part of the land application area, there is increased risk that wet conditions will require irrigation to be further delayed. Another exception is indicated in Chapter 2 where irrigation should be terminated when the lagoon depth is lowered to the minimum treatment depth. During extended dry conditions, one or more planned irrigations may have to be delayed because of an inadequate liquid level in the lagoon.
Figure 3-1. Growth rate in North Carolina of selected forage crops. Growth is expressed as pounds of forage produced per day per acre.

As seen in Figure 3-1, there are several months during the year when most crops are dormant. For example, bermudagrass is dormant in January and February and growth is “slow” during March, November, and December. If the crop is not actively growing, there is little or no nutrient uptake. In this situation, any nitrogen applied to the bermudagrass field could leach through the soil and move down towards the water table. Consequently, land application is not generally recommended during dormant periods. However, another important consideration is the liquid level in the lagoon or storage pond. Under no circumstances should the liquid level be allowed to rise to the top of the dike. Any time the level is above the...
25-year, 24-hour storm storage level there exists imminent danger of the structure overtopping. This could result in a breach of the lagoon dike and tremendous environmental damage. When a lagoon is properly managed, this situation will seldom occur; however, you must be prepared to deal with this emergency situation, should it develop. Emergency action may dictate irrigating to a dormant crop or to a saturated field. You should contact your regional DWQ office for instructions on what to do if such a situation develops.

The risk of encountering an emergency situation can be significantly reduced by utilizing a cropping system that provides the flexibility of extending the irrigation season throughout most of the year. For example, if bermudagrass is overseeded with rye in the winter, you have a cropping system in place that can accept some lagoon water during every month in most years. There may still be one or two consecutive months when fields are too wet to irrigate. In a bermudagrass/rye cropping system, the peak storage duration in the lagoon is only for the wet period, rather than the six months or longer required if only bermudagrass is being grown.

BMPs are the structural or operational practices that help you operate a waste management system with the least chance of negative impacts on the environment. BMPs help reduce nutrient losses from the farm. BMPs include erosion and sediment control to reduce movement of topsoil and nutrients into streams. Injection of wastes to reduce runoff, volatile N losses, and odors may also be a BMP.

BMPs, when properly carried out, can improve water quality. Generally, an animal operation will have a combination of several BMPs. Key BMPs for animal waste management systems include:

- waste management plan
- waste storage structure
- critical area planting
- waste treatment lagoon
Animal Waste Management Systems—April 1997

- water diversion
- stream fencing
- windbreaks
- buffer filter strips
- grassed waterway
- calibrated irrigation system
- field ditch
- surface drain, main or lateral
- waste utilization plan
- soil, waste, and plant sampling

The BMPs for your operation should be designed (and the installation reviewed) by an expert trained in these systems. It is beyond the scope of this manual to explain every BMP or combination that could be used. You should keep a maintenance schedule of your BMPs and refer to it frequently. The use of BMPs will provide water quality benefits only as long as the practices are designed, installed, and maintained properly. Many studies have been performed that document water quality improvement in streams adjacent to where BMPs have been used in surrounding agricultural areas. If BMPs are not performing their functions as designed, you should contact a technical specialist for advice on appropriate remedies.

Best management practices relating to waste management are those practices that optimize nutrient uptake by plants and minimize nutrient impact on the environment. Best management practices will change over time as technology and understanding of the complex environment improve. Likewise, BMPs are very site specific and a BMP in one place may not be useful for another location. A trained agronomist, soil scientist, or conservationist is best qualified to assess whether a specific BMP is appropriate for a given site.
Managing the amount, source, placement, and timing of nutrients are practices that will accomplish both crop production and water quality goals. These practices apply to all nutrient sources including commercial fertilizers, organic wastes, and crop residues. Appropriate application rates, timing, and placement will minimize surface water and groundwater pollution, supply adequate nutrients for plant growth and development, improve nutrient efficiency of the crop, and assist in maintaining good soil conditions to reduce runoff and soil erosion.

The following conditions are typically required in a waste utilization plan:

1. The waste utilization plan will include all the wastes generated on the farm.

2. Animal waste shall not be applied to wetlands or surface water or shall not reach wetlands or surface waters of the state by runoff, drift, manmade conveyances (such as pipes or ditches), direct application, or direct discharge during operation or land application. Proper application rate and method shall be used to ensure that these specifications are met. Any discharge of waste which reaches surface water is prohibited. Illegal discharges are subject to the assessment of civil penalties of up to $10,000 per day per violation by the Division of Water Quality for every day the discharge continues.

3. Animal waste shall be applied on land eroding at less than 5 tons per acre per year. Waste may be applied to land that is eroding at 5 or more tons but less than 10 tons per acre per year providing grass filter strips are installed where runoff leaves the field. (See NRCS Field Office Technical Guide Standard 393—Filter Strips.)

4. Animal waste shall not be applied to saturated soils, during rainfall events, or when the soil surface is frozen. When animal waste is to be applied on acres subject to flooding, it will be soil incorporated on conventionally tilled cropland. When applied to conservation tilled crops or grassland, the waste may be broadcast, provided the application does not occur during a season prone to flooding.

5. Waste shall not be applied more than 30 days prior to planting of the crop or forages breaking dormancy. A suitable cover crop should be planted to scavenge nutrients especially in sandy, leachable soils. On
soils with a high potential for leaching, multiple applications at lower rates should be used.

6. Animal waste (other than swine waste from facilities sited on or after October 1, 1995) shall not be applied closer than 25 feet to surface water. This distance may be reduced for waters that are not perennial provided adequate vegetative filter strips are present.

7. Any new swine facility sited on or after October 1, 1995 shall comply with the following: the outer perimeter of the land area onto which waste is applied from a lagoon that is a component of a swine farm shall be at least 50 feet from any residential property boundary and from any perennial stream or river other than an irrigation ditch or canal.

Note: For operations in existence prior to October 1, 1995, the setback distance from perennial streams or rivers is 25 feet.

8. Animal waste shall not be applied closer than 100 feet to wells.

9. Animal waste shall not be applied closer than 200 feet to dwellings other than those owned by the landowner.

10. Waste shall be applied in a manner not to reach other property and public rights-of-way.

11. Animal waste applied on grassed waterways shall be at agronomic rates and in a manner that causes no runoff or drift from the site.

12. The waste utilization plan will contain documentation that the producer has adequate means for disposal of the animal waste generated on the farm. One or a combination of the following will be utilized:

   a. Producer owns adequate land for the use of wastes at agronomic rates.

   b. If the producer does not own adequate land to properly use the wastes, the technical specialist will evaluate the location of other land to determine the feasibility and practicability for land application.
A notarized agreement with landowner(s) will be on file with the waste utilization plan for either:

(1) agreement for life of facility
(2) annual or multi-year agreement

These agreements shall include tract number(s) and acres where waste may be applied.

c. When third-party applicators are utilized to apply waste on land that the producer neither owns nor has an agreement to land apply waste, the producer will obtain a notarized certification from the applicator that either the waste will be applied at agronomic rates with adequate buffers or the third party is using an alternative waste utilization system that has been accepted in writing by DWQ.

d. Producer has an alternative waste utilization system accepted in writing by DWQ.

13. Apply animal waste at rates that do not exceed the nitrogen needs for Realistic Yield Expectation (R.Y.E.) for the crop being grown. Actual yields may be used in lieu of realistic yield tables at the discretion of the planner. Regulations in some areas may be more restrictive and require application rates based on nutrients other than nitrogen.

14. Waste shall be tested within 60 days of utilization and soil shall be tested at least annually at crop sites where waste products are applied. Nitrogen shall be the rate-determining element. Zinc and copper levels in the soils shall be monitored and alternative crop sites shall be used when these metals approach excess levels. The pH shall be adjusted for optimum crop production and maintained. Soil test and waste analysis records shall be kept for five years.

15. Liquid waste shall be applied at rates not to exceed the soil infiltration rate. No ponding shall occur.

16. Highly visible permanent markers shall be installed to mark the top and bottom elevations of the temporary storage (pumping volume) of
all waste treatment lagoons. Pumping shall be managed to maintain the liquid level between the markers. A marker will be required to mark the maximum storage volume for waste storage ponds.

17. An irrigation design/plan shall be prepared as part of the waste utilization plan. The design will include the type of equipment, system layout, equipment settings, operating parameters, as well as the approximate maximum useable size of field, maximum application rate (inches per hour) and maximum application per irrigation cycle. A map will be included that shows the fields and useable acres.

18. Records of waste application shall be maintained to establish actual application rates. The records will include date of application, amount of waste applied per acre by tract number and field number, most recent waste analysis and soil test report, and the realistic yield expectation (R.Y.E.) nitrogen rate. Waste application records shall be maintained for five years.

19. The waste utilization plan shall include the number of acres required for land application of sludge accumulated over a five-year period. The sludge shall be analyzed prior to application and applied at agronomic rates.

20. Land clearing for waste utilization shall be completed before certification of the plan. Cover must be established within 30 days of clearing.

21. Reduce hayland nitrogen rate by 25 percent on grassland being grazed when applying animal waste. For each ton of hay harvested from a pasture system, the full R.Y.E. hay application rate for nitrogen may be applied.

22. An Emergency Action Plan is required. This plan shall include provisions for emergency spreading or transfer of waste from all waste storage structures in the system. This plan shall provide for emergency spreading of waste to prevent overtopping or other discharges during periods when soil or crop conditions are not conducive to normal spreading.
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Additional Considerations

1. A waste utilization plan is based on average manure nutrient content and may vary by as much as plus or minus 20 percent. To properly implement this plan based on actual waste analysis, you may need additional acres or to reduce animal numbers.

2. Evaluation of the soil analysis should consider concentration of elements to assess potential toxicity or whether increased concentrations of one element (such as phosphorus) have reduced the availability of another element (such as zinc) to plants.

3. Plant tissue analysis is recommended to evaluate nutrient status and confirm that nitrogen is not excessive.

4. Proper calibration of application equipment should be done to ensure uniformity and accuracy of spreading rates.

5. Animal waste should be applied on actively growing crops in such a manner that the crop is not covered with waste to a depth that would inhibit growth. The potential for salt damage from animal waste should be considered also.

6. Odors can be reduced by injecting the waste into soil or disking after waste application. Waste should not be applied when there is danger of drift from the irrigation field.

7. Producers are encouraged to take samples of groundwater and surface water on farms where animal waste is routinely applied. Samples should be analyzed for nutrients and bacteria.

8. Harvest and remove the crop from the field it was grown in. Hay should be removed from the harvested area within one year. If stored for more than one year, hay or silage should be covered.

9. A grazing plan should be developed to encourage controlled frequent rotation grazing, multiple drinking water sites, and strategic harvesting to optimize fecal and urine distribution by grazing animals. These practices will minimize potential point sources from stock camps, shade trees, water tanks, and heavy use areas.
10. If animal production at the facility is to be suspended or terminated, the owner is responsible for obtaining and implementing a “closure plan” which will eliminate the possibility of an illegal discharge, pollution, and erosion.

11. Waste handling structures, piping, pumps, and reels should be inspected on a regular basis to prevent breakdowns, leaks, and spills. A weekly maintenance checklist should be kept on-site.

12. All existing operations that have a waste utilization plan and an irrigation system shall have an irrigation plan that includes the approximate maximum useable size of field, maximum application rate (inches per hour), and maximum application per irrigation cycle.

For new or expanding operations or systems without an approved waste utilization plan, an irrigation design and plan is required. The plan must include the type of equipment, system layout, equipment settings, operating parameters, as well as the approximate maximum useable size of field, maximum application rate (inches per hour) and maximum application per irrigation cycle.

13. Animal waste can be used in a rotation that includes vegetables and other crops for direct human consumption. However, if animal waste is used on crops for direct human consumption it may only be applied 30 days or more before planting with no further applications of animal waste during the crop season. You should consult your general permits, once received, for further guidance.

14. It is the responsibility of the owner of the facility to secure an update of the waste utilization plan when there is a change in the operation, number of animals (an increase), method of utilization, or available land.
1. What is the goal of a waste utilization plan? see page 3-4

2. Describe the four components of a waste utilization plan.
   ........................................................................................................ see page 3-5

3. How do you determine the amount of waste produced annually?
   ........................................................................................................ see page 3-9

4. What is “realistic yield expectations?” ......................... see page 3-15

5. What agency maintains information on crop yields and nutrient uptake rates for planning a cropping system for waste application?
   ........................................................................................................ see page 3-16

6. What are BMPs? ................................................................. see page 3-24