

Manure Management Guidelines for Western Washington

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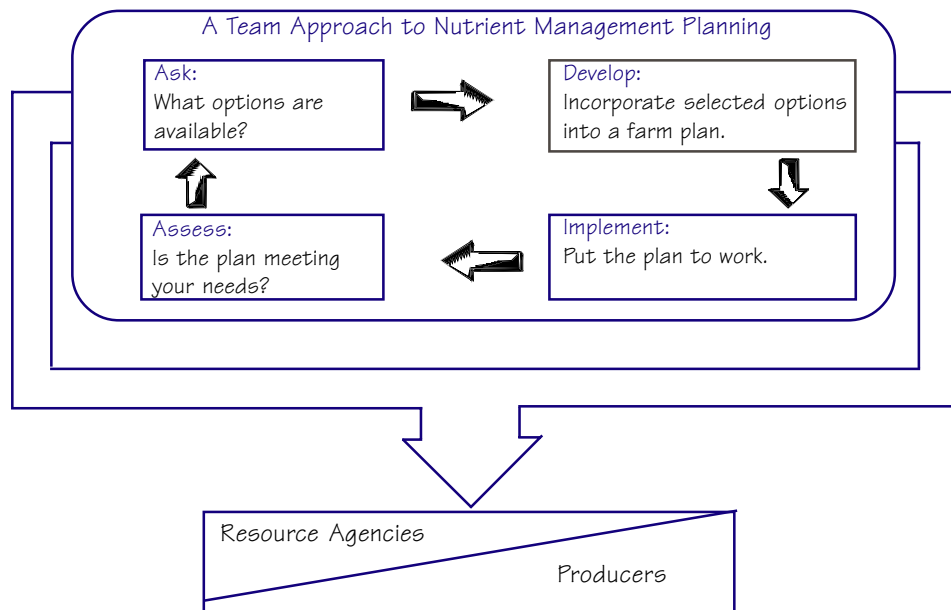
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INTRODUCTION

This document was designed to help the agricultural community meet existing regulations. It provides operators with information on farm management practices that protect both surface and ground water. These guidelines will help managers develop, implement, and monitor a nutrient management plan designed specifically for their operation.

Manure and waste products generated on a dairy contain bacteria and other contaminants that may be harmful to the health of humans, wildlife, domestic animals, fish and shellfish. Across the country, elevated nitrate levels in drinking water are being partially linked to agricultural practices. The preliminary findings of a recent study of the Abbotsford/Sumas aquifer, in Whatcom County, linked a significant percentage of total nitrate loading to agriculture. This does not mean that every farm pollutes. It means that the potential to pollute exists.

With adoption of manure and nutrient management practices and improved design and maintenance of manure storage facilities, pollution risks will be eliminated or kept as low as possible. Developing and implementing a Conservation Plan that incorporates manure management practices from this document will help operators meet that goal. It will require close cooperation and communication between resource agency planners and farm operators. This team approach ensures that a workable, economical, and environmentally sound plan is developed. There are a variety of experts and agencies available to help producers develop and implement Conservation Plans. For a description of these resource agencies, refer to the section on "Technical Assistance".



WHAT ARE MANURE MANAGEMENT GUIDELINES?

Manure management guidelines (MMGs) are a systematic approach of incorporating farm management techniques, practices and physical structures to reduce the potential for polluting surface and ground water while maintaining the profitability and stability of the farm operation.

A total systems approach is necessary for MMGs to be effective. This means that when designing and implementing MMGs, the farm operator must consider how a change in one practice may affect other areas of the operation.

A good example is a change in forages for the herd ration. A change in the crops grown or crop mix can affect milk production, cow health, farm profits, manure nutrient content, amount of manure generated, and manure application rate and timing. Another example is how the amount and timing of irrigation water applied to crop fields can affect crop yield, quality, longevity, nutrient availability, and nutrient leaching from the soil. Not all MMGs are appropriate in all situations.

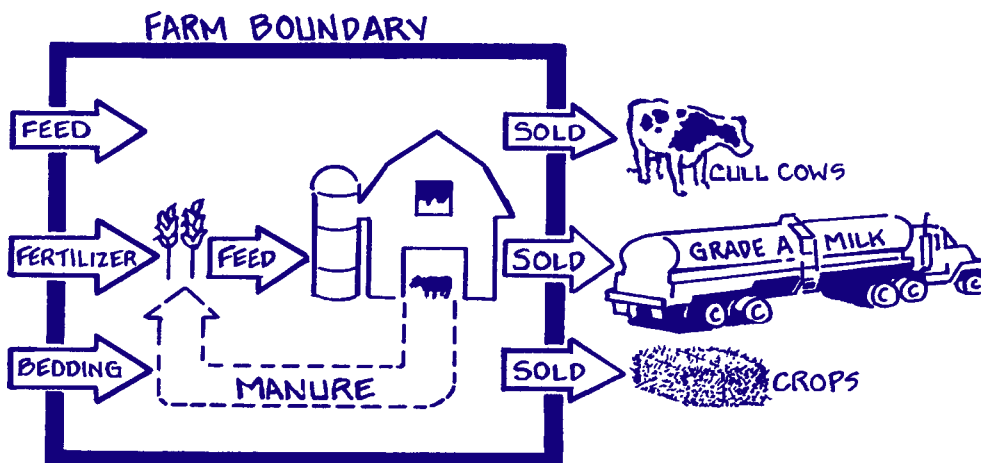
Criteria Used in Formulating Manure Management Guidelines

- ◆ Will the practice result in improved water quality?
- ◆ Does the practice have local support and application?
- ◆ Is the practice economically feasible to implement and maintain?

DEVELOPING A NUTRIENT MANAGEMENT PLAN

Dairy farms in this region are usually net importers of nutrients. The amount of nutrients brought onto the farm in the form of feed and fertilizer is often greater than the amount contained in the milk and animals sold off the farm. Nutrients that remain on the farm are applied to fields for crop growth. The continued application of nutrients to the field may exceed the crops' ability to use them. This should be avoided for several reasons:

1. Heavy manure applications can increase soil concentrations of certain nutrients above recommended levels resulting in high crop uptake and plant nutrient imbalance. High uptake of some nutrients may be detrimental to herd health when the forage is fed.
2. The excess nutrients resulting from continuous heavy manure application, can leach to ground water or run off fields into streams and become pollutants.
3. Crop yields may be reduced when excessive amounts of some nutrients are present in the soil.



Most dairies in Western Washington are net importers of nutrients.

Developing a nutrient management plan will help avoid high nutrient levels in the soil and the negative effects associated with them. Documenting the flow of nutrients in to and out of the farm is necessary to develop a comprehensive nutrient management plan. Operating under a comprehensive nutrient management plan will help guarantee optimum milk and crop yields while reducing pollution potential. Appendix A includes worksheets for determining nutrient flow.

Nutrient Levels in Manure

There are several factors that affect the amount of nutrients in fresh manure. The first set of factors are subject to management styles.

Animal Factors

- ♦ **Herd Ration:** What the cow eats determines, to a large extent, the manure volume and nutrient content.
- ♦ **Animal Size:** Larger cows have larger feeding requirements for body maintenance. This translates into greater manure production.
- ♦ **Stage of Lactation:** Daily milk production and feed intake is highest in early lactation and declines throughout the milking period. However, since cows are evenly distributed across stages of lactation this will not affect manure composition or volume in most herds.
- ♦ **Water Consumption:** Larger water intakes result in larger urine outputs. However, because there is a high correlation between milk production and water intake, it is seldom wise to limit water intake of lactating cows.
- ♦ **Herd Composition:** The proportion of calves, heifers, dry and milking cows will affect manure nutrient levels.

A second set of factors affecting nutrient content deals with facilities. These factors can be controlled by management practices.

Facility Factors

- ♦ **Type of Housing:** A nutrient management plan for a total confinement system will be much different from a pasture operation.
- ♦ **Frequency of Manure Collection:** Daily manure collection conserves more nutrients than weekly collection.
- ♦ **Type of Manure Collection System:** On a per unit basis, scraping manure retains more nutrients than flushing.
- ♦ **Amount of Water Used in Manure Handling:** Using large volumes of water will dilute manure, resulting in a lower nutrient concentration.
- ♦ **Type of Manure Storage Facility:** A covered pit retains more nutrients than a lagoon.

- ♦ **Additives to Manure Storage Facility:** Chemical or biological additives may alter nutrient levels in manure.
- ♦ **Agitation or Aeration:** The type and frequency of agitation and aeration can enhance bacterial activity. This can result in nitrogen loss through volatilization.

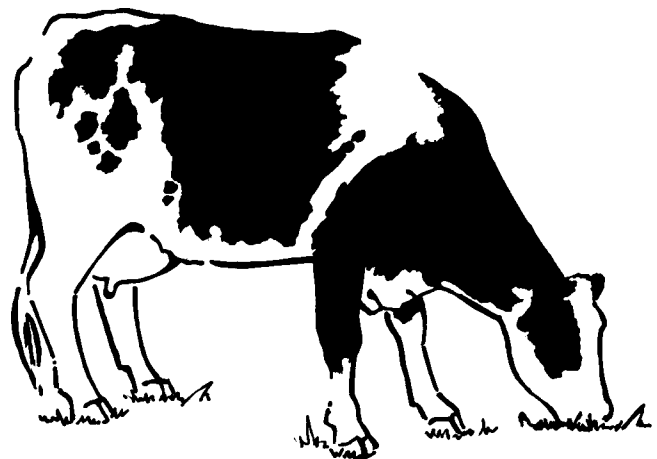
The amount of manure nutrients available to the crop is influenced primarily by the method of application. Other factors influencing nutrient availability include crop growth, weather, and microbial processes in the soil .

Field Factors

- ♦ **Application Method:** Nutrient loss through volatilization and aerosol drift is greater when big gun applicators are used as compared to tank wagons. Incorporating the manure into the soil after it is spread reduces nutrient loss from volatilization.
- ♦ **Time of Application:** Manure that is applied in late fall will leach nitrogen and denitrify over winter and have little nitrogen left in the spring.
- ♦ **Soil/Nutrient/Crop Reactions:** Crops that grow for a longer season (perennial grasses) utilize more nutrients than annual crops (corn). Soil properties affect the nutrient/crop reactions that take place in the soil. These reactions include nutrient/crop reactions that take place in the soil. These reactions include mineralization, denitrification and leaching. Soil texture influences soil properties to a large extent. For example, porosity is a factor of texture: sandy soils contain large pores so water passes through them easily. In contrast, soils containing silt and clay have smaller pores. Leaching hazard is greatest on well drained, sandy soils and runoff potential is greatest on poorly drained, silt and clay soils.nutrient/crop reactions that take place in the soil.
- ♦ **Season:** Biological conversion of organic forms of nitrogen to inorganic (plant usable) forms stops at 40°F and peaks at 80-90°F.

Ration Effects on Manure Composition

Balancing a ration for dairy herds is a management tool. Producers use it to achieve specific results such as increased milk production, an increase in milk fat or solids content, and improved herd health. Ration balancing can also affect the amount of nutrients remaining in the manure. Because 65% to 80% of the nitrogen, 60 to 85% of the phosphorus and 80 to 90% of the potassium fed to the cow will be excreted (Klausner and Bouldin), it is important from both an economic and environmental perspective not to overfeed nutrients.



The water that cattle drink may have an effect on some manure nutrients or urine output. When balancing herd rations, it is helpful to have a water analysis done so the contribution of water nutrients to the ration can be determined. This may be especially important if the water is high in nitrate. Elevated salt levels in the ration will increase water consumption. In addition to an increase in water-borne nutrients, an increase in water consumption will affect urine production.



Manure Management Guidelines for Use in Ration Balancing



- Check feed ingredients for protein sources. Protein contains about 16 percent nitrogen by weight. The type and amount of protein used (rumen degradable versus by-pass) will affect the amount of nitrogen excreted.
- Balance rations with a realistic and achievable milk production goal. This reduces the amount of nutrients fed that a cow cannot use. In turn, nutrient levels remaining in manure are reduced. Reducing ration nutrient concentration may also result in a cost savings.
- Analyze the water supply and determine what the water contributes to the ration.
- Test forages for nutrients so accurate information is used to balance the ration. Dietary Cation-Anion Balancing (DCAB) of rations may benefit herd health especially when the ration includes forages with elevated potassium (West). This may be a problem with forages from continuous, heavily manured fields.
- Communicate the above suggestions to advisors helping in ration formulation.

Recordkeeping

A recordkeeping system is an important part of your overall nutrient management plan. The information you collect provides feedback on how well your management plan is working. Your records will help track crop yields and total nutrients applied to each field. This provides you with the field data necessary to determine agronomic rates for manure applications. Without these data, you will need to call your local Natural Resources Conservation Service, Cooperative Extension, or Conservation District office to obtain average figures for crop yields and nutrient levels. For fields where crop rotation occurs, your records serve as a reminder of what crops were grown on which field. Keeping accurate records may also save you money. After reviewing your records, you may find that crop nutrient needs are being met through manure applications, thereby eliminating the need for commercial fertilizers. Appendix B is one example of how to set up forms for recording your information.

Accurate records are also a form of self-insurance. As urban areas encroach on agriculturally-zoned lands, new neighbors may raise questions related to farm practices. Your records of past nutrient applications and an up-to-date nutrient management plan will show that you are a responsible manager operating with the best information available. Such records have proven very beneficial to dairy producers involved in lawsuits.

Items to consider as part of a comprehensive recordkeeping system include:

- ♦ Your nutrient management plan.
- ♦ A site map showing the locations of barns, waste management components (pipes, storages, etc.), pastures, waste management facilities, cropland, surface water, and wells.
- ♦ A log book identifying : 1) available land area, 2) nutrient analysis of soil, 3) nutrient analysis of irrigation water, 4) manure application rates and timing on specific crops, 5) nutrient analysis of manure, 6) fertilizer applications, 7) yield and nutrient analysis of harvested crops, and 8) quantities of manure nutrients sold or exported from the farm.
- ♦ Water use records identifying successful conservation efforts which may, in turn, reduce costs associated with handling manure.
- ♦ A waste management system file that contains information on the design work for your system as well as literature and other information on manure management system equipment (pumps, spreaders, etc.).
- ♦ A correspondence file with copies of pertinent information related to your farm operation such as copies of permits and related correspondence.

MANURE STORAGE FACILITIES

Collecting and storing manure produced on the farm until the proper application time is a critical part of the nutrient management plan. When sizing storage facilities, it is important to consider projected herd expansion, breed, production level, feed intake, and ration balance. Other design considerations include precipitation, runoff, and evaporation. When possible, locate facilities to take advantage of natural visual buffers (trees, topography, etc.). Visual buffers may reduce complaints from neighbors and passersby.

To get a ballpark figure for sizing storage facilities use the formula provided in Appendix C. The actual size of your facility will be determined by volume of manure produced, local characteristics, and management approach. A properly designed facility will have enough storage so manure application can occur at a time when the nutrients will be used.

Liquid and Solid Manure Storage Systems

For liquid manure storage structures to function as designed, they must be emptied during the spring and summer. Estimating storage size and length of storage requires communication between the designer and operator. Generally, a storage system that holds six to eight months of manure and wastewater provides assurance that there will not be a need to apply manure to fields when weather and crop conditions are unfavorable. Adding additional storage at the time of design gives the producer more flexibility with the manure application schedule in case of abnormal weather or crop growth patterns. It also allows for minor herd expansion. Remember, the cost of excavating an additional 100,000 gallons capacity at the time of construction is small compared to the cost associated with enlarging an existing storage structure later.

A solid manure storage structure that functions as designed, will also store manure for application during the proper season. Manure nutrients applied when a crop is not actively growing can become pollutants to surface and ground water.

Whether you are planning a liquid or solid manure storage facility you will need to address a number of regulations and design specifications. Working with the Natural Resources Conservation Service to design your system is a good way to assure that the facility will be in compliance with existing regulations. Their services are available at no charge and without discrimination. Following is a brief description of the physical structures and management practices designed to collect, store and contain liquid manure until proper application conditions occur.

Collection Facilities

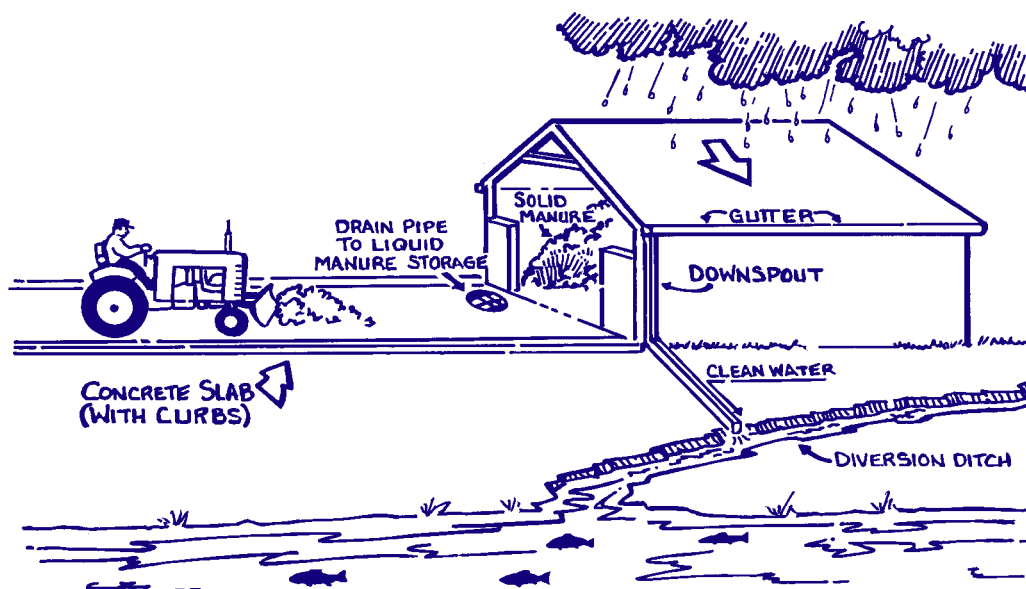
For liquid manure, collection facilities consist of physical structures that direct liquid manure and washdown water to the storage facility. These structures include concrete troughs, slabs and curbs. The collection process includes scraping the manure from the slabs or flushing it with water into a temporary holding structure for later transfer to longer term storage. Also included in this category are parlor drains and the pipes and pumps used to transfer manure from a central collection area to the long-term manure storage facility.

Collection facilities for solid manure keep manure contained in the animal confinement area and direct manure to the storage facility. These facilities, which include dry stacks, consist of waste-water drains, concrete curbs and slabs, and wooden or concrete walls. Manure is scraped and collected in the confinement area and transferred to the storage structure.

Storage Facilities

For liquid manure, these facilities hold manure until the proper time for field application. The structures include above or below ground concrete tanks, above ground steel tanks, earthen lagoons, and holding ponds. Construction specifications for earthen lagoons will vary depending on the soil characteristics of the site. Design considerations for storage capacity should also include precipitation and runoff. Lagoons can have one, two, or three separate chambers or stages to assist in solids separation and to provide recycled flushing water. Concrete bottoms may facilitate future solids removal.

Solid Manure
Storage Facility



Solid manure storage facilities are also sized for ample storage during the non-growing season. The storage structure should have a solid floor so nutrients cannot leach into the surrounding soil. A concrete slab makes an excellent surface for machinery operation and prevents leaching.

Walls (concrete or wood) on three sides of the structure allow stacking of the solids. A roof keeps precipitation off the solids and reduces runoff potential. Any runoff that does occur must be collected and handled as liquid manure.

Solids Separators

Mechanical devices are available that separate a percentage of the solid, fibrous part of the manure from the liquid portion before the manure is transferred to long term storage. Using a solids separator requires two storage facilities; one for the solids and one for the liquid. The liquid portion can be recycled to provide flush water for manure collection. The solids may be spread on fields, marketed off the farm as a soil amendment/fertilizer, used as bedding material, or used as a low quality feed ingredient for non-lactating cattle. In addition, the separated liquid is easier to apply through sprinkler irrigation systems.

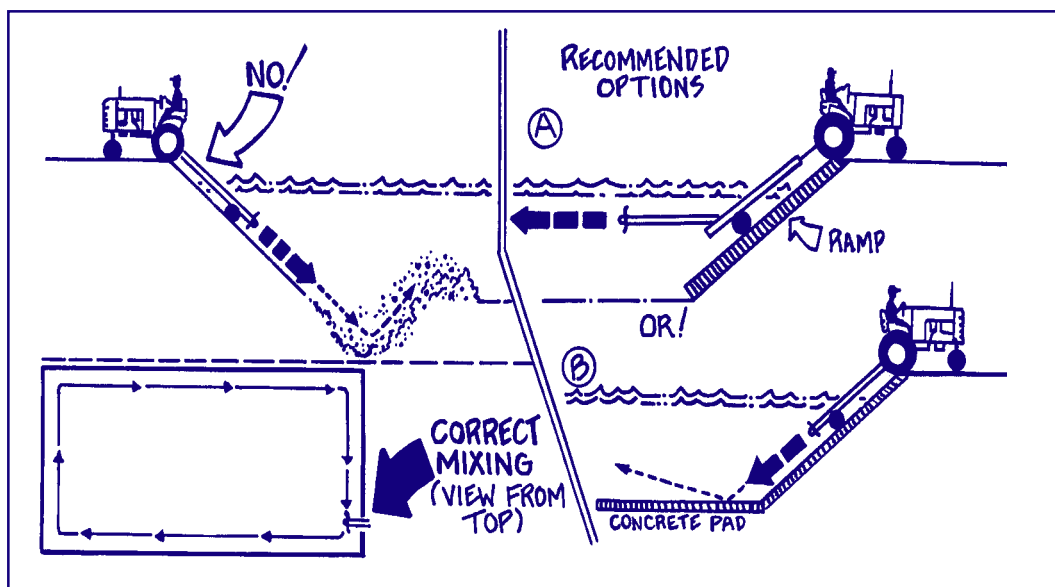
Settling Basins

With settling basins, liquid manure is directed into a basin where it remains long enough for a portion of the solids to settle by gravity. The surface liquid is then drained off and the remaining solids removed and stored. This type of system requires a minimum of two properly designed and sized settling basins.

Operations and Maintenance

Manure is an extremely corrosive and abrasive substance that can damage machinery. As a result, it is necessary to perform periodic maintenance on the system to keep it operating as designed. Contact your manure equipment dealer for specific maintenance suggestions and information for your system.

With liquid manure systems, proper manure agitation and mixing every two months will help reduce solids build-up and keep the crust manageable in the storage structure. When solids



accumulate in the storage structure they reduce holding capacity, make proper agitation difficult, and are costly to remove. Pumping from liquid manure storage lagoons, requires complete and constant agitation from various points around the lagoon to ensure that the solids become suspended and removed from the structure. It is important to exercise care when agitating a lagoon with a soil liner. Direct the flow of agitated manure so it is parallel to the surface of the lagoon and along the sides. Misdirected propeller wash can dig holes and blow bottom soil and gravel into piles making proper agitation difficult. Propeller-type agitators can disturb or destroy the seal or liner which may result in manure leakage to ground water.

Solid manure storage systems are easier to maintain than liquid systems. There are few moving parts and the mechanical equipment required to manage these structures is primarily a tractor, scraper or loader, and manure spreader. To maintain the integrity of the structure, it is important to keep it in good repair. Empty the manure storage structure during the crop growing season so that the full capacity is available for the storage season.



Manure Management Guidelines for Liquid Manure Storage and Handling



- Empty lagoons during the spring and summer.
- When designing storage facilities, add an extra month or two of storage to allow for abnormal weather or crop growth patterns and minor herd expansion.
- Keep material such as hoof trimmings or baling twine out of the manure system to avoid plugging and wrapping of pump parts and pipe.
- When agitating manure, direct the flow so that it is parallel to the surface and along the sides of the lagoon.
- Fence manure handling and storage facilities and only allow access to qualified personnel.
- Post proper safety measures and cautions where appropriate.
- Always have another person present who can help if an accident occurs. Manure storage and transfer structures may contain deadly gases. Never enter an underground storage tank without taking proper precautions including being equipped with an air supply in case of emergency.

ROOF WATER MANAGEMENT

A good roof water management system will keep rain from contacting animal manure and adding to the waste volume. Various structures and practices are combined for the purpose of collecting and diverting precipitation from the farmstead buildings.

Gutters collect precipitation from roof edges and route it to the end of the building.



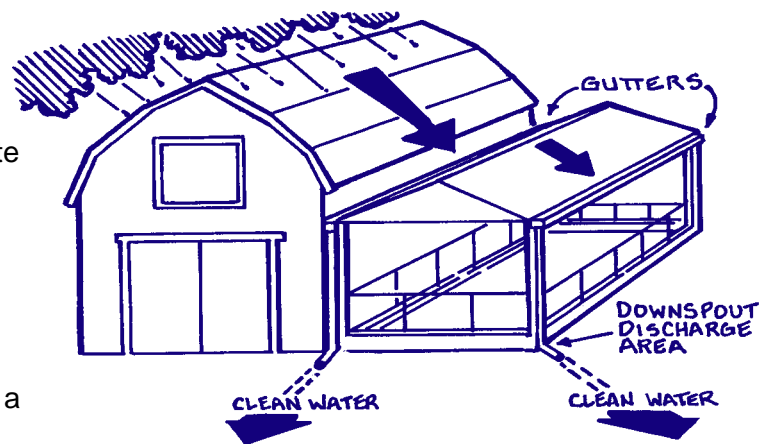
Manure Management Guidelines for Solid Manure Storage and Handling



- Use hard-surfaced floors such as concrete, for solid manure storage facilities.
- Erect concrete or wood walls on three sides of the storage structure to allow stacking of solids.
- Roof the storage structure to prevent rain from coming in contact with the manure. Contaminated runoff must be collected and handled as liquid manure.
- Size facilities with an extra month or two of storage capacity to allow for abnormal weather or crop growth patterns and minor herd expansion.

Downspouts collect water from gutters and transfer it away from the confinement area.

Downspout discharge area structure(s), such as french drains, concrete slabs, and above and underground pipes divert precipitation away from confinement areas to drainage areas. Keep discharge areas and drains clear of debris and silt. Discharge design options may include a valve system so collected precipitation can be added to the manure storage facility as a source of dilution water if needed.



Concrete diversions or curbs around the slab area will direct manure and water to a collection point for transfer to the liquid manure storage facility. Roofing the slab area and diverting rain from the confinement area will reduce the amount of wastewater collected.



Manure Management Guidelines for Roof Water Management



- Install gutters so they are not sheared off by sliding snow and ice.
- Install screens on gutters to keep debris out.
- Promptly repair damaged roof water management system.
- Keep roof water discharge areas and drains clear of debris and silt.
- Install gutters and downspouts so they do not come into contact with livestock and machinery.

Proper construction and periodic maintenance of roof water management structures is necessary to ensure optimum performance.

MILKHOUSE/PARLOR DRAINAGE

All wash water and waste generated in the milkhouse/parlor must be collected and handled as manure. If the manure collection and storage system is designed properly, you can add milkhouse/parlor liquids to the manure system rather than have a separate system.

The volume of water used in the milkhouse/parlor varies with the operation. If you can reduce the amount of water used, you will reduce the volume of liquid that must be collected, stored, and handled. Table 1 gives you an idea of how much water is being used in the milkhouse/parlor.

Table 1

Washing Operation	Water Volumes
Bulk Tank 450-2000 gallon 3000-4000 gallon 5000+ gallon	46 gallons/wash 78 gallons/wash 116 gallons/wash
Silo Tank	126 gallons/wash
Pipeline less than 16 parlor stalls more than 16 parlor stalls	60 gallons/wash 140 gallons/wash
Backflush	0.5 gallons/cow/milking
Parlor/milkhouse/holding pen cleanup	400-900 gallons/wash
Cow prep automatic manual holding pen sprinklers	1-4 gallons/wash/day 0.25-5 gallons/wash/day 5 gallons/minute/head
Flushing (deduct recycled water)	40 gallons/cow/flush
Plate Cooler (ignore if water is recycled)	8 gallons/cow/day

(Grusenmeyer and Bierlink)

FOOTBATH CHEMICALS

There is some question as to whether footbath chemicals negatively affect the bacterial and physical properties of manure. These chemicals may contaminate the manure storage system in two ways. The first is through disposal of the used chemicals directly into the manure system. The second is through the small amount of medication that the cows track out of the footbath and into the confinement area, which then goes into the manure storage structure. The use of small amounts of chemicals, in quantities sufficient to control hoof disease, probably will not affect manure properties when completely mixed with the rest of the manure and waste stream.



Manure Management Guidelines for Milkhouse/Parlor Operations



- Collect all water and waste from the milkhouse/parlor.
- Reduce the amount of water needed for milkhouse operations by repairing leaky hoses and waterers.
- Recycle milkhouse water to a flush system if possible.
- When buying new parlor equipment, consider installing systems that conserve water.

In addition to the question of footbath chemicals affecting manure properties, the use of these chemicals raise management issues. Some footbath chemicals may be considered hazardous waste in Washington state and must be handled, stored, and disposed of according to Department of Ecology regulations. Having footbath chemicals on the farm may also introduce specific requirements for Workers Right-To-Know and hazardous materials safety plans.



Manure Management Guidelines for Footbath Chemicals



- Consult with your veterinarian to be sure selected footbath chemicals and concentrations will be effective in your herd.
- Contact the Washington State Department of Ecology to determine if the chemicals and concentrations used in your operation are considered hazardous waste.
- Store, handle and dispose of chemicals identified as hazardous waste according to Washington Administrative Code, Chapter 173-303.

SILAGE JUICE MANAGEMENT

Wet silage is a concern because the juice or seepage is rich in nutrients which makes it a potential pollutant. In addition, excessively wet silage can impact feed programs by reducing dry matter intake.

Minimizing Silage Juice

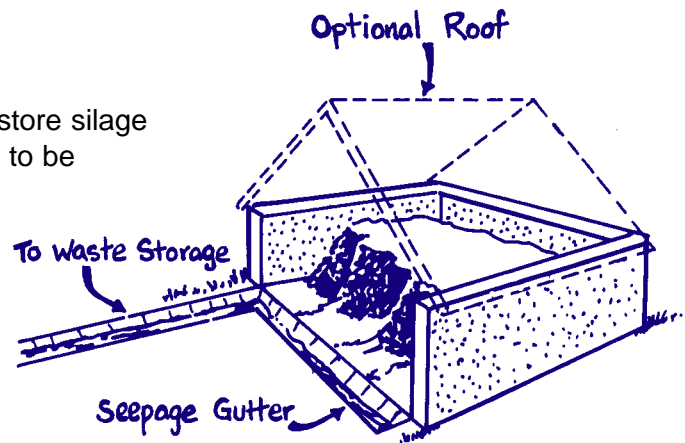
Harvesting a silage crop at the proper moisture level and maturity will produce a high quality feed while reducing juice production and runoff. A few simple tests can help identify the moisture level in the forage before chopping. For grass silage, a forage moisture meter can be used. For corn silage, the optimal moisture level for reducing juice production is reached when the milk line is halfway (50 percent) to 2/3 (66 percent) down the kernel. Dry absorbents such as alfalfa hay cubes, beet pulp

pellets, or similar materials may be useful in minimizing silage juice loss while adding feed value to the silage.

Silage Juice Collection System

Because it is difficult to always harvest and store silage under ideal conditions, some silage juice is likely to be produced. Juice production, however, is usually heaviest ten days after filling the silo. A system must be in place to collect and store silage juice. Collection systems consist of gutters or concrete curbs which direct juice to a central collection pit or sump. After collection, the juice is either transferred to the manure storage structure or added to the ration.

Design the collection system for peak flow amounts plus any precipitation that falls on or around the silage storage structure. You can reduce the amount of runoff that needs to be collected by installing a roof or covering over the bunker silo. Keeping the silage dry will also result in less wasted feed.



Manure Management Guidelines for Grass Silage



- Cut grass at the proper stage of maturity to meet forage quality goals.
- Use appropriate cultural methods (tedding, raking, correct wilting time) to dry forage to proper harvest moisture.
- Use a forage moisture meter to determine the proper moisture level (65-70%).
- Consider adding absorbents (alfalfa cubes, beet pulp, etc.) to minimize silage juice loss.



Manure Management Guidelines for Corn Silage



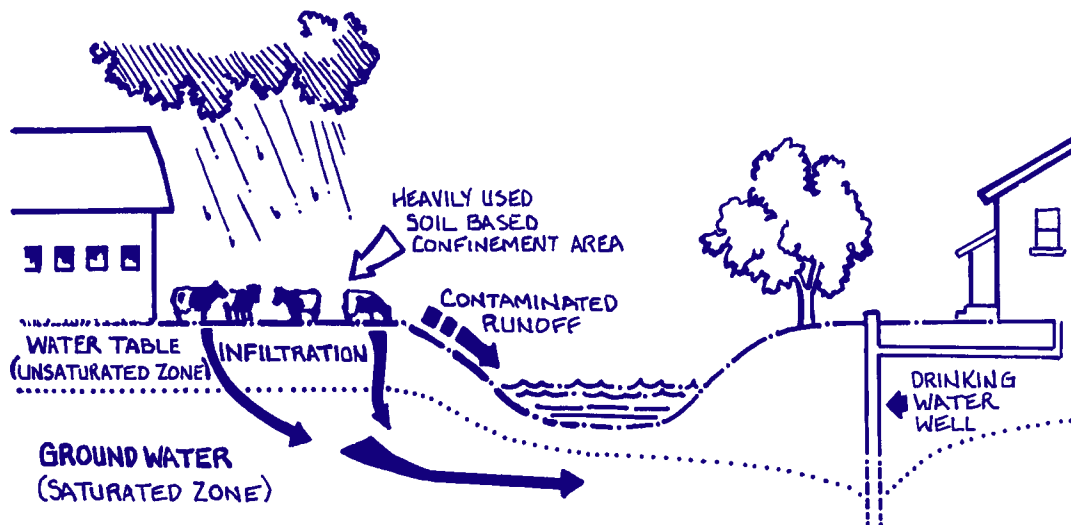
- Plant a hybrid suited to your growing area. Seed company representatives can help select the proper hybrid.
- Stagger planting dates or hybrid maturities if you have more than one field or more acres than you can harvest in a few days.
- Use proper planting date for your area.
- Use the milk line to determine crop maturity before harvesting.

CONFINED LIVESTOCK AREAS

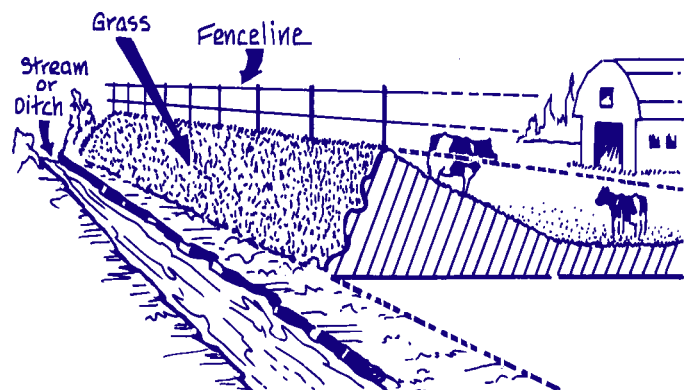
Dairy operations frequently have confined livestock areas on site. These areas may also be called dry cow lots, loafing areas and exercise yards.

Soil-Based Areas

Soil type, slope, and precipitation are factors to consider in managing soil-based areas. The combination of rain and impermeable soils with continuous, heavy animal traffic result in the confinement area becoming bare, wet and muddy. In addition to herd health problems, soil-based confinement areas can become a source of pollution if the area is located near a drainage ditch or stream.



If your confinement area is located near a source of surface water, it should be built up and graded so that runoff from the confinement area flows away from ditches and streams. A fence at the top of the grade is recommended to limit animal access to surface water. Exposed soil on the water side of the slope should be revegetated to stabilize the bank and prevent erosion.



Concrete

(Hard-Surfaced) Yards

Precipitation is the primary consideration in managing concrete confinement areas. In areas where there is a considerable amount of rain, large unroofed, concrete yards are not recommended due to the large volume of runoff that will be generated.



Manure Management Guidelines for Soil-Based Areas



- Establish alternative field areas where livestock can go when their normal confinement area is wet and muddy.
- Cover areas with sawdust, shavings, or other form of bedding to absorb waste and provide drainage.
- Locate soil-based confinement areas away from open drainage ditches and streams. Consider soil characteristics and slope when determining distance from open water channels.
- Collect manure and runoff from confinement areas. The number of livestock, frequency of use, and size of area will determine how often the manure needs to be collected.



Manure Management Guidelines For Concrete Yards



- Reduce the amount of precipitation that can mix with manure by keeping concrete yards to the minimum size needed.
- Divert clean water away from the concrete yard to avoid generating contaminated water that then must be handled as manure.
- Direct contaminated runoff from the concrete yard to the manure storage facility.
- Scrape manure from the area to an appropriate storage structure.
- Roof confinement areas and install gutters and downspouts.

PASTURE SITUATIONS

Some dairy operations use pastures for seasonal feed supplementation and cow exercise areas. This practice raises two issues: nutrient balance from manure deposited in the pasture and water quality concerns when cows have unlimited access to streams.

Nutrient Levels on Pasture

Cows grazing and loafing in a pasture deposit manure nutrients. To determine nutrient loading of the pasture, you need to consider the number of cows on the pasture, length of time they are there, size of the pasture, dominant forage species present, and time of year. Nutrients applied to the pasture must follow the same agronomic rate criteria as nutrients applied to a crop field. Pasture forage production and nutrient uptake can be calculated and the total nutrient needs determined. Nutrient needs can then be met with commercial fertilizer or manure applications. There are three key factors to consider when developing the nutrient budget including:

- 1) crediting the field for only that portion of the day that the cows are grazing;
- 2) balancing the nutrients produced from the grazing cows with the amount needed for forage production; and
- 3) adopting a grazing management system that does not result in gross nutrient overloading.



Manure Management Guidelines for Pasture Situations

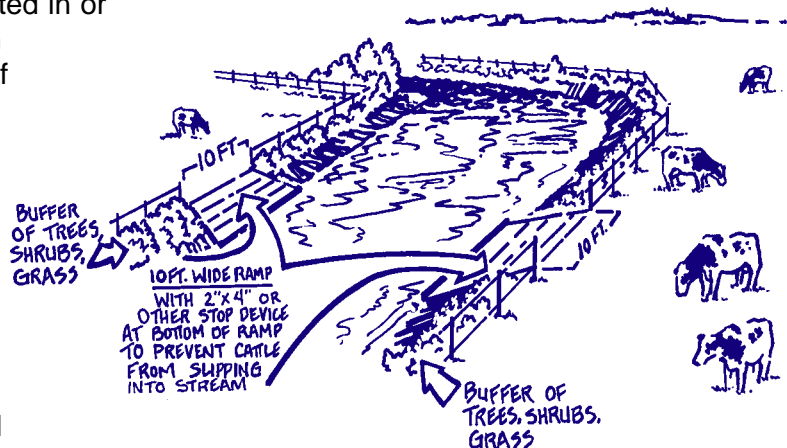


- Practice good pasture management; rotate stock, plant the right seed mix, don't overgraze, don't turn-out too early in spring, or leave stock too late into fall.
- Ensure that there are enough acres of pasture to utilize nutrients at agronomic rates.
- Calculate animal loading density and manure nutrients dropped, agronomic application rate for nutrients, and nutrient balance for pasture acres.

Keep Cows Out of the Stream

Keeping cows out of the streams not only reduces the risk of broken legs or drowned cows; it provides substantial benefits to water quality. Nutrient and fecal coliform contamination occurs from waste deposited in or near water courses. In fact, Washington state law prohibits the direct discharge of manure from cows into a stream.

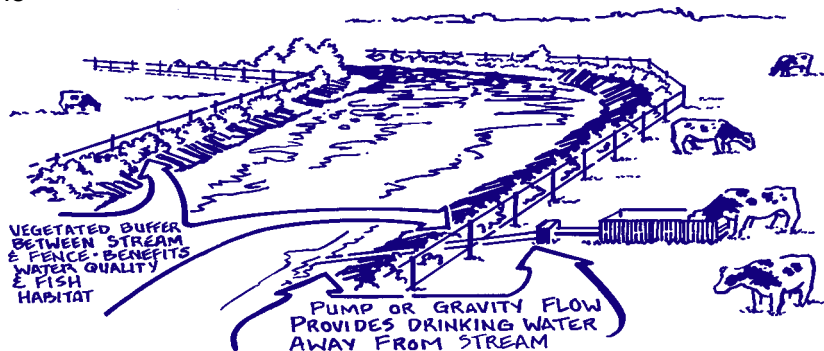
Other problems associated with unlimited animal access to streams include erosion of streambanks and sedimentation of streambeds. The physical presence of cows in the stream can destroy important fish habitat and cause turbidity from agitated stream sediments. A vegetated stream corridor not only provides water quality benefits, it also benefits fish and wildlife habitat.



The only solution to this problem is to limit cattle access to the stream. This does not mean NO in-stream access, it means CONTROLLED stream access. The goal of controlled access is to provide water for the animals without causing a pollution problem. This can be done with fencing and cattle crossings. Fencing will limit animal access to the stream and will create a corridor between the fence and stream.

When a stream acts as a physical barrier to other pastures, a cattle crossing will allow access to those pastures while reducing the impacts to the stream. The crossings also provide an access point

for animals to drink where there is some protection for the stream bottom. If you are considering a cattle crossing, contact your local Natural Resources Conservation Service office for assistance in designing a crossing that will meet your needs. Staff at the Natural Resource Conservation Service will also be able to help you determine whether you will need a permit from the Washington State Department of Fisheries for the crossing.



Other methods may be available for getting water from the stream to the animals without the animals entering the stream. These methods may include the use of piping, pumps, siphons, water tanks, and pasture nose pumps.



Manure Management Guidelines for Keeping Cows out of Streams



- Limit cow access to streams with fences and cattle crossings.
- Provide suitable stream access for stock watering or check into one of the alternative methods for getting water to the livestock (piping, siphons, pumps, etc.).

FIELD APPLICATION OF MANURE

Proper manure application to crop fields is not only an integral part of the nutrient management plan; it is a critical step in the prevention of surface and ground water contamination. Once manure is applied it must remain on the field until it is absorbed by the soil. It should not be susceptible to runoff from excessive rainfall. If manure moves beyond the targeted field, it becomes a pollutant. The difficulty of keeping manure on target changes with application method. For example, big gun applicators provide the least control and accuracy for liquid manure application while tank type spreaders give the most control. Proper management, application planning, and vigilance during application keeps manure on the desired target area and out of streams and ditches.

Manure Application Rates

There are several factors that affect manure application rates including:

Soil Infiltration Rate

Apply liquid manure to the field at a rate (inches per hour) which will not exceed the soil's capacity to absorb the liquid. This rate depends on soil type, amount of solid material contained in the manure, and duration of application. Existing soil moisture at application will affect the total amount of manure that can be applied. If a manure application exceeds the soil's infiltration rate, a portion may run off the area and pollute adjacent surface waters. Manure solids can also seal the soil surface causing infiltration to slow or stop. The information in Appendix E will help identify application rates based on soil infiltration rates.

Topography of Target Fields

Manure applied to a level field will respond differently than manure applied to a sloped field. Because runoff potential is determined to a large extent by percent slope, the rate of application is decreased as the percent slope increases. Soil infiltration rates also need to be taken into consideration when determining runoff potential on sloped fields. For assistance in determining slope effects on manure application rates, contact your local Natural Resources Conservation Service or Cooperative Extension office.

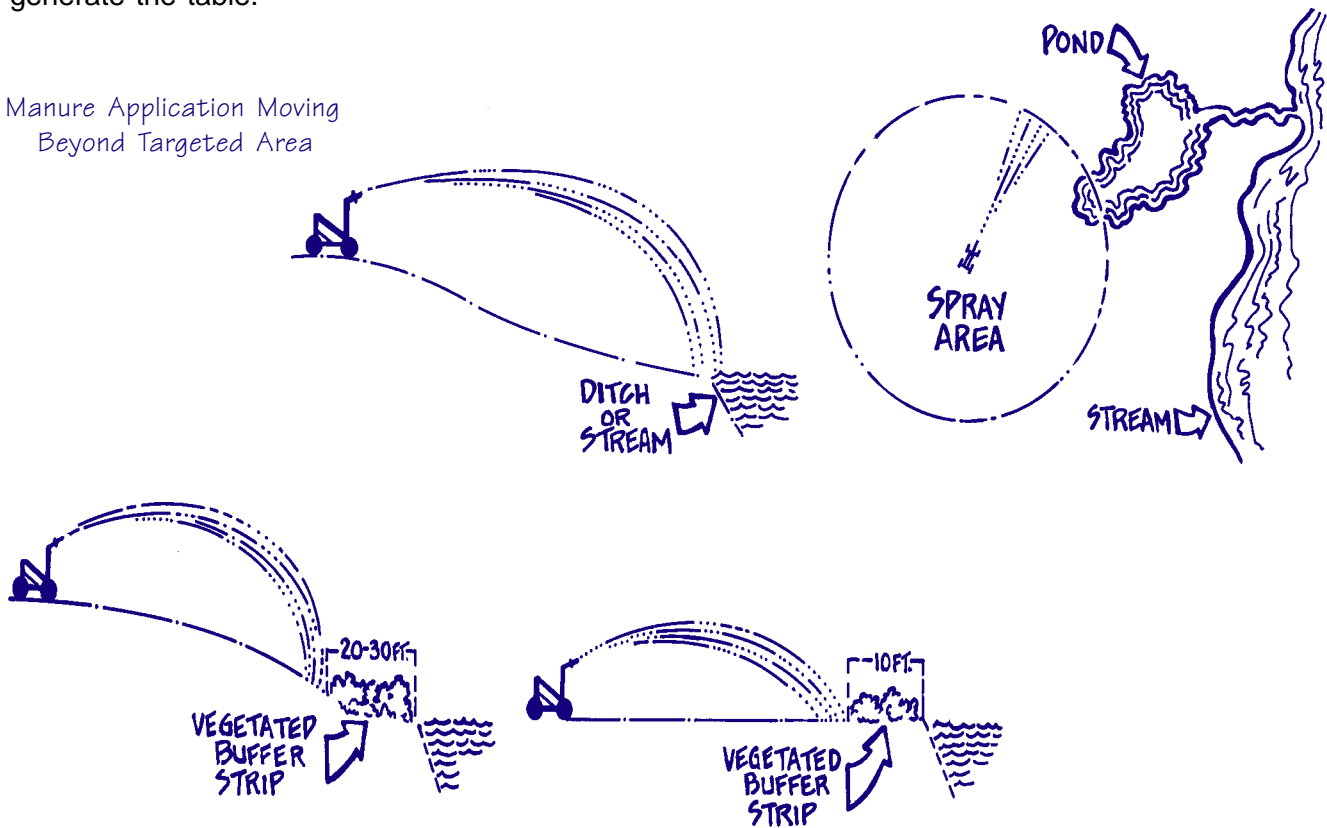
"No Manure Buffers"

Vegetated buffer strips where manure is not applied effectively reduces the pollution risk to both surface and ground water. Buffers along fields bordering roads and neighbors also help keep manure on targeted areas. Factors to consider in determining the size of a buffer include slope and soil characteristics, whether the area is vegetated or bare, and the method of manure application. The Natural Resources Conservation Service is available to assist you in determining buffer size for your site. In addition, it is a good idea to check on local regulations since individual counties may have ordinances in place that require minimum buffer sizes along streams. Table 2 provides a range for buffers in different situations. Information from agriculture publications, health regulations, and resource agency staff was used to generate the table.

Recommended Buffers (feet)	
Property lines	10
Roadways	10
Streams	10-30
Wells (domestic or irrigation)	100-200

Table 2

Manure Application Moving
Beyond Targeted Area



Manure Application with Stream Buffers

Agronomic Rate Determination for Manure Application

Apply manure to fields according to the nutrient uptake of the crop. Crop species and yield goal are important considerations when formulating the agronomic rate for each specific crop. Multiplying the crop yield by the nutrient uptake of the crop will allow you to determine the amount of nutrients the plants can remove from the soil. Appendix F provides further information on estimating nutrient content for specific crops.

It is important to consider all nutrient sources when formulating an agronomic rate. In addition to manure and commercial fertilizer, nutrient sources include soil organic matter, irrigation water, biosolids (municipal sewage sludge), food processing by-products and soil amendments.



Manure Management Guidelines for Manure Application



- Be careful not to smother the growing crop by applying too much manure with a high solids content.
- Frequently check manure application pumps, hoses, and spreading equipment to see if they are operating properly. Correct problems immediately.
- Be sensitive to neighbor and public concerns when applying manure.
- Monitor conditions AT ALL TIMES when using big gun applicators to apply manure. These applicators are highly susceptible to a number of factors that can change without warning such as wind speed and direction, equipment failure and the consistency of manure being pumped.
- Follow appropriate minimum setback requirements. A map of the field with the set back areas highlighted can help you plan your application strategy.
- Monitor weather patterns, primarily wind and rain, to reduce the chance of a weather event occurring that will move applied manure off the target area.
- Spread manure accurately and evenly to assure even distribution of nutrients for plant growth.
- Maintain accurate records of manure application to fields (amount applied, date, crop, nutrient analysis, recent soil test, etc.).
- Accurately calibrate manure spreaders, tank wagons, and other application equipment.

Manure Testing to Determine Nutrient Content

Determining manure nutrient levels will allow you to fine tune your nutrient management plan. Because many of the factors that affect the nutrient content of manure are unique to each dairy operation, the only way to determine the nutrient value is to test the manure before application.

Laboratory Testing

When collecting manure samples, it is important to completely mix the slurry to get a representative sample of the stored manure. In addition, collect several samples from different locations in the storage structure and mix together to make a composite sample. Collect the composite sample in a sealable container and freeze immediately; a sealed, warm container may produce gas and explode. It will take about one pint of manure to perform the laboratory tests. The analysis should include nitrogen, phosphorus, potassium and percent total solids. A list of analytical labs located in the Northwest is included as Appendix G.

On-Farm Testing

For on-farm testing, a \$50.00 hydrometer can give reliable estimates of the total nitrogen, phosphorous, and potassium in liquid manure. The hydrometer measures the density of the slurry and correlates that with the amount of total solids, total nitrogen, phosphorus, and potassium in the sample. The hydrometer is re-usable and requires no chemicals. Results are available in about five minutes and can be used immediately to guide manure application decisions. Hydrometers are available through the Whatcom County Manure Management Committee. Contact the Whatcom County Conservation District for more information.

Another on-farm test procedure is available to determine ammonium-nitrogen in stored manure. This procedure uses an AGROS nitrometer and takes about ten minutes. The meter is expensive, about \$600, and ONLY determines the inorganic ammonia portion of the total nitrogen present. This meter is useful for certain types of liquid storage structures where the solids content is low and most of the nitrogen is in the inorganic form. The meter may be available through local Conservation Districts.

Whatever method you choose, manure testing is important because it establishes the appropriate application rate to meet crop nutrient needs. Knowing the concentration of nutrients in manure will ensure that crops receive the proper fertilization for maximum yield while avoiding excess nutrient applications.

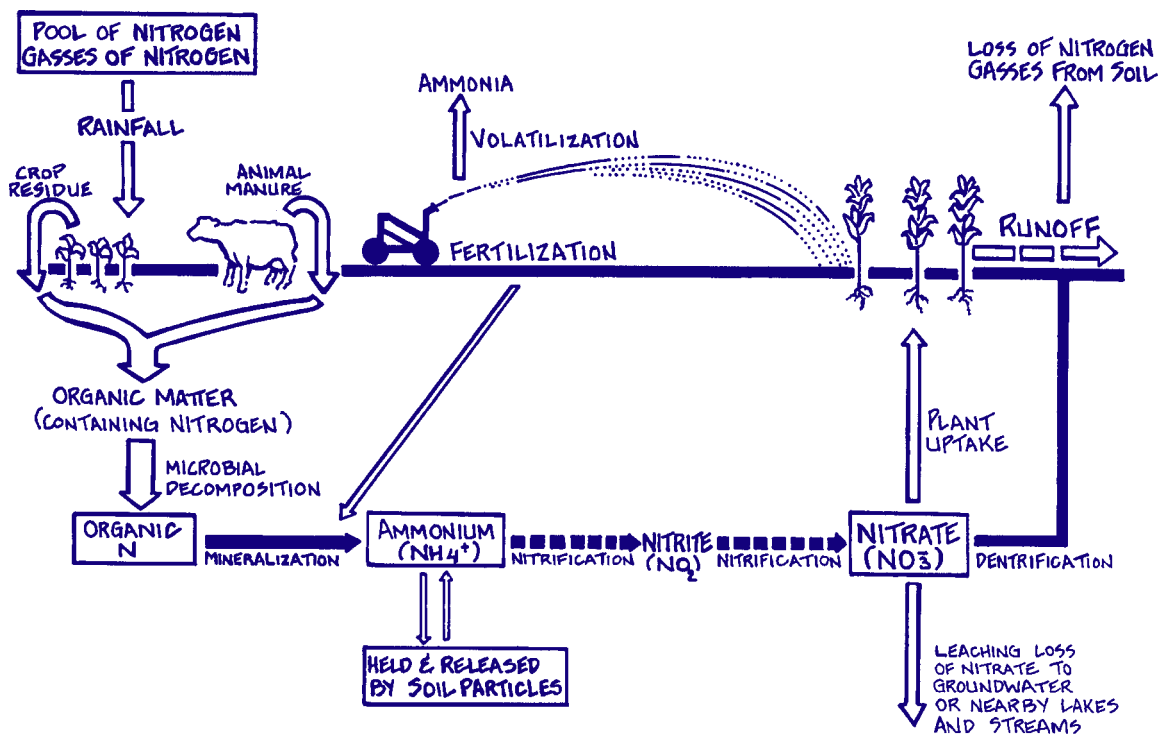
Yield Goals

When determining agronomic rates for manure application, it is important to choose achievable yield goals. Appendix F provides sample calculations for determining agronomic rates based on yield goals. Setting yield goals too high results in unused nutrients. Over-application of nutrients may result in excessive nutrient levels in harvested forage or end up as pollution in surface or ground water. To generate a suitable yield goal, average your yields for the past three to five years for each field. If the field data are not available contact your local Natural Resources Conservation Service office for help in determining expected yields for your soil type. However, since each farm is unique, you are best served by using your own data. After implementing your nutrient management plan, check to see if your harvested yields agree with yield goals. This information will allow you to adjust yield goals for the next season to meet actual conditions.

Application Timing

The best time to apply manure for crop fertilizer is spring and early summer when growing crops need the nutrients. Application after September increases the potential for excess nutrients to become pollutants. At soil temperatures above 40° F, some of the applied manure nitrogen converts

to leachable nitrate in soil. Ammonium-nitrogen applied to warm (60° F), moist soil converts to nitrate in several weeks. Soil temperatures in the fall are high enough to continue providing ideal conditions for converting manure nitrogen to nitrate. If the nutrients are not used by a growing crop, the nitrate can leach past the root zone to the ground water.



There are situations where, after careful review of site characteristics, winter application can occur. Factors considered in the review include soil type, slope, depth to water table, crop being grown, and crop height. Climate is also a factor since many low-lying areas in Western Washington are susceptible to flooding from November through April when precipitation is greatest. Frequent, occasional, or none are ratings listed in Natural Resources Conservation Service soil surveys to identify flood hazard, by month, for different soil types. If considering winter application, it is important to contact your local WSU Cooperative Extension, Conservation District, or Natural Resources Conservation Service office for help in determining whether conditions are appropriate in your situation.

A farm's nutrient management plan should identify the application sites, soil types, and, if applicable, locations for winter manure application for specific crops. This information, along with an adequately sized storage facility, gives farmers control over manure application timing. Knowing the best season for manure application is an integral part of manure management.

Controlling Manure Odors

Because odor may offend some neighbors, manure should be applied to crop fields in a way that reduces the potential odor. Practices that are effective in reducing odor are mostly management decisions and are generally not costly. Options to consider include changing the method of application and the time of day application occurs. Taking weather conditions into consideration also helps to reduce manure odors.



Manure Management Guidelines For Application Timing



- For grass, apply manure at least 30 days before cutting to allow die-off of disease-causing bacteria and viruses. Manure applied within seven days after each subsequent cutting reduces the likelihood of smothering grass and slowing regrowth.
- The best time to apply manure to corn fields is thirty days before planting.
- NEVER apply manure to bare corn fields (except whole solid and separated solids) from the beginning of September to late February.
- Follow silage corn with plantings of annual winter cover crops or fall planted annual rye grass.
- Apply manure in spring or summer, just before and during the period of crop growth and highest nutrient demand.
- Do not apply manure in fall or early winter unless it is part of an approved farm plan. Light manure applications to grass may be acceptable in early fall under ideal weather and soil conditions.
- To reduce the chance of nutrients burning the grass during hotter months, take one of the following approaches: 1) reduce the amount of manure applied; 2) dilute the manure with water during application; 3) follow manure application with fresh water; or 4) postpone application until weather conditions are more favorable.
- For fields that are tilled before planting, apply manure before the primary tillage operations to incorporate it into the soil. Incorporating manure as soon as possible after application will retain about 25% more of the nitrogen.
- Manure application to corn can occur at the soil pre-plant and pre-emergence stage.
- Liquid manure application to corn can occur after the corn crop has emerged but is less than 30 inches tall.

Irrigation and Applied Nutrients

Irrigation can become an integral part of manure nutrient management. Irrigating just after a manure application can help manure infiltrate into the soil, reduce odors from application and conserve more of the volatile nitrogen for plant use. Irrigation water will also wash manure solids off plant leaves. This reduces burn potential and prevents ingestion of manure by grazing animals. Applying too much water will cause nutrients to runoff or leach below the root zone. Excess water application also increases pumping costs.

Nutrient Levels in Irrigation Water

Nutrient levels contained in irrigation water are a factor in the total nutrient budget for a farm. To find out how many pounds of nitrogen per acre are added through irrigation, you need to know the

Table 3

water's nitrate content (in ppm or mg/L) and the amount of water applied. Irrigation water can be tested for nutrient content at commercial laboratories. The formula for calculating nitrate-nitrogen additions is included in Step 3 of Appendix F. Table 3 provides estimates of the amount of nitrate-nitrogen applied for irrigation water with different nutrient concentrations.

Nitrate-Nitrogen	per acre-inch	1 acre-foot
5 ppm	1.13 lbs N	13.5 lbs N
10 ppm	2.25 lbs N	27.0 lbs N
15 ppm	3.38 lbs N	40.5 lbs N
20 ppm	4.50 lbs N	54.0 lbs N



Manure Management Guidelines For Odor Control



- Schedule applications to avoid summer weekends and holidays when people may be out recreating.
- Avoid manure application when wind is traveling toward neighbors or populated areas.
- Plan to spread in different fields on different days based on wind conditions and proximity to neighbors.
- Apply manure during mid-morning hours when temperatures are warming and air currents are rising rather than in the evening when air is cooling and settling to the ground.
- When possible, choose the application method that reduces odor potential. Big gun applications produce a more intense odor due to high pressure spray which produces fine droplets. These droplets are then subject to wind drift. In contrast, liquid tank spreaders apply a coarse, low pressure, low trajectory spray which reduces odor. Boom applicator systems can be used with existing big gun hose reels. Using boom applicators in this manner will apply manure close to the ground greatly reducing drift and odor.
- When possible, incorporate manure immediately after application. This not only reduces odor, it preserves nutrients and reduces the runoff potential.
- Immediately irrigate fields after manure application. This can help control odors rising off the field and wash manure off the plants.

A "Report Card" for Nutrient Management Plans

There are a variety of tests that can serve as a report card on how well a nutrient management program is performing. Tables 4 and 5 identify tests that can be performed, the purpose of the test, and when it should be done. These tests are a management tool that can be used to validate or adjust each site specific nutrient management plan. In addition, test results can show that your nutrient management practices are protecting groundwater. Performing the various tests provide the numbers that answer the challenge: Are you a good nutrient manager?

For information on testing methods, contact your local Natural Resources Conservation Service, Cooperative Extension, or Conservation District office.

Table 4 - Test Uses

Tests Proposed	Corn	Grass	Use
general soil calcium, magnesium, phosphorus, potassium, and pH	X	X	monitor trend of soil nutrient levels over time
pre-sidedress soil nitrate	X		guides further nutrient applications
fall soil nitrate	X	X	evaluates how well manure application rate met crop needs
forage levels protein (TKN), nitrate, phosphorus, and potassium	X	X	feed value, quality, and herd health

Table 5 - Test Timing

Test Performed	Timing of Tests
General soil calcium, magnesium, phosphorus, potassium, and pH	Every 2 years (usually early spring).
Pre-sidedress soil nitrate	When corn crop is at 6 leaf stage.
Fall soil nitrate	Generally between August 15th and October 15th after final crop harvest. Soil testing may be delayed to early November if last manure application was early October.
Forage levels	At harvest.



Manure Management Guidelines for Irrigation



- Schedule and apply the proper amount of water for particular crop needs based on Cooperative Extension and Soil Conservation Service irrigation guide recommendations. Consider using a soil tensiometer or moisture meter to determine irrigation needs.
- Do not over-apply water. Over-application wastes water, incurs unnecessary pumping costs, increases nutrient leaching, and increases runoff potential.
- Know how much water your system applies to properly calibrate water delivery.
- Consider site limitations (soil type, infiltration rate, topography, and crop grown) when determining application rates.

HOME GROWN FORAGE

Excessive manure applications can return to haunt a farmer in the form of harmful nutrient concentrations in home grown forage. Crops assimilate abnormally high amounts of some nutrients when soil concentrations are high. This may result in forage that can be detrimental to herd health.

Potassium accumulates in the soil if not taken up by growing crops. The potassium content of the liquid fraction of dairy manure averages about twice that of nitrogen. Depending on the composition of the manure, farm plans that use nitrogen as the basis for application rates may apply more potassium than the crop can remove. This may eventually cause high potassium levels in the forage which can be a problem in dry cow rations. Nutrient applications that are consistent with agronomic rates should keep forage nutrient levels in a safe range. Forage can be tested to determine potassium levels so appropriate ration balancing and feeding management decisions can be made.

Table 6

Content of Nitrate-Nitrogen in the Dry Matter (%)	Guidelines for Feeding
0 - 0.10	Safe to feed. Use caution with pregnant or young animals at the upper range level.
0.10 - 0.20	Generally safe when fed with a balanced ration. For pregnant animals, limit this feed to one-half of the dry matter intake. Make certain that the water is low in nitrates. May cause lowered milk production and vitamin A deficiency in 6 to 8 weeks.
0.20 - 0.35	Limit this feed to one-fourth of total ration dry matter. Ration should contain adequate energy, minerals, and vitamin A. May cause milk production loss in 4 to 5 days and reproductive problems while the feed is used.
over 0.35	Toxic. Do not use. Abortion, severe depression, difficult respiration, and death may occur.

(Source: Fisher)

The nitrate levels of forage reflect the amount of nitrogen available in the soil where the forage was grown. High forage nitrate can also be caused by environmental stresses including drought, frost, cloudy weather, and fertility imbalance. Nitrates accumulate in the plant when stresses reduce crop yield to less than expected. For testing purposes, it is important to know that nitrate levels in forage can change over time. For example, corn is higher in nitrate early in the morning and lower in late afternoon. Also, the ensiling process can reduce nitrate levels by about half. Laboratories may report levels as NO_3 , $\text{NO}_3\text{-N}$, or KNO_3 . Cooperative Extension, Natural Resources Conservation Service, or Conservation District staff can help you interpret your results using Table 6.

IMPLEMENTING MANURE MANAGEMENT GUIDELINES

Technical Assistance

There are several agencies available to assist in planning and implementing MMGs and Conservation Plans. These resource agencies work with the farm operator to develop a plan that is unique to a particular farm situation. This team approach to farm plan development will ensure your



Manure Management Guidelines For Home Grown Forage



- Periodically test harvested forage for nitrate and potassium levels for use in ration balancing and to check nutrient management plan performance.
- When encountering high nutrient levels, determine the cause. If high nutrient concentrations in the soil are responsible, changes in the nutrient application rate, a change of crop, or other changes to the nutrient management plan are needed.
- Test forage for nitrate levels after the ensiling process is complete or in the form the forage is fed.
- If you detect high nutrient levels in forage, contact your Natural Resources Conservation Service, Cooperative Extension, or Conservation District office for information on available management techniques to reduce soil nutrient levels.

plan is workable and both economically and environmentally sound. The planning resource agencies available to provide this assistance include:

USDA Natural Resources Conservation Service (NRCS)

The NRCS provides technical assistance with planning, design, construction and maintenance of waste management systems. They work in cooperation with the farm operator and the local Conservation District to develop Conservation Plans. The NRCS also provides the design specifications for manure systems and Conservation Plans which are required for cost-sharing. The technical assistance provided by NRCS is available free of charge and without discrimination to any landowner who requests it.

Local County Conservation Districts (CD)

Local CDs provide technical assistance with the operation and maintenance of manure handling facilities and MMGs and they become involved in the development of Conservation Plans. Local CDs also assist operators charged with water quality violations by the Washington State Department of Ecology.

Washington State Department of Ecology (Ecology)

Ecology field staff provide technical assistance to farmers evaluating their pollution potential. They cooperate with local CDs to address agricultural water pollution problems. Ecology also provides grants and loans to farmers through local governments and CDs to control nonpoint source pollution. The agency administers state and federal water pollution control laws including discharge permits, complaint response, and water quality enforcement actions.

Washington State University Cooperative Extension (CE)

CE provides educational programs and resource material to assist with the economic analysis, selection, installation, operation and maintenance of manure handling facilities and MMGs.

Financial Assistance

Economic issues and their effect on the producer are important considerations in the adoption and implementation of MMGs. Producers make decisions based on the resources available and the ability to operate the farm in a profitable manner. Financial assistance may be available to producers for building manure storage facilities and implementing nutrient management plans. Contact your ASCS, NRCS, CD, or CE office for information on the availability of cost-share or low-interest loan programs.

REGULATORY CONTROLS

Federal and state regulatory controls are in place that lay out goals and requirements for water pollution control. The U.S. Environmental Protection Agency is responsible for the administration and enforcement of federal requirements. Most states, including Washington, have been delegated some of these responsibilities. State legislation is then passed that establishes policies and requirements to protect water quality that are consistent with federal mandates. The Washington State Department of Ecology is responsible for the administration and enforcement of requirements for water pollution control in Washington.

Legislation affecting dairy farms was passed in 1993, when the Washington State Legislature enacted the Dairy Waste Management Act (Chapter 90.64 RCW) reaffirming federal laws that require waste discharge permits for dairies. Under this Act, all dairies in Washington are required to have dairy waste discharge permits. Administrative exemptions may be available for dairies that are not discharging to surface or ground water. The permit will include the following requirements:

- The dairy will be required to implement an animal waste management plan that meets or exceeds applicable NRCS specifications.
- The discharge of pollutants to surface waters may occur only when a 25-year, 24-hour rainfall event is exceeded for that location.
- Application of manure to croplands will need to occur as specified in the farm's nutrient management plan.
- Manure storage facilities will be required to store manure during winter months when surface and ground water pollution potential is high.
- The farm animal herd size will not be allowed to exceed the capacity of the manure management system.
- The Department of Ecology must be notified if discharge to surface

RESOURCE DIRECTORY

Resource Agencies for Western Washington Counties

The agencies listed below provide farm operators with technical or financial assistance in developing and implementing Conservation Plans.

Consolidated Farm Service Agency (CFSA)
Conservation District (CD)
Department of Ecology (Ecology)
Natural Resources Conservation Service (NRCS)
Washington State University Cooperative Extension (CE)

CLALLAM

CFSA: 457-5525
CD/NRCS: 457-5091
Ecology: 586-5552
CE: 452-7831

CLARK

CFSA: 696-7649
CD/NRCS: 696-7631
Ecology: 586-5552
CE: 696-8411

COWLITZ

CFSA: 636-1300
CD/NRCS: 425-1880
Ecology: 586-5552
CE: 577-3014

GRAYS HARBOR

CFSA: 249-5900
CD/NRCS: 249-5980
Ecology: 586-5552
CE: 249-4332

ISLAND

(SERVED BY SKAGIT)

JEFFERSON

CFSA: 457-5525
CD/NRCS: 385-4105
Ecology: 586-5552
CE: 385-9158

KING

CFSA: 764-3770
CD/NRCS: 226-4867
Ecology: 649-7133/649-7167
CE: 296-3900

KITSAP

CFSA: 764-3770
CD/NRCS: 876-7171
Ecology: 649-7133/649-7167
CE: 876-7157

LEWIS

CFSA: 925-2721
CD/NRCS: 748-0083
Ecology: 586-5552
CE: 748-9121

MASON

CFSA: 753-9453
CD/NRCS: 427-9670, Ext 391
Ecology: 586-5552/5551
CE: 427-9670, Ext 395
Ecology: 586-5552

PACIFIC

CFSA: 249-5900
CD/NRCS: 875-9424/9331
Ecology: 586-5552
CE: 875-9331

PIERCE

CFSA: 536-2837
CD/NRCS: 536-2945
Ecology: 586-5552/5551
CE: 591-7180

SAN JUAN

CFSA: 336-5144
CD/NRCS: 376-4370
428-7684
Ecology: 649-7133/7167
CE: 378-4414

SKAGIT

CFSA: 336-5144
CD/NRCS: 428-4313
428-7684
Ecology: 649-7133/7167
CE: 336-9322

SKAMANIA

CFSA: (509) 696-7649
CD/NRCS:(509) 493-1936
Ecology: 586-5552
CE: (509) 427-5141

SNOHOMISH

CFSA: 334-3131
CD/NRCS: 335-5634
Ecology: 649-7167/7133
CE: 338-2400

THURSTON

CFSA: 753-9453
CD/NRCS: 754-3588/352-
6388
Ecology: 586-5552/5551
CE: 786-5445

WHATCOM

CFSA: 354-3690
CD/NRCS: 354-2035
Ecology: 649-7167/7133
CE: 676-6736

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