

Commercial Animal Waste Technician Site Manager Study Manual



Third Edition, Revised January 2015



Preface

This Commercial Animal Waste Technician (CAWT) training manual was designed as a study guide for the open-book licensing test and as a general reference for commercial Site Managers of livestock manure hauling and application operations in Minnesota. The Minnesota Department of Agriculture (MDA) prescribes and administers an examination to determine if the applicant qualifies for the CAWT site manager license. Commercial Animal Waste Technician Applicators and CAWT Company's personnel should find this manual beneficial to their work as well.

The MDA, in cooperation with University of Minnesota Extension and appropriate educational institutions, establishes and implements a program for training and licensing of CAWTs. This manual contains the information needed to take the CAWT Site Manager licensing test. Copies of this manual can be downloaded as a PDF from the University of Minnesota or Minnesota Department of Agriculture website: <http://www.manure.umn.edu>

All questions, suggestions or corrections concerning this manual and the Commercial Animal Waste Technician licensure program should be directed to:



Licensing and Certification

Minnesota Department of Agriculture (MDA)

625 Robert Street North, St. Paul, MN 55155-2538

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CHAPTER 1: THE MINNESOTA COMMERCIAL ANIMAL WASTE TECHNICIAN (CAWT) TRAINING AND LICENSING PROGRAM

Learning Objectives

After completing this chapter, you should be able to:

- List the licenses required by MDA to commercially manage manure
- List two benefits of a CAWT licensing program
- Explain when a CAWT license is needed
- Explain when a CAWT license is not needed
- Describe the responsibilities of a Site Manager
- Describe the responsibilities of an Applicator
- List one way a site manager can meet re-certification requirements
- Describe what happens if re-certification requirements are not met
- Explain what happens if a Company or Site Manager license is not renewed
- Describe where CAWT licenses must be displayed
- Identify two requirements for displaying Company license number on application equipment

Terms to Know

Commercial Animal Waste Technician (CAWT): The term used to describe those who commercially apply manure in the state of Minnesota, including CAWT Company, Site Manager, and Applicator.

CAWT Company: A licensed “for hire” business that manages livestock manure.

CAWT Site Manager: A person employed by a CAWT Company who is licensed to commercially manage all site operations including transport of manure to the application site. A site manager also supervises CAWT Applicators and manages livestock manure applications to the ground.

CAWT Applicator: A person employed by a CAWT Company who is licensed to commercially apply animal wastes to the ground under the supervision of a licensed CAWT Site Manager.

Commercial manure application site: A site encompasses locations where loading, agitation, pumping, hauling, and field application occurs.

Under supervision: CAWT Site Managers must supervise CAWT Applicators. Supervision means the Site Manager must be on site the majority (more than half) of the time, maintain voice contact and be no more than 45 minutes from the manure application site.

Commercial/for hire: A person or business engaged in managing manure for compensation; cash, credit or barter that is promised, paid, or given.

Managing livestock waste: The oversight, control and handling of livestock manure in ways that maximize agronomic and environmental benefits. Managing includes oversight of stockpiling operations.

Animal Waste: Livestock manure.

Application: Spreading manure on the ground for disposal and/or agronomic benefit.

Stockpiling: A common method of storing solid manure and used bedding/litter until it can be applied to cropland. Stockpiled manure contains at least 15% solids and is able to hold a 3:1 ratio when stacked.

Introduction

The Commercial Animal Waste Technician (CAWT) training and licensing program came about in response to requests from the professionals representing commercial livestock manure haulers in Minnesota. These companies wanted to promote education and competence of their members, and strengthen the credibility of their profession with customers, regulators, and the public. Additionally, they wanted to ensure that commercial manure companies and applicators manage manure properly for the benefit of their clients and their businesses, and to avoid degrading the waters of the state due to manure mismanagement.

In response, the Minnesota Legislature established a licensing program; MN Statute 18C.430 Commercial Animal Waste Technician. See Appendix C for the complete text of the statute. Three license types are included: a CAWT Company, a CAWT Site Manager and A CAWT applicator. This is a study manual for the certification of CAWT Site Managers.

Site Manager Duties

A Site Manager oversees all aspects of commercial manure application operations and is responsible for understanding environmental risks, safety hazards, and legal requirements of manure handling, transport, application and management. Responsibilities include but are not limited to:

- **Implementing manure management plans**
- **Loading manure**
- **Manure application**
- **Equipment calibration**
- **Equipment maintenance**
- **Supervising applicators**
- **Pit agitation**
- **Stockpiling**
- **Transportation to site of application**
- **Calculating application rate**
- **Employee training and safety**
- **Emergency preparation**
- **Environmental protection**

Stockpiling Manure

A Site Manager must oversee commercial manure stockpiling operations. Any commercial application of manure from the stockpile to the final application site must be done by a licensed CAWT Site Manager or CAWT Applicator. Those hauling and creating the stockpile of solid manure do NOT need a CAWT license.

Displaying CAWT License Number

State statute requires that the Company license number be displayed on all manure application equipment. License numbers must be:

- **At least three inches tall and high contrast colors**
- **Displayed visibly on the left front driver side door of a tanker, on toolbar, on dragline equipment, on truck box, or on box of solid spreader**

Licensing Requirements for Commercial Animal Waste Technicians

The following groups must be licensed and responsible for the proper management of manure in Minnesota:

A CAWT license IS required for:	A CAWT license is NOT required for:
1) A person that commercially applies manure for hire. 2) A person that applies (their own or their employers) manure – if the feedlot has a capacity of 300 animal units (AU) or more AND does not have an updated manure management plan.	1) A person that applies their own or their employers manure if the feedlot has a capacity of less than 300 AU. 2) A person that applies their own or their employers manure – if the feedlot has a capacity of 300 AU or more AND has an updated manure management plan.

CAWT Company

- **Complete and submit the CAWT Company application form**
- **Pay appropriate license application fee**
- **Employ at least one CAWT Site Manager**
- **Meet financial responsibility requirements**
- **Meet workers compensation as required by law**
- **Renew and pay license fee annually**
- **Display CAWT license number visibly on all manure application equipment**
 - **Numbers must be at least three inches tall and in high contrast colors**
 - **Place on the left front driver side door of a tanker, on toolbar, on dragline equipment, on box truck for solid, or on box of solid spreader**

CAWT Site Manager

- Complete and submit the CAWT Site Manager license application form
- Pay the license application fee
- Be employed by a licensed CAWT Company
- Pass (80% and above) the Site Manager exam
- Pass exam for each category desired liquid and/or solid
- Recertify at a workshop or re-test every two years
- Renew license and pay license application fee annually
- Carry a valid CAWT license ID card

CAWT Licensed Applicator

- Complete and submit the CAWT Applicator Application form
- Pay appropriate license application fee
- Be employed by a licensed CAWT Company
- Work under the supervision of a CAWT Site Manager
- Complete two hours of designated online training annually
- Pass online certification exam annually
- Renew and pay license fee annually
- Carry a valid CAWT license ID card

CAWT Applicators, Site Managers and Companies are responsible for proper manure management.

For more information on licensing requirements: <http://z.umn.edu/CAWT>

Financial Responsibility

- CAWT licenses are not issued unless certain financial responsibility requirements are met. CAWT Site Managers and Applicators are covered under the financial responsibility of the licensed CAWT Company.
- Financial responsibility may be demonstrated by:
- Proof of net assets of \$50,000 or more, or;
- A performance bond or liability insurance with the following minimum coverage:
 - \$50,000 bodily injury or death, each person; and
 - \$50,000 bodily injury or death, each occurrence; and
 - \$25,000 property damage, each occurrence.
- Proof of financial responsibility must cover the term of the applicant's license. The Minnesota Department of Agriculture (MDA) will suspend the license of a person who fails to maintain the required net assets, bond or insurance.

For more information:

<http://www.mda.state.mn.us/~media/Files/licensing/chemicals/financial.pdf>



License Application Forms and Fees

A license will be issued after completing a license application form, paying the fee, and successfully completing the certification requirements.

New application forms and payment of fees can be completed online or on paper through the mail. To receive an application form, contact MDA Licensing and Certification Unit. Application for a duplicate CAWT license card (e.g., lost cards, change of address, employer) costs \$10.00.

Call MDA to obtain a duplicate license or change of employer form.



Licensing and Certification, Minnesota Department of Agriculture

625 Robert Street North, St. Paul, MN 55155-2538

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Web: <http://www.mda.state.mn.us/licensing>

The CAWT Initial Certification Requirements

The CAWT Site Manager exam is based on the content of this CAWT manual. A minimum score of 80% is needed to pass. It is an open book exam. It is recommended that applicants bring this CAWT manual with them during the test.

Applicants are strongly encouraged to study the material in the manual before taking the test to be able to use it effectively during the test.

Testing will be administered by the MDA. Applicants who fail the test will be able to retake the test two additional times in one licensing year. The tests will be administered at the MDA office in St Paul, or at cooperative testing locations. Contact MDA at pesticide.licensing@state.mn.us or 651-201-6615 for out-state testing location information.

CAWT Applicators must watch one 2-hour session of online video training and pass a certification exam demonstrating they watched and understood the required training. The online training can be accessed on the University of Minnesota Extension website.

License Renewal Application and Recertification

License renewal and recertification are two separate things.

License Renewal

Licenses expire on December 31st of each year. In December, the MDA will distribute renewal notices for all CAWT Company, CAWT Site Manager and CAWT Applicator licenses. Licenses must be renewed to be valid.

Site Manager licenses are renewed by completing a renewal form and paying a license application fee to MDA. Renewal can be done online or through the mail. Applicants must renew a CAWT license within 12 months of the expiration date to avoid taking the certification exam again.

A license renewal form must be received by the MDA before March 1st to avoid a late fee. Renewals received after March 1st are subject to an additional charge of 50% of the required fee. The Company license must be in good standing in order for the Site Manager or Applicator license to be valid or renewed. Recertification requirements must be current in order to renew and are met through workshop attendance, re-testing, or online training.

Recertification

CAWT Site Manager recertification requirements are met by attending an MDA approved educational workshop or by re-testing. Listings of dates and locations of workshops can be found at U of MN and MDA websites. Workshops must be attended before the recertify-by date on the license. In order to re-test for recertification an applicant must pay an additional fee of \$25.00. CAWT Applicator recertification requirements are met through completing the online training accessible on the University of Minnesota Extension website.

CAWT Compliance

The MDA may revoke or suspend CAWT license for violations of statute or if financial responsibility requirements are no longer valid. If a license is revoked or suspended the license holder may not manage or apply manure for hire in Minnesota until the license is valid again.

The MDA may require additional demonstration of commercial animal waste technician qualification if a person has had a license suspended or revoked or has had a history of violations.

Record Keeping

For CAWTs, keeping accurate records is the primary way to show customers, regulators, and the public that manure is and has been applied correctly. To protect their businesses, commercial applicators should consider the financial and legal aspects of their operation when deciding what records to keep.

Company Records

If you own a manure application business, keep records of the following information:

- Dates of CAWT training and licensure for all employees
- Equipment inspections and maintenance records
- Incident reports
- Work-related deaths, injuries, and illnesses (if you employ 11 or more employees)

For each job site, as appropriate, keep track of the following information:

- Name and address of the owner of the livestock operation that produces the manure
- County, Town, Range and Section, and quarter section
- Name and address of the recipient of manure
- Date(s) on site
- Applicators name and company
- Manure nutrient concentrations (measured or table values)
- Amount of manure hauled and total acres covered
- Weather at the time of application; recent rainfall, temperature, wind direction and speed
- Actions/methods to protect groundwater and surface water

A detailed form titled "Field Manure Application Record" with various sections for recording application details. The form includes fields for: 1. Manure source information (County, State Manager, Applicator, Livestock Facility Owner, and Address). 2. Application details (Date, Time, and whether it's a spot application or full field application). 3. Field information (County, Town, Range, Section, Quarter Section, Field ID, and Acres). 4. Application method (Broadcast, Band, or In-row) and equipment used. 5. Nutrient information (Nitrogen, Phosphorus, and Potassium concentrations and application rates). 6. Weather and environmental conditions (Temperature, Wind, Rain, and Groundwater/Surface Water protection measures).

Appendix C is Field Manure Application Record Template that can be used to document manure applications. It can also be used as a training tool so Applicators in the field will know what they are expected to keep track of and why it is necessary

For manure applications in special protection areas these records must be kept for the most recent six years. For applications to all other cropland, including fields owned or leased by someone other than the farmer, these records must be kept for the three most recent years.

If you send manure samples for laboratory analysis, keep copies of the manure sampling request forms sent and the results you receive back. It is also good business practice to provide your customers with copies of your records of manure application information.

Field Specific Records

Develop and use a record-keeping system for field-specific information. It may be helpful to develop blank record-keeping forms and copy them so you or your employees can fill them out at the site. Applicators should be able to quickly track important information about manure applications and provide a useful record to show that planned application rates were achieved.

The amount of record keeping needed depends somewhat on how well your client's develop and use their own nutrient management plans. The following list of field-specific records should be kept to relay to the farm owner/manager and for your own use:

- Farm/farmer name(s), location, managers/owners involved, contact information
- Field locations (county, township, section) and size
- Date(s) manure applied
- Application method (i.e., surface, injection, incorporation)
- Manure application rates in tons or gallons per acre
- Available nitrogen and phosphorus applied per acre
- Deviations from manure application plan

The following information should be provided by the farm owner/manager and used to calculate the optimum manure rate.

- Soil tests (i.e., pH, phosphorus and potassium levels, organic matter)
- Soil type and slope (depth to bedrock or groundwater)
- Crop and nutrient demand level
- Previous crops and legume nitrogen credits
- Planned and previous manure (and biosolids) applications
- Maps/diagrams that show distance to all areas of special concern (i.e., rivers, wells, etc.)

Study Manual

The CAWT Site Manager certification exams are based on this publication. Review these materials before taking the exam. The manual is available for free download at these University of Minnesota Extension and MDA websites:

<http://www.manure.umn.edu>

<http://www.mda.state.mn.us/en/licensing/licensetypes/cawt.aspx>

References and Additional Resources

- Licensing and Certification, Minnesota Department of Agriculture (MDA) , 25 Robert Street North, St. Paul, MN 55155-2538 Tel:651.201.6615 / 800.627.3529 (TTY) E-mail: pesticide.licensing@state.mn.us Web: <http://www.mda.state.mn.us/licensing>



CHAPTER 2: THE AGRONOMIC VALUE of MANURE

Manure has real value... when managed properly.

Learning Objectives

After completing this chapter, you should be able to:

- List three soil-derived macronutrients found in livestock manure
- Identify three sources of nitrogen for crop production other than manure
- Describe some of the basic mechanisms of the nitrogen cycle
- Define nutrient availability and three factors affecting it
- Describe how manure applications enhance soil health
- Identify a benefit and a concern when applying manure to an alfalfa crop
- Explain two guidelines for applying manure to a soybean crop

Terms to Know

Available nutrient: A nutrient that can be taken up from the soil and used for plant growth.

Macronutrients: The elements required in relatively large amounts for plant growth: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S).

Soil organic matter: The organic matter component of soil, typically 1 to 5% on agricultural soils in MN, consisting of plant and animal residues, cells and tissues of soil organisms, and substances synthesized by soil organisms.

Inorganic nitrogen: Nitrogen not associated with organic matter: ammonia (NH_3), ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), nitrogen gas (N_2), nitrous oxide (N_2O).

Organic nitrogen: Nitrogen found in all organic materials (i.e., plants, animals) in the form of proteins, amino acids.

Nitrate nitrogen (NO_3^-): A water soluble form of N that easily leaches through the soil profile.

Nitrogen fixation: The conversion of atmospheric-N to plant-available-N by microorganisms in symbiosis with leguminous plants.

Ammonia Volatilization: The transformation of ammonium (NH_4^+) to volatile ammonia (NH_3) gas to the atmosphere.

Leaching: The movement of water soluble compounds (i.e., nitrate) flowing downward or laterally through the soil profile.

Runoff: Excess rain, snow or ice melt that runs off the land surface, impervious or saturated surfaces.

Runoff Pollution: Runoff that picks up and carries pollutants (e.g., nutrients, bacteria, organic matter, chemicals, soil) and flows into and degrades surface or groundwater.

The sixteen (16) recognized elements essential for plant growth: Carbon (C), hydrogen (H), and oxygen (O) are drawn from the air and water. Nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg) are soil derived macronutrients needed by plants in relatively large amounts Boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn) are needed in much smaller amount; the micronutrients.

Introduction

The soil enhancing and crop fertility value of manure is well established. Manure contains the macro- and micro-nutrients essential for plant growth. Manure is also a high quality organic matter-rich material that contributes to many important agronomic soil qualities. Careful management of manure can greatly improve soil structure. Soils with good structure resist erosion, and have higher rates of water infiltration, water holding capacity and nutrient availability. These are all important factors to profitable crop production.

Nutrient Uptake and Removal Processes

Nutrients in manure are not available to plants until they are transformed into soluble, plant available forms. The variability between available and unavailable, organic and inorganic nutrients and the liquid and solid fractions of the manure makes the determination of manure application rates based on nutrient content more difficult than with commercial fertilizers.

The Nitrogen Cycle

Crops require nitrogen (N) in relatively large amounts and nitrogen is the nutrient most often deficient for crop production. Nitrogen is water soluble and continually changing its chemical form and moving from plants through animals, the soil, water, and the atmosphere. This movement and transformation of nitrogen in the environment is known as the nitrogen cycle. Critical processes in the nitrogen cycle include:

- **Mineralization: the conversion of organic nitrogen to ammonia (NH₃-) and ammonium (NH₄+)**
- **Nitrification: the conversion of ammonia (NH₃-) and ammonium (NH₄+)** to nitrate (NO₃-)
- **Denitrification: the conversion of nitrate (NO₃-) to nitrogen gas (N₂)**
- **Immobilization: the conversion of inorganic nitrogen to organic nitrogen**
- **Volatilization: the release of ammonia (NH₃-) to the atmosphere**
- **Nitrate leaching: the downward movement of nitrate nitrogen through the soil profile.**



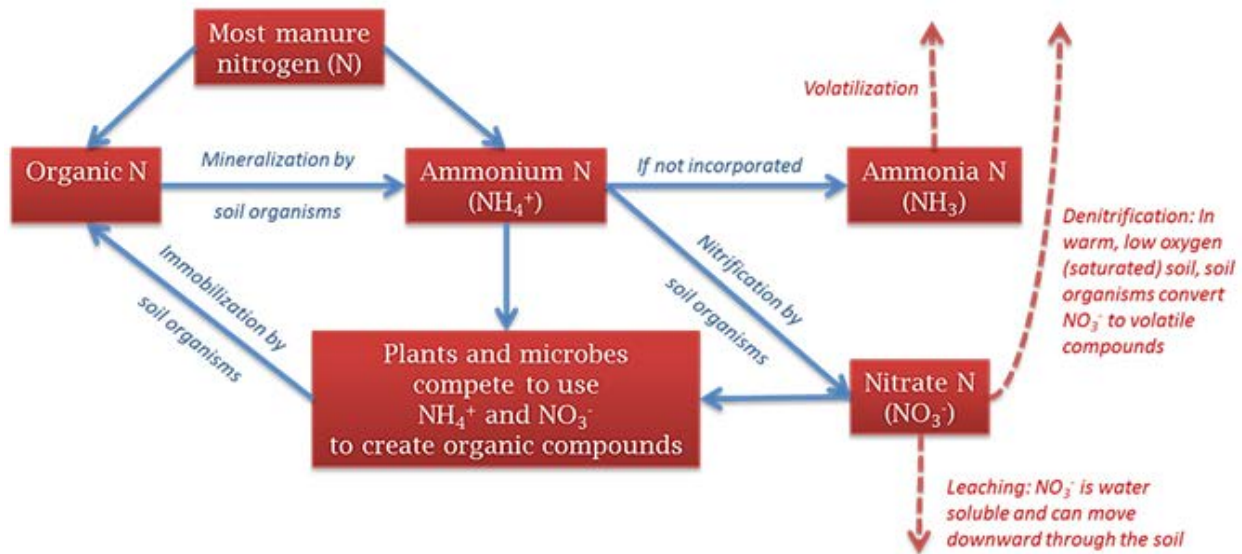


Fig. 2.1: Nitrogen Components of manure and some transformations that occur in the soil. Source: *Manure Management in Minnesota (WW-03553) 2012*. Univ. of MN Extension.

Manure Nitrogen

Manure contains nitrogen primarily in the form of organic N and inorganic ammonium N. Although manure also contains other forms of inorganic N—principally nitrate N, nitrite N, and ammonia N—these forms normally make up a small part of the inorganic N. Plants can only take up inorganic nitrogen.

Organic Nitrogen

Organic forms of nitrogen are contained in manure. When manure is applied, soil microbes transform the organic N to inorganic N, a form that can be taken up by plants. These processes are called mineralization and nitrification and are affected by temperature, moisture and time. Organic N will be converted to plant available N more quickly in warm, moist soils than in cool, dry soils. Between 25-50% of the manure’s organic N will be converted to useable ammonium N each year after the manure is applied. This value is affected greatly by the method and time of application, temperature and precipitation during the year, type of manure, and various soil factors such as texture, organic matter content, and drainage.

Ammonium Nitrogen (NH₄⁺)

The other major component of manure N is ammonium N. Ammonium N is relatively immobile in the soil, and is not subject to leaching losses. Ammonium N can be taken up by plants, volatilized to ammonia N if manure is left on the soil surface, or converted to nitrate N through the process of nitrification. While nitrate N is available to plants, it is also susceptible to denitrification in fine-textured soils and to leaching, especially in medium- or coarse-textured soils.

In addition to manure, nitrogen for crop production also comes from soil organic matter, decomposition of crop residue, fixation of nitrogen from the atmosphere by legumes, precipitation and commercial fertilizers. All of these sources should be accounted for when determining manure application rates.

Phosphorus, and Potassium

Phosphorus (P) is a naturally occurring chemical element in minerals, soil, living organisms, and water. Like nitrogen, phosphorus is required in relatively large amounts for plant growth and development. It is essential for early root development and hastens plant maturity. Phosphorus readily forms compounds with other elements and moves very slowly through the soil profile. Phosphorus readily attaches to soil particles and becomes a pollutant when soil erodes and is carried downstream in runoff. Phosphorus can also be carried in runoff directly in a soluble form. It is excess phosphorus that causes excessive aquatic plant growth and algae blooms in lakes and rivers. **Potassium (K)** is the other macro-nutrient vital to profitable crop production. The availability of P and K in animal manure is fairly consistent, with approximately 80% of the P and 90% of the K available for the first crop following manure application.

Additional Benefits of Manure

The benefits of manure are not limited to N, P and K. Manure is also a source of micronutrients. Additionally, comparisons have been made between fields with and without manure, but with similar amounts of nutrients supplied. These comparisons show that fields with manure can yield more than fields without manure. These additional benefits are often greater than the nutrient value of the manure.

Manure applications (and sound soil conservation practices) improve soil structure and the ability of soil particles to form stable aggregates, which in turn affects the soil's water holding capacity, infiltration rates, erodibility, and is related to the complex biology of soils. Additions of manure increase soil organic matter and result in a more biologically active soil. Increased biological activity will generally improve soil structure and is an indicator of the soil's general health.

Soil organic matter is any soil material that comes from the tissues of organisms (plants, animals, or microorganisms) and consists of living organisms, slightly altered plant and animal organic residues, and well-decomposed plant and animal tissues. It is rich in nitrogen (N), phosphorus (P), sulfur (S), and micronutrients, and is comprised of approximately 50% carbon (C). Soil organic matter is critical for soil function and soil quality and the positive impacts of soil organic matter are highly valuable both agronomically and environmentally, and include:

- Reduced soil bulk density
- Increased soil aggregate stability
- Resistance to soil compaction
- Enhanced fertility
- Increased water infiltration
- Reduced nutrient leaching
- Increased water holding capacity
- Resistance to soil erosion
- Increased biological activity
- Reduction of greenhouse gases (carbon sequestration)

Organic matter is increased by leaving residue on the soil surface, rotating crops with perennials, incorporating cover crops into the cropping rotation, or by adding organic residues, such as animal manure, litter, compost or biosolids. A soil with higher organic matter will generally require less applied nitrogen to achieve the same yield as the same soil with lower organic matter. Soil organic matter generally ranges from 1% to 6% for most upland soils. Soils containing 12-18% organic matter are generally classified as organic soils. Muck soils are those with more than 18-20% organic matter.

A healthy soil is a productive, profitable, resilient soil - Don't treat soil like dirt!

Applying Manure on Corn, Small Grains, Alfalfa and Soybeans

The majority of manure in Minnesota is applied to corn, small grains, alfalfa and soybeans. The following summarizes some of the basic guidelines to consider when applying manure to these crops.

Manure on Corn and Small Grains

With corn and small grains, manure management centers primarily on nitrogen management. Fall and spring applications are the best options, with injection or incorporation preferred. Because corn is a high N-demand crop, applying manure on corn makes sense and is standard practice. However, applying manure to corn to meet the corn N needs over time can lead to over application of N and P.

For first year corn after alfalfa, corn and small grains usually do not need additional N. Applying even moderate amounts of manure can result in excess N application. This “wasted” manure over-applied to first year corn after alfalfa could perhaps have been used to reduce purchased N on other fields.

When corn fields receive manure year-after-year there are 2nd and even third year N credits that accumulate as the organic N in manure takes time to become fully available. Manure application rates can be reduced in this situation, again potentially making more manure available to replace purchased fertilizer on other fields.

When manure is applied repeatedly to the same field based on crop N needs phosphorus levels build up. When soil test P levels increase, often well beyond any crop requirement, it also increases the potential for runoff pollution as any soil erosion now has a much higher P concentration. Phosphorus is the main pollutant of lakes and rivers, causing excessive weed and algae growth.

Another consideration is the application of manure with a high proportion of added organic material (e.g., straw, corn stalks, wood chips, sawdust, etc.). This can lead to yield risk if climatic conditions slow the N-mineralization process prior to crop need.

Manure on Alfalfa

Alfalfa is a legume and therefore has no requirement for applied N. Alfalfa symbiotically fixes nitrogen from the atmosphere but will readily use any added nitrogen. Alfalfa has the ability to draw down nitrate levels within its extensive root zone. Surface applied manure to alfalfa without incorporation is vulnerable to surface runoff.

If manure is applied to alfalfa, be aware that the nitrogen will have an effect on weeds and grasses in the field. A well-fertilized field will benefit all plant species in the field, including weed germination and proliferation. Another indirect effect of applying manure to alfalfa fields is compaction of the soil and root crowns of alfalfa in the field. One of the most detrimental issues of manure applications to established alfalfa is the risk of leaf/stem burn from the salts and ammonia-N.

However, alfalfa offers opportunities for manure application throughout the year. In certain situations an alfalfa field may be a good choice, especially during the summer months. With proper management, applying manure to alfalfa can be beneficial. Forages like alfalfa have low erosion, low nutrient runoff and low nutrient leaching potential.

Applying manure to alfalfa as a pre-plant treatment will minimize the risk of plant tissue burning. Alfalfa has a high demand for phosphorus (P) and potassium (K). Applying manure pre-plant to alfalfa provides a good source of these nutrients. If the manure is surface applied, ensure a good seedbed by adequately incorporating the manure. In this scenario, the amount of nitrogen (N) applied will be used in the first couple of years of the stand and should not be an environmental issue on most soils. Alfalfa also benefits from the micronutrients in manure, particularly boron.

If manure must be applied to established alfalfa fields try to select older stands that have more grasses in them. The rate of manure should be reduced to limit the amount of nitrogen (N) being applied. The manure should be applied immediately after a cutting to reduce leaf burn and to lessen the damage to the crop by the wheel tracks. Solid manure applications should be spread evenly to avoid smothering the crowns with clumps of straw, bedding, etc. Finally, manure applications at the end of stand life can result in an excess supply of soil nitrogen (N) for the following crop which can potentially increase nitrogen (N) losses to water and the atmosphere.

Manure on Soybeans

Like alfalfa, soybeans produce their own nitrogen and an increase in soil nitrogen decreases the amount produced by the plant. However, by limiting the amount of manure applied and injecting or incorporating it well into the soil, farmers can improve both soybean growth and yield. The manure supplies both phosphorus (P) and potassium (K) which is beneficial to the soybean plant.

Avoid fields that have documented disease histories, as these fields may exhibit further disease incidence with manure applications. Select fields that have lower soil test P and K, to increase the basic economic value of the manure. For a good seedbed make sure the manure is evenly distributed. Limit the amount of manure applied to meet the amount of available nitrogen the soybean crop would remove on a per acre basis.

References and Additional Resources

- Manure Management and Air Quality at the University of Minnesota:
<http://www.extension.umn.edu/manure>
- University of Minnesota Nutrient Management <http://www.extension.umn.edu/nutrient-management>
- Nitrogen Availability from Liquid Swine and Dairy Manure: Results of On-Farm Trials in Minnesota. Univ. of MN-Extension Publication 08583
- <http://www.extension.umn.edu/agriculture/nutrient-management/nitrogen/nitrogen-availability-from-liquid-swine-and-dairy-manure>
- The Importance of Soil Organic Matter in Cropping Systems of the Northern Great Plains. L. Overstreet, NDSU, J. DeJong-Huges, UM
<http://www.extension.umn.edu/agriculture/tillage/importance-of-soil-organic-matter>

CHAPTER 3: MANURE, THE ENVIRONMENT, AND HUMAN HEALTH

Manure can cause real damage... when not managed properly.

Learning Objectives

After completing this chapter, you should be able to:

- Name three components of manure that can become environmental pollutants
- Describe two pathways improperly managed manure can pollute surface waters
- Explain an adverse ecological effect on a stream impacted by livestock manure
- Explain an adverse ecological effect on a lake impacted by livestock manure
- Explain a human health effect from surface water impacted by manure runoff
- Describe two pathways improperly managed manure can pollute groundwater
- Explain an adverse human health effect from groundwater impacted by manure runoff

Terms to Know

Biological oxygen demand (BOD): A measure of the oxygen required by aerobic microorganisms to decompose organic matter present in the water.

Pollutant load: The total quantity of a particular pollutant a water body receives from all sources, nonpoint runoff and point discharges.

Nonpoint source runoff pollution: Pollution caused by rainfall or snowmelt moving over and through the ground that picks up pollutants (e.g., nutrients, sediment, pesticides) and deposits them into lakes, rivers, wetlands, and groundwater.

Water quality standard: A numeric or narrative limit for physical or chemical parameters of water bodies; the technical and legal basis for maintaining or improving water quality. Developed for intended uses, i.e., swimming, public water supply, aquatic wildlife health.

Water quality impairment: A waterbody is impaired when levels of pollutants are in excess of water quality standards. Water quality impairments include bacteria, nutrients, sediment.

Eutrophication: The oversupply of nutrients to a waterbody, which induces excessive growth of plants and algae.

Dissolved oxygen: The amount of gaseous oxygen dissolved in water from aeration and photosynthesis from aquatic plants; used by aquatic animals.

Riparian area: The land area adjacent to lakes, rivers and streams.

Introduction

Manure is a valuable resource that provides essential nutrients and organic matter to cropland. If improperly applied, however, manure can become an environmental pollutant, and a human health risk. Significant environmental problems result when phosphorus, ammonium, and organic matter from manure enters streams, rivers and lakes. Human and animal health is threatened when the pathogens in manure leach into groundwater or runoff to surface water, and when nitrates leach into groundwater.

Plant and animal life in surface waters can be seriously damaged and fundamentally changed by the nutrients and pollutants associated with manure. Riparian and aquatic wildlife habitats are damaged or lost. Populations decline and species diversity is reduced. Enjoyment of, and economic activity from, recreational activities in Minnesota is also impacted. It can also render a highly nutritious food source –fresh fish—at risk for human consumption.

Manure as an Environmental Pollutant

Weed Growth and Algae Blooms

Lakes, rivers and streams are naturally very low in phosphorus. This naturally limits aquatic plant and algae growth. Surface water normally contains a low level of dissolved phosphorus. In waters where there is a low phosphorus concentration, any increase in phosphorus concentration will dramatically affect aquatic plant growth. For example, one extra pound of phosphorus in a lake can produce hundreds of pounds of weeds and algae.

In contrast, the human managed landscape is exceedingly rich in phosphorus. While phosphorus and nitrogen are naturally present and necessary for a properly functioning aquatic ecosystem, we have nutrients reaching surface waters in excess of what occurs naturally. The excess phosphorus --the once limiting nutrient-- carried in runoff to surface waters is what stimulates excess plant and algae growth. Phosphorus is the main reason lakes and rivers are green with algae and excessive aquatic plant growth.

Phosphorus in manure and fertilizers enters lakes and streams through runoff and soil erosion. Increased phosphorus levels in the soil results in increased phosphorus in runoff water. In addition, erosion carries fine particles of soil that are enriched with phosphorus to the surface water. Eroded soil particles with attached phosphorus can settle to lake bottoms and act as a future source of phosphorus for algae and aquatic plant growth. Manure can also enter surface waters directly when spread on frozen or snow covered ground.

Nonpoint source pollution is the major cause of algal blooms in Minnesota lakes.

In salt water systems nitrogen, not phosphorus is more commonly the key limiting nutrient. The Gulf of Mexico hypoxic (low oxygen) or “dead zone” is an alarming example of excessive nutrient-rich environments. Agricultural runoff from the Mississippi watershed is the largest contributor to the Gulf dead zone.



Accelerated Aging of Lakes and Streams

Nutrients in the water stimulate the growth of aquatic plants and algae. When the plants and algae die, they settle to the lake or stream bottom. This is a normal part of lake or stream ecology. Eutrophication is the term used to describe excessive nutrients in a lake or stream, frequently due to runoff pollution, which causes a dense growth of plant life and death of aquatic life from lack of oxygen. Eutrophication of surface water --the accelerated aging of lakes and streams-- in agricultural areas is primarily a consequence of phosphorus and organic matter runoff from cropland and farmyards.

Oxygen Depletion

When manure enters surface waters through runoff or direct discharge, the organic material in the manure is broken down by microorganisms that use the material as a food source. As these microorganisms grow and reproduce exponentially, their use of oxygen reduces the dissolved oxygen content of the water body. Aquatic plants also grow excessively in water because of the additional food source (excessive nutrients).

The oxygen reducing potential of manure or other wastewater is referred to as biochemical oxygen demand or BOD. Any increase in aquatic plant growth results in a reduced dissolved oxygen content of the water. Fish and other aquatic species suffocate from a lack of dissolved oxygen. Sport fish, such as walleye and bass, are especially vulnerable. "Rough" fish species, such as bullheads and Carp, can tolerate lower oxygen levels. When sport fish die from oxygen deficiency, "rough" species flourish, and the ecosystem of the lake changes. Many large fish kills are the result of a lack of oxygen in the water because of an excess organic matter. Manure entering surface waters is one source of excess organic matter.

The environmental effects of manure on surface water can be immediate and catastrophic. Oxygen levels drop to extremely low levels causing the destruction of fish and other aquatic animals. Most fish kills from manure in Minnesota have been due to the intentional dumping or piping of manure directly into ditches, streams, or rivers.

However, runoff from a manure application to cropland adjacent to surface waters, or to tiled fields that carry the manure directly into the nearest outlet in a ditch, stream or river can result in a fish kill. These effects may be gradual and incremental, as in the buildup of phosphorus in lake sediment from years of manure runoff. Recent research to better predict rain events is helping farmers to time manure application when the risk of rain is lowest.



Toxic Blue-Green Algae

Excess nutrients in surface water increase the likelihood of blue-green algae in Minnesota lakes. Shallow lakes, are particularly vulnerable to toxicity problems caused by blue-green algae. Humans exposed to blue-green algae may develop skin rashes, nausea, and upper respiratory symptoms. In high concentrations blue green algae can be toxic. Large blooms of blue-green algae are toxic to wildlife and domestic animals, with many reported deaths resulting from ingestion.

Ammonia Toxicity

Ammonia-contaminated runoff from manure application sites is toxic to fish and other aquatic life. At high enough levels, ammonia in surface water will kill large numbers of fish. Surface water impaired by manure may also experience changes in species due to ammonia toxicity. Careful attention to proper manure application methods, rates, timing, and locations can prevent water pollution, and protect you and your manure management business.

Manure as a Human Health Risk

Manure can also be the source of human illness and health risks as a source of pathogens, nitrates in drinking water and as a source of odors that can cause a nuisance and sickness.

Pathogens

Pathogens –disease-causing organisms— found in manure, such as bacteria, viruses, protozoa, fungi, rickettsiae, and helminthes, have the potential to transmit more than 32 diseases to humans and animals. Pathogens in manure are spread through leaching to groundwater, runoff to surface water, or through the air. Cryptosporidium, a protozoan found in manure and other sources, has been responsible for numerous illnesses throughout the United States. Contaminated runoff and direct discharge of manure through tile lines increase people’s exposure to these diseases through the accidental consumption of surface water during swimming and other water sports.

Certain wells are particularly susceptible to pathogens that have leached into groundwater. These include farm and municipal wells built before 1974, wells in the uppermost levels of karst geology, mainly in SE MN, shallow sand point wells, and wells in the Central Sand Plain area.

Nitrates in Drinking Water

Two potentially serious human health effects attributed to nitrates in drinking water are known to cause methemoglobinemia (“blue baby syndrome”) in human infants and warm-blooded animals. In human infants, the nitrate is ingested, usually in water used to mix formula, and converted to nitrite in the gastrointestinal system. The nitrite, in turn, interferes with the uptake and movement of oxygen throughout the body. The pale, bluish color of the infant’s skin is the result of oxygen deprivation.

Nitrates from manure (and fertilizer) can leach from application sites through tile lines and ditches to surface water and through the soil to the groundwater. Typically, more nitrogen applied to cropland results in more nitrogen in surface water and groundwater. Approximately seven percent of all private drinking water wells tested exceed the Minnesota Department of Health's drinking water standard for nitrate, which is 10 ppm. About 1.2 percent of community wells exceed this state standard. However, livestock manure is only one of several possible sources of nitrates in drinking water. Other sources include commercial fertilizer, wastewater treatment plants, septic systems, and natural sources.

Odors and Gases

Manure odors can be a nuisance for nearby neighbors and communities. Constant foul odors can degrade the quality of life for anyone subjected to them. In addition, some people seem to be more susceptible to health effects from foul odors. Odors are emitted from facilities throughout the year but are released at the highest rates during agitation and pumping of liquid manure systems or during clean out and hauling of solid manure systems.

In addition to odor, manure emits several gases during storage and application. Some manure gases, such as hydrogen sulfide, carbon dioxide, and ammonia, can cause nausea, vomiting, eye irritation, and headaches. At high concentrations, hydrogen sulfide, carbon dioxide, and methane (another manure gas) can cause death. These health effects are primarily a concern to those in the livestock or poultry buildings or on the farm site.

Manure gas concentrations are affected by the rate of gas emission and the local weather conditions. During most of the year, manure gases are emitted at fairly slow rates. However, any agitation or mixing of manure releases gases in quantities that can cause serious health problems to those in the near vicinity of the release. The relationship between manure gases and human health is dependent on the gases involved, and the frequency, duration, and concentration of these gases in the ambient air.

The Bottom Line of Pollution Prevention

Well managed manure has great value. Mismanagement of manure can cause serious environmental damage, and has the potential to result in significant economic and/or legal consequences for CAWT Site Managers, Companies and their customers. As a professional, the Site Manager's reputation and ability to provide value to their customers depends on understanding the potential environmental and health ramifications of manure management. The rules, laws, guidelines and recommendations covered in this manual are designed to protect one of our most precious shared natural resources: water. Pollution prevention is a key component of profitable, successful manure management in Minnesota.

References and Additional Resources

- New Water Quality Standards for River Eutrophication and Total Suspended Solids. MPCA. <http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/new-water-quality-standards-for-river-eutrophication-and-total-suspended-solids.html>
- Nitrates in Drinking Water. MN Department of Health <http://www.health.state.mn.us/divs/eh/hazardous/topics/sacntrate.html>
- Blue-green Algae and Harmful Algal Blooms. MPCA. <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/lakes/blue-green-algae-and-harmful-algal-blooms.html>
- MN Dept. of Natural Resources – Water. <http://www.dnr.state.mn.us/water/index.html>

CHAPTER 4: MANURE MANAGEMENT PLANNING

A plan not written down is not a plan.

Learning Objectives

After completing this chapter, you should be able to:

- Describe how CAWT Site Manager benefits from a client's manure management plan
- Explain why a manure management plan needs to be completed well before the cropping season
- Describe four main elements found in a manure management plan
- List three components of a manure management plan that prevent over-application of manure
- Explain the concept of a field or a farm in nutrient balance
- Explain when a nutrient management plan is required by law

Terms to Know

Manure management plan: An annually updated plan that details the methods, rates, locations and timing of manure applications to maximize agronomic and environmental benefits.

Manure nutrient supply: An inventory of a livestock operation's annual production of manure used to determine the total quantity of nutrients available for crop production.

Nutrient demand: The annual quantity of nutrients used for a single crop or for an entire crop rotation cycle. This number is used to determine if the long-term trends in soil nutrient test values are increasing, decreasing or in balance; especially phosphorus levels.

Animal Unit (au): A legal term that equals 1,000 pounds of livestock (live weight basis).

Examples: one 1,000 lb. steer is one au; a 1,200 lb. cow is 1.2 au; 200, 5 lb. chickens is one au.

Concentrated Animal Feeding Operation (CAFO): A legal term that defines livestock operations that confine animals for more than 45 days during the growing season, in an area that does not produce vegetation, and that is subject to regulations based on size (e.g., less than 300, 300 to 999, and more than 1,000 au).

Introduction

Nutrient management ensures that crops get the right source of nutrients at the right rate, time and place to match crop needs and minimize nutrient losses. A nutrient management plan accounts for all activities on the farm and individual fields that affect nutrient needs and losses. Nutrient management planning is based on soil type and slope, crop rotations and residual nutrients, and takes all sources of nutrients into account. Nutrient management requires current soil tests, record-keeping, annual crop management planning, and meeting state and federal standards.

Site Managers need to know how to make use of manure management plans, when available, and be able to develop their own when their customers do not provide one. Planning in advance of field operations –including gathering all the necessary information to determine specific



manure rates for each field— saves time during application operations. It also ensures that the nutrients in the manure are utilized profitably, which is a valuable customer service.

Efficient, profitable use of manure, making sure manure applications do not pollute the environment, impact human health or result in regulatory actions requires **planning**.

Manure Management Planning

Manure management planning includes the following:

- Estimates of annual manure production and manure to be spread seasonally
- Manure nutrient content analysis
- Maps/photographs of cropland where manure will be applied
- Maps/photographs of environmentally sensitive areas
- Estimates of nitrogen inputs from legumes and commercial fertilizer inputs
- Previous and planned locations, methods, and timing of manure applications
- Protective measures to minimize manure runoff, especially in environmentally sensitive areas
- Manure applied on each field in tons or gallons/acre
- Total N and P applied taking in to account all sources

A manure management plan should be reviewed and updated annually. A good manure management plan has records of all manure and soil tests; dates, methods, locations, and rates of manure and fertilizer application. Site Managers may want to keep copies of their customers' manure management plans in their records.

If the farmer does not have a manure management plan (MMP), knowing the correct manure application rates for each field in accordance with agronomic and environmental guidelines should be in place prior to field operations. It takes time and effort to gather the necessary information and perform the various calculations for a sound MMP. It is good practice to verify application rate recommendations that are outlined in the manure management plan or requested by the farmer. For fields on which you will be applying manure, double check the rates that have been calculated by others: It is up to the Site Manager to know what is being applied, where it is being applied, and how it is being applied. As a licensed Site Manager, you will be responsible for the proper application of manure.

Balancing Long-term Nutrient Supply and Demand

One part of a comprehensive manure management plan is the long-term balance of farm nutrients—a balance between the nutrients needed by the crops and those produced by the animals. It will be useful to you, as a commercial applicator of manure, to understand some of the general principles that determine this nutrient balance.

A nutrient balance for a farm will result in a recommendation for the number of acres of cropland needed to use the manure produced from the farm's animals. This nutrient balance can be based on nitrogen (N), phosphorus (P), and sometimes potassium (K). Typically, a nutrient



balance based on N will result in fewer acres needed for land application of manure. Applying manure based on N rates may also result in an oversupply of P and K.

Applying manure based on P will result in more acreage needed for land application. Fields where manure was applied at rates to meet P recommendations will generally require additional commercial N fertilizer at some point in the crop rotation. P-based application rates are preferred since this method results in the least amount of over-application of all nutrients. This method also typically results in the most efficient use of manure nutrients.

Manure Nutrient Supply

The manure nutrient supply is an inventory of all the livestock's excreted nutrients for a particular operation. This manure nutrient supply is determined by the volume of manure excreted, the nutrient concentration of that manure, and the nutrient losses from manure storage, and application.

The manure nutrients typically used for calculating nutrient supply are nitrogen (N), phosphorus (P), and sometimes potassium (K). If manure is applied to meet the nutrient demand for either N or P, the need for K will usually be met also. Concentrations of N, P, and K in the manure depend on animal species, animal age, diet, manure handling and storage methods and other factors.

This supply of nutrients from manure should be based on annual or semi-annual manure testing. Initially, manure nutrients can be estimated using standardized "book values" based on current research. Long-term records of farm-specific manure volumes and nutrient analysis of the manure will give the best indication of nutrient supply. Testing of manure nutrients is required in MN for all manure storages with manure from over 100 animal units (au).

Nutrient Demand

Nutrient demand looks at long-term nutrient use on a farm, accounting for entire crop rotations, including carry over from year to year, and nitrogen fixation by soybeans, alfalfa, and in some cases cover crops. The number of crop acres and the amount of nutrients used by the crop throughout the entire crop rotation determine nutrient demand.

Nutrient demand also depends on the type of crop, the crop yield, the soil type, and other factors. All growing crops need N, P, and K. However, legumes, such as alfalfa and soybeans, fix nitrogen for their own use through a symbiotic relationship with rhizobia bacteria that live in root nodules. This process can contribute a substantial amount of nitrogen to the soil for use by subsequent crops. As a Site Manager, you will usually only be involved in calculating the nutrient demand for individual fields for a specific year.

Manure Application on Farms with Manure Management Plans



For livestock facilities over 1,000 animal units or those facilities that are permitted, a manure management plan is required by the MPCA. Permitted sites include livestock operations with 100 or more animal units (au) with NPDES, SDS, Interim or Construction Short Form permits. Manure Management Plans (MMP) are also mandatory for operations over 300 animal units where manure is not applied by a certified applicator, or where otherwise required through a county ordinance. Manure application plans must be followed and should be reviewed prior to any manure applications.

A comprehensive MMP will indicate manure application rates and methods of application for each field, and document the location of areas requiring special consideration and the application practices required for those areas.

To avoid over-application of manure, verify the manure application rates, including such information as method of application, nitrogen availability, and planned crop. When the manure management plan cannot be followed, for example, when the preferred field is not accessible, the CAWT Manager or Applicator should work with the farmer to determine alternative fields and application rates.

In all cases, records should be kept on the type and source of manure, when and where the manure was applied, how much was applied, and how it was applied.

Manure Application on Farms without Manure Management Plans

Applying manure on a farm that does not have a manure management plan takes extra effort to ensure that application rates meet agronomic rates and that these Minn R. Chap. 7020.225.1.A “Feedlot Rule” requirements are met:

- Manure and process wastewater must not be applied to land in a manner that will result in a discharge to waters of the state during the application process
- Manure and process wastewater must not be applied to land in a manner that causes water pollution due to manure-contaminated runoff

Table 4.1: Manure management planning minimum requirements based on animal units (au):

Requirement	< 100 au	100 to 299 au	300 to 999 au	> 999 au
Develop and maintain a manure management plan:	No	If permit is required	Yes	Yes
Keep record of land application practices:	No	Yes	Yes	Yes

Summary of variables that can impact a Manure Management Plan:

- Soil type
- Soil pH, P and K levels
- Soil % organic matter
- Field slope
- Depth to bedrock
- Depth to groundwater
- Crops to be grown
- Crop nutrient demand level
- Previous crops / legume nitrogen credits
- Planned / previous manure applications
- Irrigation use
- Distance to rivers, lakes, streams
- Distance to tile outlets, other sensitive areas
- Use of cover crops
- % Crop residue
- Time of year / soil temperature
- Price of fertilizer
- Economic, business, and personal goals

References and Additional Resources

- Manure Management Plan: A Step-by-Step Guide for Minnesota Feedlot Operators. 2010. MPCA. <http://www.pca.state.mn.us/index.php/view-document.html?gid=3538>
- Feedlots: Nutrient and Manure Management. MPCA. <http://www.pca.state.mn.us/index.php/topics/feedlots/feedlot-nutrient-and-manure-management.html> MPCA County Feedlot Office Toolbox. <http://www.pca.state.mn.us/index.php/topics/feedlots/county-feedlot-program/county-feedlot-officer-toolbox.html>
- MN University Extension - Manure Management. <http://www.manure.umn.edu>
- MN University Extension - Nutrient Management. <http://www.extension.umn.edu/agriculture/nutrient-management>

CHAPTER 5: CALCULATING MANURE APPLICATION RATES

If you don't know how much you are applying, you are not managing manure.

Learning Objectives

After completing this chapter, you should be able to:

- Manure and Nutrient Application Rates
- List three steps used to calculate application rates
- Calculate manure application rates in tons/acre (solid) and gallons/acre (liquid)
- Determine the plant-available nitrogen content of applied manure in pounds/acre
- Determine phosphorus and potassium content of applied manure in pounds/acre
- Determine nitrogen recommendation for field crops

Manure Storage Capacity, Agitation and Sampling

- Use formulas and measurements to calculate the capacity of a manure storage facility
- Explain why it is important to thoroughly agitate liquid manure
- Explain how to take a representative sample of manure
- Describe the best times to collect liquid manure samples and why
- Explain how to take a representative sample of liquid manure
- Describe the importance of uniform manure applications

Manure Spreader/Tanker/Hose System Calibration

- Explain how to determine the tons/load of a solid manure spreader
- Calculate manure tanker capacity, given the applicable formulas and measurements
- Describe how to calibrate a solid manure spreader by determining the travel distance per load
- Describe how to calibrate a liquid manure tanker by determining the travel distance per load
- Calibrate a drag hose system by determining ground speed

Terms to Know

Crop nutrient requirement: The nitrogen, phosphorus, potassium and other nutrient recommendations for agronomic crop production.

Plant-available nitrogen: The nitrogen that is available to the crop in the growing season.

K₂O: Potassium in the form of potash, the fertilizer form of potassium.

P₂O₅: Phosphorus in the form of phosphate, the fertilizer form of phosphorus.

Legume credits: The nitrogen available to subsequent crops produced by legume N-fixation.

Manure credits: The nitrogen available to subsequent crops from manure applications.

Second year nutrient credits: The plant-available nitrogen credits from manure applied or legume crops from one seasons prior.

Freeboard: The upper portion of a manure storage structure designed to be reserved for emergency capacity and not normally occupied with manure.

Calibration: Determining the application rate in tons or gallons/acre of manure application equipment.

Solid Manure: Manure with at least 15% solids that can hold a 3:1 slope when stacked.

Liquid Manure: Manure with less than 15% solids that is handled (pumped) as a liquid.

Introduction

Each time manure is spread on a field an application rate must be determined in tons/acre or gallons/acre to identify the amount of crop available nutrients applied. Application rates are calculated using these basic steps:

1. Determine the N, P and K recommendations for the crop to be grown
2. Determine the nitrogen credits from previous legume crops and manure applications
3. Determine the plant-available nitrogen and phosphorus in the manure to be applied
4. Based on the above, determine manure application rates in tons or gallons per acre

Proper manure application means that the nutrients supplied by the manure meet, but do not exceed, the nutrient demands of the crop. The rate of manure application has traditionally been based on crop nitrogen needs for non-legumes and on crop nitrogen removal for legumes. Increasingly farmers are using phosphorus-based rates to limit the buildup of soil test phosphorus, especially near surface waters and fields with the potential for runoff and erosion. Phosphorus-based rates should be considered on many livestock operations for all fields, especially those with high phosphorus soil test levels. The potential for runoff pollution increases with increased soil test phosphorus levels.

Determine Manure Application Rates

All manure applications should be accurately determined, in either tons or gallons per acre, so that crop nutrient recommendations and environmental guidelines can be achieved with confidence. The following steps are used to determine rates of application:

Step 1: Establish Nutrient Needs of the Crop

The first step is to determine the recommended rate for N, P₂O₅, and K₂O on a per-acre basis. Start with current soil tests and follow recommendations from the University of Minnesota. Current N rate guidelines for corn are based on factors such as price of N, value of crop, and soil productivity potential (UM Extension bulletin 3790, Fertilizing Corn in Minnesota, 2006.)

Soil Testing

For land receiving manure, including farm operations with no livestock, from a facility with 300 or more animal units (au), soil samples from the upper six inches must be collected at least once every four years and analyzed for phosphorus.

The farm/livestock operation owner must submit a manure management plan, if manure is to be applied where: soil phosphorus levels exceed 75 ppm (Bray P1) or 60 ppm (Olsen) in a special protection area or within 300 feet of an open tile intake, or; soil phosphorus levels exceed 150 ppm (Bray P1) or 120 ppm (Olsen) outside of special protection areas.

For complete information on soil testing, contact the **Soil Testing Laboratory at the University of Minnesota**:

135 Crops Research Bldg.
1902 Dudley Ave.
St. Paul, MN 55108

Tel: 612 625-3101
Email: soiltest@umn.edu
URL: <http://soiltest.cfans.umn.edu>

Soil nitrate testing may also be beneficial for determining manure application rate. The University of Minnesota Extension recommends fall soil nitrate testing in Minnesota counties and recommends a spring pre-plant soil nitrate test for south central, east-central and southeastern Minnesota where residual nitrogen may accumulate (e.g. manured corn or soybean ground in a medium or fine-textured soil).

The table below shows the nitrogen application ranges for various scenarios. In general, the N application rate for manure or commercial fertilizer needed to maximize net income decreases as fertilizer prices increase and/or corn prices decrease. When fertilizer prices are high or corn prices are low, profitable N rates are lower.

Table 5.1 Nitrogen Rate Guidelines for Corn When Using Manure

	Highly Productive Soils	Medium Productive Soils
Corn on Corn	130 – 180 lb. N/acre	130 lb. N/acre
Corn after Soybean	100 – 140 lb. N/acre	100 lb. N/acre

Source: Manure Management in Minnesota. Hernandez and Schmitt. 2012. University of Minnesota Extension. (WW-03553)

For previous crops other than corn or soybeans, use the corn following corn rate guideline and subtract any previous crop N credits. Soil and environmental conditions that limit crop production such as erosion, poor soil drainage, restriction to root growth, short growing season, and marginal growing season rainfall, among others, would be considered medium productivity potential. Do not exceed the high end of the recommended range because significant N losses can occur at higher rates, which can result in surface and groundwater contamination.

For complete details on N fertilization for corn:

Fertilizing Corn in Minnesota: <http://www.extension.umn.edu/agriculture/nutrient-management/fertilizer-management/fertilizing-corn-in-minnesota/>

N-Rate Calculator: <http://extension.agron.iastate.edu/soilfertility/nrate.aspx>

This web site provides a calculator to determine the maximum return to nitrogen (MRTN) at selected prices of N-fertilizer and corn directly from recent research data.

Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn (PDF):

<http://www.extension.iastate.edu/Publications/PM2015.pdf>

This publication explains the rationale and research behind the N-rate calculator (above).

Alfalfa Nitrogen Credits

Alfalfa can provide a significant amount of N to subsequent crops in rotation and can replace the purchased N fertilizer. In most cases additional nitrogen in any form (e.g., manure, fertilizer) is not needed on first year corn or small grains after alfalfa. This means reduced fertilizer cost and reduced fossil fuel consumption to produce the fertilizer. Reduced N credits occur with less stand density because of less herbage, root, and crown yield. The following recommendations are for alfalfa harvested by early September with an average amount of fall regrowth.

Table 5.2 Nitrogen Credits for Common Previous Crops

	Nitrogen Credit	
	1 st Year	2 nd Year
	----- lb. N / acre -----	
Small Grains	40	0
Harvested Alfalfa		
Plants / ft ²		
≥ 4	150	75
2 - 3	100	50
≤ 1	40	0
Red Clover	75	35
Edible beans	20	0
Field peas	20	0

Source: Kaiser, Lamb, and Eliason. 2011. University of Minnesota Extension BU-06240-S.

Step 2: Determine Nutrient Content of Manure

The total nutrient concentration of the manure must be determined, regardless of its form (liquid or solid) or livestock type. A manure analysis is the most accurate way to determine nutrient content of manure. Following good manure sampling procedures is a key to getting a representative sample and having confidence in the resulting analysis. See the **Sampling Solid Manure** and **Sampling Liquid Manure** sections on how to collect samples for analysis. A less accurate way to determine manure nutrient concentration is to use a table value:

Table 5.3: Estimated nutrient concentration of liquid and solid manure

Livestock Type		Liquid Manures --- lb./1,000 gallons ---			Solid Manures ----- lb./Ton -----		
		N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Swine	Farrow	15	12	11	14	6	4
	Nursery	25	19	22	13	8	4
	Gestation	25	25	24	9	7	5
	Finish	58	44	40	16	9	5
Dairy	Cows	31	15	19	10	3	6
	Heifers	32	14	28	10	3	7
Beef	Cows	20	16	24	7	4	7
	Finishing Cattle	29	18	26	11	7	11
Poultry	Broilers	63	40	29	46	53	36
	Layers	57	52	33	34	51	26
	Tom Turkeys	53	40	29	40	50	30
	Hen Turkeys	60	38	32	40	50	30

Source: Manure Management in Minnesota. Hernandez and Schmitt. 2012. University of Minnesota Extension. (WW-03553)

Manure Nutrient Testing Requirements (MN 7020.2225 Subp. 2)

Manure storages from facilities with over 100 animal units (AU) must be tested by the facility owner for nitrogen and phosphorus. Only individual storages with manure from facilities with more than 100 AU must be tested.

Testing is not required for each small stockpile generated by less than 100 AU.

If annual testing of manure has not been conducted in the past, feedlot facility owners (with 300 or more AU) must initially test the manure annually for the first three years and subsequently at least once every four years.

Additional testing is required when manure nutrient content is expected to change due to significant changes in precipitation, manure storage and handling, livestock, or livestock feed.

Step 3: Determine Nutrient Availability to the Crop

Total nutrient concentration for nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) will need to be adjusted to the amounts that will be available for the upcoming growing season. For N, use Table 2 to calculate the percentage of total N that will be available for the first crop year. For P₂O₅, use 80% as the availability factor, and for K₂O, use 90%.

Table 5.4: Manure-N availability and loss as affected by method of application and animal species

Animal Species and Year of Application <i>Third-year available N is not listed but can be computed by adding Year 1 and Year 2 and lost percentages and subtracting this sum from 100</i>		Time between Surface Application and incorporation			Injection	
		None	Within 4 days	Within 12 hours	Sweep	Knife
		----- % Total N -----				
BEEF	Year 1	25	45	60	60	50
	Year 2	25	25	25	25	25
Lost to N volatilization and denitrification		40	20	5	5	10
DAIRY	Year 1	20	40	55	55	50
	Year 2	25	25	25	25	25
Lost to N volatilization and denitrification		40	20	10	5	10
SWINE	Year 1	35	55	75	80	70
	Year 2	15	15	15	15	15
Lost to volatilization and denitrification		50	30	10	5	15
POULTRY	Year 1	45	55	70	NA	NA
	Year 2	25	25	25	NA	NA
Lost to N volatilization and denitrification		30	20	5	NA	NA

Source: Manure Management in Minnesota. Hernandez and Schmitt. 2012. University of Minnesota Extension. (WW-03553)

Example:

You **surface apply but do not incorporate** 10,000 gallons of swine manure from a farrowing barn. Farrowing manure has **15, 12 and 11 lb. of N, P₂O₅ and K₂O** per 1,000 gallons. 10,000 gallons would equal **150, 120 and 110 lb. of N, P₂O₅ and K₂O** respectively. Nutrient content multiplied by the 35%, 80% and 90% availability values nets **53 lb. N, 96 lb. P₂O₅ and 99 lb. K₂O** per 10,000 gallons. **Incorporating within 12 hours would increase the N availability to 75% or 113 lb. N.**

Step 4: Calculate Application Rate

In the last step, knowing what is needed and what should be available for the growing crop makes it possible to calculate nutrient application rates. Divide the total nutrient amount needed by the crop from (Step 1) by the amount of available nutrients lb per ton or lb per 1,000 gallons (Step 2), and this will provide the number of tons or thousand gallons per acre required for each nutrient.

Selecting manure rates for each field will depend on nutrient management and environmental stewardship goals. If the highest rate is selected, which is normally based on crop N needs, over-application of P_2O_5 and K_2O will take place. While building soil test P and K has some benefits, it can also have negative environmental consequences if continued over years. One strategy is to reduce the frequency that manure is applied on any one field, so that crops in the rotation will use the excess soil-P and K. If there is a deficit between what the manure application supplies and what the crop needs in nutrients, supplemental fertilizer will be needed to make up the difference.

For Phosphorus-based Manure Management Plans:

Step 5: Calculate the Amount of P Applied that will be used by Subsequent Crops

When calculating manure application rates based on nitrogen, phosphorus will usually be applied in excess of the crop recommendation. Phosphorus buildup near surface waters and pathways to surface waters is an environmental concern. For such areas, manure regulations may limit applications of manure until the phosphorus levels have been used by subsequent crops. You will need current soil tests for P levels, consider the potential P losses, and account for the total amount of phosphorus applied in a multi-year rotation. The amount of phosphorus applied that can be used by subsequent crops can be estimated in three steps:

1. Determine the amount of phosphorus applied by multiplying the rate of manure application by the available P_2O_5 content of the manure
2. Determine the P_2O_5 removal by the planned crop (<http://plants.usda.gov/npk/main>)
3. Subtract the P_2O_5 removed from the lb. of P_2O_5 applied. This will give you an estimate of phosphorus available for subsequent crops

Table 5.5: Rate of Manure Application Worksheet

	N (lb./acre)	P₂O₅ (lb./acre)	K₂O (lb./acre)
Step 1. Nutrient needs of the crop Use soil tests and University of Minnesota recommendations			
Step 2. Determine manure nutrient content (lb./ton or lb./1,000 gal.)			
Step 3. Determine available nutrients from manure (lb./ton or lb./1,000 gal.)	See Table 5.4	80%	90%
Multiply the values from Step 2 by the availability factors from Table 2:			
Step 4. Calculate the rates of application needed for each nutrient			
Divide the values from Step 1, amount of nutrient needed, by values from Step 3, the available nutrients per ton or thousand gallons:			
Selected Rate: _____ <input type="checkbox"/> t			
Determine amount of available nutrients being applied by multiplying the selected rate of application times the available nutrients (Step 3). This can be compared to crop needs (Step 1) to show where deficits and excesses occur:			
Any deficit is the amount of supplemental fertilizer that the crop will need:			

Source: Manure Management in Minnesota. Hernandez and Schmitt. 2012. University of Minnesota Extension. (WW-03553)

Estimating Manure Storage Volume

Manure volume and manure application rates determine how many acres of cropland will be needed to use all the manure from a particular storage. This information should be known before any application of manure and for estimating costs plus time to complete the job. The volume of manure in a storage structure can be estimated from previous farm records, noting how much manure has been hauled in the past, or from the design volume of the manure storage. If this information is not available, the volume of manure can be calculated using the dimensions of the manure storage.

Square or Rectangular Tanks

For square or rectangular tanks, the volume (v) can be calculated by knowing the length (l) and width (w) of the structure and the height (h) of the manure in the structure (all dimensions in feet). For square storages the volume is calculated as follows:

$$\text{Volume in gallons (v)} = \text{Length (l)} \times \text{Width (w)} \times \text{Height (h)} \times 7.48$$

Note: 7.48 is a conversion factor of gallons of manure per cubic foot, it is often not possible to get all manure out; height should be adjusted accordingly.

Example: a swine finishing barn has a pit dimension of 40 feet by 200 feet and the manure is at a height of 5.5 feet. The volume of manure is calculated as follows:

$$40' \times 200' \times 5.5' \times 7.48 = 329,120 \text{ gallons of manure}$$

Circular Tanks

The volume of circular tanks (v) can be calculated by knowing the diameter of the tank (d) and the height of the manure (h) (all dimensions are in feet):

$$\text{Volume (v) in gallons} = \text{Diameter (d)} \times \text{Diameter (d)} \times \text{Height (h)} \times 5.87$$

Note: 5.87 is a conversion factor.

Example: a circular tank has a diameter of 50 feet and a manure depth (height) of 12 feet. The volume of manure is calculated as follows:

$$50 \times 50 \times 12 \times 5.87 = 176,100 \text{ gallons}$$

Earthen Basins

The volume of an earthen storage basin is more difficult to calculate accurately because the volume is dependent on the length, width, and depth of the manure, but also on the sidewall slope. The volume of earthen storages can be estimated by multiplying the average length and width by the depth (of the pit or manure) multiplied by 7.48 to get gallons. Average length is the halfway point between the longest (top) and shortest (bottom) measurements.

Volume in cubic feet \approx Average length x Average Width x Depth (pit or manure) x 7.48

Note: 7.48 is a conversion factor of gallons of manure per cubic foot

Agitating Liquid Manure

Stored liquid manure separates into layers of solids and liquids. Agitation or mixing the manure breaks up crust, brings solids that have settled to the bottom into suspension, and distributes the nutrients uniformly throughout the manure. Agitation is the key for utilizing the nutrients in liquid manure. Liquid manure should be agitated before it is pumped out and hauled to the field for application and should continue throughout the pump-out process. Agitation is not necessary for dewatering of lagoons.

The movement of the manure through a drag hose system keeps the nutrients in suspension, while tank systems need augers or air jets inside the storage tank to maintain a uniform nutrient concentration. Agitation “boats”, floating self-propelled pumping platforms, are sometimes needed on the largest lagoons to achieve complete mixing.

Nutrient content of the manure can vary from year to year and season to season. Therefore, **proper sampling and testing of manure to measure nutrient content is the best way to determine manure application rates.** Obtaining a representative sample is critical. Manure rates based on measured nutrient content will avoid over and under application, both potentially costly outcomes.

Sampling Solid Manure

To obtain a representative sample of solid manure it is best to sample from loaded spreaders rather than from the actual manure pack. Taking several samples minimizes potential variability. With good representative sampling and no significant change in herd management, consistent results, even for solid manure, are possible.

One method of mixing a composite sample is to pile the manure and then shovel from the outside to the inside of the pile until well mixed. Fill a one-gallon plastic heavy-duty zip lock bag approximately one-half full with the composite sample, squeeze out excess air, close and seal. If you are unable to deliver to the lab immediately, then store the sample in a freezer.

Sampling while loading: Recommended method if you must sample from a stack or bedded pack. Take at least five samples while loading several spreader loads and combine to form one composite sample. Thoroughly mix the composite sample and place approximately a one-pound subsample in a one-gallon plastic bag. **Sampling directly from a stack or bedded pack is not recommended.**

Sampling during spreading: Spread a tarp in field and catch the manure from one pass. Sample from several locations and create a composite sample. Thoroughly mix composite sample together and take a one-pound subsample using a one-gallon plastic bag.

Sampling daily haul: Place a five-gallon pail under the barn cleaner 4 - 5 times while loading a spreader. Thoroughly mix the composite sample together and take a one-pound subsample using a one-gallon plastic bag. Repeat sampling 2- 3 times over a period of time and test separately to determine variability.

Sampling poultry in-house: Collect 8 - 10 samples from throughout the house to the depth the litter will be removed. Samples near feeders and waterers may not represent the entire house. Subsamples need to be proportionate to their space occupied in the whole house. Mix the samples well in a five-gallon pail and take a one-pound subsample; place it in a one-gallon zip lock bag.

Sampling stockpiled poultry litter: Take 10 sub-samples from different locations around the pile at least 18 inches below the surface. Mix in a 5-gallon pail and place a one-pound composite sample in a gallon zip lock bag.

For all solid manure samples:

- **Using a waterproof marker, label the container with the farm name, date, sample time and location**
 - Label the containers before filling with manure!
- **Record the sample ID information**
- **Put the mixed samples in clean, leak-proof, wide-mouthed plastic jars or bags**
 - Most laboratories will provide containers and postpaid mailing packages.
- **Fill no more than two-thirds to three-quarters full, leaving space for gas expansion**
 - Seal the containers tightly and put them in another leak-proof plastic bag
- **Freeze the labeled sample overnight, if possible**
- **Do not allow samples to sit in the sun or at room temperature for more than 12 hours**
- **Mail samples to the laboratory early in the week, avoiding weekends and holidays**

Include the laboratory's required paperwork and payment for the analysis

Sampling Liquid Manure

Proper agitation is needed to obtain a representative sample of a liquid manure storage facility. If manure is sampled from a lagoon that was not properly agitated, typically the nitrogen and potassium will be more concentrated in the top liquid, while the phosphorus will be more concentrated in the bottom solids. Each manure storage structure should be sampled separately since the nutrient content of manure will most likely vary from one part of the operation to another.

Manure samples should be taken throughout the pump-out process since initial agitation does not always provide uniform distribution of nutrients. Three or more samples should be taken and sent to the laboratory for analysis; one from the first third of manure being pumped, one from the middle third of manure being pumped, and one from the last third of manure being pumped. Samples taken in this manner will also provide information about the adequacy of the initial agitation process. A significant increase in nutrient concentration from the beginning to the end of pump-out indicates the initial agitation process was inadequate. For larger storage structures, a sample should be collected for every 300,000 gallons pumped.

For best results, manure should be sampled as close as possible to application. This will ensure that samples are well-mixed and representative of the manure being applied. Because manure nutrient analysis typically takes several days at a lab, **sampling at the time of application will not provide immediate manure nutrient recommendations**. These values may not be useful in determining application rates for the year they are taken but will be beneficial for calculating application rates in the future years.

Sampling liquid manure from storage — Agitate storage facility thoroughly before sampling. Collect at least five samples from the storage facility or during loading using a five-gallon pail. Place a subsample of the composite sample in a one-quart plastic container.

Sampling liquid manure during application — Place buckets around field to catch manure from spreader or irrigation equipment. Combine and mix samples into one composite subsample in a one-quart plastic container.

It is important to develop a manure sampling history and use those analyses in a nutrient management plan. Take manure samples annually for three years for new facilities, followed with samples every three to five years, unless animal management practices, feed rations, or manure handling and storage methods change drastically from present methods. NPDES or SDS permitted sites are required to sample manure every year. Obtain a composite sample following one of the procedures listed below and mix thoroughly.

For all liquid manure samples:

- **Each sample should consist of several smaller samples mixed together**
- **Take samples from the filling hose or from a bottom unloading port and mix them together in a bucket**
- **Take the sample for analysis from the bucket**
 - Make sure the bucket is stirred as the sample is taken as nutrients settle out rapidly
 - Do not use a galvanized bucket
- **Using a waterproof maker, label the container with the farm name, date, sample time and location**
 - label the containers before filling with manure!
- **Record the sample ID information**
- **Put one to two cup of the mixed samples in clean, leak-proof, wide-mouthed plastic jars**
 - Most laboratories will provide containers and postpaid mailing packages
- **Fill jars no more than two-thirds to three-quarters full, leaving space for gas expansion**
 - Seal the containers tightly and put them in leak-proof plastic bags
- **Freeze the labeled sample overnight, if possible**
- **Do not allow samples to sit in the sun or at room temperature for more than 12 hours**
- **Mail samples to the laboratory early in the week, avoiding weekends and holidays**
 - Include the laboratory's required paperwork and payment for the analysis

The most important thing is to get a representative sample. For more information on manure sampling see these publications:

- **Recommended Methods of Manure Analysis (A3769).** 2003. Peters et. al. University of WI. <http://learningstore.uwex.edu/assets/pdfs/A3769.PDF>
- **How to Sample Manure for Analysis.** Iowa State University, University Extension (PM 1558) 2003. <https://store.extension.iastate.edu/Product/pm1558-pdf>

Certified Manure Testing Laboratories

The following laboratories are certified for manure testing by the Minnesota Department of Agriculture. For more information, call 651-201-6642. The most up-to-date list can be found at:

<http://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp>

Calibrating Application Equipment

The success of your business depends on your ability to apply manure nutrients at accurate rates. After agitation and manure sampling, equipment calibration is the next important step toward creating customer confidence in your nutrient application rate.

Calibrating and operating manure application equipment to deliver accurate and consistent application rates is an essential service of CAWTs.

Calibrating a Solid Manure Spreader

The advertised capacity of solid manure spreaders is often listed in cubic feet. This is not a useful measurement. You need to calculate your actual tons per load so you can determine tons per acre that are actually being applied. You need to determine your typical load weights for each spreader and manure type. One method is to use portable weigh pads or a local stationary scale using the following steps:

1. Weigh the spreader empty - all weight bearing wheels must be weighed, including rear tractor wheels
2. Weigh several loads and calculate the average loaded weight
3. Subtract the empty weight from the loaded weight to get manure load weight
4. Divide the manure load weight in pounds by 2,000 lb./ton to get tons per load
5. Spread evenly and keep track of loads spread on each field to determine loads per acre
6. Multiply loads per acre by tons per load to get tons per acre

Calibrating a Liquid Manure Spreader

Newer tanks systems will automatically calculate the application rates using flow meters and the speed of the application equipment. Calibration can also be done using the volume of the tank and measuring the distance or time taken to empty the tank. Tank volume may be reported as “loaded capacity” by the manufacturer or as maximum capacity. The loaded capacity is approximately 85% of the maximum capacity due to foaming, not loaded on a level surface, and spillage during transport if filled to the top. Tank volume can also be calculated using either the weight of manure hauled in the tank or the dimensions of the tank.

Determining Tank Volume Using Weight

The steps to determine the volume using the weight measurements are as follows:

1. Weigh the tank empty - all wheels bearing the weight must be weighed, including tractor wheels
2. Weigh the tanker several times with full loads and calculate the average loaded weight
3. Subtract the empty weight from the averaged loaded weight
4. Convert the weight to volume by multiplying by 0.12

Example: empty tank weighs 6,000 lb and the average loaded weight is 38,000 lb. Volume in gallons: $(38,000 \text{ lb.} - 6,000 \text{ lb.}) \times 0.12 = 3,840$ gallons

Determining Tank Volume Using Tank Dimensions

If you cannot use weight scales to determine the loaded capacity of your tanker, you can use one of the following formulas where loaded capacity is approximately 85% of the maximum capacity.

The formula for determining the loaded volume of a circular tank is:

$$\text{Volume (gallons)} = \text{Length} \times \text{Diameter} \times \text{Diameter (in feet)} \times 5.1$$

Note: 5.87 is a conversion factor.

For a non-circular tank use:

$$\text{Volume (gallons)} = \text{Length} \times A \times B \times 5.1$$

Note: A and B are the width and height of the tanker (in ft.)

Example: The volume of a tank 4 feet high, 5 feet wide and 10 feet long is calculated as follows: $4' \times 5' \times 10' \times 5.1 = 1,020$ gal.

Determining Travel Distance to Unload the Tank

Once the tank volume, desired application rate, and the applicator width are known, you can calibrate tankers for the application. Use the following steps below to determine the speed of application. The example below uses the following information:

- Loaded tank volume = 3,800 gallons
- Desired application rate = 6,000 gallons per acre
- Applicator width (with overlap) = 16 feet

Calculation steps:

1. Enter tank volume (in gallons)
2. Enter desired application rate (in gallons per acre)
3. Enter application width (in feet)
4. Divide the tank volume by the application rate and by the application width. Then multiply by 43,560 (sq. ft./acre) to determine the distance covered in feet per tank in feet (Step 1 ÷ Step 2 ÷ Step 3 x 43,560).
5. Divide the distance covered per load by 5,280 to determine the distance covered per tank in miles (Step 4 ÷ 5280)
6. Divide the application rate by the tank volume to determine the number of tank loads needed per acre (Step 2 ÷ Step 1)

Calibrating a Drag Hose System

To determine ground speed during application (and, thereby calibrate your drag hose system), you need to know the desired application rate, the manure flow rate in gallons per minute, and the width of the applicator. Use the following steps to determine proper ground speed:

1. Enter flow rate (in gallons per minute)
2. Enter desired application rate (in gallons per acre)
3. Enter the application width (in feet), including overlap
4. Determine the travel speed to achieve the desired application rate by dividing the flow rate by the application rate, then dividing by the applicator width, and multiplying by 495 (Step 1 ÷ Step 2 ÷ Step 3 x 495)

Uniform Manure Application

For manure to serve as an efficient nutrient source for crops, application across the field must be uniform, from side-to-side across the swath, and from the first load to the last load.

Uniformity across the swath is related to the type of application method and implement used. Operator skill is a major factor in uniform application.

Solid Manure

Solid manure spreaders are either rear or side discharge. Uniformity can vary from side to side or in the case of side discharge, at the far end of the spread pattern. As with liquid manure spreaders it will be advantageous to overlap the outside edges to ensure uniform application rates. Spreaders also vary in the ability to maintain a uniform rate from the beginning of the load to the end. Beginning each load over the tail end of the previous load will likewise ensure a more uniform application.

Liquid Manure

Traditional tank wagons with single-point applicators often do not distribute manure uniformly. The application rate is nearly always greater nearer the discharge point than it is toward the outside edges of the swath. Adjusting the travel paths so the edges overlap provides more uniformity. Some tankers may apply manure at a greater rate along the outside edges of a swath than near the discharge point; with these spreaders, uniformity is best with no overlap. Single-point applicators can be inexpensive to operate but have hidden costs of odor and loss of nitrogen.

Measuring Equipment Uniformity

Surface application uniformity can be measured by collecting the manure as it is applied, in pans or pails for liquid manures or plastic sheets for solid manures. To measure uniformity when injecting manure, place collecting pans or pails across the width of the application swath in line with the injectors, position the application equipment in front of or behind the pans, and raise the injectors. Begin pumping the manure and then back up or drive forward so the manure is pumped into the collection pans. Starting to pump before “injecting” into the collection pans ensures that manure flow is well established in each injector before the test of uniformity begins. If the volume of manure in each collection pan is the same, your injection equipment is applying at a uniform rate. If the volumes are drastically different, you need to inspect and adjust the equipment.

References and Additional Resources

- Soil Testing Laboratory, University of Minnesota, Room 135 Crops Research Building, 1902 Dudley Ave., St Paul, MN 55108. Phone: 612 625-3101. FAX: 612 624-3420. Email: soiltest@umn.edu. Web: <http://soiltest.cfans.umn.edu>
- U of MN Nutrient Management: <http://www.extension.umn.edu/agriculture/nutrient-management>
- U of MN Manure Management and Air Quality: <http://www.manure.umn.edu>
- Best Management Practices for Nitrogen Use in Minnesota (08560): <http://www.extension.umn.edu/agriculture/nutrient-management/nitrogen/docs/08560-generalMN.pdf>
- Fertilizing Corn in Minnesota. 2006. (FO-3790-C) U of MN: <http://www.extension.umn.edu/agriculture/nutrient-management/nutrient-lime-guidelines/docs/corn-fertilization-2006.pdf>
- MPCA Feedlots — Nutrient and Manure Management: <http://www.pca.state.mn.us/index.php/topics/feedlots/feedlot-nutrient-and-manure-management.html>
- Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn <http://www.extension.iastate.edu/Publications/PM2015.pdf>
- Corn Nitrogen Rate Calculator: <http://extension.agron.iastate.edu/soilfertility/nrate.aspx>

CHAPTER 6: MANURE APPLICATION GUIDELINES and PRACTICES

Obtaining full value from manure: It all comes down to this.

Learning Objectives

After completing this chapter, you should be able to:

- Identify an **advantage** and a **disadvantage** for each application method:
 - surface/broadcast, incorporation, injection
- Describe four environmental conditions of special concern during manure applications
- Describe the phosphorus application limits for environmentally sensitive areas
- Explain the rationale for phosphorus application limits for environmentally sensitive areas
- Explain some of the pros and cons of early spring manure applications
- Explain some of the pros and cons of late fall manure applications
- Explain why a Site Manager should monitor the local weather forecast
- Identify three ways to control odor when handling manure

Terms to Know

Incorporated manure: Manure buried under the soil surface with tillage equipment within 4 days of application.

Injected manure: Liquid manure that is injected directly below the soil surface as it is applied.

Soil compaction: Soils with increased density and with less pore space, typically as a result of heavy equipment, particularly on wet soils.

Nitrification inhibitor: Compounds (e.g., Instinct™) added to manure (and certain N fertilizers) that slow down the conversion of more stable ammonium-N to leachable nitrate-N in the soil.

Sensitive area setback requirements: Defined in state law (MN Ch. 7020); the minimum application setbacks from lakes, streams, wetlands, open tile intakes, drainage ditches, wells and certain other land features where it is illegal to apply manure and where manure rates, application method and timing restriction apply.

Shallow soils: Soils 10-20 inches deep over bedrock.

Sloped soils: Soil with greater than 6% slope.

Coarse soils: Sands, Loamy sands.

Stockpiling: Storing solid manure on the ground or on a constructed, impermeable surface.

Manure Application

Surface Applied Manure

Surface applied manure that is not covered with soil is considered unincorporated. The more time elapsed between application and incorporation increases volatilization, leaching and runoff of valuable nutrients, which increases the risk of runoff pollution. Obviously, manure applied to frozen ground, hay fields, pastures or no-till systems cannot be incorporated. Unincorporated manure is at greatest risk to become runoff pollution during rain or snow melt events. Therefore, unincorporated manure should be applied to the most level fields available and with the proper setbacks from environmentally sensitive areas. Application to frozen or snow covered ground should be avoided, if at all possible.

Incorporation of Manure

Incorporation is covering surface applied manure with soil in the top four inches. Implements to incorporate manure include s-tine cultivators, concave disks, and other shallow tillage tools. Staggered s-tine cultivators provide the most uniform nutrient distribution. Shallow incorporation requires less power than injection and operates at faster ground speeds. Both s-tine and disk incorporation promote beneficial mineralization of organic nitrogen by mixing the manure uniformly in the soil.

Manure should be incorporated as soon as possible after application, preferably within 12 hours, to reduce volatilization losses and the potential for runoff losses, especially from heavy rains events in the spring and fall when manure is most likely applied.

Manure Injection

Injection is the placement of manure at least four inches beneath the surface of the soil. Spring-loaded injectors are mounted across a toolbar attached to the rear of tankers, or on a tractor with drag hose systems. The injector points are usually chisels, knives, horizontal sweeps, or disks. Injection of liquid manure provides good uniformity, and horizontal sweeps provide the most uniform distribution.

Both injection and incorporation substantially reduce surface runoff, odor, transport of pathogens, and nitrogen loss through volatilization. Potential disadvantages of injection and incorporation include distributor plugging, increased power needs, and decreased residue cover. Because these application methods conserve more nutrients, more acres may be needed to spread the same amount of manure. To further reduce manure runoff, injection and surface incorporation of manure should be performed on the contour to further reduce manure runoff.

Minimum Regulatory Requirements for Manure Application

The practices outlined below are required by Minnesota Rules Chapter 7020. Additional application practices may be required by local units of government. In all cases, manure must be applied in a manner that **does not pollute surface or groundwater**. The following minimum requirements are taken from MPCA publication "**Land Application of Manure: Minimum State Requirements**" (wq-f8-11, February 2011).

Manure (and process wastewater) application rates must be limited so that the estimated plant-available nitrogen from all nitrogen sources does not exceed crop nitrogen requirements, phosphorus needs for non-legume crops and expected nitrogen removal for legumes. Consider all nitrogen sources when calculating nitrogen rates:

- Manure applied for current and previous year
- Legumes grown in the last two seasons
- Soil organic matter
- Commercial fertilizer nitrogen
- Irrigation water
- Biosolids, process wastewater

Determinations of crop nitrogen needs, removal rates, and the amount of nitrogen available from manure or legumes are to be based on published recommendations of the University of Minnesota Extension or another land grant college in a contiguous state (ND, SD, IA, WI), with the following exceptions: 1) Estimated plant-available nitrogen from organic nitrogen sources, including manure, may deviate up to 20% from University of Minnesota recommendations when management history, soil conditions or cool weather warrant additional nitrogen application; 2) When crop nitrogen deficiencies are visible or measured, nitrogen applications above the 20% deviation can be made.

Table 6.1: Summary of Manure Application Requirements in Minnesota.

Required for farms with:	less than 100 AU	100 to 299 AU	300 to 999 AU	more than 999 AU
Manage manure to prevent water pollution:	Yes	Yes	Yes	Yes
Follow nutrient rate limits:	Yes	Yes	Yes	Yes
Maintain setbacks from sensitive areas/features:	Yes	Yes	Yes	Yes
Test manure for nitrogen and phosphorus content:	No	Yes	Yes	Yes
Test soils for phosphorus:	No	No	Yes	Yes
Develop and maintain a manure management plan:	No	If permit is required	If permit is required or is applied by non-CAWT	Yes
Keep land application records:	No	Yes	Yes	Yes

Table 6.2: Summary of nutrient application rate requirements for manure

Nitrogen (N)	<ul style="list-style-type: none"> • Cannot exceed crop N needs for non-legumes • Cannot exceed crop N removal for legumes
Phosphorus (P)	<ul style="list-style-type: none"> • No long-term soil P build-up near waters • Manure management plan with P management strategy required if applying to extremely high P soils and facility is over 300 AU
Potassium (K)	<ul style="list-style-type: none"> • No restrictions in rule

Manure Management in Environmentally Sensitive Areas

Land application of manure on or near certain soil types, landscapes, geological features, or man-made conveyances has a greater potential of polluting the surface or ground water.

Open Tile Intakes

Liquid manure and process wastewater must be injected or immediately incorporated when applied within 300 feet of an open tile intake. Solid manure must be immediately incorporated when applied within 300 feet of an open tile intake. (*Alternative MPCA-approved protective measures can be implemented if they are shown through research to provide an equal degree of water quality protection as injection or incorporation.*)

Also: Do not apply manure within **50 feet of a sinkhole**. Inject or immediately incorporate when applying manure from **50 to 300 feet on the upslope side of a sinkhole**. Do not apply within 50 feet of a **mine, well or quarry**.

Special Protection Areas

Special Protection Areas are defined areas (see Minn. R. ch. 7020.2225 Subpart 6; Land Application of Manure: <http://www.revisor.leg.state.mn.us/rules/?id=7020.2225>) and require additional manure management. These areas include land within 300 feet of:

- Protected waters and protected wetlands identified on Department of Natural Resources protected waters and wetlands maps and typically include all streams, lakes and wetlands over 10 acres (See http://www.dnr.state.mn.us/waters/watermgmt_section/pwi/maps.html)
- Intermittent streams and ditches identified on USGS quadrangle maps, excluding drainage ditches with berms that protect from runoff into the ditch and segments of intermittent streams which are grassed waterways. USGS quadrangle maps can be found at County Soil and Water Conservation District Offices or: <http://www.usgs.gov/pubprod/maps.html>

The requirements for manure application in Special Protection Areas depend on whether or not there is a permanent vegetated buffer along the water or waterway, in accordance with the following:

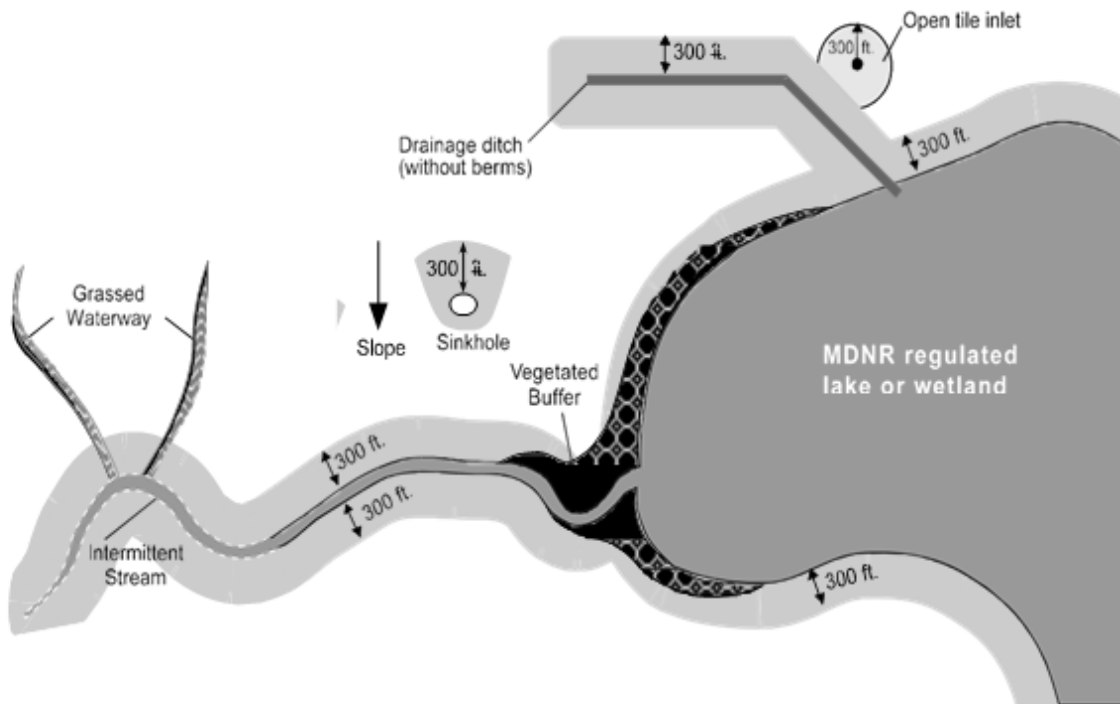


Fig. 6.1: Manure Application near Environmentally Sensitive Features (Source: MPCA)

For Land without a Perennial Vegetative Buffer in Special Protection Areas:

- Manure application within 25 feet of the water or watercourse is prohibited;
- Manure applied between 25 and 300 feet of the water or watercourse must be incorporated immediately (within 24 hours of application and prior to rainfall);
- The rate and frequency of manure application must be at a level that will not allow phosphorus to build up over any six year period if the soil already exceeds the crop needs for phosphorus. Single year application rates can be based on nitrogen needs. If manure is applied at nitrogen-based rates to Special Protection Area soils with phosphorus test levels exceeding 21 ppm Bray P1 or 16 ppm Olsen, then no additional manure applications shall occur until the phosphorus supplied by the manure has been removed by the subsequent crops.
- No application onto land in special protection areas when the soil is frozen or snow-covered.
- No application of manure by a traveling gun, center pivot, or other similar irrigation equipment.

For Land with Perennial Vegetative Buffer in Special Protection Areas:

- Minimum buffer widths:
 - 100 feet for lakes and streams
 - 50 feet for wetlands, intermittent streams, and unbermed drainage ditches
- No manure applications onto the buffers
- No application onto land in special protection areas when the soil is frozen or snow-covered.
- No application of manure by a traveling gun, center pivot, or other similar irrigation equipment

Table 6.3: Minimum manure application setbacks (in feet) near sensitive features.

	Winter Frozen or snow-covered soils	Non-Winter Incorporation w/in 24 hours		Non-Winter NOT incorporated within 24 hours	
		With P management	No P management	Vegetated buffer	Inadequate vegetated buffer
Lake, stream	300'	25'	300'	100'	300'
*Intermittent stream; DNR protected wetland; drainage ditch w/out berm	300'	25'	300'	50'	300'
Open tile intake	300'	0	0	300'	300'
Well, mine or quarry	50'	50'	50'	50'	50'
Sinkhole; no diversion berm	Downslope 50' Upslope 300'	50'	50'	Downslope 50' Upslope 300'	Downslope 50' Upslope 300'

** Intermittent streams and ditches are identified on United States Geological Survey (USGS) quadrangle maps, excluding drainage ditches with berms that protect from runoff into the ditch and segments of intermittent streams which are grassed waterways. Wetland setbacks pertain to all protected wetlands identified on DNR protected waters and wetlands maps, also available from County Soil and Water Conservation District (SWCD) offices.*

Surface Waters

A 300-foot setback from surface waters applies to all manure spread onto frozen or snow-covered soils. The non-winter setbacks for manure application in special protection areas (within 300 feet of lakes, streams, intermittent streams, public waters wetlands and unbermed drainage ditches) depend on application methods, vegetated buffer widths, and phosphorus management practices as follows:

- Non-winter setbacks can be reduced from 300 feet to 25 feet, if the manure is immediately incorporated and the rate and frequency of manure application will not result in long-term soil phosphorus build-up (e.g. over any six-year period) on soils with phosphorus test levels exceeding 21 ppm Bray P1 or 16 ppm Olsen. Crop removal rates of phosphorus can be used as a guide for limiting phosphorus rates until subsequent soil testing results are available to determine if phosphorus build-up is occurring.
- Non-winter setbacks can also be reduced along waters where permanent vegetative buffers are established. Where vegetated buffers are at least 100 feet wide along lakes and streams and 50 feet wide along wetlands, intermittent streams, and unbermed drainage ditches, the setbacks can be reduced to 100 and 50 feet, respectively.
- The surface water setback for manure applied by a traveling gun or other irrigation equipment is 300 feet.

MPCA feedlot rules also allow for alternatives to the above practices. To be approved, the alternative practices must be demonstrated through research by the University of Minnesota or another Land Grant College to provide at least as much protection as the measures above.

Phosphorus Management

Minn. R. ch. 7020.2225 requires that phosphorus management practices be implemented where:

- Manure from any size feedlot is applied in Special Protection Areas to soils that have phosphorus test levels exceeding 21 ppm Bray P1 or 16 ppm Olsen, and no permanent vegetated buffers exist along the protected water. In these areas, re-applications of manure must not occur until phosphorus from the most recent application is removed by subsequent crops as based on soil test results or crop phosphorus removal tables; or
- Manure from feedlots with over 300 animal units is applied outside of special protection areas to soils with phosphorus levels exceeding 150 ppm Bray P1 or 120 ppm Olsen, or half of these levels inside Special Protection Areas and within 300 feet of open tile intakes. Before repeated manure applications occur in such areas, an interim permit application and manure management plan must be submitted to the MPCA or delegated county, describing how phosphorus is to be managed to minimize losses to surface waters.

More information on Phosphorus management and manure application in Sensitive Areas can be found in the MPCA/NRCS fact sheet entitled "**Applying Manure in Sensitive Areas**" <http://www.pca.state.mn.us/index.php/view-document.html?gid=3530>.

Timing of Manure Application

Timing of manure application is important when conditions have the potential to create an environmental problem. Ideally liquid manure should be applied after the threat of spring runoff has diminished and prior to the period of maximum crop uptake. During this period, the manure has the least amount of time for nutrient loss. In practice, however, these restrictions may be impractical because of the large volumes of manure that your customers will likely need to have applied within this short time. Spring application also presents the added problems of the need for extra labor and machinery to meet all of your customers' needs.

Weather presents the most significant problem for spring manure application. Application during wet spring weather can lead to soil compacting, especially for manure applied with tank systems. When soil is compacted, the density of the soil is increased and the pore space in the soil is decreased. Compacted soil has the potential to decrease crop yield. Fine-textured soil, with large amounts of silt or clay, is more susceptible to compaction than is coarse, sandy soil. High clay content in the soil, heavy axle-weight loads, and high moisture content all contribute to soil compaction. Large tankers or tank wagons also run the risk of getting stuck in wet soil.

To minimize the risk of compacted soil, apply manure when the soil moisture content is low. Using a drag hose system reduces the risk of soil compaction since the equipment in the field weighs less. Due to time constraints, your customers may prefer manure applications during late summer or early fall. Fields are often less prone to soil compaction in late summer or early fall than in the early spring.

However, manure incorporation in late summer or early fall allows nitrogen in the form of nitrates to be lost through leaching, especially in warm (above 50°), moist soils. Surface application increases the potential for nitrogen runoff to surface waters. During late summer and early fall, apply manure only to those fields that have a low potential for runoff and erosion, and that are not subject to spring flooding.

After spring, late fall is the next best time to apply liquid manure, for the following reasons:

- Nitrogen conversion is slower than in the spring, summer, or early fall because the soil is colder
- Precipitation is usually less
- Drier soil is less susceptible to compaction
- Farmers and applicators have more time than in the spring

The use of a **nitrification inhibitor** (e.g., Instinct™) added to manure slows down the conversion of ammonium-N to nitrate-N in the soil. In certain situations this decreases the loss of water soluble forms of N thus increasing the N available to subsequent crops. **NOTE: Nitrification inhibitors are classified as restricted use pesticides and require a Commercial Pesticide Applicator license to apply for hire.**

Manure application when the ground is frozen or covered with snow leaves manure nutrients and bacteria on the surface. Most of the available, inorganic nitrogen will be lost. Subsequent snow or spring rains carry phosphorus and pathogens across the soil surface to lakes and streams. If you must apply manure during the winter, apply to fields with little or no slope and that are at least 300' from surface waters.

This is the least advisable time to apply. If manure must be applied to frozen or snow covered fields then apply as early in the winter as possible. Avoid late February and March. Do not apply manure when active snowmelt is occurring or when there is a probability of more than 0.25 inches of rain forecasted. At a minimum, to help prevent runoff, apply at lower rates not to exceed 3,500 gallons per acre and do not exceed 60 lb. of crop available P₂O₅ per acre.

Stockpiling of Manure

Stockpiling of manure is a common method of storing solid manure (defined as having at least a 15% solids content or able to hold a 3-1 ratio when stacked). CAWT Applicators may haul from or create stockpiles as part of their work. According to MN 7020 ("the Feedlot Rule"): Manure may not be stockpiled for more than one year, and, the same stockpile site cannot be used from year to year.

Short-term stockpiles cannot be located within:

- 300' of flow distance and at least 50' horizontal distance to surface water, sinkholes, rock outcroppings, open tile intakes, and any uncultivated wetlands which are not seeded to annual farm crops or crop rotations involving perennial grasses or forages.
- 300' of flow distance to any road ditch that flows to the features identified in bullet above or 50' of any road ditch where bullet above does not apply.
- 100' of any private water supply or unused-unsealed well and 200' from any private well with less than 50' of watertight casing and that is not cased through a confining layer at least 10' thick.
- 100' from field drain tile that is 3' or less from the soil surface.

Stockpiles are also prohibited:

- On land with greater than 6% slope.
- On land with slopes between 2% and 6%, except where clean-water diversions and erosion-control practices are installed.
- On soils where the soil texture to a depth of 5' is coarser than a sandy loam as identified in the most recent USDA/NRCS Soil Survey Manual or based on a site-specific soils investigation. This provision impacts only special cases where a field may sit on a potential gravel resource or an old river bed.
- All of the accumulated manure is required to be removed from the site at least once per year and spread on cropland at agronomic rates.
- A vegetative cover must then be established on the site for at least one full growing season before the site can have manure stockpiled on it again. Exceptions to establishing a vegetative cover is made for cattle at open lots with 100 animal units or less and where the stockpile is land-applied in fewer than 10 days. The latter exception is only allowed six times per year.

Source: MPCA publication **Manure Stockpiling Technical Guidelines**.

Recordkeeping: Short-Term Stockpile Sites

The feedlot owner which produced the manure must keep records on file for three years for each manure stockpile site. MPCA staff or the county feedlot officer may review them by request. The records must include information on: Location of each stockpile; Date it was piled; Volume of manure in the stockpile; Nitrogen and phosphorus content of the manure, and; Date when the stockpile was land-applied.

Recordkeeping: Permanent Stockpile Sites

Manure stockpiled for more than one year must be stored on a pad. The owner may need to install a liquid manure storage area to collect the runoff if necessary to prevent manure-contaminated runoff from discharging to surface and groundwater. The owner must apply for a construction permit (short form) if the manure results from 300 to 999 animal units or, apply for a NPDES/SDS permit for manure from 1,000 or more animal units.

Managing Odor from Field Application

Surface application of liquid manure produces strong odors and may result in **complaints** from neighbors. Incorporation or injection of manure will significantly reduce odors. Incorporation and injection will also reduce nitrogen losses due to volatilization and runoff. Odor emissions during surface application can be reduced by using a low-trajectory system. Applying manure on dry windy days or on sunny clear mornings will also help disperse odors. Avoid applying manure on calm humid days, weekends and holidays, and when the wind direction is toward neighbors or populated areas. It may also be beneficial to **talk to the neighbors before applying manure**, giving them the opportunity to close windows, move the laundry off the clotheslines, etc., and, to schedule around any outdoor events they may be planning, i.e., weddings, cookouts, etc.

Manure Odor and the Law During Pumping and Application

The owner of an animal feedlot is exempt from the state ambient air quality standards during the removal of manure from barns or manure storage facilities and for seven days after manure is removed from barns or manure storage facilities. For a livestock production facility having greater than 300 animal units, the maximum cumulative exemption in a calendar year is 21 days for the removal process; **MN Rules, Chapter 7020.2002 Ambient Air Quality Standard Applicability**. The operator of a livestock production facility that claims exemption from the state ambient air quality standards shall notify the commissioner or county feedlot pollution control officer. Notification must include: the names of the owners or the legal name of the facility, the location of the facility by county, township, section, and quarter section, the facility's permit number, if applicable, and the anticipated start date and the anticipated number of days of removal of manure from barns or manure storage facilities.

Maintaining Bio-security

Farmers are concerned about manure haulers spreading plant or livestock diseases from one farm to another. As part of your customer service, it's important to ensure that any equipment that comes in contact with livestock manure is thoroughly cleaned between each farm. Cleaning should include removing sediment, spray washing and disinfecting equipment, and flushing vacuum pumps and other parts of your tank or drag hose system.

Ask your customers what precautions they would like you to take. For example, areas designated as “off limits” to applicators or washing your equipment both before and after working at the operation. The bottom line is respect—for the site, for your customers' concerns, and for the community.

Additional Considerations for Manure Application

Minnesota roads

Under Minnesota Rules, Chapter 7020, tank wagons, tankers and other vehicles that haul manure on county, state or interstate highways, or through municipalities, must be leak-proof.

Crossing ditches and streams with hose systems

Placing drag or supply hoses across ditches and streams creates the potential for direct release of manure to surface waters. It is important to prevent such a spill and outline an emergency response plan should a spill take place. Precautionary measures include: monitoring for hose leaks, ensuring that hose joints are not laid in the ditch or stream, or double sleeving the hose. Applicators must have the capability to shut off the hose quickly either with radio-controlled pumps or radio contact with the pump operator.

Floodplains

Do not apply manure on soil that is subject to frequent flooding (floods every other year or more frequently). With soil that is subject to rare or occasional flooding, inject liquid manure when the likelihood of flooding is low. When applying manure on hay or pasture on floodplains, use an injection tool that minimizes disturbance to the soil cover.



A Summary of Manure Application Practices

The practices listed below are all discussed elsewhere in this chapter, but this list provides a handy reference and reminder of their importance:

- Maintain equipment in good working order
- Calibrate manure application equipment
- Time applications for full nutrient benefit
- Apply manure uniformly
- Incorporate manure within 24 hours
- Injection of manure is preferable
- Inject on the contour of sloped ground
- Avoid spreading on sloped ground
- Avoid spreading on frozen/snow covered soil
- Avoid field operations that compact soil
- Take steps to prevent runoff
- Take steps to minimize odors
- Flush tank and drag hoses between jobs
- Prepare an emergency spill response plan

The image shows a 'Field Manure Application Record' form. It is a detailed record-keeping sheet for manure application. The form includes sections for:

- Operator information: County, Company, Name, State Manager, and Applicator Name.
- Location: County, Municipality, and Address.
- Application details: Date, Time, and whether it's a first or second application.
- Field characteristics: Field ID, Acres, and Manure Applied.
- Application method: Spreading or Injection, and whether it's a first or second application.
- Weather conditions: Wind, Rain, and Temperature.
- Application rate: Gallons per acre and total gallons applied.
- Manure source: Name and Address.
- Additional notes: A space for any other information.

 The form is designed to be filled out in the field to document manure applications accurately.

Appendix C Field Manure Application Record Template can be used to document manure applications. It can also be used as a training tool so Applicators in the field will know what they are expected to keep track of and why it is necessary.

References and Additional Resources

- U of M University Extension - Manure Management. <http://www.manure.umn.edu>
- U of M University Extension - Nutrient Management
<http://www.extension.umn.edu/agriculture/nutrient-management>
- MN Pollution Control Agency (MPCA) publication: Land Application of Manure: Minimum State Requirements (wq-f8-11) February 2011.
<http://www.pca.state.mn.us/index.php/view-document.html?gid=3532>
- MN Pollution Control Agency (MPCA) publication: Applying Manure in Sensitive Areas - State requirements and recommended practices to protect water quality. May 2005.
<http://www.pca.state.mn.us/index.php/view-document.html?gid=3530>
- MPCA publication Manure Stockpiling Technical Guidelines describes the definitions, environmental impacts and requirements of stockpiling manure. May 2008.
<http://www.pca.state.mn.us/index.php/view-document.html?gid=3545>

CHAPTER 7: SAFETY

Safety is everyone's business.

Learning Objectives

After completing this chapter, you should be able to:

- Describe the fundamentals of proper equipment operation to prevent injuries
- Describe a special precaution to take with power take-off equipment
- List two precautions to avoid injuries when working with hydraulic equipment
- List four safeguards to prevent accidents when operating manure handling equipment in the field
- Describe the steps to prevent injuries from electrical equipment
- Explain why the long hours associated with manure application present a safety hazard
- List the medical emergency supplies and information to be kept in the cab of tankers or trucks
- Define “confined space”
- Recognize three hazards associated with lagoons, ponds, and uncovered below-ground tanks
- Describe the safety hazards of gases in confined manure storage areas
- Explain why the absence of “rotten egg” odor should not be used to determine manure pit safety
- List four precautions when agitating or pumping manure in a manure storage

Terms to Know

Standard Operating Procedure (SOP): Specific procedures that are always followed to prevent accidents and injuries.

Aboveground manure storage: A freestanding manure storage tank on top of the land surface separated by distance from livestock confinement buildings; may be covered.

In-ground manure storage: Manure storage built into the ground separated from livestock confinement buildings; may be covered.

Manure pit: Manure storage built underneath a livestock confinement building.

Confined space: A space large enough for a person to enter with limited means of entry and exit and not designed for continuous human occupancy; may be covered or open.

Guard (or shield): Engineered safety device to prevent injury, dismemberment or death by preventing limbs and clothing from becoming entangled in moving parts.

Hazard: Anything that can cause harm to people, equipment, property or the environment.

Hydraulic equipment: Motors or cylinders on equipment powered or operated by high pressure fluid transmitted through hoses or tubes.

Introduction

Accidents happen, often as a result of human error, poor maintenance, or other predictable behaviors and conditions. Metal, concrete, wood, and earthen structures can fail. Hoses, pipes and tanks rupture and leak. Valves stick open. Tankers or trucks tip over. Humans make mistakes. Many accidents can be prevented however, by taking proper precautions. Site Managers need to do their best to make sure everyone on site is following safe operating procedures at all times. People working in agriculture are exposed to numerous hazards that threaten their safety and health. Handling manure offers its own unique hazards. It is in your best interest to protect yourself and other employees from these hazards.

Poisoning, Suffocation, and Explosions from Gases in Manure Storage

Manure gases are a serious safety hazard. The gases, hydrogen sulfide, carbon dioxide, methane, and ammonia, are produced as microorganisms digest and ferment manure. They can collect and create three potential safety hazards in confined spaces of manure pits, and in the below-ground and aboveground storage tanks: **Toxic or poisonous reactions, oxygen depletion resulting in suffocation and/or asphyxiation, and, explosions.**

A manure pit should be treated as a confined space. They have limited means of exit and are subject to both the accumulation of toxic or flammable contaminants and to an oxygen-deficient atmosphere. These dangerous conditions may only exist intermittently, leading workers to feel safe about entering manure pits.

Fatalities associated with enclosed manure storage areas are usually by asphyxiation following suffocation. They frequently involve more than one victim because would-be rescuers enter the enclosure without proper safety equipment and procedures and become victims themselves. Be alert for the following three particularly lethal manure-gas situations:

- When entering an enclosed manure area
- When the ventilation system in an enclosed manure storage area is not working properly
- When manure is being agitated (large quantities of gas are released during agitation)

Hydrogen Sulfide (H₂S) - At low concentrations, this highly toxic gas has a rotten-egg odor. At higher concentrations it can paralyze the sense of smell, and you may not notice its presence, giving you a false sense of security. Hydrogen sulfide is heavier than air and settles near the bottom of confined spaces. It is a severe eye irritant and may cause tissue damage. At low concentrations, it causes dizziness, headache, nausea, and irritation of the respiratory tract. At high concentrations, it can cause unconsciousness, respiratory failure, and death within minutes. Hydrogen sulfide may be explosive at a wide range of concentrations (4.3 – 46%).

Methane (CH₄) - This odorless, flammable gas is also explosive at concentrations of 5-15%. At higher concentrations it displaces oxygen and causes death by suffocation. Methane is lighter than air and accumulates near the top of enclosed manure areas. Because it's odorless, you will not be able to smell its presence; therefore, always assume it is present in an enclosed manure area.

Carbon Dioxide (CO₂) - This manure gas is odorless, heavier than air, and settles near the bottom of manure pits. At low concentrations, it produces labored breathing, drowsiness, and headache. At high concentrations, carbon dioxide replaces oxygen and causes death by suffocation.

Ammonia (NH₄) - Ammonia has a sharp, penetrating, unmistakable odor. It is corrosive and can severely irritate the eyes, nose, throat, and lungs. It can be fatal at high concentrations.

Table 7.1: General Hazards of Manure Gases

Manure Gas	Low Concentrations	Higher Concentrations
Hydrogen Sulfide (H ₂ S)	Rotten-egg odor; dizziness, headache, nausea, respiratory tract irritation; explosive at concentrations from 4.3 to 46.0%	Sense of smell paralyzed, will not detect odor, unconsciousness, respiratory failure, death within minutes.
Methane (CH ₄)	Explosive at concentrations from 5 to 15%	Displaces oxygen and causes death by suffocation and asphyxiation.
Carbon Dioxide (CO ₂)	Labored breathing, drowsiness, and headache.	Replaces oxygen, death by suffocation and asphyxiation.
Ammonia (NH ₄ ⁺)	Sharp, penetrating odor; corrosive; can irritate eyes, nose, throat, lungs.	Can be fatal.

Even in an environment with sub-lethal concentrations of hydrogen sulfide, carbon dioxide, and methane, **death can still result from low oxygen levels.**

Precautions when Agitating and Pumping Liquid Manure

To protect yourself, your employees, and others, observe the following precautions when agitating or pumping manure in a pit or tank:

- **Do not enter manure pits during agitation and pumping**
- **All entrances to manure pits and tanks should be posted with warning or hazard signs**
 - Including all entryways into building where manure is being agitated/pumped
 - Buildings connected by hallways should be treated as if they are being agitated/pumped
- **Any enclosed manure area should have an operating ventilation system**
 - Make sure it is operating correctly and there is an alarm in the case of power failure
 - Be prepared to provide backup ventilation
- **Do not smoke, weld, or use an open flame near a pit or tank where methane might accumulate**
- **Keep manure agitators below the manure surface; vigorous agitation releases greater volumes of gas**

It is highly recommended to have safety equipment on hand, such as first-aid kits and floatation devices. Make sure there is another person available to get help, especially when agitating manure. Keep all children and bystanders well away from pits and tanks during agitation and pumping.

Never enter a confined manure storage area without the proper equipment and proper training.

Entering a Confined Manure Storage Area

If it is absolutely necessary to enter an enclosed manure storage area or tanker, observe the following safeguards. They will minimize, but not eliminate, the risks:

1. **Test the oxygen level with an approved meter before entering to make sure adequate oxygen is available and hydrogen sulfide concentrations are safe** (less than 10 ppm).
2. **Provide additional forced ventilation**
 - a. Use a blower with an extendable hose or duct to blow clean air into the space
3. **Monitor conditions while working as conditions can change rapidly**
 - a. Oxygen will be consumed while working in the manure storage area
 - b. Additional agitation can increase the toxic gas levels
4. **A worker in a confined space/manure storage area should wear a body harness with a safety line**
 - a. The safety line should be held by enough people and/or a winch to rescue the worker
5. **If oxygen levels are not safe or gases are present at toxic levels, use a supplied air respirator**
 - a. The person using a respirator should be trained on the use of the mask
 - b. It is important that the mask form a tight seal around the face
 - c. Respirators (e.g., dust masks, chemical cartridges) do not protect against low oxygen or toxic gases
6. **Provide a clear escape path. Don't block the path with tools or objects**
 - a. Make it as easy as possible for workers to exit the manure storage area quickly
7. **Keep fire away. Methane gas is a byproduct of manure degradation, and it is flammable**
 - a. Keep fire and other ignition sources, such as electrical tools, away from the manure storage area.
 - b. Test the methane level with an explosion meter
8. **Know first aid. Someone on the site should be trained in CPR and first-aid measures**

The MN Department of Labor; Occupational Safety and Health, covers entry into confined spaces. Call (651) 284-5050 or 1-877-470-6742 for legal requirements and additional information.

Rescues from Confined Manure Storage Areas

Be prepared to rescue someone that is stranded in a manure pit or tank. Prepare a rescue plan before the need arises with your employer/employee. Make sure the proper rescue equipment is available on-site and know how to use it properly. Here are the basic steps:

1. **Call 911 immediately**
2. **Resolve all details of your rescue plan before entering**
3. **Never attempt to rescue someone without assistance**
4. **Never enter a confined manure storage area to rescue someone unless you have the proper training, respiratory protection, clothing and boots**
5. **Administer 100% oxygen when the victim is clear of the confined space**

Manure that remains in a pipeline or hose for a few hours will generate gases, and the pipelines and hoses—and people near them—will be subject to the hazards associated with those gases. Manure gas production will be the greatest between 24 and 48 hours after the manure has collected in the pipeline or hose, but can continue for up to four weeks.

Drowning, Falls, and Other Hazards of Liquid Manure Storage Areas

Lagoons, ponds, uncovered below-ground tanks and other outdoor and open manure storage areas present numerous hazards, including **drowning**, **falling through the crust** of manure on top of the storage, and **slipping**, with your tractors and other equipment, into the storage. The farmer should have these areas fenced and posted with hazard warnings to prevent children, other people and animals from entering them. Walkways on storage piers or walls need railings.

Below-ground storage tanks are a drowning hazard. Openings into these tanks should be protected with grills, covers, or fences and posted with hazard warnings. Drowning and falls are hazards of aboveground tanks. Attached exterior ladders should be locked or attached high enough to prevent unauthorized access. Never leave a portable ladder leaning against an aboveground storage tank. Protect yourself and your staff by noting the presence of these dangers when you begin each new site.

Injuries from Agricultural Equipment

Agricultural equipment, such as manure spreaders, pumps, conveyors, and tractors, is one of the leading causes of farm injuries. This equipment can be dangerous if improperly operated. General guidelines for proper operation include:

- **Be thoroughly familiar with each piece of equipment**
 - inspect frequently, servicing or replacing as necessary
 - keep all guards and shields in place on all rotating components
 - read and follow instruction manuals
 - familiarize yourself with the safety features for the equipment.
- **Only the operator** (and a person being trained, space provided) **should ride in equipment**
- **Always stop the engine and wait for the machinery to come to a complete stop before making adjustments, clean, unclog or service equipment**
- **Allow air-brake systems to reach operating pressure before driving**
- **Keep everyone clear of equipment before starting and while operating**
- **Wear protective clothing** (i.e., rubber gloves, protective eyewear) **for emergency repairs in the field**
- **Ensure all employees receive thorough, documented training on proper equipment operation**

Thoroughly wash or rinse equipment at the end of the season. Inspect all equipment for cracks and defects. Before applying manure, make sure all valves are working properly, and replace any damaged or worn out parts, including hoses.

During application, check pressure gauges frequently and never operate pumps at speeds or pressures above those recommended by the manufacturer. Inspect all hose couplings for safe, secure connections before pressurizing and be sure all pressure is released before uncoupling hose sections.

After applying manure, clean the pumps and strainers and flush the tank or drag hose system with water, inside and out. Store hoses out of the sun to slow their deterioration. Replace deteriorated equipment. Properly secure hoses before running a “pig” through for cleaning.

Power take off and rotating shaft equipment: PTO and rotating shaft equipment must be operated with great care. Disengage the PTO and turn off the engine before servicing machinery. PTO and rotating shaft equipment call for special precautions. Ensure that the PTO shaft—including knuckles, mesh or nip points on the power-driven gears, belts, chains, sheaves, pulleys, sprockets, idlers, or other components—are guarded or shielded. Replace missing guards. Stay clear of rotating shafts. Avoid wearing loose-fitting clothing and jewelry, and tie back long hair securely.

Hydraulic systems: Hydraulic systems operate under extreme pressure. Hydraulic fluids and equipment components may reach high temperatures and can penetrate the skin, and cause severe burns, eye injuries, and skin irritation. Do not open pressurized hydraulic lines. Stay clear of leaking hydraulic lines. Use a piece of cardboard or wood, not your hands, to look for leaks in a hydraulic line.

Accidents with Vehicles: Rollovers and run-overs are the leading causes of tractor fatalities. Precautions that apply both on public roads and in the field include the following:

- **Slow-moving vehicles on public roads must have the appropriate reflectors, lights, and flashers**
- **Highway motor vehicles can only be operated by those with valid drivers' licenses**
- **Do not permit others to ride, unless there is a seat specifically equipped for passengers**
- **If a seat belt is available, use it**
- **Operate the vehicle smoothly, with no quick turns, starts or stops**
 - realize the amount of weight being pulled
- **When stopped, set the brake securely and use parking gear if available**
- **No texting should be allowed while driving the tractor or vehicle;**
- **Be familiar with the vehicle's proper operating procedure**
- **Be familiar with the vehicle's capacity and clearances**
- **Do not allow windshields or windows to be obstructed**
- **Do not allow the driver's view to be obstructed by people or by objects.**
- **Regularly inspect and service wheel bearings**
 - Harsh field conditions and being submerged in manure can cause premature bearing failure
 - Wheel loss at transport speeds is very dangerous!
- **Always consider what other traffic on the road may or may not do as you approach**

Precautions for Tractors, Trucks, or Tankers while in the Field:

- **Inspect hitches, hoses, couplings, wheels, brakes, safety chains, lights, signals daily**
- **Only hitch implements and equipment to recommended drawbar and hitch points**
- **Reduce speed when turning, crossing slopes and on rough, slick or muddy surfaces**
- **Stay off steep slopes, and stay clear of ditches, embankments and holes**
- **Do not overload trucks and tanks**
 - tankers above 2,500 gallon capacity should have independent braking systems
- **Watch where you are going**
 - especially at row ends, on roads, and around trees

Other Hazards: Electrical Equipment, Sleep Deprivation, Noise, Fire, Disease

Injuries from Electrical Equipment

- Potentially fatal injuries are possible from contact with electrical powered pumps, etc., or from adjacent power lines. Always look up! Be aware of overhead and underground lines, especially when moving metal pipelines and boom equipment. To prevent electrical injuries and death from electrocution:
- Ensure all electric motors, fixtures, and wiring near the jobsite are in good condition
- Make sure all electric motors are properly grounded
- Make sure that all electrically powered tools and equipment are properly wired
 - double insulated and/or equipped with Ground Fault Circuit Interrupters (GFCI)
- Disconnect the power source before attempting to check or repair electrical equipment
- Lock-out and tag-out electrical equipment on which work is being done
 - know and use the practices and procedures to disable electrical equipment to prevent electric shock
- Make sure all electrical installations are done according to the National Electrical Code
 - consult a certified electrician for more information

If someone is exposed to an electric shock: Turn off the power and use an insulated implement, such as a piece of wood or other non-conductive material, to separate the victim from the source of electricity.

Sleep Deprivation

Sleep deprivation is a common but frequently unrecognized and ignored safety hazard associated with the work of commercial manure application, and farming in general. It is a direct result of long hours caused by short windows of opportunity to apply manure on fields. Extended work shifts may be more stressful physically, mentally, and emotionally. This can lead to increased fatigue, stress, and lack of concentration. These effects lead to an increased risk of operator error, injuries and/or accidents. Fatigue is a message to the body to rest. If rest is not possible, fatigue can increase until it becomes distressing and eventually debilitating. The symptoms of fatigue, both mental and physical, can include:

- Weariness, sleepiness
- Reduced alertness, lack of concentration
- Lack of motivation, irritability
- Increased susceptibility to illness
- Depression, headache, giddiness
- Loss of appetite, digestive problems

Reducing the Risks Associated with Fatigue

Managers and supervisors should learn to recognize signs and symptoms of the potential health effects associated with extended work shifts. Workers who work long hours should be monitored for the signs and symptoms of fatigue. Employee showing such signs should be directed to rest, take additional breaks, eat meals, relax; get off of the equipment, stretch, walk. Tasks that require heavy physical labor or intense concentration should be performed at the beginning of the shift if possible.

Noise

Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss. Short term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours. However, repeated exposures to loud noise, such as running equipment can lead to permanent tinnitus and/or hearing loss. Noise may be a problem if:

- You hear ringing or humming in your ears when you leave work
- You have to shout to be heard by a coworker an arm's length away
- You experience temporary hearing loss when leaving work

Loud noise can reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals or malfunctioning equipment. Noise-induced hearing loss limits your ability to hear high frequency sounds, understand speech, and seriously impairs the ability to communicate. Protect yourself and others with the appropriate hearing protection, and tractor and truck cabs that are in good order, with functioning engine mufflers.

Fires

Precautions to prevent fires include being aware of potential fire conditions and refraining from smoking near equipment and combustible gases. Fire-fighting equipment should be readily accessible. Every tractor and truck should be equipped with at least one five-pound ABC dry chemical **fire extinguisher that is in working order**.

Disease-causing Organisms

Protect yourself from these hazards with simple, thorough hygiene:

- Keep your hands away from your mouth, nose, eyes, and ears when working with manure
- ALWAYS wash your hands thoroughly with soap and hot water before smoking, eating, drinking, using the bathroom, and after work
- Wear clean work clothing every day
- Wear non-permeable gloves when necessary
- Keep cuts and other broken skin covered
- If an injury results in an open wound, get a tetanus booster shot
- Thoroughly wash and clean any cut with antiseptic and cover it with clean, dry gauze and waterproof adhesive tape --these should be in your first aid kit!

Preparation and Training for Accident Response

If you work independently or with one or two other people, it's a good idea to keep a cellular phone, a list of medical emergency phone numbers, and a basic first-aid kit in the cab of your tanker or truck. Your customers should have emergency numbers posted by their nearest phones, but in some cases it may be quicker to use your cell phone to call for help. When calling for emergency medical help, be prepared to give directions to your location (i.e., nearest intersection, 911 address) and a brief description of what happened.

Employees need to know the types of safety hazards to which they may be exposed and what precautions to take. Provide appropriate "Employee Right to Know" training; document and record training offered employees. Be sure employee attendance is documented. OSHA can help assemble the necessary information to meet this requirement.

Employees also need to know who and how to call for help in a medical emergency and how to give directions to their location. Provide this basic training to new employees before they start and review it with all employees regularly. It's also a good idea to orient the emergency medical responders to your facility and equipment.

Provide first-aid equipment for your facility and at your remote sites. Cabs of vehicles and tractors make great locations to store these supplies. Have selected employees trained to provide first aid. First-aid training should include knowledge of and training for the kinds of things that can and do happen:

- Poisons, Burns, Bites and Stings
- Bandaging and control of bleeding
- Shock, unconsciousness, and strokes
- Sunstroke and heat exhaustion
- Frostbite and hypothermia
- Strains, sprains, and hernias
- Fractures and dislocations
- Cardiac-pulmonary resuscitation (CPR)
- Transportation of the injured

If you have 11 or more employees, you may be subject to federal Occupational Safety and Health Administration (OSHA) requirements concerning agricultural employee safety, training, and documentation. The MN Dept. of Labor and Industry offers OSHA consulting services to help identify hazards in your work environment without risk of citation. In some situations there may be funds available to assist with training and corrective safety activities:

1-800-657-3776 ☎ (651) 284-5060
osha.consultation@state.mn.us
<http://www.doli.state.mn.us/Wsc.asp>

References and Additional Resources

- MN Department of Transportation brochure: “Implements of Husbandry: Safety on Minnesota Roads.” <https://dps.mn.gov/divisions/msp/commercial-vehicles/Documents/Pamphlets/2012%20Implements%20of%20Husbandry.pdf>
- OSHA publication: “An Employer’s Guide to Developing an Employee Right-to-Know Program” August 2012. Minnesota Department of Labor and Industry, Occupational Safety and Health Division. http://www.dli.mn.gov/osha/PDF/ertk_gi.pdf
- Manure Gas Dangers. National Ag Safety Database. <http://nasdonline.org/document/48/d001616/manure-gas-dangers.html>

CHAPTER 8: EMERGENCY PREPAREDNESS

Accidents happen. Will everyone know what to do?

Learning Objectives

After completing this chapter, you should be able to:

- Explain the difference between an **incident** and an **emergency**
- Explain how emergency response planning reduces risks for commercial waste applicators
- Explain why it is important to have someone on site that is trained as a first responder
- Name at least one component of manure application system that should be inspected regularly
- List at least two **policies** for safe operation of manure application systems
- List at least two **activities** for safe operation of manure application systems
- Describe at least one reason for documenting an environmental incident
- Describe four steps to take to properly respond to an incident
- Name a common violation of state laws related to manure and environmental incidents
- List the contents of a manure spill response kit
- State the manure spill volume that requires operators to call the public safety duty officer
- List three pieces of information to be kept for clients records
- Describe the wrong time to review an emergency preparedness plan

Terms to Know

Incident: An accident, rupture, leak, spill, discharge, escape, disposal, or any event that releases or immediately threatens to release manure into the environment, and may cause adverse effects on the environment.

Discharge: The addition of any pollutant (i.e., manure, oil, diesel) to the waters of the state.

Waters of the State: All water bodies regulated by the state of MN, including streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems and all other bodies or accumulations of water, surface or underground, natural or artificial, public or private, which are contained within, flow through, or border upon the state of Minnesota or any portion thereof.

MN Duty Officer: Who to call for assistance with incidents or for reporting hazardous materials, petroleum and manure spills; available 24 hours/day, 7 days/week: **1-800-422-0798**

For emergencies and immediate threats to life or property, always dial 911.



Introduction

Liquid manure application systems are susceptible to leaks and spills. Environmental incidents with liquid manure application equipment include leaks from broken pipelines or hoses, either above or below ground, and spills from ruptured hoses or overturned tankers. Solid manures, while generally less volatile and not able to flow on their own, can be spilled onto roads, ditches and other waterways and carried by running water. Lack of preparation for or a poor response to an environmental incident can lead to personal injury, economic loss, environmental damage, negative public reaction, and increased scrutiny by regulatory agencies.

Developing and Implementing an Emergency Response Plan

Advanced planning is essential to minimize manure handling emergencies. While it is impossible to be fully prepared for every situation, planning ahead can decrease risk by identifying and eliminating problems before they occur. The main benefit to emergency planning is employees will be able to respond more effectively and more quickly should serious incidents occur. In general, an emergency response plan should be clearly written, posted in your place of business, updated annually, and available to all employees. All employees should be familiar with the plan and know their responsibilities in preventing and responding to incidents.

An emergency response plan should cover the following:

- The types of incidents that can potentially happen
- The basic steps to be implemented in the event of an incident
- A designated first responder from each work crew
- The phone number to the State Duty Officer, MN Dept. of Public Safety
- Emergency phone numbers of company contacts and physicians
- The types of equipment that may be needed to clean up
- The locations of emergency supplies and equipment
- A list of people/contractors who have agreed to be available, with alternates (e.g., plumbers, welders, equipment suppliers, etc.)
- Arrangements with farmers/applicators who can assist in an emergency (e.g., to share personnel, equipment, land access, etc.)
- A description of required documentation

Some livestock farms may have emergency response plans that deal with lagoon or basin leaks or overflow, runoff from open feedlots, and emergency application. Ask your clients if such plans exist, and if plans include maps of the facility and field drainage patterns, and lists of neighboring landowners, with access rights for those potentially affected by environmental incidents.

While it is necessary to have the various emergency contact numbers and procedures written down and accessible, it is more important to review procedures with all staff on a regular basis. Arrival at a new site is a good time to assess the potential for accidents based on the characteristics of the particular facility and application sites, as well as review the potential accidents that are common to all sites and the machinery you use.

Implement an Emergency Response Training Plan

Anyone applying manure needs to know how to respond properly to an environmental emergency. Train employees to recognize the circumstances that constitute an imminent danger to the environment. Teach them how to shut off manure pumping, transfer, application equipment quickly, including automatic shutdown systems.

Provide this basic training to your new employees before they start working. All employees should practice response procedures once a year. Because someone at the site of an incident needs to be able to respond immediately—without calling for instructions—assign and train a permanent, responsible employee from each work crew as a first responder.

During an emergency everyone should know what to do, there will be no time to review plans and procedures!

Establish and Enforce Policies that Promote Safe Operations

All applicators can prevent environmental incidents by operating manure application equipment safely. Think about your operation and the potential incidents that might happen. Establish and enforce clear operating policies to address those possibilities. Always use two-way radios or mobile phones to communicate between operator and attendant.

Inspect and Maintain Your Equipment

Inspect and maintain manure application equipment regularly. Inspect hoses regularly to ensure they are intact and have no leaks. Repair or replace deteriorated hoses and pumps. If you use pipelines, verify that they are working properly and make sure they have two shutoff valves, with the second as a backup. Inspect all valves to make sure they close tightly. Refer to equipment manufacturer manuals for additional safeguards. Keep records of your equipment inspections and maintenance.

With tank or solid spreader systems, observe the following policies:

- Travel at safe speeds
- Adjust load volumes for travel on hills
- Use the appropriate size tractors for the load
- Check for spills by taking the same route back to the facility
- Know (and follow) your incident response plan

With drag hose systems, follow these policies:

- Monitor hoses and hose connections continuously
 - especially in drainage ditches or near waterways!
- Use and monitor flow meters
- Do not leave pumps unattended without the ability to shut it down immediately
- Shut off all valves at the end of the day
- Know (and follow) your incident response plan

Learn from Past Incidents! An important part of prevention is learning from past mistakes. This is a good reason to document and keep a record of environmental incidents.- Review documentation of past incidents and assess the extent of damages and asses your response:

- What caused the incident?
- How much manure was released?
- Did manure reach surface waters?
- Were any employees injured?
- Were any fish killed?
- Was any property damaged?
- How long did it take to contain the manure?
- Did you have the equipment you needed?
- What could have been done to avoid the incident?
- What could have lessened the damage?

Responding to Leaks and Spills

Effective and rapid response to manure spills is crucial to limiting the damage caused by these environmental emergencies. If you're involved in a manure spill, follow these incident response steps:

1. Ensure your own **personal safety** and **attend to any injuries** first!
2. **Stop the release.** Shut off all pumping equipment and close the valves on trucks and tanks. Stop any flow due to gravity by compressing the hose or creating a dike with soil or straw bales. Keep manure from entering tile intakes, sinkholes, wells, or bodies of water. Cover any surface tile intakes that may be at risk.
3. **Prevent further damage.** Assess the extent of incident. Did the manure reach any surface waters? Approximately how much was released and for how long? Did the spill leave the property? Does the spill have the potential to reach groundwater or surface waters? Could rain cause the spill to reach surface waters? Are drinking water wells in danger (either on or off the property)? Record your observations for reporting to the appropriate regulatory agencies.

4. **Contact the appropriate agencies immediately:** Your local response team, if you need help and company emergency contact(s). The MN Dept. of Public Safety, Division of Emergency Management 24 hours/day, 7 days/week: **1-800-422-0798**

Be prepared to tell the duty officer the location of the incident, the material, volume, circumstances, and steps already taken to contain and recover the spill. The duty officer will contact the appropriate agencies, including a “spill responder” at the Minnesota Pollution Control Agency (MPCA).

If it is a large incident (or if you request it) the spill responder will help determine what else needs to be done. In most cases, a phone conversation with someone from the MPCA will suffice. In some cases the MPCA may require detailed consulting and engineering reports. If emergency action is needed to pump ditches or clean up a fish kill the MPCA may become involved.

5. **With the MPCA spill responder, determine what needs to be done.** The appropriate measures will depend on the site and magnitude of the incident, and may include:

- Vacuum pump and collect the spilled manure
- Pump contaminated water back onto the field or a collection tank
- Spread soil, straw, or sawdust over manure to keep it from running off the road or field
- Reinforce the dike or dig a secondary containment area between the spill and the water
- Divert liquid manure along the contours of the field
- Divert upstream water from flowing into the spill area
- Stop or divert channels that run to bodies of water upstream of the spill
- Apply and incorporate retrieved manure to flat land or land that slopes away from surface water

6. **Implement procedures as recommended by the MPCA spill responder.**

7. **Document the incident for your records.** Include the following information as applies:

- The date, time, and location of the incident, and when and to whom it was reported
- Description of the incident (e.g., approximate amount of manure spoiled, entering waterways, etc.)
- How the incident happened and what actions were taken
- Affected landowners and waterways
- The pumping volume per minute and/or application rate per acre, if appropriate
- The name of the owner of the manure
- What might have prevented or improved the response to this incident

Working with Regulatory Agencies

Always follow the response and cleanup instructions of the state agencies. It's a good idea to develop good working relationships with local authorities and your contacts from the MN Dept. of Agriculture and the MN Pollution Control Agency before you experience an environmental incident. One place to start is to have them review your emergency response plan.

Minnesota state agencies will be required to take enforcement action if the following situations are found to violate state laws: Direct application of manure into a lake, stream, wetland, intermittent stream, drainage or road ditch, open tile intake; Runoff to bodies of water; Failure to prevent water pollution, and; Failure to notify proper authorities when pollution occurs.



The image shows a 'Manure Hauler Incident Report' form. The title is 'Manure Hauler Incident Report' with a subtitle 'To be completed after an incident has been reported and contained/corrected/cleaned up.' The form includes fields for 'CAWT COMPANY AND LICENSE #', 'TIME OF INCIDENT', 'DATE OF INCIDENT', and 'LOCATION OF INCIDENT'. A section titled 'WHAT CAUSED the INCIDENT?' contains a grid of checkboxes for various causes: Equipment Failure, Weather Related, On-Road Accident, Power Failure, Poor Visibility, Structure or Facility Failure, Fatigue, Spill/Leak, Difficult Field Conditions, Inattentiveness, Inexperience, and Other (specify). Below this is a section for 'Describe the Incident and Response' with a note to include an estimate of amount spilled, area damaged, etc. and another section for 'Describe what might have been done to lessen the damage.' and 'Describe what actions can be taken to prevent this incident from occurring again.' At the bottom, there is a checkbox for 'Was this incident/issue a safety hazard submitted to DNR, MPCA or other agency?' and a signature line.

Appendix D is an Incident Report Template to document accidents and incidents. It can also be used as a training tool to review what happened, what might have been done to lessen the damage, and how the incident can be avoided in the future.

The MPCA and MDA consider failure to notify the state Duty Officer of an incident to be a serious violation. Establishing an incident response plan before an incident happens, notifying authorities, following the incident response plan, and documenting an incident are viewed positively by the agencies and taken into consideration when making enforcement decisions.

If someone files a complaint or groundwater or surface water is found to exceed state contaminant standards, and the source can be traced, the people responsible may be charged with misdemeanors or gross misdemeanors. The most common reasons for violations and state enforcement action are the discharge of manure into a tile drainage system, ditch or stream.

NPDES & SDS permitted facilities require a report be submitted within 5 days that includes a description of how and when the discharge/accidental release was discovered. A list of all notifications that were sent regarding the discharge/accidental release that includes: who was notified, when they were notified, how they were notified, and who sent the notifications. A written statement that includes the following information as required under your NPDES/SDS Permit:

- Cause of the discharge
- A description and approximate volume of any discharge
- Location and name of any waterway, dry ditch, gully, creek, stream, pond, lake, river receiving the discharge
- Actions taken to reduce, eliminate, and prevent a recurrence of the discharge
- Whether the discharge is still occurring, and if still occurring, the expected duration of the discharge
- Name of the person reporting the discharge

References and Additional Resources

- The MN Dept. of Public Safety, Division of Emergency Management: 1-800-422-0798
- Manure, Milk, & Silage Leachate Spills. MPCA.
<http://www.pca.state.mn.us/index.php/view-document.html?gid=3824>
- Spills and Emergencies. MPCA.
<http://www.pca.state.mn.us/index.php/topics/feedlots/county-feedlot-program/county-feedlot-officer-toolbox.html#viii>
- Emergency Response (all emergencies, spills), MPCA:
<http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup/emergency-response>

APPENDIX A: RULES AND REGULATIONS

Ignorantia legis neminem excusat - Ignorance of the law excuses no one.

Definitions Related to Rules and Regulations

MN Statutes, Chapter 18C.430: Administered by the Minnesota Department of Agriculture. The laws that regulate manure application for hire in MN: Commercial Animal Waste Technician, Manure Application: 18C.430, Commercial Animal Waste Technician; 18C.432, Manure Applicator Education and Training; 18C.433, Commercial Animal Waste Application.

MN Rule 7020: Minnesota Administrative Rule, Chapter 7020, the “Feedlot Rules”, administered by the MN Pollution Control Agency (MPCA), governs the storage, transportation, and utilization of livestock manure.

The Clean Water Act: The Clean Water Act of 1972, administered by the Environmental Protection Agency (EPA), establishes the basic structure for regulating discharges of water pollutants in the US and for establishing water quality standards.

Public Waters: All designated lakes, rivers, streams and wetlands that meet the criteria in MN Statutes, Section 103G.005, sub. 15 under the authority of the MN DNR.

Discharge: The addition of a pollutant to surface and groundwater, including a release of livestock manure, manure-contaminated runoff or process wastewater from a livestock feedlot, a manure storage area, or land application site by leaking, pumping, pouring, emitting, emptying, dumping, escaping, seeping, leaching, or any other means; includes point source and nonpoint source discharges.

Groundwater: Water below ground in the saturated zone, including waters under confined, unconfined, or perched conditions, in near-surface unconsolidated sediment or soil, or in rock formations deeper underground.

Nonpoint source pollution: Pollution from many diffuse locations over a wide land area caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away pollutants (e.g., nutrients, sediment, pesticides) depositing them into lakes, rivers, wetlands, coastal waters, groundwater.

Point source pollution: Pollutants entering water at identifiable points; any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated livestock feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Fertilizer: A substance containing one or more recognized plant nutrients that is used for its plant nutrient content, including “manipulated manures”; manure that has been mechanically or chemically treated.

Knowing: An act is committed *knowingly* if it is done voluntarily and is not the result of negligence, mistake, accident, or circumstances beyond the control of the person involved.

This chapter describes some of the laws, rules, and regulations that may affect people who apply manure for hire. It is provided for reference and will not be part of the CAWT test.

Federal Laws and Regulations

Federal regulations are documented in the **U.S. Code of Federal Regulations (CFR)** at the following website: <http://www.ecfr.gov>. Depending on the regulation, it may be enforced by a federal agency, such as the U.S. Department of Agriculture (USDA) or the U.S. Environmental Protection Agency (EPA), or, enforcement authority may be delegated to the states.

The Clean Water Acts and the National Pollutant Discharge Elimination System (NPDES)

The Clean Water Acts of 1972 and 1977 control point-source pollution, including from “concentrated animal feeding operations (CAFO)”. Under the law, a CAFO without a NPDES permit is prohibited from discharging pollutants to wetlands, permanent and intermittent streams, lakes, ponds, and rivers. For complete information:

<http://www.epa.gov/agriculture/lcwa>
<http://water.epa.gov/polwaste/npdes>

The EPA has given individual states, including Minnesota, the authority and responsibility to administer and enforce NPDES permits and to develop comprehensive water quality plans. The Minnesota Pollution Control Agency (MPCA) has this responsibility in Minnesota. Each state’s plan includes controls for both point sources and nonpoint sources of pollution. Control of point source pollutants usually relies on collection and treatment of the pollutants (i.e., collecting feedlot runoff). Control of nonpoint sources relies on management of the pollutant, (i.e., proper manure application). For information about how NPDES regulations may affect you, contact the **MPCA’s feedlot program:**

800-657-3864 / <http://www.pca.state.mn.us/index.php/topics/feedlots>
888-345-0823 / <http://www.health.state.mn.us>

Minnesota Laws, Statutes, and Rules

Some of the statutes and rules listed in this chapter affect CAWTs directly; others indirectly through their regulation of related activities (e.g., worker safety, transportation on public roads).

Law, Statute or Rule?

Laws are passed by the Minnesota Legislature while it is in session. Those laws are bound in the Session Laws of that year. A law becomes a **statute** when it is placed into the context of other statutes that have been on the books from previous years. Some laws, such as fiscal appropriations, never become statutes because of their limited nature. A **rule** is adopted or revised by the authorized administrative agency (i.e., DNR, MPCA) to make a law specific enough to administer and enforce. An agency may adopt a rule only after the legislature has enacted a law granting this authority to the agency. **To access any Minnesota Statute online:** <http://www.revisor.mn.gov/statutes>

Minnesota Statutes

Statutes of interest to Commercial Animal Waste Technicians may include the following:

Chapter 18C: Fertilizer, soil amendment, and plant amendment law. Establishes the circumstances when manure is considered a fertilizer and is of interest to anyone selling manure.

115: Authorizes the MPCA to administer and enforce laws relating to water pollution, including:

115.01: Definitions contains definitions of environmental terms such as “discharge”, “groundwater”, “point source”, and “waters of the state”.

115.061: Duty to notify and avoid water pollution discusses notification in the event of discharge of a pollutant to state waters.

115.071: Enforcement discusses remedies and administrative, civil, and criminal penalties for violations of water pollution laws.

Statute 169: Transportation. The following transportation statutes apply to vehicles using public roads:

169.32: Obstructing roads. Prohibits the obstruction of traffic by stopping, parking, or leaving a vehicle, whether attended or unattended on the traveled part of a highway.

169.42: Littering. Prohibits dumping offensive material on streets or highways and may apply to manure spills.

169.87: Weight restrictions; seasonal weight restrictions for county and town roads.



169.88: Damages; liability. This statute states that those who intentionally damage a road are liable for the damages.

Contact Commercial Vehicle Operations at MnDOT:

[http:// www.dot.state.mn.us/cvo/contact](http://www.dot.state.mn.us/cvo/contact)

Telephone: 651-296-3000

Toll-free: 1-800-657-3774

MnDOT homepage: <http://www.dot.state.mn.us>

Minnesota Rules

Chapter 7020: Animal Feedlots

MN Rules Chapter 7020 governs the MN Pollution Control Agency's "Feedlot Rules". The rules (Minn. R. 7001.0020, 7002.0210 to 7002.0280, and Minn. R. ch. 7020) govern the storage, transportation, and utilization of manure. In general, the feedlot rules apply to all aspects of livestock production, including the location, construction, operation and management of feedlots, manure handling facilities, and land application of manure. There are four major sections in the rules: **Registration program; Permit program; Delegated county program;** and **Technical standards** for discharge, design, construction, operation and closure. There are also minor sections for permit fees, incorporation by reference, submittals and records, and definitions. The **full text** of the statute is available on line MN Office of the Revisor of Statutes: <http://www.revisor.mn.gov/rules/?id=7020>

For **complete information** on the implementation of MN 7020 go to this MPCA website:

<http://www.pca.state.mn.us/index.php/topics/feedlots/feedlot-rules.html>

For the MPCA or County Feedlot Officer:

<http://www.pca.state.mn.us/index.php/topics/feedlots/index.html#contacts>

Rule 7060.0600: Protection of underground waters. Manure applications in Minnesota may be subject to this rule if the components of the manure are allowed to leach into the groundwater. This rule is enforced by the MPCA.

Local Ordinances

CAWTs and customers may also be subject to local ordinances. Local ordinances can vary from township to city to county. They also change frequently. It is good business practice to develop good working relationships with local authorities and to stay informed of current ordinances. For more information about local ordinances:

Association of MN Counties: 651-224-3344 / <http://www.mncounties.org>

MN Association of Townships: (763) 497-2330 / (800) 228-0296 /

<http://www.mntownships.org>



Other Rules of Interest to CAWTs

The Clean Air Act of 1970 and the Clean Air Act Amendment of 1990

(<http://www.epa.gov/air/caa>)

The Clean Air Act (CAA) provides for uniform air quality standards and the control of emissions from existing facilities. EPA is authorized to enforce these environmental laws. Most air quality complaints and civil suits related to poultry and livestock operations have been because of odor.

The Occupational Safety and Health Act

(<http://www.dol.gov/compliance/laws/comp-osh>)

Under the 1970 federal Occupational Safety and Health Act, an employer with eleven (11) or more employees is required to keep records and make reports to the Occupational Safety and Health Administration (OSHA), including all work-related deaths, injuries, and illnesses. Other OSHA regulations that an agricultural employer may be subject to include: Roll-over and overhead protection; field sanitation; and guarding of farm equipment. To determine if you are subject to these regulations, contact the Minnesota Occupational Safety and Health Administration:

877-470-6742 / <http://www.doli.state.mn.us/mnosha>

Federal Motor Carrier Safety Regulations (<http://www.dot.state.mn.us/cvo>)

People who operate manure spreaders, tankers, or other motorized vehicles on public roads may be subject to federal Motor Carrier Safety regulations (49 CFR Parts 40 and 300-399). If companies operate commercial motor vehicles, they and their employers may be subject to 49 CFR, part 382 (Controlled Substances and Alcohol Use and Testing); part 391 (Qualifications of driver); part 392 (Driving of motor vehicle); and part 393: (Parts and accessories necessary for safety). For more information, contact Commercial Vehicle Operations of the MN Dept. of Transportation (MnDOT):

651-296-3000 / Toll-free: 800-657-3774



MN Statute 18.82: Transport of noxious weed propagating parts in infested material or equipment

(<http://www.revisor.mn.gov/statutes/?id=18.82>)

This statute requires a permit to transport noxious weeds on public roads. Those who transport manure on public roads are subject to this statute if the manure being transported contains any noxious weed seeds. Contact the **Seed and Noxious Weed Unit** of the MN Dept. of Ag. (MDA):

651-201-6000 / Toll free 800-967-2474 /

<http://www.mda.state.mn.us/plants/badplants/noxiouslist>

MN Statute 221: Motor carriers and pipeline carriers. This statute is enforced by MnDOT. For interpretation of these statutes or more specific information about how they may apply to your situation, contact MnDOT's Commercial Vehicle Operations.

Statute 609: Criminal Code. The following sections of this statute may be of interest to Site Managers:

609.671: Environment, criminal penalties. This section defines the term "knowing" and penalties for environmental violations.

609.74: Public Nuisance. This section states that anyone who renders a public road dangerous for travel is a public nuisance; punishable as a misdemeanor.

MN Rule 6120.3300: Zoning Provisions. This rule includes the following subparts:

Subpart 4: Shoreland alterations. Requires the use of earth and/or vegetation to minimize runoff to public waters or shore impact areas.

Subpart 7: Agricultural use standards for shoreland areas. Requires the proper application or use of earth and/or vegetation to minimize the impacts on public waters or shore impact areas.

This rule is enforced by the Minnesota Department of Natural Resources.

(888) 646-6367 / <http://www.dnr.state.mn.us/shorelandmgmt>

APPENDIX B: MN STATUTE 18C.430: COMMERCIAL ANIMAL WASTE TECHNICIAN

The text of Minnesota Statute 18C.430 is included for your convenience; always check for latest version at: <http://www.revisor.leg.state.mn.us/statutes/?id=18C.430>

18C.430 COMMERCIAL ANIMAL WASTE TECHNICIAN.

Subdivision 1. Requirement.

- (a) A person may not manage or apply animal wastes to the land for hire:
- (1) without a valid commercial animal waste technician applicator license;
 - (2) without a valid commercial animal waste technician site manager license; or
 - (3) as a sole proprietorship, company, partnership, or corporation unless a commercial animal waste technician company license is held and a commercial animal waste technical site manager is employed by the entity.
- (b) A person managing or applying animal wastes for hire must have a valid license identification card when managing or applying animal wastes for hire and must display it upon demand by an authorized representative of the commissioner or a law enforcement officer. The commissioner shall prescribe the information required on the license identification card.
- (c) A commercial animal waste technician applicator must have a minimum of two hours of certification training in animal waste management and may only manage or apply animal waste for hire under the supervision of a commercial animal waste technician site manager. The commissioner shall prescribe the conditions of the supervision and the form and format required on the certification training.
- (d) This section does not apply to a person managing or applying animal waste on land managed by the person's employer.

Subd. 2. Responsibility.

A person required to be licensed under this section who performs animal waste management or application for hire or who employs a person to perform animal waste management or application for compensation is responsible for proper management or application of the animal wastes.

Subd. 3. License.

(a) A commercial animal waste technician license, including applicator, site manager, and company:

- (1) is valid for one year and expires on December 31 of the year for which it is issued, unless suspended or revoked before that date;
- (2) is not transferable to another person; and
- (3) must be prominently displayed to the public in the commercial animal waste technician's place of business.

(b) The commercial animal waste technician company license number assigned by the commissioner must appear on the application equipment when a person manages or applies animal waste for hire.

Subd. 4. Application

(a) A person must apply to the commissioner for a commercial animal waste technician license on forms and in the manner required by the commissioner and must include the application fee. The commissioner shall prescribe and administer an examination or equivalent measure to determine if the applicant is eligible for the commercial animal waste technician license, site manager license, or applicator license.

(b) The commissioner of agriculture, in cooperation with University of Minnesota Extension and appropriate educational institutions, shall establish and implement a program for training and licensing commercial animal waste technicians.

Subd. 5. Renewal application.

(a) A person must apply to the commissioner of agriculture to renew a commercial animal waste technician license and must include the application fee. The commissioner may renew a commercial animal waste technician applicator or site manager license, subject to reexamination, attendance at workshops approved by the commissioner, or other requirements imposed by the commissioner to provide the animal waste technician with information regarding changing technology and to help ensure a continuing level of competence and ability to manage and apply animal wastes properly. The applicant may renew a commercial animal waste technician license within 12 months after expiration of the license without having to meet initial testing requirements. The commissioner may require additional demonstration of animal waste technician qualification if a person has had a license suspended or revoked or has had a history of violations of this section.

(b) An applicant who meets renewal requirements by reexamination instead of attending workshops must pay a fee for the reexamination as determined by the commissioner.

Subd. 6. Financial responsibility.

- (a) A commercial animal waste technician license may not be issued unless the applicant furnishes proof of financial responsibility. The financial responsibility may be demonstrated by (1) proof of net assets equal to or greater than \$50,000, or (2) a performance bond or insurance of the kind and in an amount determined by the commissioner of agriculture.
- (b) The bond or insurance must cover a period of time at least equal to the term of the applicant's license. The commissioner shall immediately suspend the license of a person who fails to maintain the required bond or insurance.
- (c) An employee of a licensed person is not required to maintain an insurance policy or bond during the time the employer is maintaining the required insurance or bond.
- (d) Applications for reinstatement of a license suspended under paragraph (b) must be accompanied by proof of satisfaction of judgments previously rendered.

Subd. 7. Application fee.

- (a) A person initially applying for or renewing a commercial animal waste technician applicator license must pay a nonrefundable fee of \$25. A person initially applying for or renewing a commercial animal waste technician site manager license must pay a nonrefundable application fee of \$50. A person initially applying for or renewing a commercial animal waste technician company license must pay a nonrefundable application fee of \$100.
- (b) A license renewal application received after March 1 in the year for which the license is to be issued is subject to a penalty fee of 50 percent of the application fee. The penalty fee must be paid before the renewal license may be issued.
- (c) An application for a duplicate commercial animal waste technician license must be accompanied by a nonrefundable fee of \$10.

History: 1998 c 401 s 17; 2013 c 114 art 2 s 41

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APPENDIX C: MANURE FIELD APPLICATION RECORD TEMPLATE

Printed on the next two pages to be copied/photocopied.

Use second side to describe environmentally sensitive area management



CAWT Field Application Record

CAWT Company name/license #:					
Site Manager name/license #:					
Applicator name(s)/license #:					
Livestock Farm/Facility Owner: Farm/Facility Address: Phone #:					
Farmland owner receiving manure (if different than above): Address: Phone #:					
Manure Source – storage facility/site description:					
Field Location - County:		Town:	Range:	Section:	¼ Section:
Field ID:	Acers:	Date(s) manure applied:			
Weather Conditions (e.g., recent rainfall, temp., wind direction/speed):					
Soil Moisture (e.g., dry/hard, field capacity, saturated):				<input type="checkbox"/> Frozen/Snow covered	
Crop:		Previous Crop:			
Manure type: SWINE: <input type="checkbox"/> Farrow <input type="checkbox"/> Nursery <input type="checkbox"/> Gestation <input type="checkbox"/> Finish DAIRY: <input type="checkbox"/> Cows <input type="checkbox"/> Heifer BEEF: <input type="checkbox"/> Cows <input type="checkbox"/> Finishing Cattle POULTRY: <input type="checkbox"/> Broilers <input type="checkbox"/> Layers <input type="checkbox"/> Tom Turkeys <input type="checkbox"/> Hen Turkeys				<input type="checkbox"/> Liquid <input type="checkbox"/> Solid	
Application equipment used:					
Application Method: <input type="checkbox"/> Surface Applied <input type="checkbox"/> Incorporated w/in _____ Hours <input type="checkbox"/> Injected					
Spreader/Tanker load size: _____ <input type="checkbox"/> tons <input type="checkbox"/> gallons					
# of loads on this field: _____ <input type="checkbox"/> Tons <input type="checkbox"/> Gallons applied/acre					
Manure nutrient content:		_____ lbs. N	_____ lbs. P ₂ O ₅	_____ lbs. K ₂ O	
<input type="checkbox"/> Measured <input type="checkbox"/> Table values		<input type="checkbox"/> /Ton -- OR -- <input type="checkbox"/> /1,000 gallons			
1 st year nutrients applied; lbs./acre: _____ N _____ P ₂ O ₅ _____ K ₂ O					

Describe any “Special Protection Areas” present and actions taken to protect them:

Environmentally sensitive feature(s) on or near this field ✓		Setback requirements observed ✓	Description of feature, actions, methods
	Lake, stream:		
	Intermittent stream:		
	Drainage ditch:		
	Open tile intake:		
	Wetland:		
	Sinkhole, well, mine, quarry:		

Load tally (✓)																			

Map/Drawing of Field/Features

APPENDIX D: MANURE HAULER INCIDENT REPORT TEMPLATE

Printed on the next page to be copied/photocopied.



Manure Hauler Incident Report

To be completed after an incident has been reported and contained/corrected/cleaned up.

CAWT Company and License #: _____

DATE OF INCIDENT: _____ TIME OF INCIDENT: _____

LOCATION OF INCIDENT (County, Township, Section, ¼ section, property owner, field #, etc.):

WHAT CAUSED the INCIDENT? Check () all that apply all that apply

- Equipment Failure
- Weather Related
- On-Road Accident
- Power Failure
- Poor Visibility
- Structure or Facility Failure
- Fatigue
- Slip/Fall
- Difficult Field Conditions
- Inattentiveness
- Inexperience
- Other (specify):

Describe the Incident and Response

Use the reverse side to more fully describe what happened, if needed, include an estimate of amount spilled, area, distance, etc., and any damage, i.e., injury, fish kill, property damage.

Describe what might have been done to lessen the damage:

Describe what actions can be taken to prevent this incident from occurring again:

Does this incident require a written report submitted to DNR, MPCA or other agencies?

Yes No

Signature of person(s) filing out this report

Date

To report a manure spill or other incident:

24-hours a day, seven days a week, CALL:

1 - 800 - 422 - 0798

Program this number into your phone!

You will reach the State Duty Officer at the MN Dept. of Public Safety. Be prepared to provide:

- **The location and time of the incident**
- **The material, approximate volume, circumstances**
- **The steps already taken to contain the incident**
- **Your name and phone number**
- **Your CAWT license number**

Ask the Duty Officer to notify all appropriate agencies, including the MN Dept. of Agriculture.

For emergency response always dial 911 first

NOTES/Contacts:



