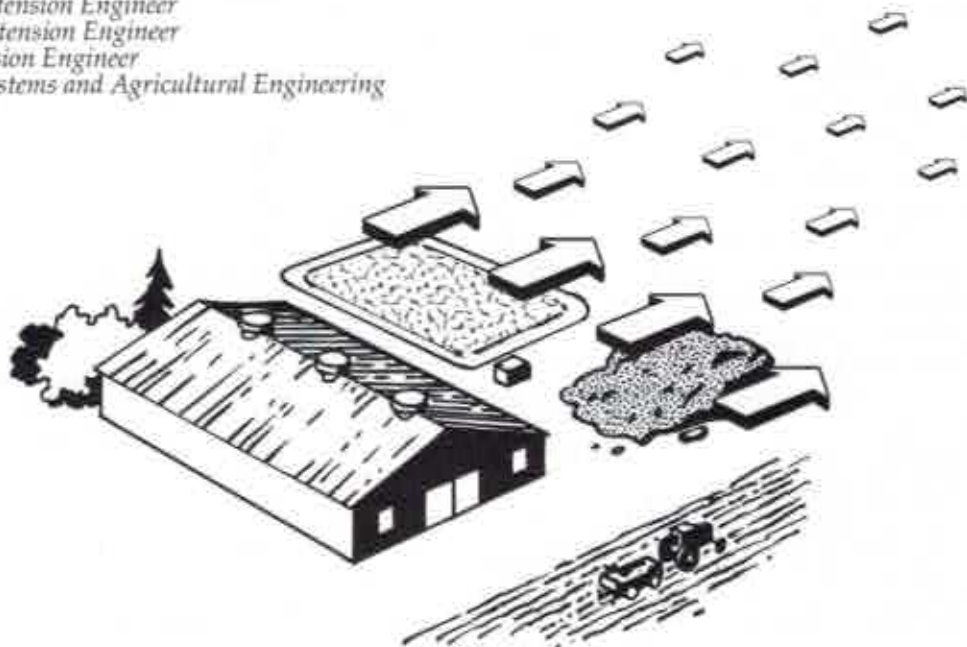


Preparing an Odor Management Plan

David Schmidt, Extension Engineer
Larry Jacobson, Extension Engineer
Kevin Janni, Extension Engineer
Department of Biosystems and Agricultural Engineering



Introduction

Minnesota Rules Relating to Animal Feedlots and Storage, Transportation, and Utilization of Animal Manure, Chapter 7020.0505 Subpart 4 B, requires feedlots with 1,000 animal units or more to submit an air emission plan. This plan must include:

- *methods and practices that will be used to minimize air emissions resulting from animal feedlot or manure storage area operations including manure storage area start-up practices, loading, and manure removal;*
- *measures to be used to mitigate air emission in the event of exceedance of the state ambient hydrogen sulfide standard; and*
- *a complaint response protocol describing the procedures the owner will use to respond to complaints directed at the facility including a list of each potential odor source at the facility, a determination of the odor sources most likely to generate significant amounts of odors, and a list of anticipated odor control strategies for addressing each of the significant odor sources.*

This air emissions plan must address odor specifically but may also include dust and specific gases such as hydrogen sulfide and ammonia. Although this air emission plan is only required for those sites over 1,000 animal units, all feedlots should consider writing such a plan. An odor management plan helps avoid nuisance odor conflicts and shows the intent to be a good neighbor. This publication presents information on preparing odor management plans for farms of any size.

Odor Management Plans

Manure management plans have become a standard practice for most animal production systems. These plans document the proper handling and application of manure onto cropland. Likewise, odor management plans systematically identify potential odor sources, determine control strategies to reduce these odors, and establish criteria for implementing these strategies.

The development of an odor management plan consists of the following four steps:

- Create a list of the potential odor sources on the farm.
- Determine which of the odor sources are the most likely to bring about odor complaints.
- List one or two odor control strategies for each of the significant odor sources.
- Develop a protocol to respond to odor complaints.

(A guide can be found on pages 7 and 8.)

IN PARTNERSHIP ...

College of
Agricultural,
Food, and
Environmental
Sciences

UNIVERSITY OF MINNESOTA

UNIVERSITY OF MINNESOTA
Extension
SERVICE

Inventory of Odor Sources

Nuisance odors can be the result of a single odor source, a single odor event, or the combination of several sources and events. Therefore, it is important to conduct a thorough inventory of all odor sources on the farm. This inventory should be conducted on-site in a systematic way to ensure that all odor sources are included.

Odors from an animal production site originate from three primary sources: manure storage structures, animal housing (including open lots), and land application of manure. However, other sources such as dead animal disposal sites, silage piles, feed centers, and any other areas where organic matter is present may also contribute to odor emissions. These other odor sources are often overlooked in discussions about nuisance complaints. For instance, improperly managed dead animal disposal sites can generate significant amounts of odors. Intermittent odor events (e.g., manure agitation) should also be listed in the odor inventory because often these events, though infrequent, can be the source of significant odor emissions and thus generate odor complaints.

A brief description of each odor source should be included in the inventory. This description should include the size of the odor source (physical area) and its distance and direction from roadways, neighbors, property boundaries, etc. (See shaded box below.)

Descriptions of odor sources should include the following types of information:

Buildings

- Size/dimensions
- Number and size of animals
- Distance to neighbors and public areas
- Distance to property line
- Ventilation system
- Feeding system
- Manure system (liquid, slurry, solid)
- Topographical features

Manure storage

- Type of storage
- Type and number of animals contributing
- Size/dimensions
- Distance to neighbors and public areas
- Distance to property line

Land application of manure

- Type of application equipment (broadcast, knife inject, sweep inject, etc.)
- Timing of manure applications
- Location of manure applications and distance to neighbors
- Agitation procedure

Table 1. Odor emission reference rate for animal and poultry housing*

Species	Animal Type	Housing Type	Odor Emission Number (Rate)	
Cattle	Beef	Dirt/concrete lot Free stall, scrape;	4	
	Dairy	Free stall, deep pit; Loose housing, scrape.	6	
		Tie stall, scrape	2	
Swine	Gestation	Deep pit, natural or mechanical	50	
		Pull plug, natural or mechanical	30	
	Farrowing	Pull plug, natural or mechanical	14	
	Nursery	Deep pit, natural or mechanical; Pull plug, natural or mechanical	42	
		Finishing	Deep pit, natural or mechanical	34
	Poultry	Broiler	Litter	1
		Turkey	Litter	2
				Hoop bar, deep bedded, scrape; Cargill (open front), scrape
	Loose housing, scrape; Open concrete lot, scrape	11		

*Taken from Livestock and Poultry Odor Workshop Manual II, Department of Biosystems and Agricultural Engineering, University of Minnesota, 2000.

Table 2. Odor emission reference rate for manure storage*

Storage Type	Odor Emissions Number (Rate)
Earthen basin, single or multiple cells	13
Steel or concrete tank, above or below ground	28
Crusted stockpile	2

Earthen basins are designed for manure storage only. A properly designed treatment lagoon may have far less odor.

*Taken from Livestock and Poultry Odor Workshop Manual II, Department of Biosystems and Agricultural Engineering, University of Minnesota, 2000.

Determination of High Odor Sources

A good odor management plan must also identify which of the many on-farm odor sources have the highest potential to create nuisance odors.

Research has shown that some odor sources emit more odor per unit area than other sources (Tables 1 and 2). Therefore, both relative odor emissions and the size of the odor source must be considered in determining the high odor sources. Intermittent sources, such as liquid manure agitation and pumping or land application, also cause relatively high odor emissions and should be considered in the development of a list of high odor sources.

Another factor to consider in determining high odor sources is the proximity of the sources to public areas or neighbors. Dilution of odors is caused through the mixing of odors with ambient air. This dilution of odorous air is a function of distance, topography, and meteorological conditions. Farther distances between odor sources and the public will result in fewer nuisance complaints. Topographical features can either enhance dilution or reduce dilution depending on the particular feature. Wind breaks or tree lines will encourage mixing of the odorous air with clean air, whereas valleys or low areas may reduce odor dilution. Meteorological conditions also affect dilution. Maximum dilution occurs when the cool air near the ground is heating and rising. Conversely, during the late evenings when it is calm and the atmosphere is cooling, the odorous air is trapped near the ground and there is little dilution. Of these three factors—distance, topography, and meteorology—separation distance will likely have the biggest impact on nuisance complaints.

Possible Odor Control Technologies

Odor control technologies can be thought of in three different categories—those that reduce the generation of odors, those that decrease the emission of odors, and those that increase dilution of odors. Several of these technologies are listed in Table 3. (See also the shaded box on page 5.) Since there is little known about many of these technologies, the odor management plan should list one, two, or possibly three control technologies for each of the high odor sources. If the first odor control strategy proves ineffective, then the second or third strategy can be implemented.

Reduce Odor Generation

Control technologies that reduce the production or generation of odorous gases include: manure treatment technologies such as anaerobic digesters or aeration systems, diet manipulation to reduce the amount of manure produced or the amount of nutrients in the manure, or chemical or biological additives. Manure treatment technologies can be very effective at odor control but are typically expensive. Chemical additions

can also be effective, and the cost depends on the specific chemical and the frequency of addition. Biological additives are typically less expensive than manure treatment or chemical additives, but their effectiveness often varies by farm site and particular additive.

Reduce Odor Emissions

Technologies considered to reduce emissions are those that capture and treat the odorous gases before they leave the site. In most situations these gases are converted through biological, physical, or chemical processes to other non-odorous gases. Biofilters are a good example of a technology that reduces odor emissions. A biofilter treats the odorous gases as they are emitted from an odor source. Microorganisms in the biofilter media oxidize these complex odorous chemicals into simple odorless compounds. The air emitted from the biofilter is nearly odor free.

Increase Odor Dispersion

Technologies that disperse and dilute odors include shelterbelts, windbreak walls, and setback distances. Of these, setback distances are the most effective. New information on shelterbelts suggests that some odor reduction occurs because of the increased turbulence caused by the windbreak and because of some capturing of the odorous gases on the tree foliage.

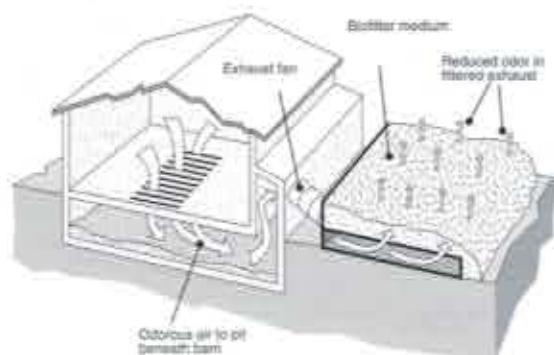


Figure 1. Biofilter on exhaust fans for odor control.

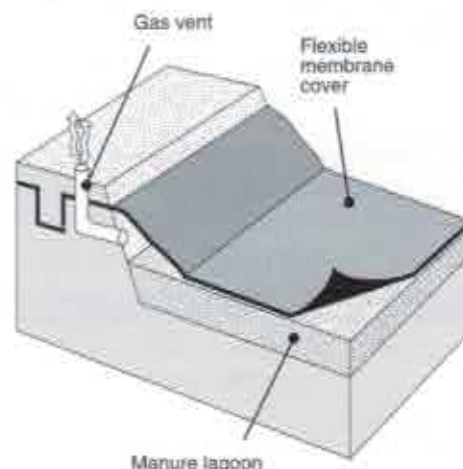


Figure 2. Manure storage cover for odor control.

Table 3. Odor control technologies.

SYSTEM	DESCRIPTION
Odor Control Technologies for Buildings	
Biofilters	Odorous gases are passed through a bed of compost and wood chips; bacteria and fungal activity help oxidize organic volatile compounds.
Biological and chemical wet scrubbers	Odorous gasses are passed through a column packed with different media types; water (and/or chemical) is sprayed over the top of the column to help optimize biological and chemical reactions.
Diet manipulation*	Enzymes added to diet to improve nutrient utilization; diets formulated to reduce crude protein content; or other changes in diets to enhance digestion.
Fat added to feed	Dust reduction and subsequent odor reduction by adding fat to the feed.
Manure additives*	Chemical or biological products are added to the manure.
More frequent manure removal*	Fresh manure (fewer than 5 days old) produces less odor than stored manure.
Nonthermal plasma	Odorous gases are oxidized when passed through plasma.
Oil sprinkling	Vegetable oil is sprinkled daily at low levels in the animal pens.
Ozone*	Ozone is added to the ventilation air to oxidize the odors.
Shelterbelts*	Rows of trees and other vegetation are planted around a building, thus creating a barrier for both dust and odorous compounds emitted from the building exhaust.
Windbreak walls*	A solid or porous wall constructed 10 to 15 feet from the exhaust fans will cause dust to settle out and will also help disperse the odor plume.
Odor Control Technologies for Manure Storages	
Aerobic treatment	Biological process where organic matter is oxidized by aerobic bacteria; mechanical aeration is required in order to supply oxygen to the bacterial population.
Anaerobic digestion	Biological process where organic carbon is converted to methane by anaerobic bacteria under controlled conditions of temperature and pH.
Floating clay balls	Floating clay balls cover the manure surface.
Geotextile cover	Geotextile membranes are placed over the surface of the manure.
Manure additives*	Chemical or biological products are added to the manure to reduce gas formation.
Natural crust	Dairy and sometimes swine storage basins can form a natural crust. This crust will reduce odor emissions.
Solid cover	Non-porous cover floated on, or suspended over, the liquid surface. Covers trap gases before they escape. Gases must be drawn off and treated.
Solid composting	Biological process in which aerobic bacteria convert organic material into a soil-like manure called compost; it's the same process that decays leaves and other organic debris in nature.
Solid separation*	Solids are separated from liquid slurry through sedimentation basins or mechanical separators.
Straw cover	An 8-12 inch blanket of dry wheat, barley, or other good quality straw floated on the manure surface reduces emissions.
Odor Control Options for Land Application of Manure	
Manure incorporation or injection	Manure is incorporated immediately after land application or manure is injected under the soil surface.
Chemical addition	Chemicals added during agitation to reduce hydrogen sulfide or ammonia emissions.
Odor Control Options for Other Odor Sources	
Mortality composting	Method to dispose of dead animals. Carcasses are buried in sawdust or some other organic composting material. Decomposition takes place very rapidly.

*Effectiveness of these technologies has not been verified.

Farm Management for Odor Control

Barn management

- Avoid manure build-up in corners and alleys
- Clean up spilled feed
- Use high fat feeds
- Spouts and covers on feed equipment
- Wet/dry feeders
- Keep barn floors as dry as possible

Outdoor lot management

- Maintain good drainage on the lot
- Restrict other runoff water from entering the lot
- Remove manure accumulation from fence lines and feeders

Manure storage

- Construct windbreaks around storage area
- Encourage crust development
- Install manure discharge pipes that enter below manure surface

Land application

- Apply manure when wind is blowing away from neighbors
- Apply manure on days that are windy and sunny between 10:00 a.m. and 4:00 p.m.
- Avoid application on weekends and holidays
- Inject manure or incorporate immediately
- Agitate the manure without spraying the manure into the air

New Facilities

New or proposed facilities should be designed to minimize odor emissions. Currently, there are no standard criteria for "odor reducing designs." However, any facility designed to reduce the surface area of manure exposed, control dust, capture and treat gaseous emissions, increase dilution of emissions, or treat manure could be considered as a design to reduce odor emissions. This may be as simple as building a deep pit manure storage versus having an outdoor manure storage structure, using a pull plug system with manure stored in an outside covered storage structure, or using a wet/dry feeder system to reduce dust. A new or proposed facility might also include plans for future odor control technologies should an odor problem ever arise. The design might include a designated space for a biofilter, liquid solid separation equipment, or plans for a windbreak. Solid manure systems also produce less odor per unit area than liquid systems and should also be noted on the odor management plan. Many new ideas and technologies are being developed to control odor. Those that prove successful should be integrated in future livestock and poultry facility designs.

Odor Complaint Response

One of the most important pieces of an odor management plan is the response protocol to address odor complaints. This is a critical issue from three perspectives. First, it is sometimes difficult to separate serious odor complaints resulting from excessive odor emissions from odor complaints registered by disgruntled neighbors during non-odor events. Second, it is difficult to determine how many valid complaints are needed to trigger the implementation of an odor control technology. And third, there must be some method for monitoring the effectiveness of the technology. The complaint response protocol will set up an odor monitoring plan and set guidelines for an acceptable number of odor events and some method to evaluate the effectiveness of an odor control technology. For this, it is critical to foster and maintain a good relationship with neighbors and other community members.

Item 1. Avoid Odor Complaints

Avoid odor complaints by making an effort to control odor emissions, including peak odor events such as manure agitation or land application of manure. These efforts and their perceived effect on odors should be documented.

Item 2. Establish a Relationship with Neighbors and Community Members

An effective complaint response protocol requires the input of neighbors and other community members such as environmental service specialists, county feedlot officers, and county and township officials. These individuals provide an honest evaluation of farm odor impacts. They could be listed on the odor management plan and help in the development of the complaint response protocol. A team approach fosters communication and flow of information which is critical to responding to complaints.

Item 3. Monitor Odor Events

Monitoring odor events will help verify odor complaints and identify odor sources. Monitoring might include scheduled drives around the farm perimeter with a notebook recording the date, time, and location of the monitoring and the strength of any odors that were detected. Other monitoring might include record keeping of odor events by neighbors or community members. Strength of odors can be recorded on a three point odor intensity scale where 1=detectable odors, 2=recognizable odors, and 3=very distinct and annoying odors.

Item 4. Set Acceptable Intensity and Frequency Standards

Since odors are a part of all livestock and poultry farming enterprises, it is impossible to expect 100% odor free air around the farm. However, frequent odor events of high intensity are unacceptable. Therefore, some reasonable frequency of odor events should be established. This frequency could include a given number of odor events per month or per year that are acceptable. Above this frequency, the odor management plan would be implemented. Establishing the acceptable frequency and intensity (how often and how strong) of odor events should be done with input from neighbors and community members so everyone is familiar with the goals of the farm.

Item 5. Evaluate the Odor Control Technology

After an odor control technology has been implemented, an honest evaluation of its effectiveness is needed. A complaint response protocol will outline evaluation

methods and techniques. This evaluation will most likely be similar to Item 3—Monitoring Odor Events.

Maintaining Odor Management Plans

An outline for an odor management plan is given on pages 7 and 8. This plan should be reviewed and adjusted as needed on an annual basis. Changes in farm operation and management; additions or modifications of buildings or manure storages; changes in ownership of surrounding property; or changes in local, state, or federal regulations may all be reasons for altering the odor management plan. The success of any farm operation can be measured by the avoidance of community conflicts and nuisance complaints. This requires a planned approach to odor management and good communication between the farm management and the community.

Air Emissions Plan for Dust and Other Gases

An odor management plan is only one part of an air emissions plan. A complete air emissions plan would likely cover hydrogen sulfide, ammonia, and dust. Unfortunately, little information is available on the emissions of these gases from livestock and poultry facilities or on effective control technologies.

Creating a complete air emissions plan requires documentation similar to an odor management plan where emission sources and control strategies are identified. A key difference between odor management plans and management plans for other gases or particulates is in the goal of the plans. Odor management plans are written to reduce the impact of odors on the surrounding community. Hydrogen sulfide management plans are written to reduce the concentrations of hydrogen sulfide at the property line to levels below 30 ppb or 50 ppb according to the *Minnesota Rules Chapter 7009.0080*. The goal for ammonia and dust management plans is to reduce the total loading of these constituents to the atmosphere (e.g., tons of particulates emitted to the atmosphere per year). These differences in goals result in a plan that would be similar to odor management plans in source identification and possibly control technologies, but would be different in monitoring protocol and the response to measured exceedances of the standards.

www.extension.umn.edu

FO-7637-C
2001

Copyright © 2000, Regents of the University of Minnesota. All rights reserved. For ordering information call (800) 876-8636.
Produced by Communication and Educational Technology Services, University of Minnesota Extension Service.

The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the University of Minnesota Extension Service is implied.

In accordance with the Americans with Disabilities Act, this material is available in alternative formats upon request. Please contact your University of Minnesota Extension Service county office or, outside of Minnesota, contact the Distribution Center at (800) 876-8636.

The University of Minnesota Extension Service is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation. Printed on recycled paper with minimum 10% postconsumer waste, using agribased inks.

Odor Management Plan

Farm Name: _____ Developed by: _____
 Date: _____

Listings of Farm Odor Sources and Descriptions (Refer to text pages 1-3.)

Odor Source	Description	Nuisance Potential high, med., low	Odor Management Plan
e.g. Manure Storage Basin	200 X 300 foot dairy earthen storage 100 feet from county road	high	A. Maintain crust by switching to straw bedding. B. Blow straw cover on in spring and maintain crust or straw cover throughout the season
1.			
2.			
3.			
4.			
5.			

Odor Management Plan (page 2) (Refer to text page 5.)

Complaint Response Protocol A complaint response protocol might include, but not be limited to, the following items:
1) Steps taken to avoid nuisance odors.
2) Steps to establish a working relationship between neighbors and community members.
3.) Odor event monitoring protocol.
4.) Defined frequency of acceptable odor events beyond which the odor management plan would be implemented.
5. Criteria for monitoring the effectiveness of the odor control technology / management.