Management and Environmental Considerations When Siting and Managing Mortality Composting Facilities

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Introduction

With livestock operations, one of the first considerations when addressing production and environmental practices is the collection, storage, and utilization of manure. One aspect that is often overlooked is the potential impact of farm facility siting, layout, and management on the environment, the neighbors, and the farm's operations. With proper planning, implementation, and maintenance adverse impacts can be managed with positive benefits in environmental protection, neighbor relations, and farm operations. As it is part of a farm's facility this also applies to a farm's mortality composting system. Therefore, while the information below has broader applications, it introduces the potential impact of mortality composting on the environment, the neighbors, and the farm's operations.

Another way to group a mortality composting facility's potential impact is into aspects related to water management, nuisance issues, and farm working conditions and efficiencies. Water management is a factor because when water comes in contact with materials such as manure, mortality, bare soil, etc., it has the potential to transport chemicals, microorganisms, and particulate matter. The pollution potential of this transport is largely dependent on the source (Table 1), destination, amount, and concentration. Delivery to vegetated areas with sufficient soil depth to allow nutrients and other water borne components treated by vegetation and soil filtering is usually considered beneficial and desirable. However, delivery directly to receiving surface and ground waters without sufficient pretreatment should normally be avoided.

Nuisance issues are a broad range of conditions that vary in scale from minimally noticed to strongly objectionable. They may also have significant impacts on farm operations. Personal perceptions play a role in determining how objectionable a condition is perceived. Often there is a distance factor that plays a significant role in nuisance factors. Odors should less be less objectionable as distance to neighbors increase. For some nuisances scale or magnitude is a factor. A little mud, or a few flies may be barely noticed. But excessive mud can hinder operations, and a large number of flies may generate complaints. Nuisance management can make the difference between good neighbor relations and complaints filed to regulatory authorities and follow-up inspections.

Farm operations impacts are related to the time, effort, and expense of mortality composting. It may be the difference between having to work in the dark and the convenience of electrical lights at the barn. Or it may be the lack of all-weather access to the facility delays immediate and proper disposal of mortality. Site locations, design, and management that lead to excessive nuisance complaints may require time and effort to address that could be used elsewhere.

Table 1. Relative water quality risk of contrasting feedstock

Feedstock	Nutrient content	Pathogen content	Relative water quality risk
Ground wood or bark	Low	Low	Low
Fallen deciduous leaves	Low	Low	Low
Ground woody yard debris	Low	Low	Low
Ground leafy yard debris	Medium	Low	Medium
Wood shavings with some horse manure	Low	High	Medium
Separated dairy solids	Low	High	Medium
Vegetable packing waste	Medium	Low	Medium
Vegetative food waste	Medium	Low	Medium
Mixed food waste	High	Medium	High
Bedding and manure	Medium	High	High
Concentrated manure	High	High	High
Livestock mortalities and slaughterhouse waste	High	High	High
Adapted from Brewer, L., N. Andrews, and D. Sullivan. Agricultural Composting and Water Quality. Publication EM 9053. Oregon Extension Service. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/39040/em9053.pdf. Based on authors' professional experience and judgment.			

General Approach to Addressing Concerns

Management practices or actions to address the potential impact of mortality composting facilities on the environment, the neighbors, or the farm's operations often have effects in the other two areas. For example, correcting excessively muddy conditions that drain directly to a stream will improve farm working conditions, reduce water quality impacts, and potentially reduce complaints from downstream neighbors. Given the fact that management practices can have multiple effects in the concern area and potential impacts with other parts of the operation, careful consideration should be given to the selection, implementation, and management of the mortality composting facilities. In addition to the information in this publication, assistance is available from various educational and service oriented organizations. Further, as the material presented is somewhat general in nature, local information sources, building, and zoning codes as well as environmental regulations should be considered.

When considering a new mortality composting facility or modifications to an existing facility the first step is to determine your needs. This is followed by considering your options and deciding which to implement and whether to do so all at once or over a period of time. Drawing out a sketch or general map of the farm and surrounding area may be helpful in this process. It should include items like buildings, fences, supply water sources, drainage ways, ponds, streams, neighbors, and visual buffers like tree lines.

After implementation, proper maintenance should be practiced to get maximum benefit of the planning and implementation process. Periodically how well the facilities work should be assessed and potential improvements considered.

Key Concepts

In the process just described there are some key concepts that should be kept in mind.

- **Keep clean water clean:** Minimize the amount of water coming in contact with potential pollutant sources.
- **Manage potential pollutant materials and areas:** Use practices that reduce pollutant transport by water.
- **Treat dirty water:** Contaminated water should be treated in some way
- **Minimize nuisance conditions:** Use practices that minimize annoyance factors for operation and neighbors.
- **Keep operation as inconspicuous to the public as possible:** An operation that isn't noticed does not receive complaints.
- **Make management and maintenance part of daily tasks:** The likelihood of system failure and resulting problems increases as management and maintenance decrease.

Water Runoff Management

Since very little can be done to reduce runoff volumes, the existing runoff must be managed. The three basic concepts of runoff management are to keep clean water clean, manage potential pollutant materials and areas, and treat the dirty water.

The idea is to prevent clean runoff water from entering potential pollutant materials and areas. The clean water that enters these areas can pick up nutrients, sediments, and microorganisms. Avoiding this is accomplished by redirecting the flow of runoff water. The runoff water that needs to be redirected comes from roofed areas or ground surfaces up-slope. Where water does not enter potential pollutant materials and areas, it is usually not necessary to redirect runoff.

During a rain, the water will do one of several things. It may evaporate back into the air. It may infiltrate into the soil. Or, it may move as surface runoff. Vegetation and surface depressions may provide temporary storage or retention of the water, but eventually it will evaporate, infiltrate, or run off.

To understand the factors that affect runoff volume the equation below is helpful.

Runoff Volume = (Inches of Rain - Infiltration - Evaporation) x Area of Concern

This equation shows that less rain and a smaller area of concern will reduce the runoff volume. Increasing infiltration and evaporation will also reduce the amount of runoff.

Unfortunately, it is usually difficult or impossible to control these factors. Rain and evaporation are weather conditions that cannot be influenced. Usually, infiltration is also beyond control. No infiltration occurs when rain falls on roofs and concrete surfaces. In vegetated areas, the vegetation serves to slow surface water movement, which increases the time for infiltration and evaporation to occur.

Because of the factors that influence runoff, it is difficult to predict volumes. However, looking at a couple of example situations can help to provide a feel for potential runoff volumes. The maximum runoff will be generated when infiltration and evaporation are zero. Assuming they are nearly zero can be a reasonable assumption for such areas as roofs and concrete surfaces. Under these conditions, a 1-inch rain generates 0.62 gallons of runoff water for each horizontal square foot of surface. This means that in a 1-inch rain, a 25- by 100-foot (2,500 square feet) roof area can generate 1,550 gallons of runoff water.

If you assumed that half the rainwater falling on grass either evaporated or infiltrated, the same 1-inch rain would generate over 13,000 gallons of runoff water per acre or 0.31 gallons per square foot.

Ground surface runoff

Surface diversions are usually used to redirect the runoff water from up-slope areas. These diversions catch the runoff water and divert the flow to an acceptable release point. At times unvegetated ditches may need to be converted to vegetated drainage swales so the drainage itself doesn't become a source of sediment through erosion. In certain situations, gravel-filled trenches with a perforated pipe may be appropriate. They are sometimes used in situations where it is desirable to redirect the flow of water that occurs beneath the ground surface.

Steps should be taken to prevent erosion and standing water in the diversions. When designing surface diversions, care should be used to consider not only the flow of water but also vehicle traffic. Since large volumes of water and significant flow rates are possible, care should be used where the ground runoff water is released to prevent erosion.

Roof runoff water

If the runoff is from a roof, there are two options. The first is to use gutters to direct the runoff water to downspouts. At each downspout, the water can be either released to flow away from the heavy use area or enter a pipe or drainage channel to flow to an acceptable release point. According to NRCS's Agricultural Waste Management Field Handbook (AWMFH) design recommendations, a gutter system should be designed for the heaviest 5-minute rain event that is expected to occur about every 10 years. In Arkansas, this means the northern counties should design for a 0.6-inch rain. The southern counties should design for a 0.65-inch rain. Most of Oklahoma would be about 0.63 inches (Figure 1). When the gutter system is used to prevent roof water from entering manure storage units, a 25-year 5-minute rain event should be used. In Arkansas, this means the northern counties should design for a 0.65-inch rain. The southern counties should design for a 0.75-inch rain. For eastern Oklahoma the design value would be about 0.7 inches.

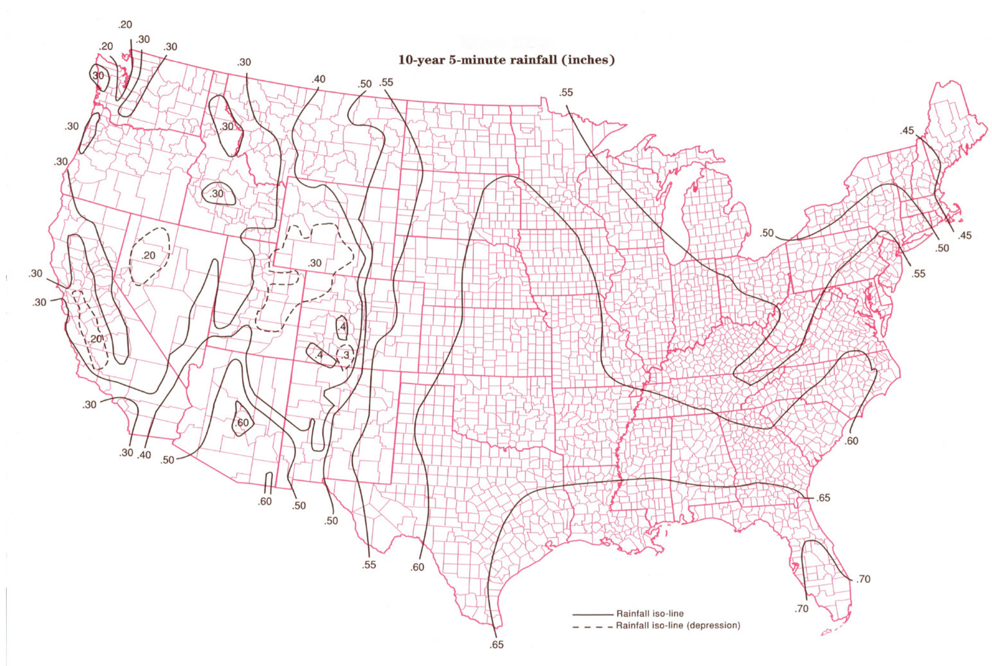

Figure 1. Rainfall intensity map in inches for a 5-minute event with an average recurrence interval of 5 years. Adapted from Part 651, Agricultural Waste Management Field Handbook. Chapter 10, Agricultural Waste Management System Component Design. USDA National Resources Conservation Service. (210–VI–AWMFH, Amend. 31, August 2009). http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=31529.wba

The second option is to use drainage channels under the roof eaves to catch runoff water and direct it around the area of concern to an acceptable release point. Drainage channels under the roof eaves should not be used if they would expose water to a potential pollutant source or there is less than a 12-inch roof overhang. In addition, if blowing rain is a concern, such as with a compost shed, unguttered roof runoff water may contribute to problems inside the buildings. Drainage channels may be open surface channels or gravel-filled trenches with perforated pipe in the bottom. All surfaces beneath roof eaves, including drainage channels, should be designed to move the water away from the building and to avoid standing of water. In general, they should be sloped at a 1 to 5% grade away from the building. All drainage channels should also be protected from erosion by vegetation, gravel or concrete.

Roof runoff control systems will often contain a combination of gutters and drainage channels as well as areas of unmodified drainage where the runoff water does not need to be redirected. The decision of where to use gutters and drainage channels is affected by owner preferences and site conditions. Larger roof areas require larger gutters and larger and/or more downspouts. Also, there are often concerns about snow and ice damage to gutters. With proper placement, the potential for snow and ice damage is reduced. (Figure 2)

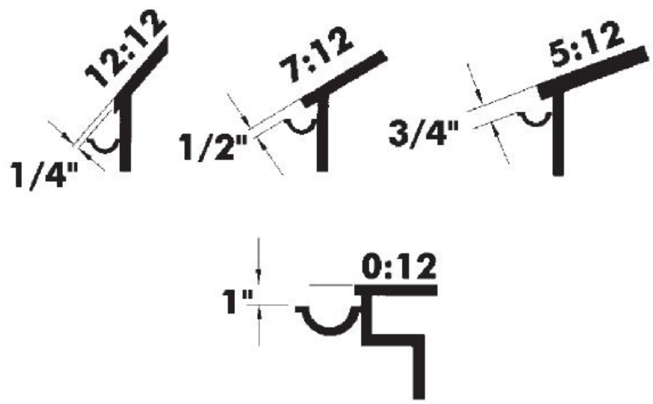

Figure 2. Proper gutter placement to protect gutters from snow and ice damage. Adapted from Fulhage, C., J. Hoehne, D. Jones and R. Koelsch. Manure Storages. Publication MWPS-18-S2. Midwest Plan Service. https://www-mwps.sws.iastate.edu/catalog/manure-management/sect-2-manure-storages from

Direct precipitation into potential pollutant materials and areas

Proper management of these areas starts with the design of the area itself. Ideally mortality composting would take place under roof and all ingredients and compost would be protected from the weather. However, for small farms and infrequent mortality events this is not usually practical or cost-effective. In some instances, Arkansas for example, if a compost ingredient contains manure the compost must be protected from the weather due to regulation interpretation.

If mortality compost piles will be exposed to the weather, feedstock and mortality compost piles should be sized and shaped to minimize the amount of water soaking into and potentially back out of the material. Piles should be shaped to encourage water to shed off the top of the pile rather than pond and soak into depressions. For large volume piles this is likely best achieved by forming windrows. If this is the case, the long axis of the windrow should run up and down the slope to minimize the ponding of surface water flowing into the pile. Many materials will tend to swell and seal to help with this process. For individual mortality, and small piles, using wire or wooden containment walls should help with the water shedding process.

For infrequent mortality events it may be possible and desirable for the compost pile to be surrounded by a grassed surface. For more frequent mortality events this is not feasible due to equipment traffic and need for all weather access requiring the use of compost pads and heavy use areas.

There will be situations where it is necessary to direct precipitation directly onto composting heavy use areas. These areas should be no larger than necessary. Excessively large areas take land out of other potentially productive uses and increase the volume of rainwater being exposed to the soil/manure mixture of the heavy use area. However, areas that are too small or poorly laid out will not meet composting storage and management needs. In addition, the flow of equipment traffic in the area should be considered when the placement of fences and gates is determined.

One of the biggest problems of these areas is getting them to support equipment traffic during the wet periods of the year. Reducing the volume of water and the time of exposure to the water helps these areas stand up to the traffic. The clean water diversions discussed earlier reduce the amount of water entering these areas. Proper surface grading helps to move the water off the area and prevent standing water. Recommended slopes range from 1 to 7%. Ideally a slope of 2 to 4% should be sufficient to ensure drainage without causing excessive erosion. Avoid steep slopes as they will cause the runoff to form gullies and washes. In addition, the distance water flows should be kept to a minimum.

In soils where clean water diversions and proper grading will not be sufficient to avoid excessively muddy conditions, practices such as gravel (with or without geotextile underlayment), coal ash products, or concrete are options. Remember that the best approach is to address drainage and clean water diversion problems first. Then, if necessary, consider constructing surfaces to support equipment traffic. As soils vary in their load carrying ability personal experience, and soils assessment should be consider when selecting composting sites. NRCS's site http://websoilsurvey.sc.egov.usda.gov provides access to the soil characteristics for the parcel of ground of interest.

Treating runoff water exposed to pollutant materials and areas

As it is very likely that at least some of the water that comes in contact with a potential contaminate then move across the land surface or into the soil, this water needs to be treated. Fortunately the natural processes of vegetation growth and soil biological and chemical processes provide this needed treatment if the processes are not overloaded and given time to work.

The first typical treatment and isolation approach is to provide sufficient horizontal and vertical distance to both isolate but also treat water exposed to potential contaminates. While recommended buffer distances vary, Table 2 provides some example values. Appropriate regulations should also be consulted.

Table 2: Commonly recommended minimal horizontal and vertical separation distances for composting and manure handling activities.

Sensitive area	**Minimum separation distance (feet)**
Property line	50-100
Residence or business	200-500
Well or other potable water source	100-200
Surface water (wetlands, steams, ponds, lakes)	100-200
Subsurface drainage pipe or drainage ditch discharging to natural water course	25
Water table (seasonal high)	2-5
Bedrock	2-5
Note: Required minimal separation distances will depend on pertinent regulations or state/local practices.	
Adapted from Rynk, R., et.al., On-Farm Composting Handbook. Publication NRAES-54. Northeast Regional Agricultural Engineering Service. https://www-mwps.sws.iastate.edu/catalog/home-acreages/farm-composting-handbook. Table 7.1 pg 65.	

The second treatment approach is collection and storage of water until it is land applied. In theory, this can be accomplished by a collection tank and buried field lines similar to a residential septic system. Another approach would be the use of storage ponds followed by either irrigation or honey wagon land application. Regulatory, practical, and economic considerations suggest against these approaches.

The most commonly recommended approach of treatment is for the water to uniformly flow across a vegetated surface so that sediments have a chance to settle out of the water and the water has a chance to infiltrate the soil. Often called filter strips, this process utilizes shallow slow water flow. Water evaporation is also likely encouraged further reducing water volumes to enter surface water bodies. The effectiveness of filter strips diminish if significant channelized flows occur.

A filter strip may require some earthwork before seeding. Often, however, existing pasture areas with well-established forage can serve as the filter strip. The width, or length of flow, of a filter strip is based primarily on the slope of the land in the strip. Steeper slopes require wider filter strips. As other factors are also considered in sizing filter strips your local NRCS office is a source of appropriate design guides for your location. As the soil biological and chemical processes are involved in the treatment soil depths should not be excessively shallow. Also a dense stand of grass or other suitable vegetation is needed to slow water flow and utilize nutrients extracted from the treated water.

Filter strips require some management for successful and continued operation. As the objective is to maintain a uniform stand of vegetation and have the runoff flow as a uniform sheet of water across the surface, overgrazing and traffic damage to the vegetation needs to be avoided. Excessive vegetative growth and sediment deposits may also cause channelized flows to occur. Fertilizer requirements for filter strips may also be different from surrounding areas. Therefore, it may be necessary to occasionally mow and remove plant material and sediment that has been deposited in the filter strip.

Normally, one edge of a filter strip is adjacent to the downslope edge of the runoff area so that the water to be treated flows as a uniform sheet into the filter strip. At times the topography of the site does not allow this to occur. In these situations grassed drainage swales may be appropriate to transfer water to the filter strip. The vegetation in drainage swales is similar to that of filter strips. This combined with the need to avoid erosion mean the swale should be wide and shallow. If the filter strip elevation is above that of the water source area, demonstrations have shown the promise of using short term (a few days) water storage, pumps, and land application to the treatment vegetation. As this is a relatively new approach, requires the use of a pump, and potentially a permit, it should probably only be used if an alternative composting area could not be located.

Nuisance Issue Management

Identifying and managing nuisance issues associated with mortality composting requires an understanding of what constitutes a nuisance and realizing that the annoyance level is greatly determined by who is making the determination. The perspectives of the operator of the morality composting site, the operator's spouse, their farming neighbor, and non-farming neighbor are all likely to differ. What the operator perceives as a nuisance will likely get addressed. However, not addressing the concerns of others may likely generate complaints that result in poor neighbor relations, calls to regulatory authorities, and even legal action.

Proper management

The first general approach to manage potential nuisance issues is to properly manage the mortality composting process. Immediately incorporating the mortality into the compost pile means it is not available to generate odors, breed flies, or be taken home by the neighbor's dog.

After the mortality is added to the pile, if it is properly surrounded (top, sides, and bottom) by bulking material there should be no leachate from the piles, odors will be significantly diminished, and the pile should not attract vectors such as flies and various carnivores such as opossums, raccoons, coyotes, and the neighbors' dogs.

One of the challenges with carnivores is that it appears that when mortality is always completely and adequately covered they likely will not become a problem. However, carnivores appear to be easily trained by a few events of poor management to dig into the pile looking for the mortality. This problem can be reduced by placing the compost pile within a bin or fenced area. Success against coyotes has been reported by the use of a single strand electric fence with a wire height of about 18 inches. These barrier approaches may be effective. However, continuous proper management to avoid the problem is recommended.

Distance and visual buffering

Another approach is to isolate the mortality composting operation from individuals that might consider it a source of nuisances. The first approach to providing this isolation is separation distance to reduce the potential for nuisances like odors from being noticed. Table 1 provides some suggested values. While distance may also help somewhat to hide or make less noticeable the operation the second isolation method of visual barriers of bushes, trees, building are more effective at hiding or at least helping the operation blend into the background and be less noticeable. The idea is, if the mortality composting operation is not noticed, it is much less likely to be perceived as a source of nuisances.

This concept of visibility typically being related to the perception of something being a nuisance, suggests the idea of making sure that the mortality composting operation, as well as the entire farm, be neat, clean, and as visually appealing as possible. This is an application of the idea that if something "looks bad it must be bad." The importance of appearance is likely to increase if the neighbors and road traffic aren't familiar with normal farming practices.

Operational Considerations

Operational considerations deal with identifying what is needed, and how to implement and manage practices to satisfy those needs. The first step in this process is to develop a good estimate of the number, size, and frequency of the mortality to be composted. This information then helps to decide between a composting system better suited for managing low-volume, low-frequency mortality or a high-volume, high-frequency mortality. This helps identify both the size and expense of an appropriate system. This size, in terms of area requirements, will help to determine the best location on the farm to compost mortality. In addition to area requirements and the concepts discussed above, additional factors that should be considered are providing lights for after dark activities, and a ready source of water for any needed compost moisture adjustments. Finally, do the management requirements fit into daily management tasks.

The basic idea is, if the composting system is poorly designed, located, inconvenient to manage, or doesn't match operator preferences, the likelihood of proper management taking place goes down. At the same time the likelihood of negative impacts on the environment, neighbor relations, and farm working conditions increases.

Summary

For a mortality composting system to be effective and fulfil its promise as a mortality management system, proper planning, design, implementation, and management are essential. To do so, many interacting factors will need to be considered. However this challenge can be met if the following general principles are followed.

- Keep clean water clean.
- Manage potential pollutant materials and areas.

- Treat dirty water.
- Minimize nuisance conditions.
- Keep operation as inconspicuous to the public as possible.
- Make management and maintenance part of daily tasks.

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