Guide to Agricultural Composting

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Acknowledgements

The purpose of this Guide is to encourage and safeguard agricultural composting. Towards these ends, the Massachusetts Department of Agricultural Resources (MDAR) and the Department of Environmental Protection (MassDEP) have developed a regulatory framework that provides appropriate resource protection without unduly inhibiting farming activities.

The guide was originally written by Sumner Martinson of MassDEP and the late Maarten van de Kamp of MDAR. It has been updated in 2010 by Saiping Tso of MDAR.

Much of the material presented in these guidelines was taken from the "Leaf and Yard Waste Composting Guidance Document" produced by the Massachusetts Department of Environmental Protection.

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INTRODUCTION

These guidelines are intended for Massachusetts farmers engaged in agricultural composting and, more specifically, for those who wish to compost materials not generated from their own farming operations. Massachusetts recognizes and encourages on-farm composting; however, there are environmental considerations and state regulations that dictate circumstances when a farm may need either a permit or a compost registration.

Ultimately the composting process should lead to a useable, saleable, quality material that has value for land application. This guidance document describes facets of composting that all operators should understand before undertaking the practice. Part I of the guidance points out state regulations that pertain to composting, and the registration process. Part II describes the science of composting, which is a biological process and warrants a basic understanding. Part III describes the major technological methods of composting. Parts IV and V identify planning considerations when selecting and then preparing a compost site. Part VI describes operation and maintenance procedures necessary for successfully managing a compost operation and, finally, Part VII outlines the information to include in preparing a Compost Plan for Agricultural Composting Registration from the Massachusetts Department of Agricultural Resources ("MDAR").

PART I: REGULATIONS AND REGISTRATION PROCESS

In general terms, composting is defined as the accelerated biodegradation and stabilization of organic materials under controlled conditions."[1] Agricultural composting, defined as "the composting of certain organic materials, including animal manures, vegetation and food processing by-products, for beneficial (on farm or off-farm) agricultural use,"[2] is a distinct sub-set of composting activity. Depending on the scale of the operation, siting, types and sources of materials being composted, agricultural composting may be viewed as an agricultural practice or as solid waste management. This important distinction has significant financial and legal implications for agricultural composters.

Regulatory Background

With a few, specific exceptions, solid waste facilities require a "site assignment" from the Massachusetts Department of Environmental Protection ("MassDEP"). At issue in past years has been whether farms, when undertaking the time-honored agricultural practice of composting "wastes" from their own operations and other sources, have been engaging in solid waste management activities and are, thus, subject to the regulatory control of MassDEP. In order to recognize the legitimate agricultural nature of such on-farm composting operations, and avoid unnecessary regulatory control, MassDEP and MDAR have undertaken the joint responsibility for agricultural composting registration oversight.[3] Specifically, MassDEP has granted conditional exemptions under the Solid Waste regulations (310 CMR 16.00) for agricultural composting operations, and MDAR has established an Agricultural Composting Registration process.

[1] 330 CMR 25.00
[2] 310 CMR 16.02
[3] *See* 330 CMR 16.05(4)(c), 330 CMR 25.00 and M.G.L. c. 21H, Sec. 7.

Department of Environmental Protection Regulations

To determine whether a farm qualifies for a conditional exemption under MassDEP's Site Assignment Regulations for Solid Waste Facilities, familiarity with pertinent sections of the regulations and some definitions are necessary. These have been excerpted below.

To read the regulations in their entirety, go to the MassDEP website (www.mass.gov/dep) or obtain copies from the State Bookstore.

> *310 CMR 16.00: Site Assignment Regulations for Solid Waste Facilities*
>
> *16.05(4) Conditionally Exempt Composting Operations. The following composting operations and activities do not require a site assignment provided the operation incorporates good management practices, is carried out in a manner that prevents an unpermitted discharge of pollutants to air, water or other natural resources of the Commonwealth, and results in no public nuisance:*
> *…..*
>
> *(c) Agricultural Waste Composting. A composting operation for agricultural wastes, when located on a farm engaged in "agriculture" or "farming" as defined in M.G.L .c. 128, Sec. 1A. Such composting operation may, in addition to agricultural wastes, utilize the following compostable materials, provided the operation is registered and complies with policies of the Department of Agricultural Resources:*
>
> 1. *leaf and yard waste;*
> 2. *wood wastes;*
> 3. *clean newspaper or cardboard;*
> 4. *clean, compostable (i.e. thin) shells, and clean bones;*
> 5. *non-agricultural sources of manures and animal bedding materials.*
> 6. *less than 20 cubic yards or less than ten tons per day of vegetative material; and*
> 7. *less than ten cubic yards or less than five tons per day of food material.*

Role of the Department of Agricultural Resources

MDAR is responsible for administering an Agricultural Composting Program to register those operations that qualify for the "Agricultural Waste Composting" exemption, above. The program regulations are found in the regulations promulgated at 330 CMR 25.00 (see Appendix A). Farms registered with MDAR attain status as "an agricultural operation conditionally exempted from site assignment as a solid waste facility." This agricultural composting registration recognizes the legitimate agricultural nature of such on-farm composting operations, resulting in minimal MassDEP regulatory control and exemption from related permitting requirements.

An agricultural operation only needs to register with MDAR if it is planning to bring waste materials on to its property from off-site to compost with waste materials which are generated on-site. In order for MDAR to register an agricultural operation as an agricultural composter, the operation must be an agricultural unit, as defined in M.G.L. c. 128 Sec. 1A (see Appendix B).

The agricultural unit can only compost "agricultural wastes" and other compostable materials that are allowed by MassDEP regulation. The definition of "agricultural waste" follows below; the other types of materials allowed are those listed above (items 1 – 7).

> "Agricultural waste" is defined as "discarded organic materials produced from the raising of plants and animals as part of agronomic, horticultural, or silvicultural operations, including but not limited to animal manure, bedding materials, plant stalks, leaves, and other vegetative matter and discarded by-products from the on-farm processing of fruits and vegetables." (310 CMR 16.02, and 330 CMR 25.02).

Any agricultural operation which is only composting its own on-site generated waste materials does not need to register with MDAR. Agricultural composters considering materials from sources not listed in 310 CMR 16.05 should be aware that use of such materials may require a Determination of Need or Beneficial Use Determination from MassDEP. Composters should contact their regional office for guidance on this issue. Contact information is provided in Appendix E.

Agricultural Composting Registration Process

Farm operations that qualify for an Agricultural Composting Registration ("Registration") with MDAR need to fill out the "Agricultural Composting Registration Application Form," which can be found on the MDAR website (www.mass.gov/agr/programs/compost/index.htm) or obtained by calling the MDAR office. The compost "plan" submitted with the application, should follow the principles laid out in this document, "Guide to Agricultural Composting."

Application forms are submitted to MDAR, at which point a site visit will be requested in order to view the compost location. If a Registration is granted, a Certificate of Registration will be mailed to the applicant that is valid for a period beginning with the actual date of issuance and ending on the following March 31st. The Registration allows the registrant to compost the materials specified, in the manner and location described in the application. Thereafter, the registrant will receive an Annual Report form from MDAR to be filled out and returned to MDAR prior to April 1 in order to continue the registration for one year (April 1 – March 31). The Annual Report allows MDAR to track any changes that may have occurred in the operation, such as: volumes or types of material being composted, end-uses of the finished product, changes in contact information, etc. The registrant shall also submit information to MDAR upon request to ensure compliance with 330 CMR 25.00. MDAR may charge a fee for a Registration as permitted by law. A fee may be required for initial registration and for each annual renewal subject to an approved fee schedule.

In addition to the site visit and compost plan submitted with the Registration application, MDAR may take other factors into consideration before issuing an Agricultural Composting Registration. MDAR and MassDEP must determine whether the farm is exempt from MassDEP site assignment regulations (310 CMR 16.00). Answers to the following types of questions are considered when assessing suitability of the agricultural exemption:

- Is the composting operation located on a farm engaged in 'agriculture' or 'farming' ? Is the farm a genuine agricultural, commercial enterprise ?

- Are only materials described as allowable under 330 CMR 16.00 and 330 CMR 25.00 to be composted?
- How integrated is the composting operation into the farming operation ? Is composting a major or minor activity in relation to the entire agricultural operation, in terms of labor inputs and gross revenue ?
- How much of the compost feedstocks are provided by the farm ? Does the operation import most of the materials for composting ? How much of the compost is used on the farm ?
- What are the characteristics of the neighborhood ? Is the operation located in a rural or residential neighborhood? What is the proximity of the proposed compost operation to neighbors ? What type of roads provide access to the farm ? Is the site at least 50 feet from the property line ? Is the site hidden from neighbors by distance and screening ?
- What is the composting knowledge base of the operator ? Has the operator completed a basic course in composting ? Does the operator have the time to devote to managing the operation ?

Once the Registration is issued, the registrant must ensure that the agricultural composting operation remains in compliance with 310 CMR 16.00 and 330 CMR 25.00. Specifically, the registrant must comply with the provisions of 330 CMR 25.05, which provide the following:

> (1) Agricultural composting facilities must be secure from illegal dumping of waste materials.
> (2) Composting operations shall comply with all state and local regulations governing agricultural composting including those which relate to siting requirements (310 CMR 16.00) and the Department's Agricultural Compost Guidelines.
> (3) The operation of the composting facility must be done in a manner to minimize odors, noise, drift of materials, and risk to humans or the environment.
> (4) All demonstration composting facilities must be available to the Department for educational purposes on such terms as the Department may require, for the purpose of complying with M.G.L. c. 21H, § 7B.
> (5) If an agricultural compost operator makes nutrient claims of their finished compost material, then such operators are subject to M.G.L. c. 128, §§ 64 through 83 and, 310 CMR 15.00.

It is important to remember that an agricultural composting operation is not automatically entitled to a Registration simply because it is deemed to be an “agricultural” or “farming” operation. An agricultural composting operation must comply with the requirements set forth in 310 CMR 16.00 and 330 CMR 25.00. MDAR is authorized to suspend or revoke a Registration if it “finds that any portion of the Agricultural Composting Registration application includes false or misleading information, or the operation of a registered composting facility is in violation of the regulations or guidelines, or is acting not in the best interest of Massachusetts agriculture…” *See*, 330 CMR 25.06. This suspension or revocation of the Registration will also revoke the exemption status and thereby the operation will be required to comply with MassDEP Regulations for Determination of Need for Site Assignment as set forth in 310 CMR 16.05(4).

PART II: BASIC COMPOST SCIENCE

Composting is a managed process which utilizes microorganisms naturally present in organic matter and soil to decompose organic material. These microorganisms require basic nutrients, oxygen, and water in order for decomposition to occur at an accelerated pace. The raw materials going into the compost are often referred to as "feedstock." The end-product, compost, is a dark brown, humus-like material which can be easily and safely handled, stored, and applied to land as a valuable soil conditioner. The composting process is dependent upon several factors, including: the population of microorganisms, carbon to nitrogen ratio, oxygen level, temperature, moisture, surface area, pH, and time. These factors, which are described below, are dependent upon one another and understanding them is important for managing a successful compost operation.

Microorganisms

Microscopic organisms are responsible for decomposing organic materials, using it as food, and giving off oxygen, water vapor, and heat in the process. They multiply rapidly and decompose most efficiently when they have food (i.e., compost feedstock) containing balanced nutrients, water, ample oxygen, and favorable temperatures. It is the composter's responsibility to maintain a proper balance of these conditions in order to promote microbial activity and hasten the decomposition process.

Nutrients – Carbon to Nitrogen Ratio (C:N Ratio)

The availability and proportion of nutrients, in particular carbon and nitrogen, can be a limiting factor in the composting process. Microorganisms require carbon for energy and nitrogen for protein synthesis in order to grow and multiply. The rate of decomposition is dependent on the balance of carbon to nitrogen in the feedstock. For rapid decomposition, the ideal carbon to nitrogen ratio is 30 to 1 (30:1). That ratio represents 30 parts carbon to 1 part nitrogen by weight. In general, a range of 20:1 to 40:1 is considered optimum.

With a ratio of greater than 40:1, nitrogen becomes the limiting factor, and the rate of decomposition slows. Examples of materials with high C:N ratios are: dry leaves, sawdust, woodchips, and paper products. Carbon-rich materials tend to be dry and porous. These may be mixed with lower C:N materials to achieve an overall C:N ratio in the optimum range.

With a C:N ratio lower than 20:1, the excess nitrogen may be given off as ammonia or nitrous oxide. The resultant loss of nitrogen will lower the nutrient value of the end product. Examples of materials with low C:N ratios are: poultry manure, fresh grass clippings, and food waste. Nitrogen-rich materials tend to be wet, dense, and are often odorous. Therefore, it is important to mix these with high C:N ratio materials to increase the carbon content for the microorganisms, and also to absorb excess moisture and provide a bulking agent to achieve more pore space and oxygen in the pile.

Oxygen

The microorganisms that are primarily responsible for rapid decomposition are aerobic (oxygen-needing) organisms. If oxygen content falls below 5%, these aerobic organisms die off and are replaced by anaerobic organisms (which do not require oxygen). Anaerobic organisms operate less efficiently, resulting in a slower decomposition rate. In addition, the by-products of

anaerobic digestion are methane, ammonia, and hydrogen sulfide, which can result in strong, unpleasant odors.

If sufficient oxygen is maintained during the compost process, odors can be kept to a minimum and rapid decomposition can be maintained. This is most commonly achieved by turning the composting windrow or pile to introduce more oxygen into the mixture. However, other means of aeration exist, such as by pumping air into a compost pile through perforated pipes.

Moisture

Microbial activity occurs in a film of moisture on the surface of the organic material. The moisture is required to dissolve the nutrients utilized by microorganisms and to provide a suitable environment for population growth. Optimal moisture content for composting materials is 40-60% moisture, by weight. Too little moisture will inhibit microbial activity and slow down the composting process, while too much moisture will restrict the flow of oxygen because all pore space is taken up by water instead of air, and anaerobic conditions will begin to develop. If oxygen levels get too low, the compost will need to be turned.

Temperature

Heat is generated as microorganisms decompose organic material. Therefore, temperature is the best indicator of the rate of decomposition occurring in a compost pile. There are two ranges of temperature within which most of the compost process happens. Each range is based on the types of microorganisms most active at those temperatures. Both the mesophilic range (50-105°F) and the thermophilic range (over 105°F) supports microorganisms that decompose organic materials, but the most active phase of composting happens mainly in the thermophilic range. It is also in this range that pathogens and weed seeds are destroyed. A temperature of 131°F or above must be maintained for a minimum of 3 days in order to destroy human pathogens. Most weed seeds are destroyed at 145°F.

As temperature exceeds 140°F, the rate of decomposition begins to decline as a less-efficient class of thermophilic organisms dominates. It is, therefore, recommended to maintain temperatures between 100-140°F for efficient composting during the active phase. When temperatures move out of the optimum range, it is usually because the level of oxygen has dropped too low or moisture level is no longer optimal (either too dry or too wet). Monitoring the temperatures in a composting pile provides a good guide as to when remedial measures may be needed to maintain or return to efficient composting conditions. Turning the compost piles greatly helps in moderating temperatures.

Surface Area/Particle Size

The activity of microorganisms during decomposition occurs on the surface area of organic material. With smaller particles, there is greater surface area per unit volume of material on which biological activity can occur. Also, nutrients are more readily available when the material is physically broken down. Thus, compost feedstocks with smaller particle size, such as shredded leaves as opposed to un-shredded leaves, will decompose more quickly. It is important to keep in mind, however, that materials with very small particle size, such as sawdust, can become anaerobic due to compaction and restricted oxygen flow.

pH

The composting process yields an end-product with a near neutral pH, regardless of the pH of the beginning feedstock materials. Normally it is not necessary to raise the pH by adding lime or ashes and, in fact, doing so may only raise the pH too high, which results in the formation and loss of ammonia.

Time

Composting is an accelerated decomposition process; however, the length of time it takes to go from raw materials to stabilized, finished compost can vary considerably. If all the above basic conditions are maintained at optimal levels, then compost times can be as short as a few weeks. If, on the other hand, piles are turned infrequently, or the C:N ratio of the mixture is too high, then composting can take a year or more.

There are two main phases to composting. The first phase is the most active phase of composting. This is where temperatures fluctuate between the thermophilic and mesophilic ranges and decomposition is rapid. A newly formed compost pile will quickly reach high temperatures and then as microbes use up the available oxygen, they will become less active and temperatures will drop. Introducing more oxygen into the pile by turning will cause the microbes to multiply rapidly again and the active phase will continue until oxygen is again depleted. This cycle will repeat – temperature drop, aeration, temperature rise – until all the easily digestible organic material is consumed by the microbes. When temperatures do not again rise after turning, then the compost is ready for the "curing" phase.

In the curing phase, different populations of microbes continue to decompose but at lower temperatures. This phase can last one to several months, during which time the compost becomes stabilized in the sense that by-products, such as ammonia, are no longer being generated in amounts that would be harmful to plants if compost were applied to the soil.

PART III: COMPOSTING METHODS

There are four basic composting methods, three of which will be discussed here. The fourth, passive composting, is more of an unmanaged composting method that is difficult to do without producing odors and requires very long composting times.

Windrow Composting

Compost is formed into long, narrow piles. This is the method used most often for on-farm composting. Width and height of windrows depends on the equipment used to turn and aerate the piles, and lengths are usually based on area constraints of the site. Most farms turn with a front end loader or tractor. The size of the windrows will be determined by the reach of the equipment. Specialized windrow turners that turn piles in place often require wider, lower piles ranging from 3–9 ft high and 9–20 ft wide. Windrows turned by front-end loaders can be as high as the operating reach of the bucket, typically between 6–10 ft high and 10–20 ft wide.

Turning frequency will vary depending on the characteristics of the feedstock and weather conditions. As decomposition progresses, the piles will shrink in size from 25% to 75% of the original size depending on the density of the original mix. Two or more windrows may then be combined to make room for new raw materials.

Windrow composting is a year round activity. If interior pile conditions warrant turning in the winter, the operator should select a day when the temperature is above freezing to turn the piles, if possible.

Windrow covers, which are basically specialized blankets laid on top of a windrow, can be used to retain moisture and heat, contain odors and dust, and prevent animals from burrowing into the piles.

Aerated Static Piles

A base layer of porous material, like woodchips, is formed around lengths of perforated pipe. Raw materials to be composted are thoroughly mixed and then formed into piles atop the base layer. The pile may be topped with a geotextile cover or with a layer of finished compost to help retain odors, heat, and moisture. The piles are not turned, but rather aerated by mechanical blowers that force air into the piles via the pipes.

In-Vessel Composting

This method utilizes a variety of aeration techniques, all of which involve containment of the compost. The degree of containment can vary from a three-sided bin, with or without a roof, to a fully enclosed rotating drum. Mixing and aeration can be accomplished through the simple act of moving the compost from one bin to another using the bucket of a front-end loader, or by a wide range of technologies involving mechanical turners and forced aeration.

PART IV: SITE SELECTION

Proper site selection is a prerequisite to the establishment of safe and effective composting operations. The location of a composting operation directly impacts the amount of site preparation required and the measures needed to satisfy environmental and regulatory requirements.

Protection of Water Resources

Sites need to be evaluated for their potential impact on water resources. Of primary concern are proximity to public water supplies, wetlands, floodplains, surface waters, and depth to groundwater.

1) Sites must not be located within 400 feet (Zone I) of a public drinking water supply well or within 250 feet of a private well. For sites located within a Zone II or interim wellhead protection area (1/2 mile radius), MassDEP may require that extra precautions be taken in the design or operations depending on the quantities and types of material to be composted. Sites within Zone II may not be allowed under certain circumstances.

2) Operations must be sited in accordance with the Massachusetts Wetlands Protection Act. Under the wetlands regulations, siting of composting and storage areas is considered to be "normal improvement of land in agricultural use" when it occurs on land in agricultural use when it is directly related to the production or raising of certain agricultural commodities, and when it is undertaken in such a manner as to prevent erosion and siltation of adjacent water bodies and wetlands.

3) Sites should be located at such a distance to ensure that there will not be any potential adverse impacts from compost site runoff into surface waters.

4) Soils should be permeable enough to minimize runoff, yet capable of filtering drainage water. Excessively drained soils (e.g., sand) should be avoided if possible, as they may lack the physical properties necessary for effective filtering of potential contaminants. Highly impermeable soils (e.g., clay) should also be avoided if possible, as this may lead to poor site drainage and excessive runoff or erosion.

5) Sites should be avoided where groundwater rises closer than 4 feet or where bedrock is closer than 5 feet from the surface. Such conditions may lead to an operating surface that is too wet, and it increases the potential for nutrients to leach into groundwater.

Buffer to Sensitive Land Uses

With the recent rate of Massachusetts land development, many farmers are encountering new neighbors who like the idea of living next to a farm, but not the odors and noises of a farm. In these situations, the close proximity of residences, schools, or parks, may actually warrant the use of composting instead of the alternative practices of spreading or stockpiling raw manures. However, management of a composting site becomes especially critical when sensitive land uses are nearby.

Buffers, in the way of distance and/or visual screens, can go a long way toward reducing the real or perceived aggravations of noise, odor, litter, and aesthetic objections often associated with

composting operations. A distance of at least 250 feet from the nearest residence to the composting area is recommended, and the composting site should be at least 50 feet from the property line. More importantly, the buffer must be adequate to satisfy reasonable neighbor concerns. Keep the activities as far away from the property line as possible.

Area Requirements

Sites must be of adequate size to handle the projected volume of material to be composted. There are no standards in area requirements for composting, because with each set of technological and design options, there is a different area requirement. The main point is that an operation should not have an unmanageable volume of materials on site. In general, the less-intensively compost piles are managed, the more space is required because composting times will be longer. If piles are turned frequently or if air is pumped into static piles via perforated pipes, then composting times will be reduced and a smaller area will be required for a given volume of material.

Besides the actual footprint of the compost piles or windrows, consideration must be made for the area required for drop-off and mixing of materials, equipment maneuvering, curing areas, storage of finished compost, and buffer areas between the compost site and sensitive land uses.

Topography

Site preparation can be a significant startup cost for composting operations. Sites that are open, nearly level, and needing minimal surface preparation are preferable. A gentle slope (1-3%) is optimal to allow water to run off and prevent ponding. Even on gentle slopes, grading and surface preparation may be required where existing soil conditions and grades do not allow for proper drainage or support of machinery during wet periods.

Composting on steep slopes may impede the maneuverability of equipment, and can cause runoff and erosion problems. These sites should be avoided because of prohibitive costs associated with extensive cut and fill to grade the site appropriately.

Accessibility

Compost operations should be readily accessible to all vehicles and equipment normally expected on the site. Sites must be secure from indiscriminate access that might lead to potential vandalism or dumping of unwanted material. If the primary means of entry onto the farm is near many residences or other sensitive land uses, consider alternate, more remote entrances for trucks associated with the compost operation, if possible.

PART V: SITE DESIGN

Once selected, the compost site must be designed to promote efficient operation and to minimize adverse environmental impacts. Design requirements will vary with the method of composting, type of equipment employed, and the physical characteristics of the site. Farmers should consider the following issues when planning for composting significant volumes of materials.

Surface Preparation

The most common method of on-farm composting involves forming windrows that are turned with a front-end loader. This requires a surface capable of handling frequent, heavy equipment that can stand up to the scraping action of the bucket and to the rutting caused by tires. Depending on soil and drainage characteristics, it may be necessary or advantageous to construct a compacted gravel pad or an impermeable asphalt or concrete pad on which to mix the materials and form the windrows. Impermeable pads are recommended where soils are highly permeable or groundwater rises to within 4 feet of the surface.

If rutting occurs, the pad should be graded to eliminate ponding. Standing water at the base of windrows can lead to anaerobic conditions in the pile and result in odors. Ponding due to rutting caused by equipment should be avoided at all costs.

Drainage and Runoff Management

If the compost is to be formed into windrows, the windrows should be oriented up and down the slope rather than across the slope so that rainwater can flow between the rows. The runoff that leaves the compost area must be managed to prevent erosion downslope, and runoff should not enter surface waters without adequate filtering or detention time to remove particles and nutrients. A simple way to slow down runoff and remove contaminants is to keep a fairly level, wide, grassed area between the compost pad and any surface water. More elaborate systems comprised of diversion ditches and detention basins may be warranted if topography and layout do not allow for a simple vegetative treatment area.

Additionally, any runoff coming onto the compost area from uphill should be diverted around the site to keep the compost area as dry as possible. Berms, diversion ditches, and grassed waterways can be constructed to keep uphill water from flowing onto the compost site.

Roads

Access roads should be designed to make drop-off and pick-up of material as easy as possible. They should be designed for a circular traffic pattern where feasible. Roads should be capable of supporting delivery and fire vehicles during all four seasons, and designed to minimize erosion and dust.

Visual Screens

Visual screens should be considered for farms located in more populated settings. Protecting the aesthetic integrity of the neighborhood will go a long way in reducing opposition to composting operations. There are many options for blocking visibility from neighbors and public roads, such as: planting or leaving in place a dense thicket of trees or tall hedges, constructing a high earthen berm, building a fence, or strategically placing outbuildings and other farm structures.

Access Control

Controlling access to the site prevents illegal dumping and vandalism. The level of security required is dependent upon the potential risk for illegal behavior. Gates, fences, or cables at access points would prevent easy entry. Natural barriers are also good inhibitors.

Signs

While most farm-based compost operations will not need signs, those operations that are highly visible or that encourage drop-off by individuals may benefit from appropriate signage. A sign could be posted at each entrance indicating the operation name, nature, and operator. On-site signs would be helpful in directing vehicles to unloading and pick-up areas, identifying traffic patterns and prohibited areas.

On-Site Water Supply

Operations may need to have a water supply for wetting the piles if they become too dry, and for fire protection. Possible sources include ponds, streams, wells, public water supply, or water trucks. Water requirements would be largely based on the moisture content of the incoming feedstocks and to a lesser degree on weather conditions during composting.

PART VI: OPERATION AND MAINTENANCE

Even well designed operations, located on choice sites will prove problematic if not properly operated and maintained. Composting involves "managed" decomposition, so it is crucial to closely monitor every aspect of the compost operation in order to avoid unexpected and unwanted results, which can quickly lead to strained relations with neighbors and local officials, environmental violations, and an undesirable end-product. The following briefly describes key areas of management for the successful compost operator.

Quality Control of Incoming Materials

The types and quantities of materials to be accepted at the operation should be clearly stated, especially for deliveries of off-farm materials. This practice will help settle disputes later if unwanted material (contaminants) should be found in a delivery or if the volume of material dropped off is more than can be effectively handled. However, despite making these conditions explicit to the suppliers of feedstock materials, every delivery to the farm should be inspected for quality. A small amount of contaminants can be expected, such as pieces of plastic in yard waste deliveries, and they should be removed as much as possible before materials are mixed and composted.

Equipment and Staffing

The equipment required for composting depends on the composting method used. The current composting literature is rich with descriptions of composting methods and equipment, so one can refer to it for detailed discussion. A front end loader is the most basic piece of equipment that is required. Additional equipment might be necessary for the following activities: delivery and transport to and from the site; mixing materials; turning/aerating piles; monitoring temperature; watering; screening; grinding; bagging; spreading finished compost. Sharing low-use equipment (such as screeners) with nearby farms and modifying existing equipment are ways to cut costs. As with any farming operation, it is imperative that all equipment be maintained in good working condition.

Staffing needs will depend on the type of equipment used and the volume of material processed. It is desirable to have an operator on-site to log and inspect deliveries of incoming materials, and it becomes critical when incoming materials are putrescible and require immediate mixing with carbonaceous material. Composting can involve quite a time commitment on the part of site operators, so the number of staff and hours involved should be well understood from the outset. Plan for known busy periods on the farm (e.g., planting and harvesting times) either by having more staff on hand for the composting operation, or consider limiting the quantities of incoming materials, if possible.

Storage of Material Before and After Composting

Materials can be delivered to staging areas for storing and mixing, or directly to the area of pile formation. While delivery straight to the piles saves time and cost, staging areas speed up the delivery process, allow for more thorough mixing, and lead to better pile formation. Delivered materials should be incorporated into composting piles before anaerobic conditions and resulting odors develop. Usually 48 hours is a reasonable limit for carbonaceous materials, but it depends on the nature of the material. Putrescible material may need to be incorporated immediately.

When the active, high heat phase of composting is finished, the pile can be moved to an area for the curing phase. Because odors are not a problem at this point and the pile will not need aeration, piles can be larger. When the curing phase is finished and the compost is ready to be sold or used, it may be moved to yet another location to accommodate easier pick-up or transport of material.

All staging, mixing, and storage areas should be kept neat and orderly.

Monitoring and Managing Compost Piles

All the necessary conditions for microbial activity must be monitored and managed within the compost piles. Temperature can be monitored with a dial thermometer that has a stem long enough (36 inches) to reach the interior of the pile. Measurements should be taken at several locations to get a more accurate reading for the pile (or section of windrow) in question. When the temperature gets too high (>160°F) the pile should be turned to release heat. Likewise, when the temperature drops below 100°F prior to stabilization, the pile should be turned to introduce more oxygen for the microbes.

Moisture can be monitored by using the "squeeze" test. A handful of compost should ball up and feel moist when squeezed, but not to the point of dripping water. If the pile gets too dry, water can be added using a hose or sprinkler during turning, or turning while it is raining. Simply sprinkling water on top is usually not sufficient because water tends to shed off the windrow. If the pile is too wet, it will need to be turned or remixed with drier materials.

Record Keeping

Record keeping is an often overlooked, yet vital component of composting. A log book should be kept for incoming materials: date of delivery, volume and/or weight, type of material, and source. Records should be kept as to the mix or "recipe" of raw materials that are used to form compost piles so that adjustments can be made until the optimum recipe is achieved.

Each pile or windrow will require records indicating: date of pile formation, recipe, temperature readings/dates, turning dates, amount/date of water added, date it was combined with another windrow, date it was moved to the curing pile. When windrows are formed over a period of time, flags or stakes can be set into the windrow to differentiate a younger section from an older one. These records will help the compost operator understand the throughput potential of the operation.

A wind indicator to show which way the wind is blowing is important. Wind speed and direction should be recorded on a daily basis especially when actively turning the compost. For sample record-keeping forms, see Appendix C.

Other records that may be useful include: operator hours, fuel requirements, and equipment repairs.

Contingency Plans

A contingency plan is important because it will allow for an alternative management plan in the event of contaminated deliveries, natural disasters, fiscal problems, and equipment failures. An

acceptable backup site should be identified to which material can be moved, if necessary. If finished compost is not selling or otherwise not being used and storage space is at capacity, new incoming materials should not be accepted. If a contaminated delivery is made, the supplier should take the load back at his expense. This condition should be part of the agreement between the composter and the supplier.

PART VII: PREPARING A COMPOST FACILITY PLAN

A well developed plan facilitates the compost registration approval process. The applicant composter needs to reassure MDAR that each component of the operation – from securing feedstock materials to end-use of the finished product – has been fully thought through and planned out. In most cases, the plan should not require engineering designs or detailed scientific descriptions of the composting process. However, it should include written descriptions, maps and sketches in order to convey the physical location and layout of the site, the operation and management plan, and plans for the final product. The following provides more details on what should be included.

Narrative

A written description should address the following basic issues in a simple and concise manner:

Site Description: How large is the site and how will the surface be prepared? What was the site used for previously? What are the general slope and drainage characteristics? Describe soil properties. Describe distances to surface water, wetlands, and drinking water supply wells (refer to Appendix E at the end of this guide for sources of soil, topography, and wetland maps).

Distance to Sensitive Land Uses: Describe the presence of close neighbors, schools, playing fields, etc. Indicate distances to each.

Drainage and Runoff Management: Describe how runoff will be controlled at the site. Indicate any berms, diversion ditches, detention basins, or vegetated treatment areas on an attached map or sketch.

Compostable Materials: Name or describe materials to the extent that they are known in advance. Estimate volumes or weights to be composted. What is the planned compost "recipe" or ratio of compostables? Are any materials available seasonally or intermittently?

Staging Procedures: Describe delivery and drop-off of raw materials. If odorous materials will not be mixed immediately, describe storage and containment methods.

Quality Control: How will the quality of the feedstock material and of the finished compost be monitored? How will non-compostable materials (e.g., plastic) be removed and disposed of?

Mixing and Piling Materials: How will the compost piles/windrows be mixed and constructed? Give the number, height, length and width of the piles. Will piles or windrows be combined after they shrink in size?

Aeration**:** Describe the method and type of equipment that will be used for aerating the compost piles.

Moisture and Temperature Levels: How will adequate moisture and temperature levels in the compost piles be maintained?

Composting Time Duration: Estimate how long composting will take from beginning to finished product.

Personnel: What personnel will be used and how will they be trained?

Equipment: What equipment will be used and for what purposes?

End-Use: What is the intended final use of the compost? Will it be spread on farm fields, sold in bulk, bagged and sold?

Contingency Plan: Is there an alternative, temporary site to which the compost can be moved should the primary site become unusable? If farm-generated animal manure is being composted, is there a way to handle the manure if the other feedstocks become unavailable?

Maps

At the very least, provide a location map showing the compost site in relation to roads, town boundaries, and natural features such as streams and water bodies. The site can be drawn onto a U.S. Geological Survey (USGS) topographic map, which depicts cultural and physiographic information. An assessor's map or aerial photographs may also be used. Refer to Appendix E at the end of this guide for sources of maps.

Drawings

A detailed drawing of the layout of the compost operation should be provided. This can be drawn onto an assessor's map or an enlarged aerial photograph, or may be simply hand drawn entirely. The following information should be shown on the drawing:

1) Property boundary
2) Location and orientation of windrows. Draw the number of anticipated windrows onto the plan, indicating length, width, and spacing between windrows.
3) Location of drop-off, mixing, and loading areas
4) Location of curing and/or storage areas
5) Farm roads, public roads
6) Drainage and runoff controls (e.g., berms, swales, grassed areas). Indicate direction of water flow.
7) Surrounding farm buildings and fields
8) Surface water and wetlands
9) Drinking water wells
10) Occupied buildings within 500 ft
11) High fences, tree lines, hedgerows, or other visual screens between compost site and the public

Appendix A

330 CMR 25.00: AGRICULTURAL COMPOSTING PROGRAM

Section

25.01: Purpose

330 CMR 25.00 establishes criteria whereby the Department of Food and Agriculture (now the Department of Agricultural Resources) may register and provide education and technical assistance to agricultural composting operations. Agricultural compost operations registered by the Department of Agricultural Resources are conditionally exempt from site assignment pursuant to the Department of Environmental Protection regulations (310 CMR 16.05(3)(g) and (h)).

25.02: Definitions

Agricultural Composting: the composting of agricultural wastes and other compostable materials on an agricultural unit resulting in stabilized compost products for agricultural and horticultural uses.

Agricultural Unit: land which conducts activities listed in M.G.L. c. 128, § 1A.

Agricultural Waste: discarded organic materials produced from the raising of plants and animals as part of agronomic, horticultural or silvicultural operations, including but not limited to animal manure, bedding materials, plant stalks, leaves, other vegetative matter and discarded by-products from the on-farm processing of fruits and vegetables.

Compostable Material: an organic material that has the potential to be composted, excluding wastewater treatment residuals, which is not co-mingled or contaminated by significant amounts of toxic substances.

Composting: a process of accelerated biodegradation and stabilization of organic material under controlled conditions yielding a product which can safely be used.

Department: the Department of Agricultural Resources.

DEP: the Department of Environmental Protection.

Disposal: the final dumping, landfilling or placement of solid waste materials into or on land or water or the incineration of solid waste.

Physical Contaminants: any non-biodegradable material such as plastic, metal, glass, stones, or masonry debris.

Registration: approval by the Department as an agricultural composting operation.

25.03: Agricultural Composting Registration

The Department may register agricultural composting operations if the Department determines that:

(1) the compost operation is located on agricultural unit;
(2) the applicant has submitted a completed application;
(3) the applicant agrees to a site visit and to comply with the Department's Agricultural Compost Guidelines;
(4) the applicant demonstrates knowledge and capability to conduct the agricultural composting operation to produce a stabilized compost product.

25.04: Composting Materials

(1) Registered agricultural compost operations can only use defined agricultural wastes and other compostable material allowed by DEP regulation pursuant to 310 CMR 16.05 (g) and (h) whether those materials are generated on-site or off-site.

(2) Physical contaminants must be removed from the raw materials prior to mixing at the compost site. Separated physical contaminants must be appropriately disposed. Materials received from off-site locations must be source separated.

25.05: Operation of Composting Facilities

(1) Agricultural composting facilities must be secure from illegal dumping of waste materials.

(2) Composting operations shall comply with all state and local regulations governing agricultural composting including those which relate to siting requirements (310 CMR 16.00) and the Department's Agricultural Compost Guidelines.

(3) The operation of the composting site must be done in a manner to minimize odors, noise, drift of materials, and risk to humans or the environment.

(4) All demonstration composting facilities must be available to the Department for educational purposes on such terms as the Department may require, for the purpose of complying with M.G.L. c. 21H, § 7B.

(5) If an agricultural compost operator makes nutrient claims of their finished compost material, then such operators are subject to M.G.L. c. 128, §§ 64 through 83 and, 310 CMR 15.00.

25.06: Revocation of Agricultural Composting Registrations

If the Department finds that any portion of the Agricultural Composting Registration application includes false or misleading information, or the operation of a registered composting site is in violation of the regulations or guidelines, or is acting not in the best interest of Massachusetts agriculture, the Department may suspend or revoke the registration which will also revoke the exemption status and thereby the operator must comply with DEP Regulations for Determination of Need for Site Assignment as set forth in 310 CMR 16.05(4).

REGULATORY AUTHORITY

330 CMR 25.00: M.G.L. c. 21H, § 7.

Appendix B

Definitions: Farming, Agriculture, Farmer

M.G.L – Chapter 128, Section 1a

PART I. ADMINISTRATION OF THE GOVERNMENT

TITLE XIX. AGRICULTURE AND CONSERVATION

CHAPTER 128. AGRICULTURE

DEFINITIONS

Chapter 128: Section 1A. Farming, agriculture, farmer; definitions

Section 1A. "Farming" or "agriculture" shall include farming in all of its branches and the cultivation and tillage of the soil, dairying, the production, cultivation, growing and harvesting of any agricultural, aquacultural, floricultural or horticultural commodities, the growing and harvesting of forest products upon forest land, the raising of livestock including horses, the keeping of horses as a commercial enterprise, the keeping and raising of poultry, swine, cattle and other domesticated animals used for food purposes, bees, fur-bearing animals, and any forestry or lumbering operations, performed by a farmer, who is hereby defined as one engaged in agriculture or farming as herein defined, or on a farm as an incident to or in conjunction with such farming operations, including preparations for market, delivery to storage or to market or to carriers for transportation to market.

Appendix C

Windrow/Pile Temperature Monitoring Record

Windrow or pile number _____

Date constructed _____

Ingredients and comments _____

_____

_____

Date	Time	Moisture rating	Odor rating	Wind direction	Temperature (°F) / Distance from end of pile (ft)				Turned?	Rain or water added?

Appendix D

Animal Mortality Management

UMassAmherst Outreach UMass Extension

Disposal of Dead Livestock & Equine

Introduction:

Methods and processes of dealing with dead animals have always been and continue to be a concern in all animal production operations both large and small, slaughter plants, and other facilities that have animals. Proper disposal methods/systems are especially important due to the potential for disease transfer to humans and other animals, and the pollution of soil, air and ground water. Properly composting animal carcasses may be less of a threat to groundwater than burial or unattended surface dumping. Composting has been shown has a viable means of disposing of dead livestock, horses and birds. (This method is not recommended for whole herd or flock disposal cases).

On-farm composting of dead animals generated on the same farm as the composting facility is exempt from having a permit if operated in compliance with the Massachusetts Department of Agriculture regulations. (Refer to MDAR 330 CMR 25:00).

Best Management Practices:

Burial

Burial must be no less than 6 feet deep with a minimum of 30 inches of soil cover. Burial must be in well drained soils and be at least 2 feet above the highest groundwater elevation. Burial must be at least 100 feet from a private well, 200 feet from a public well, 50 feet from an adjacent property line, 500 feet from a residence and more than 100 feet from a stream, lake or pond. Burial cannot be in a wetland, floodplain or shoreline area.

Check with your state's environmental agency or state veterinarian before you begin composting dead animals.

Composting

1. Check with your state's environmental agency or state veterinarian before you begin composting dead animals. The Massachusetts Department of Environmental Protection, for instance, does not require a permit.

2. As an underlying layer, or substrate, use a mixture of hay, manure and bedding with moisture content between 40 to 50 %. Odor can be kept to a minimum as long as the pile is turned to aerate it and the covering material has enough carbon sources, such as straw, sawdust or hay, to provide a 25:1 ratio of carbon to nitrogen.

3. Construct a windrow 10 feet wide by 4 feet deep of the dry manure and bedding mixture. Locate it on a solid spot where the ground slopes 1 to 2%. Site it lengthwise with the slope of the land so runoff and snow can't puddle against the windrow. If possible, orient the windrow north to south so that only one end faces a cold exposure. Choose an area where tractors can maneuver in all weather.

4. Once you've placed a carcass (might want to puncture the rumen on cattle to avoid a gas buildup and possible explosion), cover it with at least 2 feet of the same manure and bedding mixture that is underneath the carcass. Maintain a stockpile of the material for covering. Carcasses can be added anytime but should be spaced about 4 feet apart.

5. The pile must heat up for proper composting. Use a compost-style dial thermometer, ideally with a 30-inch long probe, to monitor the temperature. Temperatures around the carcass will rise to 150 to 160 degrees. Monitor temperatures every two to three weeks. When temperatures fall to 110 to 125 degrees, stir the material with a bucket loader, allowing oxygen to re-activate the composting.

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6. Left untouched, an adult carcass will compost in five to six months. Stirring the mix and covering the carcass again can accelerate the time. Colder temperatures slow the compost process. When the air temperature is above 50 degrees and the pile is turned when its temperature drops below 120 degrees, the soft tissue in a 1,500-pound cow will finish composting as quickly as two to three months.

There will be less bony residue with younger carcasses. Calves, for instance, may compost in three to four weeks under summer conditions. In areas with heavy rainfall, the process can be slowed if there's too much moisture, preventing aeration.. Anchor a tarp over the windrow or mix some very dry sawdust or shavings into the substrate.

7. When you see no more soft animal parts, you can spread the compost or leave it in place. Bones, which degrade very little, can be pulverized to spread on fields, creating good fertilizer. Or they can be left in the pile.

Resources:

Glanville. Thomas. Dr. 1999. Iowa State University – Iowa Extension. Composting Dead Livestock – A new solution to an old problem. Department of Agricultural & Biosystems Engineering, ISU. Ames. IA. 50011.

Livestock and Poultry Environment Stewardship (LPES) Curriculum. Mortality Management. www.lpes.org/Lessons/Lesson51/51_Mortality_Management.html

Massachusetts Department of Agriculture Resources. 251 Causeway Street. Suite 500. Boston. MA 02114. Phone (617) 626-1700. Website: www.mass.gov/agr

Rynk, Robert, et.al 1992. On-Farm Composting Handbook. Northeast Regional Agricultural Engineering Service. 152 Riley-Robb Hall. Cooperative Extension. Ithaca, N.Y. 14853-5701.

For more information visit www.umass.edu/cdl

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Appendix E

ADDITIONAL RESOURCES

GENERAL READING

BioCycle: Journal of Composting and Organics Recycling. Published monthly by The JG Press, Inc., Emmaus, PA.

Massachusetts Department of Environmental Protection. *Leaf and Yard Waste Composting Guidance Document.*

Rynk, Robert (ed). 1992. *On-Farm Composting Handbook.* Natural Resource, Agriculture, and Engineering Service, Ithaca, NY.

USDA, Natural Resources Conservation Service. 2000. "Chapter 2: Composting" in *National Engineering Handbook, Part 637: Environmental Engineering*.

SOURCES OF MAPS

TYPE OF MAP	SOURCES
Topographic maps	U.S. Geological Survey (USGS) website to locate and order 7.5 and 15 minute series topographic maps: http://topomaps.usgs.gov/.
	USGS topographic maps can be purchased at many hiking and outdoor sporting stores.
Soil maps	USDA Natural Resources Conservation Service (NRCS). Contact your local Service Center (http://www.ma.nrcs.usda.gov/), or contact the State Office at: 451 West Street Amherst, MA 01002-2953 Phone: 413-253-4350
	Web Soil Survey provides soil maps on the web. Interactive mapping tool allows one to zoom into an area and print a custom map showing soil types. Soil properties are accessed through the Soil Data Explorer tab on the website: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Aerial photographs	USDA Natural Resources Conservation Service (NRCS) or the USDA Farm Service Agency (FSA). Contact your local Service Center. NRCS: http://www.ma.nrcs.usda.gov/ FSA: http://www.fsa.usda.gov/FSA/stateoffapp?mystate=ma&area=home&subject=landing&topic=landing
	MassGIS website for ordering maps on-line. Many different kinds of maps are available through MassGIS. http://www.mass.gov/mgis/
Wetland maps	MA Department of Environmental Protection (MassDEP), Wetlands Program. Contact MassDEP office: One Winter Street Boston, MA 02108 Phone: 617-292-5500 http://www.mass.gov/dep/water/resources/wetlands.htm
	MassGIS website for ordering maps on-line. Many different kinds of maps are available through MassGIS. http://www.mass.gov/mgis/

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