

**Best Practices
For Environmental Protection in the Mushroom Farm Community**

254-5401-001



**Bureau of Waste Management
Division of Municipal and Residual Waste**



How Can You Improve Relations with the DEP and Your Neighbors – While Reducing the Need for Permits?

(The answer is in this FREE Manual for Mushroom Farmers!)

- By implementing Best Management Practices, you can enhance your operation's profitability and reduce the need for expensive and time-consuming permits – while satisfying DEP requirements.
- A Mushroom Farm Environmental Management Plan (MFEMP) will help your neighbors understand that your farm is operating according to the highest environmental standards, and will help improve coexistence with nearby residents.
- Your MFEMP will actually help maintain or improve the condition of your soil, and prevent the pollution of surface water, groundwater and air, as well. In fact, Best Management Practices have already resulted in cleaner water and soil – and improved relations with nearby residents.
- Best Management Practices can help you avoid liability issues, by allowing you to be better prepared.

- ✓ Improved wharf design produces better substrate – and prevents surface water and groundwater contamination.
- ✓ Proper Mushroom Compost (MC) and wastewater storage documentation could save you major hassles – and reduce pollution events.
- ✓ Are you properly storing or managing your MC? (The right answer could mean one fewer permit application.)
- ✓ Is your farm producing runoff? The solution may be as simple as installing a roof downspout.
- ✓ Does your farm's terrain present unusual challenges? Your plan will help you address your unique needs – and remain compliant.
- ✓ There are many cost incentives and funding sources to help you prepare and implement your plan.
- ✓ Your county conservation district manager can help you prepare an MFEMP at little or no cost.
- ✓ If your operation is complying with Best Management Practices, you may not need four permits.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

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AUTHORITY: Solid Waste Management Act (35 P.S. §§6018.101 et seq.) and regulations at 25 Pa. Code Chapter 289

POLICY: It is the Department's policy to provide a person or municipality with the information necessary for the proper use or disposal of mushroom compost.

PURPOSE: The purpose of this document is to provide uniform instructions and operating procedures for the use or disposal of mushroom compost.

APPLICABILITY: This guidance will apply to all persons that own or operate a mushroom operation.

DISCLAIMER: The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

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CHAPTER 1

INTRODUCTION TO THIS MANUAL

Mushroom growers, like many other farmers, are finding that being successful requires much more than merely applying their knowledge of agriculture to their crop of choice. Many aspects of farming are coming under the scrutiny of neighbors and evaluation by regulatory agencies. Especially in the environmental area, requirements are becoming more widely and more stringently applied to those activities once considered “just part of growing mushrooms.”

While growers are not interested in spending money or time unnecessarily, there is widespread agreement that now is the time to reevaluate mushroom growing practices in light of current environmental laws, regulations, and policies and begin the process of making needed upgrades. The first step for every grower is to review normal farm practices for potential sources of water pollution or odors. With heightened interest in the proper reuse and management of residual (usually solid) wastes, these materials need to be appropriately managed under the law.

Growers bear responsibility for the ultimate disposition of waste from mushroom growing operations, including mushroom compost (MC). As a generator of waste, assigning, selling, entrusting or in any way transferring the waste requires steps that must be taken to ensure that the person receiving, transporting, storing and composting this waste is managing it in a manner authorized by law and not adversely affecting human health or the environment. If the waste is MC, it must be managed in accordance with an approved Mushroom Farm Environmental Management Plan (MFEMP). Waste, including MC, that is not being managed appropriately may result in penalty assessments against responsible parties.

This manual is intended for both mushroom farmers and non-farmers. It should be an educational document for those individuals needing to understand mushroom growing practices, e.g., field inspectors or interested citizens. The basics of mushroom farming are presented in Chapter 2. For the grower, this manual functions like a yardstick against which growing practices can be compared. Chapters 3 and 4 take the reader step by step through the mushroom growing process and present for each operation the suggested practices to reduce pollution potential. While they may be regarded as ideal, many of these practices are quite attainable for both large and small mushroom farms. Chapter 3 also discusses opportunities that growers can explore to reduce a farm's potential for odor problems. In Chapter 5, two aspects of mushroom growing, making mushroom substrate (MS) and MC management, are evaluated under the Pennsylvania residual waste regulations. The Best Management Practices (BMPs) discussed in this chapter not only reduce the potential for pollution, but also the regulatory burden that a grower could face. When these BMPs are followed, residual waste permits are not required. Chapter 6 introduces technical BMPs based on Pennsylvania Technical Guide for Soil and Water Conservation (PATG) specifications that can be used at individual farms depending on its specific needs.

Current mushroom farm operations may fall short of BMPs and may present potential sources of pollutional discharge. If so, farmers need to change operations or upgrade their facilities to eliminate these problems. Chapter 6 introduces a mechanism whereby this process can be carried out in an efficient and effective way. An MFEMP and the planning process necessary for the development of the plan can be used as the vehicle to get from current farm status to a point of greater compliance. An MFEMP must be developed and implemented for all aspects related to the MC processing both on and off the mushroom growing site. Mushroom farms that grow other varieties of mushrooms, for example

shiitake and oyster mushrooms, do not use mushroom substrate as described in this manual and do not produce MC.. These farms still need to have an environmental plan, with the details prepared specifically for that farm at that location. The handling of wastewater, waste materials and other potential pollutants needs to be consistent with the methods shown in this manual. A non-Agaricus mushroom farm needs to have BMP's shown in an approved MFEMP. In doing so, the farmer may find, as an added incentive, a reduction in the number of specific permits required by the Pennsylvania Department of Environmental Protection (PA DEP).

This manual was updated in 2012 and is based on current scientific understanding. Due to changing regulatory and environmental demands on mushroom growers, more up-to-date guidance will become necessary. This manual will be revised periodically. Growers and other readers of this manual are urged to become acquainted with current regulations and to follow proposed changes in laws and regulations. An active and responsible community can assist agencies in developing the most effective regulations to accomplish environmental protection for the common good.



CHAPTER 2

AN OVERVIEW OF MUSHROOM FARMING

2.1. Introduction

Cultivation of the *Agaricus* (white or crimini) mushroom consists of six steps: Phase I composting, Phase II composting, spawning, casing, pinning, and cropping. These steps are described in their naturally occurring sequence. Of course, there are other related activities necessary to support these basic steps. Overall, it takes approximately 10-15 weeks to complete an entire growing cycle from the start of composting to the final cleanup after harvesting has ended.

2.2. Phase I: Making Mushroom Substrate

MS is the growing medium that provides nutrients needed for the mushrooms to grow. MC is the material remaining after growing mushrooms. Composting is the procedure used to change the nutrients found in the feedstock ingredients into forms that are available to and selective for mushrooms; it produces a medium most suited for the growth of the mushroom to the exclusion of competing fungi and bacteria. There must be correct moisture, oxygen, nitrogen and carbohydrates present throughout the composting process or the nutrients will be inadequate to support the future mushroom crop. Mushroom farmers use various recipes when formulating MS. (See Table 1 on page 5 for common ingredients.) Their choices are based on the availability and cost of the ingredients and the individual characteristics of their own farming practices. Generally speaking, however, two slightly different types of substrate are made by mushroom farmers based on the use of two different starting materials: 1) straw-based stable bedding containing horse manure or 2) a mixture of hay and corn cobs or straw. A variety of other ingredients are added in order to improve the nutrition and structure of the developing substrate. Preparation of MS recycles vast quantities of agricultural nutrients, especially stable bedding from horse farms, race tracks and poultry litter. By utilizing these nutrient-rich materials productively, the mushroom farming community performs a service to the environment and those who need a positive pathway for these recyclables. The general procedure for growing mushrooms involves several key steps referred to as:

- Pre-conditioning and Phase I
- Phase II
- Spawning
- Casing
- Pinning
- Cropping and Harvesting
- Emptying

Pre-conditioning and Phase I is the preparation of substrate at a farm that usually involves the steps of pre-conditioning and Phase I composting. Pre-conditioning of the straw and other incoming substrate components allows for a quicker initiation of the composting process once the materials are combined.

Pre-conditioning involves mixing large volumes of straw and hay with water to soften the stems and de-wax the straw. These ingredients are typically piled 10 feet high or more and allowed to stand for several days. During this time moisture enters the previously dry materials and naturally occurring microbes begin to grow. After the ingredients are softened, the pile is typically moved to a mixer/turner to form a long pile or row of substrate, usually called a rick, in order to begin Phase I composting. Most ricks are roughly 5 to 7 feet wide, 5 to 8 feet high, and as long as necessary or practical. The rick must hold its shape but be loose enough to allow for aerobic conditions throughout. Phase I composting can also be performed in large, partially-enclosed aerated floor facilities, called bunkers, horizontal silos, tunnels or bins. Providing aerobic conditions during the compost generation process ensures that the resultant compost will provide the proper growing conditions for the mushroom crop and minimizes the generation of potentially offensive odors from the composting area. Turning and watering are done at approximately 2-day intervals. Turning provides the opportunity to water and mix the ingredients, as well as to relocate the substrate from the cooler exterior to the warmer interior and vice versa. The aeration accomplished by turning is short-lived, so rick construction, structure, and contents are critical in promoting aerobic conditions. The number of turnings and the time between turnings depend on the condition of the starting material and the time necessary for the substrate to heat up. Water addition is critical. Too much water will exclude oxygen by occupying the pore space and may lead to unnecessary loss of nutrients due to leaching. Too little water can limit the growth of bacteria and fungi. As a general rule, most of the water is added when the rick is formed and at the time of first turning, and thereafter water is added only to adjust the moisture content. On the last turning of Phase I composting, water may be applied generously to carry sufficient water into Phase II. Water, nutritive value, microbial activity and temperature are closely linked; when one condition is limiting, the whole composting process may be affected.

Phase I composting lasts from 7 to 16 days, depending on the nature of the material at the start, its characteristics at each turn, the season, and the particular practices at a given farm. At the end of Phase I, the substrate should have: a) a brown color; b) short, pliable straws; c) a moisture content from 68 to 74%; and d) indicators of nitrogen conversion. When these conditions have been reached, Phase I composting is completed.



Table 1: Mushroom Substrate Ingredients

Ingredient	Rationale*				Typical Source	
	N ¹	C ²	B ³	O ⁴		L ⁵
MAIN INGREDIENTS						
Corncobs (whole, ground, crushed, pelletized)	X	X	X		Corn farm, corn sheller	
Hay	X	X	X		Hay farm	
Horse manure - straw bedded	X	X	X		Horse farm or track	X
Poultry litter/manure	X				Poultry farm	X
Straw		X	X		Grain farm	
SOME COMMON ADDITIONAL INGREDIENTS						
Ammonium nitrate	X				Fertilizer plant	X
Brewers grains (wet or dry)	X				Brewery	X
Corn fodder		X	X		Corn farm	
Feathers or feather meal	X				Poultry processor	
Grape pumice		X			Grape processor	
Ground wallboard				X	Soil conditioner supplier	
Gypsum				X	Gypsum rock	
Gypsum, synthetic				X	Soil conditioner supplier	
Hardwood tree leaves		X			Municipal leaf collection	
Lime				X	Soil conditioner supplier	
Mushroom stumps and culls			X		Mushroom farm	X
Seed - hulls		X			Seed processor	
Seed - meal	X				Seed processor	X
Seed - oil	X	X			Seed processor	
Shredded newspaper		X			Newspaper recycler	
Spent lime				X	Sugar processor	
Sugar cane (bagasse)		X	X		Sugar processor	
Sugar cane (pulp)		X			Sugar processor	
Urea	X				Fertilizer plant	X
Other substitute items may be found locally available						

* The above materials represent common ingredients used for the preparation of mushroom substrate, their function(s) in the substrate, potential for leaching, and typical sources. 1 = nitrogen, 2 = carbon, 3 = bulk, 4 = other reasons, including flocculent or pH control, 5 = leachable.

2.3. Phase II: Finishing the Compost

Phase II composting may or may not occur at a farm and continues the conversion of nutrients into a selective food supply for the mushroom. First, pasteurization is performed to kill any insects, nematodes, competing fungi, or other pests that may be present in the substrate. Second, ammonia levels that formed during Phase I composting are reduced. Since fungi depend on other organic MC for nutrition, the correct nutrient levels must be provided.

Phase II composting can be viewed as a controlled, temperature-dependent, ecological process using air to maintain the substrate in a temperature range best suited for the nitrogen-converting organic MC to grow and reproduce. The growth of the thermophilic (heat-loving) organic MC depends on the availability of carbohydrates in a usable form and the presence of nitrogen, some of which is in the form of ammonia.

Phase II can be managed in three different ways, depending on the type of growing system used:

1. *Multiple Zone*: Substrate is packed into wooden trays, the trays are stacked six to twelve high, and the trays are moved into an environmentally controlled Phase II room. Thereafter, the trays are moved to other special rooms, each designed to provide the optimum environment for each step of the mushroom growing process.
2. *Single Zone, Bed/Shelf or "Pennsylvania Double"*: Substrate is placed directly in the stationary beds in the room used for all steps of crop culture.
3. *Tunnel*: The most recently introduced variation of a multiple zone system, the environmentally controlled "tunnel," is an enclosed system that provides air supply and temperature control so that Phase II conditioning is completed in bulk form rather than in individual trays or beds.

Spawning is the mushroom culture equivalent of planting seeds for a field crop. However, mushrooms are "planted" using fungal mycelia rather than seeds. A fungal mycelium propagated vegetatively is known as a spawn. Spawn-making requires specialized laboratory facilities where mushroom mycelia can be propagated in pure culture. Spawn-making starts by sterilizing a mixture of cereal grain (rye, wheat, millet, and other small grains are used) plus water and chalk. Once the sterilized grain is inoculated with mycelia, it is incubated to promote full colonization.

Mushroom farmers purchase spawn from commercial laboratories. At the mushroom farm, spawn is thoroughly mixed into the substrate using a special spawning machine. Once the spawn has been mixed throughout the substrate, the substrate temperature and the relative humidity in the growing room are managed to optimize growth.

The spawn grows out in all directions from a spawn grain. The time needed for spawn to fully colonize the substrate depends on the amount of spawn added, its distribution, the substrate moisture and temperature, and the nature or quality of the substrate. The spawn run growth usually requires 10 to 21 days.

A more recent technique may also be used to control spawn run in bulk containers of substrate. Then, the substrate with spawn is placed in trays, beds or shelves prior to the next step, casing. Also, spawn grains may be mixed with substrate prior to placing the substrate in trays or beds.

Casing is a top-dressing applied to the spawn-run substrate and is necessary for mushrooms to grow from the mycelia that have grown throughout the substrate. Casing is not used to supply nutrients; rather, it acts as a water reservoir and provides a place where rhizomorphs form. Rhizomorphs look like thick strings and form when the very fine mycelia grow together. Casing should be able to hold moisture since moisture is essential for the development of a firm mushroom. Casing materials vary from farm to farm as different growing techniques may respond better to one casing rather than another. Typically, the casing has some percentage of peat moss, although this is not a required component. Some common casing materials include: peat moss from Canada or from Ireland, lime in one of several forms, and infrequently, recycled MC.

Pinning is the stage where the small outgrowths from the rhizomorphs, called initials, primordia or pins, form in the casing layer. These outgrowths continue to grow larger through a button stage, and ultimately enlarge into a harvestable mushroom. Harvestable mushrooms appear 16 to 28 days after casing.

Pinning affects both the potential yield and quality of a crop. The management of water content of the casing, relative humidity, and carbon dioxide content of the air are all essential in determining crop yield and quality.

Cropping and Harvesting is usually called flush, break or bloom and refers to the repeated 3- to 5-day harvest periods during the cropping cycle. The harvest periods are followed by a few days when no mushrooms are available to harvest. Once mature mushrooms are picked, the inhibitor to mushroom development is removed, and the next flush moves toward maturity. This regrowth repeats itself in a 7- to 10-day cycle, and harvesting can be repeated as long as mushrooms continue to mature, though the yield decreases with each picking cycle. Some farms harvest through two flushes, others may continue for three or four. Temperature, water management, and ventilation continue to be critical parameters throughout the flushing period.

Another deciding factor related to the length of harvesting time is the necessity to maintain low levels of disease pathogens and insect pests, as infestation can cause total crop failure. Pathogens and insects can be controlled by cultural practices coupled with the use of pesticides, but it is most desirable to exclude these organisms from the growing rooms. Shorter harvesting periods reduce the time for pests to become established and proliferate in the crop or growing room. After the last flush of mushrooms has been picked, the growing room should be closed off and the room should be pasteurized with steam or steam with added sanitizing agents. This final step is designed to destroy any pests and mushroom diseases that may be present in the crop or the growing room, thus minimizing the likelihood of infesting future crops.

Emptying is when MC is removed from the house or growing room, and the room is prepared for a new batch of fresh substrate. Mushroom farmers often wash the empty room and may on occasion sanitize the walls, floors, ceilings and all wood surfaces. The resulting MC is delivered to farm fields or facilities for further composting.

CHAPTER 3

MANAGEMENT OF RAW MATERIALS AND MUSHROOM SUBSTRATE

3.1. Introduction

As discussed in Chapter 2, generating a substrate for the growth of the mushroom crop is a critical first step in mushroom culture for most cultivated commercial mushrooms. Poorly produced compost will invariably mean disappointing yields for the farmer.

The Agriculture, Communities and Rural Environment (ACRE) initiative resulted in the State enacting Act 38 of 2005, which includes requirements for nutrient management and odor management at 3 Pa. C.S.A. §§501-522. Relevant regulations are located in Title 25, Chapter 83 of the Pa. Code. Non-animal operations such as mushroom farms and persons producing MS for the mushroom growers are not obligated under Act 38 to complete and follow odor or nutrient requirements; however, provisions for both odor and nutrient management are provided in the manual as BMPs as a means of demonstrating that the mushroom operation is properly addressing odor and nutrient impacts from their facility.

Because some materials used in this substrate are high in nutrients, the mushroom farmer must take care at the farm to keep these nutrients separated from the natural water resources. This chapter reviews the composting process in the context of BMPs,¹ which help protect these resources from degradation.

A well-run operation for preparing substrate should evidence an efficiency of design and orderliness of operation which, in concert with good housekeeping and water management, will go a long way to protect water and air resources.

3.2. Watering Raw Materials and Ricks

As noted in Chapter 2, watering the raw materials and the ricks of substrate is an essential operation. If watering is optimal, bacteria and fungi cause changes in the raw materials in the rick (windrow), changing the mix of raw materials into a substrate that is selective for the *Agaricus* mushroom. Bacteria and fungi also metabolize nutrients and convert them into microbial protein. Excess water, however, can lead to anaerobic activity within the ricks and produce a sour product with the risk of malodors. Excess water can also lead to the loss of nutrients, which can become pollutants if not properly controlled.

A recommended practice is to add sufficient water, but not cause wash-out of ingredients and generation of large quantities of leachate. To find the balance point, wetting of the initial piles of substrate ingredients in the preliminary or “pre-wet” step, the watering volumes and schedules for the substrate ricks, rick turning schedules, and composting period can all be modified. Since loss of some water from the ricks is normal and unavoidable, the design and operations on the

¹ This manual contains BMPs of two types: preferred ways of performing normal mushroom growing activities and technical BMPs as described by the Natural Resources Conservation Service (NRCS). The operational BMPs originate from current acceptable practices and from the requirements imposed by regulations. The operational BMPs are described in Chapters 3, 4 and 5. Chapter 6 and Appendix A contain references to the NRCS BMPs. Appendix A contains a list of BMPs being used by the county conservation districts based on NRCS’ BMPs.

compost wharf must be adequate to control the highly nutritious water. Initial design of the wharf can be helpful in this regard, but wharves can be upgraded to meet the same objective. This objective, simply stated, is to keep all leachate, whether from raw ingredients or from the ricks, on the wharf surface unless it is being discharged to an approved wastewater collection unit or recycling system.

3.3. Wharf/Turning Yard Operations

Wastewater can be associated with the production of MS, the storage of MC and from composting of MC for later uses. However, the mushroom farmer has opportunities to reduce the potential for MS ingredients or leachates to come in contact with water resources. The wharf should be of sufficient size to accommodate the ricks and also the movement of raw materials. Storage locations should be chosen taking into account the concentrations of soluble nutrients in the raw materials and the nutrients' potential to generate leachate of environmental concern. Placement of raw materials and ricks should be optimized to reduce unnecessary traffic and tracking of materials on the wharf. It is critical to provide sufficient room for operations and high-quality storage areas for raw materials.

The wharf area must be paved or covered with an impervious material and sloped toward impervious collection areas. Ideally, this paved wharf area may be under roof, but this is not practical for most farms. Though roofing is expensive, it is advisable for storing high nutrient, leachable raw materials like chicken manure. Roofing will minimize the potential for contact of manure nutrients to contact with groundwater and surface water and thus minimize the leaching of nutrients into the collection basin.

While storage of raw materials on paved wharf areas is the preferred management practice, alternatives can be considered for certain raw materials that have minimal or no potential to leach nutrients or other constituents. For these materials that do not generate leachates, bare ground storage is acceptable. For added protection, the raw materials should be covered securely with waterproof tarps. In some cases, inventory quantities can be reduced to accommodate the size of the storage area.

Wharf runoff generated by storm events differs from normal leachate production because the mushroom farmer has less opportunity to control its rate, volume and frequency. Nonetheless, good practice and environmental laws dictate that there be no discharge of untreated stormwater from the wharf to the surface or groundwaters of the Commonwealth. Provisions must be made for control of stormwater. The wharf must be designed and operated to minimize run-on of stormwater, and drainage channels must be adequately sized and constructed to carry stormwater away prior to any contamination with wharf material. Care must be taken to size stormwater units to accommodate higher volumes of water from storm events. Critical in this regard are the design and construction of collection basins. The code numbers for these management practices are listed in Appendix A. Once constructed, these stormwater management structures must be maintained to be serviceable at all times to control stormwaters. Any stormwater generated on the wharf must be collected and treated as wastewater. The wastewater may be stored in tanks or impoundments as discussed in Chapter 5.



Care taken in daily operations can also reduce the likelihood of pollution. “Good housekeeping,” such as cleaning up clumps of compost and raw materials scattered about the wharf and replacing them in ricks or storage areas can reduce the strength of runoff and potential for odor production. The collection of these stray materials in dry weather can control dust and the dispersal of pollution-generating materials. Dry, dusty areas can be lightly moistened with a fine spray of water to reduce dust. Keeping drainage channels and ditches that lead to collection basins free of wharf solids allows them to serve their purpose better. It also reduces the extent to which the solids will dissolve into the water being carried in the ditch, thus reducing the pollution load on the collection and treatment system. Stormwater and drainage channels should likewise be kept free of obstructing materials. As suggested earlier, using as little water as necessary to make a good compost can also be a way of reducing leachate generation.

Collected wastewater can be reused on some wharves in the substrate preparation process. Leachate and wastewater from the wharf can be added judiciously to the mix of raw materials in the early “pre-wet” heaps or later to the ricks themselves. This practice adds moisture and nutrients to the mix and also reduces the accumulation and storage of high-strength wastewater in collection basins. This recycled liquid, sometimes called “goodie water” should be kept aerated and agitated to maintain at least a 1 ppm dissolved oxygen (DO) concentration. High DO may not be beneficial, as one farm found that recycled water with 2 ppm DO did not provide as good a supply of nutrients and microbes for the substrate. Maintaining a measurable 1 ppm DO is important to reduce anaerobic activity and those associated odors. Screens and filters are a wise investment to keep solids out of the water entering the collection basins, thus keeping solids out of the waste stream and facilitating the replacement of these solids into the ricks.

Wastewater can also be applied to MC storage piles or spread on crop fields in accordance with the land application procedures identified in Chapter 5. This wastewater may be stored in tanks or impoundments as discussed in Chapter 5.

3.4. Regulatory Best Management Practices for Normal Farming Operations

The practices that will be discussed below apply to normal farming operations, which include most mushroom farms. Normal farming operations are defined in the residual waste regulations

as the customary and generally accepted practices engaged in by farms for agricultural production provided such practice does not cause pollution to the air, water, or other natural resources. It also applies to management, collection, storage, transportation, use and disposal of agricultural wastes on land where such materials will improve the condition of the soil, growth of crops or restoration of land for the same purpose.

a. Normal Farming Operations

A waste management permit is not required for a mushroom composting operation solely engaged in preparing MS. The composting operation must comply with the following:

1. The composting must be conducted on a farm or other facility that complies with this manual and has an approved and implemented MFEMP. (See Chapter 6.)
2. The compost must be made using agricultural wastes and associated co-products such as those listed in table 1 on page 5. .

However, if the composting operation does not comply with BMPs in this manual, it must obtain a residual waste processing permit from the PA DEP.

b. Management of Waste

Although the farmer's goal may be to generate zero waste material, a small amount of waste may be unavoidable. Wastes generated in the MC process, for example, wastewater, excess substrate or off-spec substrate, must be collected and stored as indicated in this manual and an approved MFEMP. These wastes must be:

1. Reused in the substrate production process;
2. Land applied according to the application rates included in this Manual; or
3. Managed as waste under the residual waste regulations.

If these wastes are not directly reused, they must be stored in accordance with the provisions of this manual. (See Chapter 5 for more details regarding wastewater use and storage.)

Records must be maintained by the mushroom farmer on an annual basis of the amount of waste generated from the MS production activities and the disposition of the waste.

3.5. Odor Reduction Opportunities

Odors are sometimes associated with compost operations. They are a natural occurrence but need to be minimized. Mushroom growers should adopt odor control BMPs as part of their approved MFEMP. These BMPs could include but are not limited to overall sanitation, dust and substrate management and recyclable water management. Other ways the mushroom farmer can reduce the odor potential of the wharf area include:

1. Not using more nitrogen-rich raw ingredients than necessary to produce a nutritious compost for the future mushroom crop.
2. Maintaining aerobic composting operations.
 - a. Not overwatering and thereby creating anaerobic conditions and nutrient wash out.
 - b. Making sure the initial mix of ingredients is thorough, especially with manures, to avoid producing anaerobic clumps in the compost.
3. Preventing standing water and poor drainage areas in the wharf, including around raw material storage areas.
4. Trapping solids before they enter the collection basin. If solids are already present in the basin, remove them regularly.
5. Aerating and agitating stormwater runoff water that is in collection basins or impoundments.
6. Maintaining maximum available isolation distances from where the composting operation is carried out and other potential land uses.
7. Screening (fences, trees, landscaping, berms) and shielding the composting operation from the view of adjoining property owners.

See the *Mushroom Substrate Preparation Odor-Management Plan*; Penn State College of Agricultural Sciences <http://www.americanmushroom.org/pdfs/MshrmSubstr.pdf>.

CHAPTER 4

GROWING THE MUSHROOM - SPAWNING THROUGH HARVEST

4.1. Introduction

This chapter continues describing the practices for minimizing negative environmental effects from mushroom farming. The sub-headings are given in chronological sequence for producing mushrooms. This chapter contains some reference to pesticide application practices, but additional related information can be found at <http://extension.psu.edu/ipm/agriculture/mushrooms/mushroom-manual.pdf/view>. The Pennsylvania Department of Agriculture may provide fact sheets covering all aspects of pesticide safety and current worker protection standards.

4.2. Spawning

As indicated in Chapter 2, the process of spawning is equivalent to the planting of seeds for a field crop. The spawn arrives on the farm in sealed containers that exclude other microorganisms. While spawn is being mixed with MS it is considered good practice to keep the area clean and to close the doors where possible. Cleanliness keeps undesirable fungal spores and bacteria from entering during the mixing procedure.

Good practices during spawning involve proper handling of solids rather than water. The packaging for the spawn should be either recycled or placed in refuse containers. Substrate and spawn mixture spilled during the mixing operation should be squeegeed from the floor and placed with MC or stumps for utilization or disposal.

Immediately after spawning, a grower may choose to place a thin film of polyethylene over the spawned substrate to increase CO² concentrations in the tray or bed, help preserve water in the compost, and protect the surface from pests and mushroom pathogens. The film is not generally reusable and should be properly discarded once removed. Good practices call for the film to be placed without delay in the refuse for removal by a properly licensed solid waste disposal company. While awaiting removal, the plastic should be protected from rain to eliminate the potential for runoff of low-level pesticide residues from the plastic surface.

4.3. Casing

As indicated in Chapter 2, the fully colonized substrate is covered with a layer of casing material to induce the formation of the mushrooms. This step involves a major input of solid material (peat and limestone, organic soil recycled from MC, or virgin soil) to the mushroom farming operation.

Recommended practices include the reasonable activities related to good housekeeping. If casing material is stored outside in bulk, it should be treated as other raw materials, and erosion into streams or storm sewers should be prevented. Inside of the house or growing room, good housekeeping dictates that any spilled substrate or casing material should be picked up at least daily. Spilled material is pushed with a floor squeegee and picked up with a shovel. The squeegeed materials are not to be placed with new casing for use on beds or trays because

contact with the floor may add impurities to the material. Sweeping with a broom may cause dust and can spread disease within the facility. The floor debris should be handled and managed in the same manner as MC. The water used to moisten the cased substrate may also be used as a means for the application of low levels of minerals or pesticides. In these cases, especially, water should be applied at a rate low enough that the casing will absorb it all. Multiple small waterings should be used rather than a single large watering to avoid exceeding the absorption rate of the casing. Thus, there should be essentially no water or pesticide runoff from the casing to the next lower level or onto the floor.

A recommended practice on mushroom farms is to use a dedicated tank and pump system for watering. This system works as follows: the tank is filled only to the volume needed for a specific water application. If there are to be additives for that water application, those powders or solutions are placed in the tank and mixed. All pesticides mixed in the tank must be used according to the pesticide label directions. Mixing must continue during the pumping. It is a recommended practice also that only sufficient mixture be prepared in the tank for a specific room or house, so that there is no leftover chemical requiring storage or disposal. The tank and pump system are useful for plain water application as well as for water with additives because the pump assures a constant pressure at the sprinkler head. In contrast, the well pump connected to a pressure tank provides a varying pressure, particularly as other valves are opened and closed. Good water quality practices do not allow the use of a pesticide injection system that will place chemicals or pesticides directly into fresh water supply pipes.

4.4. Fruiting and Crop Care

Pinning is initiated by shocking the mycelia with an introduction of fresh air to lower temperatures and carbon dioxide concentration. Therefore, pinning does not have any environmental effects in terms of odors, water and solids management.

Once the pins are formed and begin to grow larger, the casing needs more water. As described above under casing, the applied water may have additives for controlling undesirable bacteria or fungi. Again, the amount of water should not be too much for the casing to absorb, thus preventing any runoff to the floor.



4.5. Harvesting Operations

Mushrooms are harvested by hand. After picking the mushroom, the harvester trims off the ends of the mushroom, often called stumps, and accumulates them in a container for removal from the room or house. Harvesting also generates some over-ripe and misshapen mushrooms that have no commercial value (culls) and a small amount of dislodged casing material. Fallen harvesting debris should be swept from the floor and placed together in the container specifically designated for stumps. Stumps may be placed into the ricks to become part of future substrate or may be spread thinly on crop land. Land application practices such as those recommended for MC in Chapter 5 should be used for application of stump material. Stump material should not be left in piles near mushroom houses or elsewhere because it rapidly degrades, attracting flies, sustaining their life cycles, and generating odors.

Workers move from house-to-house or room-to-room according to the harvest schedule. To reduce the transport of mushroom diseases, the workers may wet the bottoms of their footwear on a mat saturated with disinfectant. These mats can be located at the door(s) to each room or house. Also, the workers' tools may be brushed clean and dipped in disinfectant. As with pesticides, spills of these disinfectants must be avoided, and spill control and cleanup measures must be in place.

As noted in Chapter 2, mushrooms grow in cycles (flushes, breaks, blooms). Between flushes, water is applied to the casing to supply the next mushrooms. This water application should be performed in the same careful manner as mentioned above under casing.

4.6. Post-Harvest Clean-Out

After the last picking, the room or house may be prepared for a heat treatment. It is good practice to add live steam to the room or house for the purpose of pasteurizing the substrate and interior surfaces. This practice reduces the spread of disease prior to moving all of the substrate and casing material from that location. MC should be removed from the trays or beds and handled in an environmentally safe manner as described in Chapter 5 of this manual.

The room or house may be further disinfected or sanitized after the MC is removed. Particularly during the outbreak of a mushroom disease, scrubbing the walls and remaining wood in the room and another application of heat may be used as a guard against future infection.

On occasion, during the growing cycle or after the substrate has been removed, it may be appropriate to wash down the walls and floor of the mushroom house. For this reason, the floor drains need to be connected to approved wastewater facilities. These wastewater facilities should be designed in accordance with all state and federal requirements as well as recommended standards for agricultural operations as described in NRCS Technical Guides. This wastewater should not be directly discharged to a stream or any other surface water or groundwater resource. If the mushroom growing facilities are adjacent to substrate production, then the floor drain piping can be connected to the goodie water tank. An existing farm without floor drains needs to have an approved collection system for wash-down wastewater. For some mushroom farms, phase I material is delivered to a concrete pad adjacent to the upper-level doors of the mushroom house. This delivery is timed for filling into the house that day or the next day. Since the phase I material remains on the concrete for as long as 24 to 36 hours, the pad needs to be designed for adequate diversion of clean, upslope stormwater and the proper management of

any contaminated runoff and leachate. Channels for the collection of contaminated runoff need to provide pathways that do not stagnate and that lead to either a temporary holding tank, or an appropriately sized and maintained grass infiltration area, approved as part of the MFEMP. After the substrate filling operation is completed, the concrete work area should be cleaned of substrate debris and any runoff generated during this cleaning operation should be directed to the appropriate storage or treatment area. If there is a tank for collecting lawn area stormwater, the method to clean the pad should avoid washing the spilled material into the clean stormwater holding tank.

For other mushroom farms, trucks drop the substrate directly into a conveyor for the filling operation. Such practices typically leave a small amount of debris on the concrete for easy clean-up and therefore little, if any, contaminated runoff is generated for collection and treatment or recycling. For these farm situations, the stormwater system for this transfer area would not include collection, but an appropriate grass area is needed down slope.



4.7. Insect Monitoring and Control

In Pennsylvania, there are two fly species (Phorid and Sciarid) that feed on mushroom tissue and have the potential to cause economic damage to the mushroom farm. These flies must be controlled to numbers below the economic threshold level. Integrated Pest Management (IPM) techniques aid the farmers in minimizing the quantity of chemical insecticide needed for fly control. IPM requires that the farmer know the level or number of flies in the room, so a monitoring device is essential. By observing the number of flies at the monitor, the experienced mushroom farmer can determine the flies' time of entry, life cycle, and potential for infestation. This is critical information for the farmer to judge the potential economic impact.

Using the observations at the monitor, the farmer can schedule the timing and dose of insecticides. The IPM technique helps to make the most efficient use of expensive chemicals. Good housekeeping and farm sanitation practices help to eliminate breeding locations for all species of flies. As mentioned earlier, the stumps and overripe mushrooms should be removed from the harvest areas to reduce that source of growth media for flies. For further information view: <http://extension.psu.edu/ipm/agriculture/mushrooms/mushroom-manual.pdf/view>.

4.8. Pathogen Control

Mushrooms have pathogens, too. Various species of bacteria, other fungi, and viruses can attack mushrooms. The farmer should use good sanitation practices as the first line of defense against these pathogens. In the event that an infestation occurs, and economic impact will be felt if the disease were to go unchecked, i.e., the economic threshold is exceeded, then chemical or biological control methods would be needed.

It is important to have as much information about the disease as possible so that pesticide use is most effective, not excessive. Some diseases can be spot treated, while others need whole-house treatment. From both an environmental and economic viewpoint, minimal use of pesticides is best. The farmer must apply pesticides according to label directions when needed to control a specific problem.

4.9. Pesticide Handling and Regulations



The U.S. Environmental Protection Agency (EPA) sets rules and regulations for pesticides that apply across the nation. Each state may establish additional rules for the handling and application of pesticides. The Occupational Safety and Health Administration (OSHA) has regulations that apply to pesticides and other hazardous materials. Each mushroom farmer must comply with regulations that are intended to protect the environment as well as people at the farm and nearby residents. This manual does not list all of the regulations for the use of pesticides, including limitations on MC use, but the farmer is expected to abide by the current rules and the instructions on the pesticide label. The county extension service is a good source of information regarding pesticide use, as is the Pennsylvania Department of Agriculture.

4.10. Trash Disposal

General trash and refuse items on a mushroom farm include typical household items such as newspaper, magazines, printout paper, lunch containers, beverage cans, etc. Unique to mushroom farms are: the plastic film used to cover the substrate during spawning; wood (lumber) not strong enough to stay in service for trays, beds, or shelves; pesticide containers; and broken harvest containers. Spawn and casing packaging should be recycled or added to the general trash. The mushroom farmer should ensure that a properly licensed waste disposal company removes the waste materials and that the wastes are properly disposed of at an appropriate disposal site. If municipal waste is generated at seasonal farm labor camps, the regulations for proper management of refuse must be instituted. (7 Pa. Code § 177.13)

In anticipation of refuse removal, it is good practice for the discarded items to be covered. In general, a dumpster or other covered container is provided by the contract hauler. The farmer should be sure to place items in the container so that precipitation does not wash off chemicals, such as pesticides or nutrients. The recommended method to dispose of discarded lumber is to cut it to short lengths and place in the container. Containers for liquid pesticides should be triple-rinsed and punctured prior to disposal. Emptied bags for powdered pesticides may be discarded as municipal waste. Protective clothing, disinfectant mats, footwear, filters, etc., that are discarded must be managed in accordance with the pesticide or disinfectant label and the existing state regulations.

CHAPTER 5

MANAGEMENT OF WASTES FROM MUSHROOM GROWING OPERATIONS — MUSHROOM COMPOST AND WASTEWATER

5.1. Introduction

Agricultural waste, which includes waste from mushroom growing operations, is a residual waste under the Pennsylvania Solid Waste Management Act (Act), 35 P.S. 6018.101-6018.1003.l. Section 501 of the Act requires a permit prior to processing or disposing of or beneficially using residual waste, which would include land application. However, the requirements of Section 501 do not apply to agricultural waste produced in the course of normal farming operations provided that such waste is not classified as hazardous. To meet the definition of “normal farming operations” operations must conform with applicable laws, and the use of agricultural waste must not pollute the air, water or other natural resources of the Commonwealth. The BMPs in this manual are designed so that the use of mushroom farm wastes in this manner will not pollute the air, water or other natural resources of this Commonwealth.

In this chapter, the residual waste management requirements for MC wastewater or other potential wastes from mushroom growing operations are discussed. By managing these materials as outlined in this chapter, the farmer can reduce his responsibility for obtaining permits and still minimize the potential for pollution. This chapter also describes how these management practices and a MFEMP (described in more detail in Chapter 6) can work together to the advantage of the farmer. This chapter also discusses the use of certified manure haulers and brokers when transporting MC off site. The Pennsylvania Commercial Manure Hauler and Broker Certification Act (Act 49 of 2006), 3 P.S. §§2010.1-2010.12, provides training, testing and certification requirements for individuals hauling and brokering manure in Pennsylvania. This law applies to manure, which is an ingredient used in the preparation of MS, but does not apply to MC. However, the practices utilized by certified manure haulers and brokers may be used to demonstrate that a hauler or broker has the requisite knowledge to properly manage MC in accordance with the law. If the Act 49 practices are not used to establish that BMPs have been met, the PA DEP may approve other methods if deemed appropriate.

5.2. Normal Farming Operations

If a farmer produces MS from materials that are agricultural wastes or co-products and uses all of the substrate on a mushroom farm, those activities are normal farming operations and exempt from permitting requirements.

Using the MC for the growth of crops, the establishment of lawns, turf grass production, landfill revegetation, and other horticultural uses can all be performed as normal farming operations when done in accordance with this manual. Again, use of the BMPs in this manual benefits the farmer or subsequent user of the MC.

5.3. Recordkeeping

Recordkeeping represents an important and inexpensive management practice that can be used by the grower to verify the proper use and disposal of MC and wastewater. When the grower

maintains records consistent with this section, the grower can also fulfill his/her obligations under the residual waste regulations.

The amount of recommended recordkeeping is related to the type and scale of MC and wastewater management programs. Substantial recordkeeping requirements are only triggered for large-scale MC uses or when these materials leave the farm. When large volumes of MC are given away, sold, or taken away, the grower must maintain records of the date, volume, and identity of the person taking the waste, a brief description of the proposed use and a description of the co-product determination. This can be recorded directly on the sales agreement, copies of which are available to the grower and the user of the MC.

Small-scale programs require very little in the way of recordkeeping. For giveaway programs in which MC is picked up by homeowners or other small-volume operations, such as when MC is sold on a dump truck-load basis for landscaping, the grower needs only to estimate the annual total volume of materials given away or sold.

Where passive composting (as described later in this chapter) is being carried out, the grower must maintain records of the length of MC storage and when the MC was removed. For example, a grower has four fields approved for passive composting that are included in the MFEMP. For each field the grower must record the dates when MC is applied and dates when it was removed for its subsequent use, along with a rough estimate of volume.

Wastewater resulting from making substrate can be utilized as part of makeup water in substrate preparation. It can also be applied for its irrigation and nutritive value to farm fields and be conducted as a normal farming operation, if done in accordance with this manual. In the first case, the wastewater remains in the process, and no requirement for recordkeeping is triggered. In the case where wastewater is applied to farm fields, no additional recordkeeping is necessary as long as the water is applied as outlined in an approved nutrient balance sheet.

However, more recordkeeping is required if, for example, a mushroom grower gives away 10,000 gallons of wastewater from the substrate preparation operation ten times during one year to Farmer Jones, a grain farmer. Jones welcomes the wastewater and uses it as part of his normal farming operations for both the water and the nutrients. In this case, the mushroom grower should keep records of the transactions including the dates, volumes of wastewater, name of recipient (Jones), and use of wastewater.

If the wastewater and MC are managed as suggested in this section, the grower can minimize the recordkeeping needs and be in compliance with the residual waste regulations.

5.4. Isolation Distances and Existing Facilities

The following two sections deal with storage and composting of MC. Certain aspects of the physical locations of these facilities may either increase or reduce their environmental impact. Distances have been established, known as isolation distances, that separate these facilities from sensitive areas (wetlands, streams, drinking water sources, occupied residences, etc.).

However, some flexibility may be available (for example, in the development or updating of the MFEMP) where existing facilities do not meet all the distance restrictions noted here. This flexibility is most likely to be applicable to stationary facilities that have been in operation for

several years prior to the publication of this manual, are already covered by a MFEMP or other farm plan, or are located at the farm where the MC was generated. For example, where a low permeability pad or roof effectively reduces the threat of groundwater contamination, these isolation distances may not apply.

It is, nonetheless, highly recommended that these isolation distances be observed wherever possible. Farmers or other operators are strongly encouraged to design new facilities or modify existing facilities to be consistent with these restrictions in order to assure pollution prevention in the future.

Applications of MC will need to be consistent with a MC Field Crop Application Sheet (Appendix C) for importing operations receiving more than 100 tons of the material within a 12-month time frame. This responsibility is to be described in the contract entered into between the grower and the MC broker/purchasing company. The broker shall provide a MC Field Crop Application Sheet for each agricultural operation that is importing the MC material.

When the MC will be directly transferred to an importing agricultural operation for land application on that importing site, the mushroom grower shall supply a MC Field Crop Application Sheet (Appendix C) in order to provide direction on the proper application rate of the material.

For third-party brokers or purchasing companies that further process the MC on their sites for purposes other than direct application to agricultural lands, a MC Field Crop Application Sheet is not required.

If the MC is hauled to another land parcel owned by the grower farm, then the grower will maintain responsibility at the other location. This responsibility for on-site storage of the material is described below according to the expected use of the MC.

Small-scale MC relocation programs (less than 100 tons per year to a given importer) require very little in the way of recordkeeping. For giveaway programs in which MC is picked up by homeowners, the grower needs only to estimate the annual total volume of materials given away. For the occasional sale of MC directly from the farm on a dump truck-load basis for landscaping, there need only be a record of who received the material, when and how much.

5.5. Hauling and Temporary Holding

Any temporary storage of the MC shall be done in such a way as to ensure that there is no direct discharge of material or runoff to surface or groundwater resources. NRCS standard practices shall be followed for any storage. {Roof Runoff Structure (558)(9/09), Sediment Basin (350)(1/10), Stormwater Runoff Control (570)99/10}. The site may require runoff collection and/or a structure for storage. Selected examples of temporary storing methods include: on soil, on a pad, and under a roof. On any soil base location, the seasonal high water table must be deeper than 20 inches. Also, isolation distances are required for all sites. The storage location must be at least 300 feet from a drinking water source; at least 300 feet from an occupied dwelling, unless the owner agrees to a reduced distance; and no less than 100 feet from a stream, wetland, spring or sinkhole. Runoff practices must be addressed on a site-specific basis. The duration of storage is the primary factor in determining the other site characteristics, as follows:

1. For a storage period of less than 120 days, and at a site that is not continuously used for storage, the base may be soil. Site grading guidelines and erosion control practices must be followed.
2. For land application areas, usually field crops, where MC is not stored continuously in the same location, MC may be stored on soil until the next cropping cycle but in no case longer than 180 days. The storage must be part of an approved and implemented farm nutrient management plan (unless an MFEMP has been prepared for the location). The maximum volume to be stored in a field cannot exceed the volume that will be land applied in that field, in accordance with this manual and the Penn State Agronomy Guide, during the next growing season.
3. For a storage period of more than 120 days, but less than one year, the MC must be stored on a pad or under a roof. The pad must follow NRCS specifications for an impervious surface. For an on-farm storage facility, the maximum volume of MC that may be stored at the location where the MC is generated during the course of one year cannot exceed the annual volume of MC generated by that mushroom farm. For a non-farm storage facility, the maximum volume of storage for one year cannot exceed 20,000 cubic yards or 2 acres in size. The operation must be in compliance with 25 Pa. Code Chapter 102 (relating to erosion and sediment control), and cannot pollute the air, water, or other natural resources of the Commonwealth. The storage facility owner must maintain records of the date and volume of all MC that is received and the date and volume of all MC that is removed from the facility. In addition, the records must include the name of the mushroom grower bringing MC to the site, the name of the person removing the MC, and a brief description of the use of the MC.
4. Storage (no management) of a given load of MC is not allowed for longer than a year. Either active composting or passive composting procedures must be followed to stabilize MC prior to use for horticultural applications.
5. Transfer facility - A site that is used to receive and re-distribute MC must have an impervious pad and runoff management practices. All runoff coming in contact with MC needs to be collected and treated. The MC at this site is delivered and removed regularly, so that no specific material remains for more than one year. It is expected that the MC at a transfer facility is typically less than 30 days old.

5.6. Composting of Mushroom Compost

a. Passive Composting or Curing of Mushroom Compost

Passive composting or curing involves creating shallow piles of MC from a farm and allowing it to decompose naturally into a more stable, humus-like product that can be used as casing in mushroom growing operations or for other agronomic uses. This system cannot maintain the same high temperature conditions necessary for rapid composting and therefore results in slower decomposition. According to these BMPs, the cured MC must be used in a manner consistent with the land application procedures identified in this chapter to qualify as a normal farming operation. The composting of

MC must be conducted in a manner that prevents groundwater degradation and surface water pollution.

The BMPs of a passive composting operation must be carried out in the following ways:

1. The MC must be processed in a layer not to exceed three feet in depth. Since MC self-compacts during the early days of its placement, the depth should be measured 30 days after placement.
2. The passive composting process must be managed in accordance with an approved MFEMP.
3. The passive composting process must be completed in three years or less, unless a longer period is needed to prepare the MC for a particular use. If this is the case, the specific alternate practice must be included in the MFEMP.
4. The same field cannot be used for additional passive composting until the field has undergone two resting years (years of no application). During the resting period the crop must be planted and harvested to remove nutrients.
5. The operation must assure prevention of stormwater runoff to the greatest possible extent.
6. If passive composting is taking place on an impervious surface, the runoff water must be collected and treated or reused according to the dissolved and suspended nutrient concentrations. Collection facility design and impervious pad construction need to be consistent with NRCS specifications.
7. To reduce the potential for air dispersion, surface water runoff, and groundwater contamination, a fast-growing vegetative cover must be established on the surface of the MC within six months after placement.
8. Passive composting is prohibited in the following locations: within the 100-year floodplain; within 100 feet of a wetland; within 100 feet of a sinkhole; within 100 feet of a perennial stream or other waters of the Commonwealth; within 300 feet of a drinking water source; within 100 feet of the property boundary; and in areas where the seasonal high water table is less than 20 inches from the surface during any season of the year if carried out on bare soil.

If passive composting is carried out using the practices noted above, groundwater monitoring will not be required. However, if the practices are modified in any way that results in more MC being applied per acre, groundwater monitoring may be required. Monitoring should be conducted in a manner that demonstrates groundwater degradation is not occurring. This monitoring may include but not be limited to underdrain monitoring, lysimeter monitoring or groundwater monitoring. The monitoring should be done on a quarterly basis and must be approved as part of the MFEMP. The parameters tested on a quarterly basis must include, at a minimum, specific conductance. If the specific conductance level exceeds 200 μmhos above the background level, the following additional parameters must be added beginning with the next quarterly sampling: sulfate,

DOC, chlorides and nitrates. (Though nitrates can enter groundwater from a variety of sources, many of which are not related to MC placement, nitrates can serve as an indication of the effect of poorly managed MC on groundwater.)

If the monitoring indicates that groundwater degradation has occurred or is occurring that exceeds a remediation standard as defined in the Administration of Land Recycling Program Regulations (25 Pa. Code Chapter 250) for any constituent, a schedule must be developed within one month which indicates the steps to be taken to further investigate the groundwater degradation or to initiate mitigating measures, which may include removal. The removed MC must be properly managed using the practices noted in this manual or properly disposed. The groundwater remediation must meet a cleanup standard under the Land Recycling and Environmental Remediation Standards Act, 35 P.S. §§6026.101-6026.909. In the future, the same area should not be used for passive composting unless a revised design that will not cause groundwater degradation is approved and made part of the MFEMP.

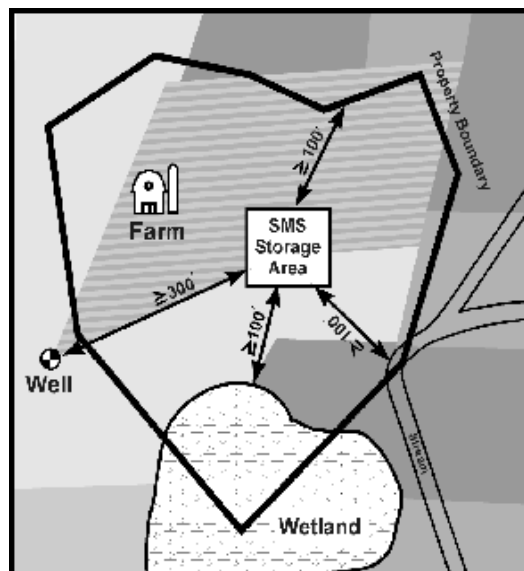


Figure 5.1: Isolation Distances for Passive Composting of MC

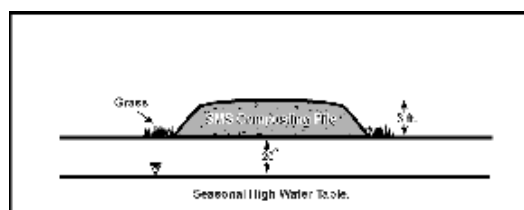


Figure 5.2: Passive Composting of Mushroom Compost

b. Active Composting of Mushroom Compost on a Farm

Active composting involves mixing the MC and forming it into elongated piles commonly called windrows. These windrows are periodically turned or agitated. This process provides faster decomposition due to the attainment of high temperatures and the trapping of the heat within the mass of the pile. Turning the pile provides temporary cooling to the hot pile interior, rotates cool outer material to the pile interior, replenishes pile porosity, and disperses decomposition gases and water vapor.

After composting, the cured MC must be used in accordance with this manual. If used as part of normal farming operations, the cured MC must be used in accordance with the land application procedures identified in this chapter. Additionally, all active composting must be done in accordance with an MFEMP. Otherwise, an individual or general permit is required for composting and subsequent use of the material.

The BMPs of an active composting operation must be completed within one year and must be carried out as described below.

1. The composting and storage of any MC or composted MC must be conducted on a concrete, asphalt, or low permeability compacted earthen pad that is capable of containing and collecting all liquids generated from the composting process, or it must be conducted in a vessel or under a roof.
2. Any liquids collected from the process must be directly reused in the composting process or stored and land applied in accordance with this chapter.
3. Composting must be maintained by means designed to promote largely aerobic conditions.
4. The compost windrows must be constructed promptly, in no case longer than two (2) weeks following receipt of the MC.
5. The MC composting facility, excluding any areas used for storage of bagged product or bulk product under cover, should not exceed an area that the composter cannot adequately control. (Facilities of greater than 5 acres may be subject to additional requirements and review.)
6. Composting is prohibited in the following locations unless conducted within a vessel: within 20 inches of the seasonal high water table; within the 100-year floodplain; within 100 feet of a wetland; within 300 feet of an occupied dwelling, unless the owner agrees in writing to a lesser distance; within 300 feet of a residential well; within 100 feet of a sinkhole; and within 100 feet of a perennial stream or other waters of the Commonwealth and within 100 feet of a property boundary.
7. All stormwater should be diverted around the pad. A berm around the pad should be established to prevent run-on and collect run-off.

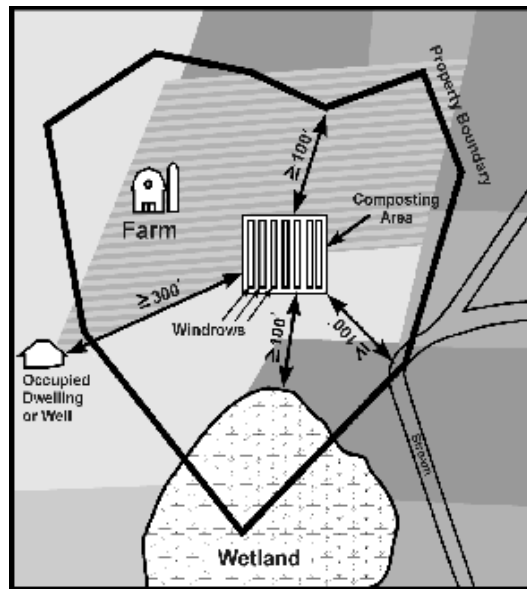


Figure 5.3: Isolation Distances for Active Composting of MC

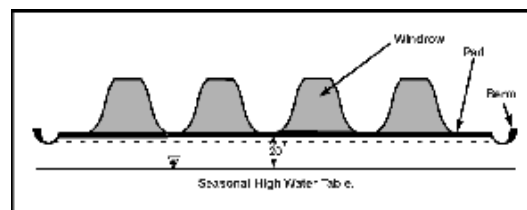


Figure 5.4: Active Composting of Mushroom Compost

5.7. Storage and Reuse of Wastewater from Mushroom Compost Operation

As noted earlier, wastewater also can result from the production of MC and from its storage. To a much lesser extent, it can result from composting of the MC for later uses. The collected wastewater can be reused in the substrate generation process, reapplied to MC storage piles, or spread on crop fields as a normal farming operation if performed in accordance with the land application procedures identified in this chapter. The wastewater may be stored in tanks or impoundments as discussed below.

a. Storage of Wastewater in Tanks



To avoid the detailed design and operating requirements necessary for storage impoundments, such as liners and groundwater monitoring, it is recommended by the PA DEP that tanks be used for wastewater storage. The following are requirements for storage tank use under this manual.

1. The tanks must have sufficient shell strength to ensure that they do not collapse or rupture. No wastewater can be placed in a tank if it would cause the tank to rupture, leak, corrode or otherwise fail. Tanks must be constructed in accordance with the NRCS's Pennsylvania Soil and Water Conservation Technical Guide and Specification 313 criteria and all other local, state and federal requirements.
2. The tank must be inspected during construction or installation and annually during operation for uniformity, damage and imperfections.
3. Subsurface tanks used for wastewater storage must be hydrostatically tested annually and when there is evidence of a leak. This can be done by comparing measurements over a 48-hour period. Visual inspection can be used where subsurface tanks are constructed in vaults or other structures that provide sufficient space for physical observation. If a leak is detected, the PA DEP Regional Office must be contacted.

b. Storage of Wastewater in Impoundments

Storage in impoundments is more heavily regulated by PA DEP because of concerns for groundwater protection. NRCS's Pennsylvania Soil and Water Conservation Technical Guide provides various operational and structural standards that apply to mushroom farms. The MFEMPs are expected to follow the appropriate standards that have been tested and reviewed for reliability. The relevant technical guide numbers are listed in Appendix A.

5.8. Land Application of Mushroom Compost and Wastewater

The MC and wastewater generated from mushroom growing operations can be valuable agricultural by-products that should be put to use in normal farming operations. Applying the MC to fields and lawns nourishes vegetation; improves the tilth, aeration, and water-holding capacity of soil; decreases soil erosion potential; and promotes the growth of beneficial soil organisms. As an alternative to diverting all wastewater to tanks or impoundments prior to its final use, wastewater can be diverted to a vegetated area or similar arrangement that is capable of filtering solids and using all nutrients without causing pollution. This practice must be approved as part of a MFEMP.

Unfortunately, many MC or wastewater management systems do not fully utilize the nutrients in MC. Applying MC or wastewater in excess, at the wrong time, or improperly handling it in other ways, releases the nutrients into the air and water. Instead of nourishing crops, the nutrients may leach through the soil and into groundwater. One common misuse of agricultural waste, for example, is to apply it to a field and then to supply a crop's nutrient needs with commercial fertilizer without considering the nutrients contained in the waste. An efficient MC or wastewater management and application system meets, but does not exceed, the needs of the crop and thereby minimizes pollution.

The following sections identify the BMPs for the land application of MC and wastewater generated from the storage of MC.

a. Site Considerations

The mushroom grower or other person who applies MC or wastewater must follow certain regulations to ensure they are protecting soil quality. For first-time applications of MC to a crop field, a Field Crop Application Sheet must be developed. For subsequent MC applications to that field, a Nutrient Balance Sheet should be completed. A Nutrient Balance Sheet should also be completed for all fields where wastewater is applied. The county conservation district or a private consultant may assist in developing either a Field Crop Application Sheet or Nutrient Balance Sheet.

The county conservation district or a private consultant may also develop or assist in the development of the MFEMP. The MC or wastewater may not be applied on the soil surface within 100 feet of a drinking water source, springs, sinkholes, streams or lakes. The setback can be reduced to 35 feet for streams and lakes with a permanent vegetative buffer.

b. Nutrient Content of Mushroom Compost or Wastewater from Mushroom Compost

Agricultural applications of MC must be consistent with the Mushroom Field Crop Application Sheet (Appendix C) for operations receiving more than 100 tons of the material within a 12-month time frame. The broker needs to provide a Mushroom Compost Field Crop Application Sheet to each agricultural operation that is importing mushroom compost for land application.

The amounts of nitrogen, phosphorous, and potassium, or N-P-K, in the MC or wastewater vary depending upon the materials used to develop the substrate, as well as

the methods of handling the MC or wastewater prior to field application. Because the nutrients and other chemicals in the MC or wastewater can vary due to the different substrate mixes, each mushroom farmer or other person who land applies MC and wastewater must analyze the MC and liquids to determine, at a minimum, their N-P-K nutrient content. After the baseline nutrient content is established, repeated analyses are not necessary unless the ingredients in the substrate mix are changed or the mushroom grower has reason to believe that changes in the MC composition have occurred.

c. Application Methods and Timing

Wastewater

The MFEMP will specify the methods and timing of wastewater and MC application. Wastewater can be used to irrigate and fertilize an existing perennial crop (for example, hay) or a seasonal field crop. It can be applied to the ground or vegetation surface, or it can be incorporated into the soil.

Seasonal application timing and site selection are important considerations for wastewater application. Spring application is best for conserving nutrients. At this time, wastewater application can be coordinated with crop germination or the end of the dormant period for an existing crop. Summer application of wastewater is suitable for small-grain stubble, non-crop fields, or little-used pastures. Fall application of wastewater generally results in greater nutrient loss than does spring application. However, if wastewater is incorporated or injected immediately, the soil will immobilize some nutrients, especially at soil temperatures below 50°F. During this season, wastewater is best applied to fields to be planted in winter grains or cover crops. If winter crops are not to be planted, wastewater should be applied to the fields containing the most vegetation or crop residues.

Winter application of wastewater is the least desirable from both a nutrient use and pollution point of view. The frozen soil surface prevents rain and melting snow from carrying nutrients into the soil. The result is nutrient loss and pollution through runoff. Winter application of wastewater should be avoided by foresight and good planning. If occasional spreading is necessary, the wastewater should be applied to distant fields with the least runoff potential. Application should be in areas that are at least 100 feet from streams and that have slopes less than 3%, unless other provisions are made in the MFEMP. The wastewater should be applied to limited access fields in early winter, then to nearer fields later in the season when mud and snow make spreading more difficult. Winter application of wastewater must not cause surface water pollution. Measures to prevent surface water pollution must be addressed in the MFEMP.

Mushroom Compost

Mushroom Compost is a material of proven value for soil conditioning and long-term fertilization. It provides a variety of plant macro and micronutrients, many of which are in the organic form and have slow-release properties. MC adds much-needed organic matter to poor or impoverished soils.

MC can be applied as a top dressing to an existing crop (for example, hay), as mulch or as a fertilizer. Due to the physical characteristics of MC, its nutrients are in a more stable form than those in its raw ingredients or in manures. They pose less threat to surface water resources if reasonable care is taken to avoid application to areas where erosion is likely.

As noted above for wastewater, MC can be applied during any season, but spring applications are most beneficial for seasonal field crops. Summer application is also suitable for small-grain stubble, non-crop fields, or little-used pastures. Spreading MC following the removal of one hay cutting has logistical advantages and also provides nutrients for the growth of the next cutting. MC application in the fall should be targeted for fields with winter grains, cover crops, significant vegetation or crop residues. As with wastewater, winter application of MC requires careful choice of fields and must be performed according to any winter restrictions in the MFEMP. MC may also be stored until the season of use as outlined earlier in this chapter.

Because of its solid form, MC can be applied to more steeply sloped fields with less threat of nutrient loss and pollution than can wastewater. Slopes up to 12% can be used for MC application in spring, summer or fall. During winter, slopes should be limited to 3%, and application should be in areas that are at least 100 feet from streams. Vegetated buffer areas located at the base of steep slopes can effectively take up nutrients that might be transported during heavy precipitation. A 35-foot setback from streams should be the minimum distance for MC application when a permanent vegetative buffer is provided.

d. Application Rate

In the MFEMP a Field Crop Application Sheet or Nutrient Balance Sheet will provide a guide as to the amount of MC to be placed on the field or other crop. It is important that the nutrient contents (N-P-K) of the MC match the needs of the vegetation in the application areas. See Appendix C for supporting information. For wastewater application to crop land, the nutrient balance as well as a limit on the amount of liquid to be applied over a specified time may also be part of the plan. See the conservation district for site-specific plan development regarding wastewater system design and operational planning.

The amount of available nitrogen in the material to be applied to the land is limited to the amount of nitrogen required by the crop to be grown. The organic nature of the MC gives it slow release properties and allows only a portion (approximately 20% of its nitrogen to be available in the first year. If MC is being applied as the only fertilizer, this fairly low rate of nitrogen availability will affect the amount of MC to be applied. The application guidelines in Appendix C account for this slow-release. Occasionally, MC is used as a protective layer to reduce evaporation, prevent erosion or control weeds—somewhat in the role of mulch. For those uses where subsequent tillage is avoided, the depth may be up to six inches.

Under some circumstances, test results of soil fertility, wastewater or MC could point to other constituents as the basis for application rates. For more information on calculating the annual application rate based on crop nutrient requirements and soil fertility management, consult with the county conservation district or NRCS representative, or

refer to the most current edition of the Penn State Agronomy Guide. Additional information on the land application of wastewater is available from the PA DEP Regional Water Quality Management Program.



e. Mushroom Compost Uses Other Than Normal Farming Operations

There is an increasing potential for the use of MC in numerous non-farming applications such as reclaiming mined land or assisting in the establishment of wetlands. This use is not considered a normal farming operation, and, therefore, the permit exemption for its use does not exist. However, in many instances, the use of MC can be done as part of another permit. For example, the use of MC in re-vegetating a landfill or active mine site can be done as part of the operating permit issued to those facilities. In other instances, a general permit for beneficial use may be obtained from the PA DEP Bureau of Waste Management for the use of the materials to reclaim active mines or establish wetlands, or a determination that the MC is a co-product for these purposes may be pursued. Also, PENNDOT has used MC in roadside restoration efforts in their Strategic Recycling Program. If the MC is qualified as a co-product for these uses, no residual waste permit is required. At these operations, the use of MC that is covered by a general permit or qualified as a co-product may also need to be approved as part of a permit or approval issued by the PA DEP for the particular mine reclamation or wetland construction activity. The beneficial use of finished compost under General Permit WMGR025 is for use, marketing or distribution as a soil conditioner, soil amendment, fertilizer, mulch or for erosion control. The finished compost is not considered a waste when it has satisfied the conditions of this permit.

Since these uses are not considered normal farming operations, the grower must maintain records of the date, volume and identity of the person taking the waste, a brief description of the proposed use and a description of the co-product determination.

f. Distribution and Sale Requirements

In addition to the requirements in this manual, MC that is sold or distributed in bulk or bag as a fertilizer or soil conditioner in the Commonwealth must be registered with the Pa. Department of Agriculture. MC has a dual purpose specialty fertilizer/soil

amendment label available showing the results of chemical analysis in 2005 (Appendix B). The label provides a generic outline of labeling requirements for MC or MC mixed products that would be marketed as a fertilizer, soil amendment or both.

A specialty fertilizer is a fertilizer distributed for non-farm use and fertilizer material primarily intended to supply plant nutrients other than nitrogen, phosphate and soluble potash. All fertilizers must be sold on the basis of net weight because of the requirements of the guaranteed analysis.

A soil amendment is any substance that is intended to change the chemical or physical characteristics of soil. A plant amendment is any substance applied to plants or seeds that are intended to improve germination, growth, yield, product quality, reproduction, flavor or other desirable characteristic of plants.

Multi-purpose products intended to supply plant nutrients, soil/plant amendments and/or limiting materials must be labeled, licensed, and registered (as required) under each respective law prior to being offered for sale, sold or distributed in Pennsylvania.

Specialty fertilizers and soil and plant amendment materials are regulated through the product registration to ensure consumer safety and efficacy. Samples are collected and analyzed to ensure products are currently registered, meet labeling requirements and are not adulterated.

For licensing, labeling, product registration and tonnage reporting, the program requirements for fertilizer and soil amendments are available for review at the Pennsylvania Department of Agriculture website at www.agriculture.state.pa.us.

g. Water Management for Nutrient Control

This section on water management addresses water with several different identifying adjectives: 1) fresh water coming from a well, 2) goodie water used to increase the moisture content of substrate, 3) roof water and lawn area stormwater, 4) runoff water from hard surfaces where substrate or ingredients are present, and 5) leachate. Any wastewater not used in accordance with normal farming operations and managed in accordance with these BMPs may require waste and/or water permits for processing, use or disposal.

Water added to the raw materials provides the necessary moisture balance for the desired microbial action in substrate preparation. Bacteria and fungi metabolize nutrients and convert them into microbial protein. Excess water applied to the substrate can lead to the loss of nutrients, which can become pollutants if not properly managed. A recommended practice is to add sufficient water, but not so much water as to cause wash-out of ingredients and nutrients. To find the balance point, wetting of the initial piles of substrate ingredients in the preliminary or “pre-conditioning” step, the watering volumes and schedules for the substrate ricks, substrate turning schedules, and composting period may need to be modified until the optimum microbial growth is obtained. Since release of some water from the ricks is normal and unavoidable, the design and operation on the compost wharf must be adequate to control and capture the highly nutritious runoff (referred to as goodie water). The initial design process for a new wharf is the most

effective time to consider and address this issue, but existing wharves can and must be upgraded to meet the same objective.

Enclosed or partially enclosed facilities for preparing substrate usually have an aerated floor. Fresh air, with oxygen and lower temperature, is used to manage the microbial growth in the substrate material. These types of enclosed facilities have microbial and condensation water coming from the bottom of the bunker or horizontal silo. This excess water is high in nutrients and can be reused for wetting the incoming ingredients. This collected water is also referred to as “goodie water,” recognizing its important characteristics that help facilitate the composting process. Application of this goodie water to the incoming materials provides additional bacteria to aid the substrate nutrient conversion. Since this goodie water is already in pipes, it can be handled by gravity or pumping, and transferred to appropriate temporary holding. If holding the goodie water more than a few hours, there may need to be supplemental aeration to keep the beneficial microbes growing and to address odor issues associated with this important water supply, and microbe inoculation source.

Rainwater falling onto the substrate preparation area differs from natural leaching of microbial water from the substrate. Storm events may deliver large volumes of water, whereas the leachate may be a relatively small volume. Nonetheless, good practice and environmental laws dictate that there be no discharge of untreated runoff from the raw materials storage area, the wharf or bunkers to the surface or groundwaters of the Commonwealth. The runoff water generated on the wharf (goodie water) must be collected and used in the composting procedure, or treated as wastewater. The collection of the goodie water is not only important for the environment, but this water serves an important role in hydrating and inoculating the composting materials in order to facilitate the composting process. The need to dispose of this goodie water on fields outside of the composting process is only necessary to address uniquely historic rainfall events where the accumulation of this water is in excess of the needs for the composting process. The goodie water may be stored in either tanks or impoundments, and must be aerated. Aeration, including agitation, that keeps dissolved oxygen concentration at 1 milligram per liter (1 ppm) has been found most beneficial for both odor reduction and application of goodie water to substrate mixes. The volume of containment for this recyclable water must be designed according to the total area of impervious material and the appropriate rain intensity values for the farm location (see NRCS standards). Recyclable goodie water from the wharf can be added judiciously to the mix of raw materials in the early “pre-conditioning” heaps or to the bunker substrate, or to ricks during turning. This practice adds moisture to the mix and also reduces the accumulation of high strength nutrients in collection basins. This recycled goodie water must be kept aerated to reduce anaerobic activity, odors, and settlement of solids in the collection basins.

Provisions must be made for control of clean stormwater as well. The wharf and ingredient storage areas must be designed and operated to negate the run-on of stormwater to these surfaces. All upslope diversion systems and associated drainage channels implemented to keep this clean water must be adequately sized and constructed to carry storm-water away, preventing contamination by wharf material. Care must be taken to size stormwater storage units to accommodate the higher volumes of water from storm events. Critical in this regard are the design and construction of roof water and lawn area stormwater collection basins or infiltration areas intended to manage

stormwater flow in order to minimize damage to downstream areas due to excessive hydraulic loads. References for these management practices are listed in Appendix A. Once constructed, these stormwater management practices must be maintained to be serviceable at all times to control clean stormwaters. This relatively clean stormwater may be used for substrate preparation when needed. Emergency drawdown of a full storm-water pond can be provided by land application (irrigation) equipment. Such land application events need to be planned according to both nutrient and hydraulic guidelines (see nutriment management references) with the expectation that nutrient concentrations in this water source will be negligible.

Rain water that lands on a substrate rick and filters through and out of the rick can carry away nutrients. This water trickling through the ricks is referred to in this guidance document as leachate. A covered bunker for aerated composting will not have leachate, but as noted above there is water expected in the floor drains of a bunker. Leachate relative to MC piles and rows is addressed in Chapter 5.

Care taken in daily operations can also reduce the likelihood of pollution. “Good housekeeping” should include cleaning up clumps of MC and raw materials scattered about the wharf and placing them in ricks or with raw materials ready for the next batch of MC. The collection of these stray materials in dry weather can control dust and the dispersal of pollution-generating materials. Dry, dusty areas can be lightly moistened with a fine spray of water to reduce dust. Screens and filters are a wise investment to remove solids from the water entering the collection basins. Keeping drainage channels free of wharf solids allows them to better serve their purpose. It also reduces the extent to which the solids will dissolve into the channel water, thus reducing the pollution load on the collection and treatment system. Stormwater and drainage channels should likewise be kept free of stones, gravel, and other inorganic materials. As suggested earlier, using the appropriate amount of water to make a good substrate also minimizes runoff volume.



CHAPTER 6

MUSHROOM FARM ENVIRONMENTAL MANAGEMENT PLANS (MFEMPs)

6.1. Introduction

Under state law, PA DEP has the responsibility to protect the quality of the waters of the Commonwealth and the authority to require a permit for the management of groundwater and surface water.

However, PA DEP has determined that those processing facilities that operate in accordance with this manual and that have developed, filed, and implemented an MFEMP may not be required to obtain a waste management permit or comply with the residual waste storage requirements. An MFEMP is a carefully planned program and documented record outlining how the mushroom farmer or landowner intends, within practical limits, to manage the farm to prevent pollution incidents and to maintain or improve the condition of the soil, water, and air resources.

To comply with applicable regulations, all operations listed below need MFEMPs:

1. farms that produce mushrooms,
2. farms and other producers of MS, and
3. MC processors.

The NRCS's Pennsylvania Soil and Water Conservation Technical Guide provides various operational and structural standards that apply to mushroom farms. The MFEMPs are expected to follow the appropriate standards that have been tested and reviewed for reliability. The relevant technical guide numbers are listed in Appendix A.

6.2. The MFEMP

The MFEMP may be developed for a specific operation in cooperation with the NRCS and the county conservation district, taking into account the particular characteristics of the operation. An updated MFEMP is required periodically according to the conservation district, usually every three to five years. For many farms, in addition to improved operational measures, some new BMP structures will need to be installed. The agencies that assist in development of the MFEMP may also provide technical help for installation of the practices. With certain qualifications, there may be cost-share funds available to implement the MFEMP.

As the MFEMP is implemented, it serves as a documented record of the farmer's effort to comply with regulatory requirements. If the requirements in the plan are being met, the MFEMP will serve in the place of a PA DEP permit and will be kept on file with the PA DEP Regional Water Quality Management Office.

The MFEMP will focus on the detailed design requirements for structures and specific management activities that will prevent pollution during normal farm operations. The MFEMP will also provide the procedures to follow in the event of a pollution incident to minimize the impact of the pollution. It will need to be updated to reflect changes in technology, government regulation, and when the potential to cause pollution changes at the farm.

All farms that apply MC or wastewater as a soil conditioner or fertilizer and that are not required to develop a full MFEMP must develop and implement a nutrient balance sheet. A nutrient balance sheet incorporates the BMPs to control plant nutrients for crop production and water quality protection. A conservation plan identifies conservation practices and, at the very least, includes an erosion and sedimentation control plan. In addition, all farms that apply mushroom compost as a soil conditioner or fertilizer or wastewater, including water coming from the compost production or storage areas, must follow the guidelines for application (Appendix C).

6.3. Basic Components of an MFEMP

The MFEMP is designed to prevent pollution or the danger of pollution to the ground or surface waters of the Commonwealth. It identifies specifically the required BMPs to meet those objectives. These are normally covered in the following plan components. All components shown below may not be required for each farm.

a. Erosion and Sediment Control

This section of the plan looks at the soils, geology, topography, ground cover, and other natural features of the site. Depending on these natural features, BMPs may be required to prevent erosion and pollution from sediment. Some examples of BMPs are: contour strips, diversions, waterways, terraces, crop rotation, and critical area planting. The Clean Streams Law and regulations promulgated thereunder, 25 Pa. Code, Chapter 102, require an erosion and sedimentation control plan for all plowing or tilling activities.



b. Surface Water and Stormwater Management

Earlier chapters have presented operational practices that can reduce potential for pollution of surface waters. When properly implemented, a stormwater management plan will assure that the quality of runoff during a storm event is protected. At most

mushroom farm operations, stormwater runoff can be divided into uncontaminated and contaminated water. The uncontaminated water must be directed away from possible sources of contamination or carried through the site using BMPs such as diversions, underground pipe systems, roof downspouts, gutters, drains, and waterways. BMPs must be in place to ensure that contaminated stormwater is managed so that no discharge occurs to the surface or groundwater.

c. Groundwater Protection

The plan includes a section describing the BMPs to be instituted or constructed to prevent or minimize groundwater contamination. Some of the BMPs that could be utilized include storing raw materials and MC on impervious surfaces or under roofs, installing monitoring wells around impoundment structures, and developing well head protection zones.

d. Nutrient Management for MC Utilization or Spray Irrigation Programs

A Mushroom Compost Field Crop Application Sheet is site specific and implicitly accounts for the crop nutrient requirements (nitrogen, phosphate and potassium), providing for maximum crop yields while protecting water quality. The Application Sheet includes the following: expected crop yield, and any limitations based on proximity to water resources and a 35-foot buffer from stream, lakes and ponds. If spray irrigation is to be utilized at an operation, a Nutrient Balance Sheet may be required to include a water budget, spraying schedule, proper sizing and layout to address infiltration and water holding issues, as well as other necessary BMPs.

MC that leaves a mushroom growing farm for field application should be applied on those fields according to the MC Field Crop Application sheet. The receiving farmer will maintain those appropriate records unless the mushroom grower or their employee is applying the MC, in which case a copy of the record is maintained at the exporting farm.

A Nutrient Balance Sheet is site specific and includes the field crop requirements for the management of nutrients (nitrogen, phosphorus and potassium) required for maximum crop yields while protecting water quality. The Plan includes the following:

1. expected crop yield;
2. existing nutrient levels in the soils;
3. the season, method of application, and the amount of nutrients applied to maintain optimum nutrient levels for a particular crop;
4. normal farming practices including liming, pest control, crop rotation, and harvesting;
5. a description of farming practices such as spray irrigation of runoff water collected from the wharf or MC storage areas, impoundments, and land application of MC; and

6. limitations based on land slope, cover type, infiltration rates, soil moisture and proximity to water resources.

e. Integrated Pest Management (IPM)

Use of chemical pesticides can be minimized when an effective IPM Plan is in place. IPM involves developing and implementing a program to determine the threshold population size of a pest at which an economically meaningful level of crop damage occurs and minimizing pest damage in excess of that level. Pest control may be accomplished using the proper non-chemical or alternative controls. It is recommended that chemical control of pests should be used only as needed. An IPM Plan includes the proper use, handling, and storage of all pesticides. (See <http://extension.psu.edu/ipm/agriculture/mushrooms/mushroom-manual.pdf/view> for more information on pest management.)

f. Operations and Maintenance Requirements

Any BMP that is installed has normal required maintenance. No system, no matter how well it worked when it was installed, can function without maintenance. Operation and maintenance for individual practices are described in the NRCS's Pennsylvania Soil and Water Conservation Technical Guide used by county conservation districts. The following are examples of items to address:

1. Grassed diversions, waterways, and impoundment embankments need to be mowed at least twice a year;
2. Structures must be inspected for cracks or structural failure;
3. Pumps need periodic inspection and greasing; and
4. Schedules for the removal of solids from collection basins, screens or entrapments should be developed.

These items and others pertinent to the specific farm should be included in the operation and maintenance section of the MFEMP. Recordkeeping is an important part of the operations and maintenance component of the MFEMP as it is being implemented. The BMPs should be listed and checked off as they are inspected. The inspection date and any corrective action taken should be recorded.

g. Best Management Practices Implementation Schedule

The implementation schedule must include a full listing of the farm's planned BMPs with the dates they are scheduled to be implemented. The detailed schedule must be included in the MFEMP, but can be revised by requesting and receiving approval from the county conservation district and sending a revised schedule to be placed in the file at the PA DEP Regional Water Quality Management Program.

h. Odor Management

Odors are natural occurrences in mushroom composting operations. However, a farmer must minimize and control potential odors from his operation. Many of the odor reduction techniques and BMPs have already been described in Chapter 3, section 3.5, Odor Reduction Opportunities. A description of the specific odor control methods that will be utilized at the farm should be included in the MFEMP.

i. Emergency Preparedness Plan

An Emergency Preparedness Plan outlines the types of emergencies that require notification of community and government agencies, the steps to minimize the damage in a pollution event, and the telephone numbers a farmer needs to have immediately available if an emergency occurs. A description of the Emergency Preparedness Plan must be included in the MFEMP.

j. Wastewater Management

The plan identifies the methods of collection, monitoring, and the reuse or disposal of all wastewater collected from the wharf area and the mushroom growing operation.

k. Mushroom Compost Management

The plan must provide for the management, reuse or disposal of the MC and any off-spec substrate.

6.4. Development of an MFEMP

A mushroom farmer has alternatives when deciding who will prepare and provide technical assistance in developing an MFEMP. The county conservation district and/or the NRCS will prepare the plan, usually at little or no cost, upon request of the farmer as time, resources and priorities permit. There are also many private consultants and engineering firms qualified to develop MFEMPs in consultation with the county conservation district or the NRCS. Regardless of who develops the MFEMP, all structural and management BMPs will be evaluated based on current and relevant technical standards and specifications. The MFEMP must be reviewed and approved by the PADEP through the local conservation district.

6.5. Funding Sources to Implement BMPs

The mushroom farmer has the basic responsibility to pay for the cost of implementing the MFEMP. However, some governmental sources of funding are available periodically. The United States Department of Agriculture (USDA) may have a cost share program to provide incentives to install BMPs. A local work group made up of farm, government and community representatives sets the local priorities and allocates funds to selected projects. Farms in certain watersheds or within the Chesapeake Bay watershed may be eligible for other funding as well. There are also various state programs that provide grants or low interest-loans for the installation of BMPs. A farmer interested in participating in any of these funding sources can get information and direction from either the county conservation district or the NRCS.

6.6. Monitoring for Compliance

MFEMPs should be submitted by the County Conservation Districts to the PA DEP Regional Waste Management Section, which will share with Regional Water Quality Management personnel as appropriate. A template MFEMP is available in Appendix D.

APPENDIX A

CONSERVATION PRACTICE STANDARDS PREPARED BY USDA - NATURAL RESOURCES CONSERVATION SERVICES

Selected Examples:

These may be relevant to Mushroom Farm Environmental Management Plans

Access Road - PA560

Water and Sediment Control Basin - PA638

Grassed Waterway - PA412

Filter Strip - PA393

Manure Transfer - PA634

Sediment Basin - PA350

Structure for Water Control - PA587

Waste Storage Facility - PA313

Windbreak/Shelterbelt - PA380

Pumping Plant - PA533

Roof Runoff Structure - PA558

Underground Outlet - PA620

For Standards applicable in Pennsylvania, go to this website, and then select PA using the following address:

http://efotg.sc.egov.usda.gov/efotg_locator.aspx

OR, look at the general national website to get started:

<http://www.nrcs.usda.gov/technical/efotg/>

APPENDIX B

FERTILIZER LABELS FOR MUSHROOM COMPOST

“PA Department of Agriculture may obtain samples of MC if sold or distributed as a commercial fertilizer. Penalties shall be assessed for deficiencies from the guaranteed analysis.”

MC is a relatively consistent material as it comes from the *Agaricus* growing facility. With this uniformity, the consumer can be confident of minimum nutrient content values for nitrogen, phosphorous, and potassium. The following page shows a Sample Fertilizer Label for MC-Fresh, that is, just as it comes from the growing room. Also shown in this appendix is a table of nutrient values for other forms of MC.

SAMPLE: FERTILIZER LABEL: FRESH

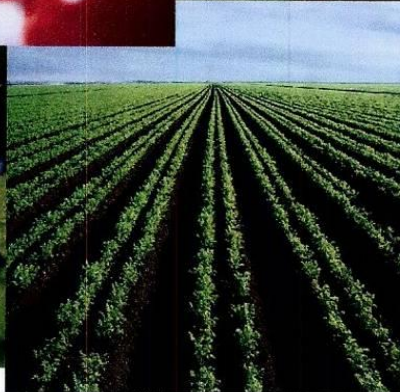
Fresh Mushroom Compost Fertilizer & Soil Amendment:

Guarantor

Fresh Mushroom Compost

Fertilizer & Soil Amendment

The Possibilities



are Endless...

0.9-0.5-1.0

GUARANTEED ANALYSIS

Total Nitrogen (N)	-----	0.9%
Available Phosphate (P2O5)	-----	0.5%
Soluble Potash (K2O)	-----	1.0%

Net Wt. XX lbs.

Manufactured by:
Company Name
Address, PA

Generic Fertilizer Label: Fresh Mushroom Compost Fertilizer & Soil Amendment:

Guarantor

Fresh Mushroom Compost Fertilizer & Soil Amendment

Mushroom Compost is made from agricultural materials, such as wheat straw bedded horse manure, hay, poultry manure, cottonseed meal, cocoa shells, sphagnum peat and gypsum, providing a consistent, formulated & homogeneous product. After mushrooms are harvested, the Mushroom Compost is pasteurized. The resulting compost can be used for agricultural crops since it is an ideal fertilizer and soil amendment with important nutrients.

Mushroom Compost has high water and nutrient holding capacity and exhibits no nitrogen draw down problems. As a fertilizer and soil amendment for farming, turf management and home gardening, Mushroom Compost supports plant growth in a variety of plant applications such as: corn yields, broccoli and cabbage yields, tomato yields and turf applications.

Recommended Application: (Guarantor) recommends applications in the spring and fall, however, it can be applied at any time of the year or season. Incorporate (Brand) into the soil to increase absorption and nutrient dissemination. Apply by dropper spreader, whirlwind spreader, broadcast by hand, sprinkle or side dress around the base of plants. May be mixed and applied with other products.

Application Rates will vary with soil analysis and purpose of application. (Guarantor) recommends soil testing before application of any fertilizer or soil amendment.

Active Ingredient: 100% Mushroom Compost

(Guarantor) guarantees that you will be 100% satisfied with the results of this product. If for any reason you are not completely satisfied, return the unused portion along with a copy of your register receipt and a SASE to (Guarantor) and we will cheerfully send you a refund.

All recommendations, application rates and directions for use of this product are to be considered a guide. Climatic conditions, geographic location and other influential factors in using this product are beyond the control of the manufacturer.

SAMPLE

Spent Mushroom Substrate (SMS) Primary Plant Nutrient & Guaranteed Analysis

• Analysis of Fresh⁽¹⁾ SMS

Primary Plant Nutrient	Minimum Value	Mean %	Maximum Value	Standard Deviation of the Mean %	Minimum Guaranteed Analysis %	Maximum Guaranteed Analysis %
N (Nitrogen)	0.773	1.127	1.525	0.206	0.9	1.3
P ₂ O ₅ (Phosphate)	0.338	0.675	1.203	0.184	0.5	0.9
K ₂ O (Potash)	0.726	1.257	1.868	0.291	1.0	1.5

• Analysis of Passive⁽²⁾ SMS:

Primary Plant Nutrient	Mean at each Time Interval (Months)								Minimum Guaranteed Analysis	Maximum Guaranteed Analysis
	0	3	6	9	12	15	18	24		
N (Nitrogen)	1.127	1.109	0.902	0.946	1.101	1.093	0.825	0.825	0.9	1.2
P ₂ O ₅ (Phosphate)	0.675	0.654	0.713	0.617	0.596	0.833	0.644	0.940	0.5	0.9
K ₂ O (Potash)	1.257	0.548	0.795	0.898	0.722	0.979	0.659	0.662	0.6	1.0

• Analysis of Active⁽³⁾ SMS:

Primary Plant Nutrient	Minimum Value	Mean %	Maximum Value	Standard Deviation of the Mean %	Minimum Guaranteed Analysis %	Maximum Guaranteed Analysis %
N (Nitrogen)	1.038	1.141	1.258	0.110	1.0	1.2
P ₂ O ₅ (Phosphate)	0.719	0.781	0.833	0.057	0.7	0.9
K ₂ O (Potash)	1.139	1.272	1.427	0.145	1.1	1.4

⁽¹⁾Fresh SMS refers to SMS obtained directly as it is removed from a commercial mushroom production facility (data represents mean of 30 samples). All data was compiled on a percent wet volume basis.

⁽²⁾Passive (Static-aged) SMS refers to SMS piled and sitting passively outdoors in a field (data at 0 months was obtained from fresh SMS data above, and remaining data represents mean of 3 samples per time interval from 3 through 24 months). All data was compiled on a percent wet volume basis.

⁽³⁾Active (Active-aged) SMS refers to fresh SMS aerated on a repeated and regular basis for three months (data represents mean of 3 samples). All data was compiled on a percent wet volume basis.

APPENDIX C

MUSHROOM COMPOST FIELD CROP APPLICATION SHEET AND TABLE SHOWING MAXIMUM ANNUAL APPLICATION RATES

The following pages/sheets should be photocopied and provided to farmers who apply Mushroom Compost (MC) to agricultural fields. As noted in Chapter 5 of this Manual, a completed MC Field Crop Application Sheet should be retained by the appropriate business for each MC application. This record of application will provide evidence of proper procedures should authorities have questions in the future.



MC Field Crop Application Sheet

MC Application Date: _____

Planting Date: _____

Field Identification: _____

Crop to benefit from MC: _____

Crop area in acres: _____

Expected yield: _____

Application of MC needed, according to the attached reference table: _____

Total delivery needed for this yield in this field: _____

Other Considerations: _____

After harvest report:

Yield per acre: _____

Crop Quality: _____

Diseases: _____

Pests: _____

MUSHROOM COMPOST MAXIMUM ANNUAL APPLICATION RATES

Crop	Yield	MC Maximum Annual Application Rate/Acre	Inches/Acre
Corn Grain	100 bushel	30 tons (105 yd ³) ¹	0.8
Corn Grain	125 bushel	40 tons (140 yd ³) ¹	1.1
Corn Grain	150 bushel	50 tons (175 yd ³)	1.3
Corn Grain	175 bushel	60 tons (225 yd ³)	1.7
Corn Silage	17 tons	40 tons (140 yd ³)	1.1
Corn Silage	20 tons	50 tons (175 yd ³)	1.3
Corn Silage	23 tons	50 tons (175 yd ³) ¹	1.3
Corn Silage	26 tons	60 tons (225 yd ³)	1.7
Grass hay ³	3 tons	50 tons (175 yd ³)	1.3
Grass hay ³	4 tons	60 tons (225 yd ³) ²	1.7
Grass hay ³	5 tons	80 tons (280 yd ³)	2.1
Wheat	50 bushel	15 tons (52 yd ³)	0.4
Wheat	60 bushel	20 tons (70 yd ³)	0.5
Wheat	70 bushel	20 tons (105 yd ³) ¹	0.8
Soybeans	30 bushel	30 tons (105 yd ³)	0.8
Soybeans	40 bushel	40 tons (140 yd ³)	1.1
Soybeans	50 bushel	40 tons (140 yd ³)	1.1

General Note: In addition to meeting the nitrogen needs of these crops, these application rates listed above will supply all the necessary phosphorus and potassium needs of the various crops listed above.

Please be aware that continual annual applications of these compost materials on farm fields may elevate phosphorus levels in the soils. Farmers are recommended to soil test their fields at least once every three years to monitor phosphorus levels in the soil.

Use caution when applying MC near to water bodies or active drinking water sources. In general it is best to maintain at least a 35-feet, no-application buffer from water bodies and a 100-feet, no-application buffer from drinking water sources.

¹ These fields may benefit from an additional 10 lbs of nitrogen applied per acre.

² These fields may benefit from an additional 20 lbs of nitrogen applied per acre.

³ Applications of greater than 1" of MC on a growing sod crop could damage productivity of the field. Application rates on sod fields of over 1" are recommended to be split applied over the course of the growing season. For example, application to a 4-ton grass field could be split applied to 0.9 inches in the early spring, with an additional 0.8 inch application after the first cutting.

APPENDIX D

A TEMPLATE DOCUMENT FOR A MUSHROOM FARM ENVIRONMENTAL MANAGEMENT PLAN

A template document for a MFEMP has been developed by the Chester County Conservation District. This Word® document is available by contacting that office.

Website: <http://dsf.chesco.org/conservation/site/default.asp>

The table of contents for the template is essentially the same as the list of components presented in Chapter 6. The Table of Contents for the template as of October 2011 is presented below:

TABLE OF CONTENTS

CONTACT INFORMATION

SITE LOCATION

TYPE OF MUSHROOM/AGRICULTURE OPERATION

OPERATION STATISTICS

Environmental Concerns for this Operation

WASTEWATER MANAGEMENT

Interior Mushroom House Wastewater Collection

Wharf Runoff Collection

MC Wastewater Collection

Isolation Distances and Existing Facilities

MUSHROOM COMPOST (MC)

Normal Farming Operation and Permit Requirements

Storage of MC Prior to Reuse on Farms

Storage Plan for MC

Composting of MC

Isolation Distances and Existing Facilities

HANDLING OF MUSHROOM STUMPS

NUTRIENT MANAGEMENT

Nutrient Analysis

REUSES OF MUSHROOM COMPOST AND/OR WASTEWATER

Land Application of MC and/or Wastewater

Method and Timing Directions for MC and/or Wastewater Application

Isolation Distances and Existing Facilities

EROSION AND SEDIMENT CONTROL

STORMWATER MANAGEMENT

INTEGRATED PEST MANAGEMENT

AIR QUALITY MANAGEMENT

GOOD HOUSEKEEPING

RECORDKEEPING

BEST MANAGEMENT PRACTICES (BMPs)

BMPs Installed Prior to the Development of a MFEMP

BMPs Implementation Schedule

Operation and Maintenance of the BMPs

REFERENCES

EMERGENCY PREPAREDNESS PLAN

Emergency Contact Numbers

MFEMP AGREEMENT SHEET

ADDITIONAL MAPS

Soils Map

Contour Map (w/ Streams and Watershed)

Existing Conditions Map

Planned Conditions Map

