



DEPARTMENT OF  
**ECOLOGY**  
State of Washington

# **Siting and Operating Composting Facilities in Washington State**

## **Good Management Practices**

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# **Siting and Operating Composting Facilities in Washington State**

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## **Good Management Practices**

Waste 2 Resources Program  
Washington State Department of Ecology  
Olympia, Washington



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# Executive Summary

This document presents common sense actions that a facility can adopt to help compost facility operators run a successful composting operation. Note that this document should not be referenced in its entirety in any Compost Facility Plan of Operations or permit because it provides information that is not relevant to all facilities. Different facility design, feedstocks, location, and climate all influence the daily operations and compost quality, making some of the actions suggested in the GMPs irrelevant at a given facility.

In Washington State, some composting activities are regulated by the compost standards set forth in the Solid Waste Handling Standards, [WAC 173-350-220](#). Where appropriate, these GMPs reference existing standards; however, the GMPs themselves are not regulatory. In addition, these GMPs are not meant to substitute for interactions between compost operators, local authorities or other compost experts. While they provide guidance, the GMPs do not address complicated regulatory issues.

## Zoning and siting criteria

Washington's solid waste handling standards for composting do not prescribe specific location standards. However, all conditionally exempt and permitted facilities must comply with Performance Standards, [WAC 173-350-040](#), which require compliance with all local, state, and federal laws and regulations.

- A compost facility feasibility plan should start with a conversation with the planning and zoning division of your local government. Find out about plans for future development in the area. Composting may generate odors at varying times and intensities, depending upon many different conditions. The tolerance for those odors may depend on the proximity of your neighbors. Plans for future development of the area around your facility may also influence property taxes.
- Think about the ability for future facility expansion at any site you consider.
- Composting involves movement of large volumes of materials. Consider evaluating a site's proximity to markets and access to major roads or rail lines for shipping in-coming and out-going materials. Consider impact of truck traffic on local roads, as well as transport costs if your site is very remote.
- Before designing a facility and committing to a site, learn about the microclimate for that area, and the soil and groundwater conditions. Consider the following:
  - What is the predominant wind direction and how hard does the wind usually blow?
  - What direction does air drift during air inversions at your site?
  - What is the average annual rainfall?
  - How much rain falls during 25, 50 and 100 year storm events?
  - What types of soil are you building on? Is the soil sandy/rocky and very permeable, or heavy clay?
  - How far is the facility from the nearest surface water body?
  - Where and how deep is the seasonal underground water table?

## Facility operators and management training

If everyone is trained in safety, compost basics and good management practices, the compost facility will have a better chance of operating successfully.

- Operators and managers responsible for supervision of the compost facility are required to have adequate training [WAC 173-350-220\(4\)\(a\)\(vi\)\(A\)](#)
- For current compost facility operator training classes, check with organizations such as the [Washington Organic Recycling Council](#) (WORC), [U.S. Composting Council](#) (USCC), and the [Solid Waste Association of North America](#) (SWANA).





## Health and safety training

Owners or managers are responsible for providing safety training to employees according to their individual job duties, [WAC 173-350-220\(4\)\(a\)\(vi\)\(B\)](#).

- Safety, fire, and emergency plans must be included in a facility’s plan of operations and should be clearly posted and regularly reviewed.
- Check with [Washington Labor and Industries](#) for applicable safety rules.
- You are responsible ([WAC 296-800-160](#)) to make sure that your employees have, use, and care for the appropriate personal protective equipment (PPE)
  - PPE is used to protect the eyes, face, head, body, arms, hands, legs, and feet. This includes items such as goggles, helmets, hearing protection, head covers, gloves, rubber slickers, disposable coveralls, safety shoes, protective shields, and barriers.
- Minimize dust at your facility by paving and sweeping often, dampening loads of material before moving them, and planting live hedges to ‘trap’ dust before it moves off site.
  - Consider providing “sanitation stations” and space for staff to conveniently wash up and change clothes.
  - If your facility has confined spaces, train both staff and inspectors on the risks of entering these areas. Confined spaces may have dangerously high levels of hydrogen sulfide gas and ammonia. *Over exposure to hydrogen sulfide in confined spaces has caused deaths.*

## Develop, follow and update your plan of operations

A Plan of Operations is a required element of a facility permit, [WAC 173-350-220\(4\)\(f\)](#). The plan must have specific details, such as an approved list of feedstocks and how they will be handled, a pathogen reduction plan, safety, fire and emergency plans, and an odor management plan.

- Keep your Plan of Operations at your facility and readily available for review.
- Your employees should be familiar with your Plan of Operations. Make copies available for each employee.
- Regularly review your Plan and note changes that you want to make in your operation.
  - Facilities should communicate often with their regulators about intended changes and update the Plan(s) whenever changes are made, especially before permit renewal.

## Odors

Odor management is vital to the success of your compost facility. No compost facility is expected to be odor free. However, ([WAC 173-350-040](#)) requires the facility to not violate the regulating air authority’s emission standards or ambient air quality standards at the property boundary. Facilities must also comply with chapter [Washington Clean Air Act \(70.94 RCW\)](#). The operating standards outlined in [WAC 173-350-220\(4\)\(a\)\(i\)](#) also require facilities to control dust, nuisance odors, and other contaminants to prevent migration of air contaminants beyond property boundaries. Consider the following steps if applicable to your facility and situation:

- Consider working with other experienced composters, consultants, and regulators to develop an odor management plan. An odor management plan is a required element of your Plan of Operations.
- Lessen complaints regarding “normal” compost odors by educating the neighbors around your facility. Consider providing tours and other educational opportunities.
- Determine whether the odors are from your facility or some other source.
- Respond quickly to odor complaints by remediating the source of odor. If possible, talk to the complainant to determine if odors issues have been resolved.
- Some of the GMPs in this document may help you avoid or resolve odor issues. Consider incorporating them in your odor management plan as appropriate.



## Managing feedstocks

Understand which feedstocks are necessary to produce good compost, how much they’ll cost (or how much you’ll get paid to take them). Knowing how to handle those feedstocks is imperative to the success of your facility. Recognize the variable nature of the markets for those materials. Look for and be open to alternatives – especially for critical feedstocks such as wood chips.

### Capacity

Capacity means the maximum amount of material that can be contained on-site at any one time. All material includes, but is not limited to, incoming waste, feedstocks, bulking agents, stockpiled wastes, active composting, curing piles, composted materials, and sorted recyclable material on site.

- Keep seasonal processing capacity in mind when considering new contracts to accept materials.
- Include options for alternative processing locations or consider flexible pricing of both incoming feedstocks and finished compost to accommodate future requirements and emergencies in your contracts.
- Before expanding processing capacity, examine the markets for finished product.
- Unsold, finished compost can become an odor source. Identify how the compost will be managed. Develop alternative markets and storage sites for finished compost when traditional markets are slow.
- In general, the larger the facility, the greater the potential for odor generation. Usually, the need for biofilters, tipping buildings and air handling systems increase with the increased capacity of the facility.

## Receiving

If your facility processes feedstocks that are prone to contamination (plastic, glass, etc.) or if you know loads will be smelly or highly putrescible, you can prepare ahead of time.

- Incoming loads from specific generators may be repeatedly contaminated with non-compostable materials.
- Consider developing contract language with generators that allow you to redirect or reject excessively contaminated loads of incoming feedstocks. Generators should be liable for the expense of disposal.
  - Engage local recycling educators to speak with generators about the value of producing a safe, high quality compost product.
  - Identify the source of contamination and ask your hauler to speak with the generator.
- Incoming loads from specific generators (or at specific times of the year) may smell worse than others.
  - Schedule incoming loads when you are prepared to mix them with bulking materials such as wood chips immediately upon arrival.
  - If your facility composts residential yard debris, you may need extra bulking materials in the spring and fall when extra loads of wet grass clippings come in.
- Consider stockpiling carbon bulking materials like wood chips and overs (see Glossary at end of document) so they are available to quickly mix into putrescible feedstocks. This increases porosity to facilitate aerobic microbial activity.
  - Keep bulking materials dry if possible. Wet, stockpiled wood chips can become an odor source.
- Consider asking the generator to mix dry material, such as sawdust, in with putrescible feedstocks *before* delivery to your facility.
- Consider testing pH of incoming materials. If pH is too low (below 5.8), feedstocks may begin to “pickle” and release volatile organic acids and hydrogen sulfide. Low pH will prohibit growth of aerobic bacteria. Quickly blend with neutral or higher pH feedstocks, such as woodchips. *A reasonable pH range for growth of aerobic microorganisms is between 5.5 and 8.5.*
- If you regularly receive materials with pervasive odors, consider covering your tipping/receiving area. This will allow you to use fans to pull air from the headspace of the tipping building and treat the air in a biofilter.
- Have a backup plan. Identify other facilities that can process the same feedstocks as you do. If your facility has reached capacity, you may be able to send incoming loads to another facility. *If you want to use this option, make sure you have outlined it in your Plan of Operations.*



- Consider some of the following options for handling foul smelling feedstocks such as:
  - Immediately add bulking, or special bulking materials, that can treat the odors.
  - Include fees in your contracts so that generators pay for, and therefore help to minimize, excessively odorous loads.
  - If rejecting stinky loads is an option, write your contracts to clearly state that foul smelling loads will be turned away.
  - Identify disposal options and reject foul smelling feedstock loads when possible.

### Blending and/or grinding

This primary processing phase helps build the correct mix of feedstocks and will help manage odors during composting, and determine the final quality of your product.

- Process incoming feedstocks as soon as possible.
- Add the appropriate bulking materials to introduce porosity. Optimal porosity (>30% free air space) will keep wet materials from going anaerobic and will help reduce odors.
- Consider maintaining a stockpile of prepared bulking materials (covered if possible), so that during busy times they are available and not dependent upon grinding or other processing.
- Blend bulking materials with feedstocks as needed to reach an optimal range of carbon to nitrogen ratio (20:1 to 40:1) which increases microorganism growth.
- If you use a grinder, consider using water misting equipment that fits with your system. A mist of water along discharge points will help keep dust and odors down while providing optimum moisture for the composting process.
- In case of equipment failure, identify other facilities or rental outlets where you can obtain critical equipment, such as loaders, grinders, screens, etc. Also, have a plan for redirecting incoming feedstocks.



## **Managing compost piles**

Compost piles that are not controlled to promote aerobic conditions are out of compliance with Washington's solid waste law, Solid Waste Management Reduction and Recycling, [RCW 70.95.030](#), and the rule, [WAC 173-350-220](#), that defines composting requirements. A good mix with proper aeration and moisture will speed composting and reduce potential odors.

## C:N Ratio

The C:N (Carbon to Nitrogen) ratio is one of the key components to building the right environment for the growth of aerobic microbes in your compost pile. They need a balanced diet of available energy sources (C) and nutrient sources (N).

- *A typical C:N range is between 20:1 and 40:1*, depending on available feedstocks and desired finished product. A low initial C:N mixture has a greater potential to generate odors; an excessively high C:N mixture may not generate many odors, but it will be very slow to decompose.
- Mix high carbon feedstocks such as woody materials with high nitrogen feedstocks such as food scraps and lawn clippings. An ideal mix will optimize microbial activity and will speed composting by raising the temperature in the compost pile to thermophilic (>113° F) levels.
  - For example, many wood chips have a C:N of approximately 600:1, and food scraps may have a C:N of 15:1. Therefore, food scraps have a higher nitrogen content than wood chips.
- Use mass balance or compost calculators to develop an approximate “recipe” for your available feedstocks. Most calculators will provide you with the C:N ratio after you’ve entered the characteristics and volumes of feedstocks you are working with.
  - Ecology’s [Compost and Healthy Soil website](#) has several compost calculators listed under the Tools and other Resources section. These calculators can help you build recipes using different feedstocks.
- Consider testing your feedstock mixtures at a lab to provide accurate C:N information, particularly if you encounter problems with your mix.

## Pile size

This will be determined by a facility’s composting technology and feedstocks. Pile size affects moisture loss, heat retention, aerobic conditions in the pile, and the speed of the composting process.

- Consider making smaller piles (10 feet high or less) if high volumes of smelly, wet feedstocks are part of your mix. Smaller piles allow you to manage them more intensely to control odors and to allow for more complete air flow.
- Piles should be small and porous enough to promote convective/passive air flow. You may also employ forced aeration or other means of introducing oxygen to meet aerobic composting requirements.
- Check your local fire codes. Fire districts may limit pile sizes (some as low as 14 feet high), regardless of the feedstocks or composting technology you use.
- Do not drive on your compost pile; this compacts the material, slows the composting process and creates anaerobic conditions.



## Moisture

Aerobic microbes move through the compost pile in thin films of water that coat each particle. Ample moisture on available feedstocks ensures good microbial activity throughout the pile. Oxygen is diffused into the films of water from the free air space (pores) in the compost pile. Too much water will fill the pores and “drown” the aerobic microbes, creating anaerobic conditions.

- Start your compost piles with appropriate moisture levels. *A typical moisture range is between 40% and 70%*, depending on feedstocks and composting technology. To minimize odors, manage moisture level by not exceeding 60% moisture ([WAC 173-350-220\(4\)\(g\)\(iii\)](#)).
- If needed, moisten a pile during the blending or grinding phase to ensure even distribution and absorption of water.
- If piles dry out during the compost process, inject water with a lance or water piles with a sprinkler before turning, or if you have the equipment, add water as you turn the pile to ensure all materials are evenly moist.
- Dry a wet pile by adding dry bulking material, increasing aeration, or increasing the frequency of pile turning.
- A pile that is too wet may lead to anaerobic conditions, lower temperatures, excessive leachate and odors. A pile that is too dry may lead to incomplete composting and potential odors when the pile is rewetted.
- Rainfall or un-even watering on very dry piles may create conditions for spontaneous combustion. To reduce the risk of fires, maintain moisture levels >40% evenly throughout the pile. Be sure to monitor the temperature for excessive heat buildup.



## Aeration

Sufficient oxygen levels in your compost will help keep odors in check and will speed the composting process. There are many ways to promote aerobic conditions inside a compost pile including passive aeration, turning a pile and forced aeration.

- Consider measuring oxygen levels with an oxygen probe at different heights and depths throughout the compost. Oxygen levels should typically be predominantly above 10% to avoid anaerobic odor generation. Aerobic organisms can survive with as little as 5% oxygen. However, if the oxygen level falls below 10 percent in the large pores, parts of the compost pile can become anaerobic (i.e., without oxygen).
- If you do not compost with a forced aeration system, you can facilitate passive aeration by building small windrows on a one foot deep plenum (see Glossary) of woody overs or other coarse woody material. Air will be pulled in through the porous plenum, and as the temperature rises inside the pile, the air also rises, creating convective aeration.

- If moisture level, temperature, particle size and C:N ratio are all optimal, aerobic microbes will quickly use up the available oxygen. While anaerobic conditions will be found in some locations in the pile during active composting, make sure the pile can get the air it needs to maintain primarily aerobic conditions. This will help reduce odors and speed the composting process.

Porosity and particle size

Feedstocks should be sized large enough to maintain porosity throughout the pile, yet small enough to allow microbes access to the nutrients.

- Typical particle sizes for bulking agents should be between 1 and 4 inches.
- Small, uniformly sized particles may pack together, prevent air flow, and create anaerobic conditions.
- Large particles help maintain porosity but will not contribute to C:N ratio as they are not readily available for microbial decomposition.
- Pile *porosity* should be as uniform as possible which means air can flow freely throughout the pile. Thoroughly blend feedstocks prior to active composting to create uniform porosity.

pH

pH is the measure of acidity to alkalinity on a scale of 1 to 14. A pH range between 1 and 7 is acidic, a pH of 7 is neutral, and a pH between 7 and 14 is alkaline.

- Feedstocks affect pH which affects microbial activity and odor generation. An acceptable pH range is between 5.5 - 8.5
- High nitrogen feedstocks with a pH above 8.0 may lead to excessive releases of nitrogen and ammonia.
- High nitrogen feedstocks with a pH below 5.5 may create excessive organic acids and lead to a “dirty sock”, or silage smell and pile cooling.
- Consider correcting the pH of a pile by mixing more neutral or basic materials into the pile or increasing aeration.

Pathogen reduction

- Washington’s composting rule ([WAC 173-350-220\(4\)\(a\)\(vii\)](#)) requires that composters implement pathogen reduction activities. Finished compost must be tested and must meet the limits for Fecal Coliform or Salmonella as indicated in the tables below.

Fecal Coliform	< 1,000 Most Probable Number per gram of total solids (dry weight).
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Salmonella	< 3 Most Probable Number per 4 grams of total solids (dry weight).
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- *In vessel composting* - the temperature of the active compost pile must be maintained at 55° Celsius (131° Fahrenheit) or higher for three consecutive days (seventy-two hours); or
- *Aerated static pile* must have a cover such as a synthetic material or a layer of finished compost to ensure that pathogen reduction temperatures are reached and vectors are controlled – the temperature of the active compost pile must be maintained at 55° Celsius (131° Fahrenheit) or higher for three consecutive days (seventy-two hours); or
- *Windrow composting* - the temperature of the active compost pile must be maintained at 55° Celsius (131° Fahrenheit) or higher for fifteen days or longer. During the period when the compost is maintained at 55° Celsius (131° Fahrenheit) or higher, there must be a minimum of five turnings of the windrow; or
- *An alternative method* that can be demonstrated by the owner or operator to achieve an equivalent reduction of human pathogens.
- Pathogen reduction is generally achieved through microbial action which causes the pile to heat up. If the microbial environment in the pile is not correct, then pathogen reduction may not be achieved. If a pile is not heating up, check the following parameters in your compost pile: moisture and oxygen levels, pile size, pH, C:N ratio and particle size.
- Composting facilities must abide by the testing requirements outlined in WAC 175-350-Table 220-A, Table 220-B, Table 225-A, and Table 250-A. Meeting pathogen reduction reduces indicator pathogens such as salmonella and fecal coliform bacteria which are commonly found in lawn clippings and yard debris.
- Some compost systems are designed to regularly monitor and record temperatures in the compost pile. If your system is not automated, regularly check temperatures at representative locations throughout your pile during the active and curing phase of composting. Excessively high temperatures (>165° F) or ambient (low) temperatures may indicate problems in your pile, such as aerobic microbe die off.
  - While some systems are designed to operate at high temperatures, accurate monitoring should still be part of your daily routine.



## Biofilters

Biofilters are a designed component used to manage odors in several different compost systems.

### Healthy biofilters

Biofilters host microbes that live on odor compounds. If the microbial population in the biofilter is healthy and the air being treated stays in the biofilter for a sufficient amount of time, most odors will be consumed before they are released into the atmosphere.



- Constructed biofilters, designed to treat odors from forced air compost systems, will vary depending on size of operation. However, there are several things in common among all biofilters.
  - While biofilter media will depend on the design of your compost system, a consistent moisture level is important for all biofilters. Moisture allows odorants to adhere to the outside of particles that make up the biofilter. The microbes that consume the odorants live in the film of water coating the biofilter particles.
  - Particle size is important; it will dictate retention time and treatment of air being pulled from the compost pile. Too much fine material in the biofilter will clog biofilter pore space. Clogged pores may result in incomplete air distribution and excessive moisture levels. If the biofilter media is too coarse, it will not be able to “hold” and treat the incoming air for odor removal. Moistened material evenly before/during biofilter construction, and maintain adequate moisture levels, (between 50% and 65%) for the life of the biofilter.
- In a forced air system, measure backpressure and flow at the filter plenum. A drop in pressure may tell you about a deteriorating biofilter which can cause channeling or short circuiting, allowing air to escape that has not been properly treated. An increase in pressure may indicate clogging.
- A biofilter can also be a layer of wood chips or a blend of chips and coarse finished compost covering an aerated static pile of compost. If an operator is covering the pile with this type of biofilter, it should be six inches to one foot thick over the entire pile. This will help discourage vectors (flies, birds, etc.) and insulate the pile to ensure all parts of the pile meet pathogen reduction requirements. This layer will also help process odor compounds coming off the pile. As with a constructed biofilter, all material added to the top of the pile should be:
  - Moistened to be effective at biofiltration.
  - Made of finished compost overs with a stability above 5 (see Curing section below), or from other products that contain no putrescible materials.

## Managing curing compost

After compost has met pathogen reduction requirements and has started to cool down to mesophilic temperatures (below 113° F), it enters the curing phase. Depending on the desired end product, you should continue to manage for microbial activity in your pile to achieve a stable product.

### Curing

If active composting has occurred under optimal conditions, then cooler temperatures in your compost pile indicate less microbial activity due to decreased availability of food. This leads to the curing phase where a certain level of biological stability, (commonly measured by microbial respiration), must be obtained before compost can be considered finished compost. The Solvita Test Kit is often used for measuring stability; a rating of 5, moderately unstable is the lowest acceptable rating for finished compost, ([WAC 173-350-220\(4\)\(a\)\(ix\)](#)). The methods for measuring stability (including Solvita) are outlined in the [USCC Test Methods for the Examination of Composting and Compost](#).

### Moisture

Maintain moisture levels between 40% and 60% to support remaining microbial populations and increasing fungal growth.

- Consider using one or a combination of the following practices to prevent curing compost piles from becoming saturated during rainy seasons:
  - Cover piles with a “blanket” that sheds water, but allows the pile to breathe.
  - Keep curing and finished piles on forced air to maintain aerobic conditions.
  - Turn piles to evenly distribute moisture.
- Check for consistent moisture levels throughout the curing compost pile. If the pile did not get enough moisture during the active compost phase, the pile may heat up again when optimal moisture levels are reached.

### Temperature

Large, curing piles may retain thermophilic (>113°F) temperatures even after they have reached an acceptable level of stability because they are biologically active and are insulated from ambient air temperatures.

- Conditions in the curing pile, such as oxygen, carbon to nitrogen ratio, and moisture levels should be controlled to promote further aerobic decomposition. This will help control odors.

### Aeration

Curing piles need oxygen. The following actions may help your curing compost piles reach a stable state more quickly.

- Consider keeping curing piles small to facilitate passive aeration.
- Consider turning curing piles when oxygen levels drop below 10%.
- Consider putting larger piles on forced air to maintain adequate oxygen levels.
- Consider covering curing piles to avoid anaerobic conditions due to excessive moisture.

## Sampling

Permitted and some exempt facilities must test their finished compost before they can sell it. *See the Contamination section on page 14 for testing parameters.* Before compost can be tested, samples representative of the entire cured pile, must be collected.

- Use an accredited laboratory that tests composts and agricultural samples. They will let you know how to prepare the samples for shipping, including chain of custody paperwork, shipping containers and holding times.
  - Ecology's Laboratory Accreditation site gives you the option to search for a lab based on their name, location or testing parameter.
  - [http://www.puyallup.wsu.edu/soilmgmt/Pubs/Analyt\\_Labs\\_PNW\\_EB1578E.pdf](http://www.puyallup.wsu.edu/soilmgmt/Pubs/Analyt_Labs_PNW_EB1578E.pdf)
  - <http://www.puyallup.wsu.edu/soilmgmt/Pubs/Poster-CompostAnalysis.pdf>
- Create a composite sampling plan to help you prepare lab samples that represent the conditions throughout



your pile. The following is a brief example of a composite sampling plan:

- Gather sterile equipment for collecting samples, such as rubber gloves, trowels, stainless steel bowls, re-sealable plastic bags, and a five to ten gallon bucket.
  - Visually divide the pile into five sections.
  - Make a vertical cut from top to bottom in five different sections with a sterile tool, which could be a shovel or the bucket of a front end loader.
  - Grab three samples (top, middle and bottom) from each vertical cut and mix in one large clean vessel, like a five gallon bucket.
  - Depending on the amount of material required by the lab, you may need to divide, discard, and remix your sample until you have the appropriate amount.
  - Immediately prepare your sample for shipping according to the lab's requirements, which may include cooling or freezing.
  - Record when, where, and who sampled.
- The lab results from your sample will tell you whether your compost is finished, and safe to sell.

## Managing finished compost

Composted materials meeting the state compost standards described in [WAC 173-350-220\(4\)\(a\)\(x\)\(C\)](#) are still considered a solid waste but may be stored off of a pad.. See the *Contamination* section on page 14 for testing parameters. Composted materials that do not meet the standards are still considered solid waste.

Finished compost will continue to cure. As with active and curing compost, moisture and oxygen levels should be managed to protect finished product quality. Maintaining product quality will depend upon facility infrastructure and the specifics of the product.

### Moisture

Consider using one or a combination of the following practices to prevent finished compost piles from becoming saturated during rainy seasons.

- Cover piles with a “blanket” that sheds water, but allows the pile to breathe.
- Keep finished piles on forced air to maintain aerobic conditions.
- Turn finished piles to evenly distribute moisture.

### Aeration

Even finished compost will have some level of microbial activity so adequate oxygen levels should be maintained in the pile. Consider using one or a combination of the following practices

- Keep finished piles small to facilitate passive aeration.
- Turn finished piles when oxygen levels drop below 10%.
- Put larger piles on forced air to maintain adequate oxygen levels.
- Cover finished piles to avoid anaerobic conditions due to excessive moisture.

## Temperature

- Brief reheating for up to a week is okay after screening finished compost as the new pile is mixed, new surfaces are exposed, and the pile is oxygenated. However, extended thermophilic temperatures indicate microbial re-growth, which means composting was incomplete during the active phase. The following conditions may result in incomplete composting during the active phase:
  - Excessive temperatures that prematurely kill aerobic microbes.
  - Anaerobic conditions due to compaction or excessive moisture.
  - Extreme pH level that creates a hostile, aerobic microbial environment.
  - Imbalanced C:N ratio.
- If finished compost maintains thermophilic temperatures for more than a week, compost should be managed like curing compost. Conditions in the pile, such as oxygen and moisture levels, should be controlled to promote continued aerobic decomposition.

## Screening

Screening will be determined by what your customer is looking for in a compost product, and when they want the product.

- Screen at least a week before you expect to deliver product. Screening often reenergizes microbes, which means the compost could briefly re-heat for up to a week.
- If you are concerned about odors, do not screen on air inversion days. In stagnant air, odors remain concentrated.
- If you are concerned about odors, do not screen on days when the wind is blowing directly at neighbors.
- As screening may release odors, consider using water mist to control dust and odors during screening.



## **Contamination**

Contamination may occur at every phase of the composting process, from feedstock collection points, to storage of finished product. Finished compost produced at permitted facilities in Washington (and some exempt facilities) must meet the metal and other contamination testing parameters outlined in [WAC 173-350-220\(4\)\(a\)\(x\)](#) and shown below.

Table 220-B Testing Parameters

<b>Metals and other testing parameters</b>	<b>Limit (mg/kg dry weight), unless otherwise specified</b>
Arsenic	≤ 20 ppm
Cadmium	≤ 10 ppm
Copper	≤ 750 ppm
Lead	≤ 150 ppm
Mercury	≤ 8 ppm
Molybdenum	≤ 9 ppm
Nickel	≤ 210 ppm
Selenium	≤ 18 ppm
Zinc	≤ 1400 ppm
Physical contaminants <sup>1</sup>	≤ 1 percent by weight total, not to exceed .25 percent film plastic by weight
Sharps	0
pH	5 - 10 (range)
Biological stability <sup>2</sup>	Moderately unstable to very stable
Fecal coliform <sup>3</sup>	< 1,000 Most Probable Number per gram of total solids (dry weight)
OR	
Salmonella	< 3 Most Probable Number per 4 grams of total solids (dry weight)

<sup>1</sup>A label or information sheet must be provided with compost that exceeds .1% by weight of film plastic. See WAC [173-350-220](#) (4)(f)(iii)(D)(I).

<sup>2</sup>Tests for biological stability must be done as outlined in the United States Composting Council Test Methods for the Examination of Composting and Compost unless otherwise approved by the jurisdictional health department.

<sup>3</sup>Test for either fecal coliform or salmonella.

Note: Biosolids composters regulated under this chapter must communicate with the jurisdictional health department to determine if different testing parameters and testing frequencies are required.

Testing frequency is based on amount of composted material produced. A representative sample of composted material must be tested for every 5,000 cubic yards produced, or every three hundred sixty-five days, whichever is more frequent.

## Inert material and sharps

Washington's compost testing parameters require  $\leq 1\%$  of physical contaminants, such as plastic and glass, and no (zero) sharps in finished compost product.

- Visually check and hand pick contaminants from incoming feedstock loads BEFORE grinding.
- Consider using air and magnets on conveyors and screening systems to remove plastic and ferrous metals.
- Increase education for generators, such as grocery store managers, their employees, and home owners to reduce contamination. Work with local solid waste/public works departments and/or hauling company for extra outreach help.
- Keep compost area clean; make sure plastic bags are not blowing around your facility.
- Identify disposal options and reject feedstock loads that are consistently contaminated.

## Pathogens, pesticides, herbicides, weed seeds, and metals (arsenic, cadmium, copper, etc.)

The composting process reduces many pathogens, pesticides, and weed seeds. However, some pesticides may be persistent, and recontamination from weed seeds or pathogens can occur after compost has gone through its curing phase.

- Some herbicides such as clopyralid and aminopyralid continue to be problematic for composters that take crop waste or manure. These pesticides are mostly used on agricultural crops to control broad leaf weeds.
  - If you process manure, hay or other agricultural residues, you should periodically perform bioassays as described on WSU's Web page: <http://www.puyallup.wsu.edu/soilmgmt/Pubs/CloBioassay.pdf>.
  - Learn more about clopyralid at: <http://www.puyallup.wsu.edu/soilmgmt/Clopyralid.htm>.
  - Learn more about aminopyralid at: <http://whatcom.wsu.edu/ag/aminopyralid/>.
- If metals exceed acceptable levels, examine incoming feedstocks to determine which ones contribute to the metal load in your finished product. Reduce that feedstock or eliminate it.
- To ensure that you are meeting pathogen reduction requirements, routinely take and record temperatures throughout your compost piles. Temperature recording times and locations may be automatic in some engineered compost systems.
- Facility design and good housekeeping play a fundamental role in reducing contamination. Consider the following actions to help you avoid contaminating a finished compost product.
  - Design facility so leachate and storm water drain away from finished compost piles and flow towards leachate collection systems.
  - Finished compost should be physically separated from incoming feedstocks and active compost piles to avoid recontamination.
  - To avoid cross contamination, clean equipment thoroughly (bucket, wheels, etc.) if using on both incoming feedstocks and outgoing compost.
  - Incorporate all incoming feedstocks in an active compost pile and completely clean receiving area at the end of each day.
  - Do not allow leachate to pond or pool at the base of compost piles.

- Keep aisles between piles clean to avoid “track out” and loose debris that could be blown about.
- Understand predominant wind direction and design your facility so finished product will be upwind of incoming feedstocks and active compost areas. Consider the following actions to help you avoid contaminating a finished compost product.
  - Cover finished piles when possible to keep weed seeds from blowing in and contaminating your compost.
  - Blowing dust may carry contaminants. Consider keeping dust to a minimum in dry conditions by spraying water on piles and in aisles.

## Leachate

Leachate is the liquid that is contaminated with dissolved or suspended materials after it has been in contact with solid waste such as incoming feedstocks. At permitted compost facilities in Washington with leachate ponds or lagoons, the ponds or lagoons must be designed according to [WAC 173-350-220\(3\)\(e\)](#).

### Leachate/stormwater

Keep leachate and stormwater separate and manage them separately.

### Leachate pond/lagoon

Leachate pond/lagoon is one operational method of handling water. Leachate is generally accumulated at facilities located in high rainfall areas or at facilities that process high moisture feedstocks. Leachate can be the source of odors when accumulated and should be considered in the design as well as managed to reduce potential odors.

- Consider filtering leachate and stormwater through a compost sock or berm to remove some of the particles and nutrients that may have washed off your compost pad.
- To keep the leachate pond from going anaerobic and getting odorous, consider increasing aeration if biological oxygen demand is high.
- Leachate ponds should be low enough before the beginning of the wet season to contain the leachate generated during the wet season.
- Consider cleaning your leachate pond during dry times to remove sediment. This will help maintain pond capacity and reduce nutrient loading when pond fills with water again.
  - The sediment may be blended with other feedstocks in the primary composting phase.
- If odors from the leachate pond persist, consider consulting with an engineer or a wastewater treatment specialist.



### Use of leachate

Leachate can be used to water incoming feedstocks.

- If leachate is not odorous, it can be added during the feedstock blending phase in order to meet the optimal moisture needs for active composting.
- Because most leachate has not been treated to reduce pathogens, **DO NOT** use leachate to water piles after you've started to achieve pathogen reduction or on finished compost. Leachate will re-contaminate curing and finished compost.
- Additional uses of leachate may be approved depending on conditions of your facility permit.

### Ponding by piles

Ponding, or pools of leachate that collect on impermeable surfaces, can be an odor and contamination source.

- Slope your facility to ensure proper drainage into the leachate collection unit.
- Clear the leachate raceway of loose debris that could impede water flow.





# Glossary

**Anaerobic:** A compost pile is anaerobic that has predominantly less than 10% oxygen on average. Anaerobic means without air and refers to an area where there is no available oxygen in the air or dissolved oxygen in water. Anaerobic areas can produce methane, hydrogen sulfide and other undesirable substances.

**Aerobic:** A compost pile is aerobic that has predominately greater than 10% oxygen on average. Aerobic means with air and refers to an area with oxygen and water with dissolved oxygen. Some byproducts of aerobic decomposition are carbon dioxide and water.

**C:N:** C:N refers to the supply of carbon (C) relative to nitrogen (N). High carbon materials, such as wood chips, cardboard, and corn stocks, frequently have low moisture levels and are more difficult to break down. High nitrogen materials, such as manure\*, food scraps and fresh grass clippings, frequently have higher moisture levels and are easier to break down. Aerobic microbes need a balanced C:N diet of 30:1 to optimally perform, and tolerate a C:N range between 20:1 and 40:1.

(\* Manures will range from low C:N, such as chicken manure to higher C:N, such as horse manure.)

**Leachate:** Leachate means water or other liquid within a solid waste handling unit that has been contaminated by dissolved or suspended materials due to contact with solid waste or gases.

**Nuisance Odor:** Any odor which is found offensive or may unreasonably interfere with any person's health, comfort, or enjoyment beyond the property of a facility.

**Overs:** Screened woody debris, generally larger than 2 inches that did not break down during the active composting phase. Overs are generally greater than one inch in size, and have been screened out of finished compost. They may be blended with new feedstocks to provide porosity and carbon or used as a component of a biofilter.

**Plenum:** A plenum is a dedicated space to allow for air flow or circulation. A plenum could be either under or above a compost pad, and may be constructed of pipes or coarse material that allows for air flow. Some compost piles may be built on top of wood chip plenums to encourage convective air flow.

**Temperatures:** As they rise and fall based on microbial activity, temperatures become an important tool for telling what may be happening in your compost and curing piles.

- Psychrophilic temperatures range from 5° F to 50° F (-15°C to 10° C).
- Mesophilic temperatures range from 50° F to 113° F (10°C to 45° C); the most abundant and active microbes live at these temperatures.
- Thermophilic temperatures range from 113° F to 176° F (45° C to 80° C).

# Resources

## Resources in Washington State

### **Washington State University, Puyallup – Soil Management - [www.puyallup.wsu.edu/soilmgmt/](http://www.puyallup.wsu.edu/soilmgmt/)**

The goal of the Washington State University – Puyallup soil management program is to protect water quality, maintain soil productivity, and facilitate recycling of organic wastes by applying soil science principles to agricultural and waste management problems. Since 1991, research has focused on evaluating nutrient availability from organic materials to enable the determination of appropriate rates and timing of applications for crop production.

### **Washington State University Center for Sustaining Agriculture and Natural Resources – [www.csanr.wsu.edu](http://www.csanr.wsu.edu)**

The Washington State University Center for Sustaining Agriculture and Natural Resources provides a focal point for addressing issues, practices, and technologies relating to agriculture and natural resource viability.

### **Washington Organic Recycling Council - <http://www.compostwashington.org/>**

The Washington Organic Recycling Council (WORC) is a nonprofit corporation formed in response to demands for increased recycling of organic materials. WORC sponsors several workshops and conferences throughout the year including Compost Facility Operator Training and Advanced Organic Topics.

### **Northwest Biosolids Management Association – [www.nwbiosolids.org](http://www.nwbiosolids.org)**

The Northwest Biosolids Management Association (NBMA) supports the beneficial use of biosolids and addresses the challenge of finding safe, economical ways to manage biosolids. The organization's purpose is to share knowledge about biosolids management between member agencies and companies; local, state and federal regulators; and the general public. The mission of the NBMA is to advance environmentally sound biosolids management.

### **Washington Department of Ecology – [www.ecy.wa.gov/programs/swfa](http://www.ecy.wa.gov/programs/swfa)**

Ecology's Waste 2 Resources Program provides information and resources to ensure the proper environmental management of solid waste through waste reduction, recycling and safe disposal; to provide technical assistance, education, planning assistance and regulatory interpretation to local governments who implement solid waste management programs; to assist local governments through grants to develop and implement these programs; and to ensure consistent and effective enforcement of air, water and waste laws for major industries.

## Other resources

### **The Compost Resource Page - [www.howtocompost.org](http://www.howtocompost.org)**

This Website covers all aspects of composting with information and links to home composting, vermicomposting, large scale composting, products and services, and a connection to The Composter's Forum, an interactive bulletin board and discussion site.

### **Cornell University, Department of Agriculture & Biological Engineering – <http://compost.css.cornell.edu/index.html>**

This website provides access to a variety of composting educational materials and programs developed at Cornell University in New York. Check out their Natural Resources Agricultural Engineering Service (NRAES) publications. NRAES produces and distributes many up-to-date comprehensive guides related to composting. Along with other publications, you will find the "On-Farm Composting Handbook", "Field Guide to On-Farm Composting", and "Composting for Municipalities, Planning and Design Considerations".

### **Mulch and Soil Council – [www.mulchandsoilcouncil.org](http://www.mulchandsoilcouncil.org)**

The mission of the Mulch and Soil Council is to define quality products and promote an open marketplace for producers of horticultural mulches, consumer soils and commercial growing media.

### **US Composting Council - [www.compostingcouncil.org](http://www.compostingcouncil.org)**

The US Composting Council (USCC) is a trade and professional organization promoting compost. They provide a unified voice for the growing composting industry. USCC is involved in research, public education, composting and compost standards, expansion of compost markets and the enlistment of public support.

### **USDA Natural Resources Conservation Services Soil Quality Institute – <http://soils.usda.gov/sqi>**

This site has a number of excellent links and information on soil quality. The Soil Quality Institute also produced and distributes the Soil Biology Primer which is a 52-page booklet that introduces the role living organisms play in the soil productivity and air and water quality. The Primer contains lots of information specifically on the Soil Food Web.

### **United States Environmental Protection Agency - <http://www.epa.gov/wastes/conservation/composting/index.htm>**

The EPA website provides general information, technical information and research for folks composting at different scales. It also provides links to laws, statutes and publications that are available nationwide.

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