COMPOSTING
For
ANIMAL SHELTERS AND KENNELS

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Table of Contents

Introduction

It has become apparent in recent years that many places in the United States and throughout the world are running out of landfill space. Still, sources of waste are innumerable and garbage trucks are bursting at the seams. For years the animal welfare community has been sending literally tons of valuable organic materials to landfills and incinerators, overtaxed sewage and septic systems, or simply thrown in open piles creating potential for water quality problems. Perhaps because alternatives have been few, it is quite common for animal shelters and kennels to bag the manures from cat and dog pens and simply throw it in the dumpster with all the other trash. Not only is this an expensive way to dispose of this rather heavy material, but it also wastes what could otherwise become a wonderful, rich, odorless soil amendment. In the Spring of 2000 the Monadnock Humane Society in Swanzey, New Hampshire embarked on an attempt to solve both of these problems by designing and implementing a composting system.

Composting continues to gain acceptance throughout the world as a means of dealing with organic wastes. However, specific health and safety issues surrounding dog and cat waste composting create a lingering veil of skepticism. Despite the many books, journals, magazines, and web sites that contain good general information about composting, there is relatively little information available that is specific to kennels or shelters.

This manual has been created to serve as a guide to organizations interested in composting and offer a valuable alternative means of handling kennel and shelter waste. It is laid out as a walk-through process for starting a composting system at a kennel or shelter. Beginning with some background information about composting, it covers the planning, design, implementation, and long-term maintenance of a system. The information provided has been collected from a variety of sources including months of trial and error. Some references are provided for further reading.

Composting Basics

Composting is defined as the biological degradation of organic matter under aerobic conditions to a stable, humus-like material. It has been called a science and an art. The science of composting makes it practical while the art makes it fun. The process used in composting has been around since long before we started using it as a waste management tool or an industrial process. In fact, anyone who has visited a forest and kicked up the leaves and needles on the forest floor has seen the result of this process. The dark humus material underneath is the decomposed leaves and needles from previous years. In composting we simply try to optimize the process to make efficient uses time, space, and other resources. Though it seems to be a rather modern idea in many of our communities, evidence exists that humans have been composting since ancient Egyptians sent their excrement to piles outside the cities where it eventually composted and could be used as a soil amendment for growing food.

There are several factors central to the composting process:

1. *Carbon and Nitrogen (C:N ratio)*.

   Carbon is one of the elements responsible for making a substance organic. Basically, anything animal or vegetable contains carbon. The microorganisms that facilitate composting (mainly the bacteria) use carbon for energy and growth. Carbon can come from materials like bark mulch, dry leaves, sawdust, straw or hay, and even shredded paper.

   Nitrogen is used by microorganisms in a compost pile for protein and reproduction. Materials such as food scraps, wet (fresh cut) grass clippings, and manures are generally high in nitrogen. In the case of kennel and shelter waste, the manure is the main source of nitrogen.

   The relationship between carbon and nitrogen is important in a compost pile and is expressed as the C:N ratio. Basically, this ratio reveals the amount of available carbon to the amount of available nitrogen. The ideal ratio is between 25 and 30(C) : 1(N). All of the materials mentioned above have various C:N ratios and will affect the balance in a compost pile. Dog and cat manures are typically high in nitrogen (C:N ~10-15:1) and wet. Materials such as dry leaves or saw dust are generally high in carbon (C:N ~40-60:1) and dry.

It is possible, but not necessary to have potential composting materials analyzed for individual C:N ratios. How to achieve a good ratio in your compost pile will be discussed later.

2. *Oxygen*.
   Aerobic compost piles, by definition, need oxygen to work properly. The desirable microorganisms in a pile use it as part of their life processes much as animals do. Without good aeration throughout the pile it becomes anaerobic, a process of decomposition that is slower and more likely to emit foul odors. This is where mixing and turning the compost is essential. It may be difficult to judge the amount of air in a pile, but ideally, all particles in the pile should have contact with air, but not so much that it dries out.

3. *Moisture*.
   The microorganisms in an active compost pile live in the thin film of moisture that coats each particle in the pile. A dry pile has too little of this habitat for good populations and a wet pile reduces the amount of oxygen available. A good pile has 50-60% moisture (like a moist sponge) and is uniform throughout.

Part of what makes active composting different from the decomposition on the forest is that a pile facilitates increased microbial activity and creates heat as a metabolic by-product. The mass of a pile further acts as an insulator allowing temperatures within it to rise substantially. For the purposes of composting animal waste it is the microbes in the pile that do all the work and create all the heat necessary. As usual, science has classified the composting process according to the heat energy involved. *Mesophilic* composting occurs between 50 and 105ºF and *thermophilic* over 105ºF. The *thermophilic* process is most effective for properly composting shelter and kennel waste.

Pathogens and Disease

Dog and cat feces often carry several organisms that may cause disease in people and in other animals. Bacteria such as E.coli and intestinal parasites such as roundworm are often present in feces and spend part of their life cycle in soil. Fortunately, these pathogens can be effectively eliminated in a compost pile if proper conditions are maintained. This concept is referred to as the Process for Reduced Pathogens or PFRP (Conditions for PFRP are discussed in Pile Maintenance). A staff or other local veterinarian should be able to identify what pathogenic organisms are common in your area. In general, contact with these organisms can be minimized with simple safety precautions such as protective clothing and gear. Problems can be avoided by treating the entire composting process with the knowledge of these potential hazards. See: Other Considerations.

Regulations and Ordinances

One of the first steps in planning to compost animal feces and wastes is to research existing regulations. Both state agencies and local governments should be contacted. In some states, small-scale composting operations do not fall within the scope of state regulations, but it is always good to start with this step to avoid some frustration later in the process. There may be certain volumes at which a composting site qualifies for regulation so be sure to collect as much detailed information as is available. Furthermore, developing a relationship with regulatory agencies can be a great way to get publicity for your project. Often *local health, planning, and conservation agencies* are helpful in gaining acceptance for your project within the local community and region. State and federal agencies may also be aware of funds available to help the project and can sometimes offer technical assistance. Some contacts for New England states are listed in appendix F.

Designing a System

Though a successful composting system need not take a lot of money or time to build, attention paid in the design phase will eliminate potential for future problems. There are a few helpful and relatively simple considerations in designing a system.

1. *Collection*.

In many cases the methods by which waste is collected in a shelter or kennel need only minimal modification for composting. In fact, if the waste is presently put in a dumpster or other receptacle for removal, only its final destination need be changed to the composting site. Keeping in mind that simplicity and minimal points of contact are goals of any project of this nature, here are some things to consider:

Containers. Containers should be rigid, smooth sided (to avoid build up of raw material in corrugations and ridges), large enough to manage waste based on your specific collection schedule, small enough for staff to handle safely, and rust and corrosion resistant. Plastic trash cans or 5-6 gallon buckets *with lids* work well for many applications. Trash bags should be avoided because they are themselves a waste product and are messy during transfer of materials to the pile. Containers can be lined with some carbon source (whatever is used in the compost pile) to keep odors down, minimize need for cleaning, and inoculate the manure with needed microorganisms. A periodic cleaning of collection containers may be worthwhile.

Transport. Again, the fewer steps from kennel to compost pile the better. Depending on the cleaning schedule for cages, etc., a collection container can be carried or wheeled around for each collection. These containers can then be safely stored away from potential contact until there is enough to start composting. Ideally, collection and transport are all one process. For instance, if waste is collected in a wheelbarrow or other cart (also lined with carbon source), it can be collected and taken directly to the compost site. See Pile Maintenance for more considerations for this method.

2. *Volume and Composition of Waste*

Unless you already keep track of how much compostable waste you have it is a good idea to perform some sort of study to determine the volume of materials you have for composting and what that material consists of (if more than just manure). These numbers are essential in determining how big your system will need to be to effectively handle your waste. It may be astonishing to find out how much material and money is wasted in sending it to a landfill or incinerator for disposal.

In composting there is an important distinction between the amounts of waste as measured by volume and that as measured by weight. The volume is what determines how big the system needs to be while the weight per volume gives us clues about the volume density, an important factor in determining mixing ratios. In the case study of a Humane Society shelter from which this manual is written, volume, weight, and composition were determined. The following coefficients can be used to calculate an estimate of waste produced based on the number of animals contributing. The method by which these figures were determined is detailed in appendix D. It may be useful to perform a similar study to best estimate amount of waste generated.

Waste generation per animal (average):

	Per day	**Per week**	**Per year**
Dog Waste	0.33 lbs	2.3 lbs	121 lbs
	0.1gal	0.7 gal	36.4 gal (~5 ft^3)
Cat Waste	0.15 lbs	1.1 lbs	54.6 lbs
	0.04 gal	0.3 gal	15 gal (2 ft^3)

3. *Site Considerations*

When you know how much material you will have you can begin to design the system that will handle it. Since materials are usually generated continually throughout the year, a composting system will need to work on a batch basis. That is, at some interval determined by the amount of material (once per week, month, etc.), a batch of material consisting of the manure and the carbon source are mixed and allowed to compost. With this in mind consider the following in system design:

A. Space requirements. You will need enough space to handle all waste materials plus the carbon source needed in composting. For example, if your mix ratio is 2 parts carbon source to 1 part waste, and you have 6 gallons of waste, you will need room for a total of 18 gallons to accommodate the 6 gallons of manure plus the 12 gallons of carbon source. (see Finding a Mixture Recipe next page). Remember to make room for curing compost and storage as well as active compost piles. Allow for active piles (batch) to remain in the bin for 1 month before moving and curing compost to remain for about 6 months. The process of composting will reduce the volume of a pile by as much as 50% so your space requirements for curing and finished compost can reflect this reduction.

B. Odor control. There is great potential for odors when composting this kind of material, but with proper pile management problems will be minimal. Starting with a good mix and turning when necessary are important in keeping odors down. A 2-3 inch layer of carbon material over the piles will act as a filter as well as an insulator. If strong odors persist there may be a different problem with the pile such as mixture or moisture content (See Troubleshooting a Compost Pile, page 9).

C. Access. Keep the compost site as near the source as is practical for easy transportation of materials while keeping any odors and contaminants away from animals and staff.

D. Weather. Prevailing winds should be used to carry any odors away from the facility and neighbors when possible. Rain and snow should be kept off of active compost piles to make managing the moisture content easier and to prevent contaminated run-off from spoiling local fresh water sources. Some sort of roof may be necessary. Compost piles can be active in winter in many areas, but only if sufficient quantities of manure are available. Small piles will not have enough mass to heat up sufficiently in winter. Probably no less than a cubic yard will be active in freezing temperatures because the mass of a pile acts as a self-insulator as well as providing adequate food for microorganisms. A three inch thick layer of carbon material can be placed over the entire pile to further insulate it. Saw dust works very well as an insulator. Extra storage space may be required. Insulated compost bays are another alternative if year-round composting is necessary where winter temperatures might otherwise limit PFRP.

E. Soils. Well-drained soils are best for siting compost piles. Since animal and food wastes often liquefy during the composting process, avoid areas near drinking water wells or areas where ground and surface waters may become contaminated. Pads should be slightly sloped to move excess liquids including any rain water away from the pile. These liquids can often be collected to use when the pile needs moistening. Consider impervious pads such as concrete if no other alternative is acceptable.

4. *Building Materials*

The actual construction of your composting system is limited only by the imagination of its designer, but again, it is best to keep it relatively simple. It is possible to compost without the use of any sort of bin or container by simply making piles on the ground. However, *containment bins help maintain a neater compost area, act as an insulator for the piles, help maintain airflow by exposing more surface area to air, and generally make the whole process easier*. Regional climate and other site considerations will help determine the appropriate style and building materials. Many styles of compost bins are manufactured and available for sale at home and garden centers, or through the publications mentioned at the back of this manual. If you intend to build your own there are a few other considerations. Some examples are included in appendix B.

A. Material durability. Plastic, concrete, metal wire or mesh, and wood are all commonly used and each has its strengths and weaknesses. Since the composting process involves moisture and high temperatures the material you choose should be resistant to rotting. Keep in mind that other materials will work too.

Wood - Untreated wood lumber will not last long under normal composting conditions. Pressure treated wood is somewhat durable, but chemicals used to treat the lumber may be a concern if the finished product is to be used for growing food products and can inhibit the growth of organisms essential to the composting process. Recycled or composite lumber may be suitable if it is available. Discarded shipping pallets can work well as bins and are often available in quantity from local sources.

Metal – Wire mesh or fencing is commonly used for backyard composting, but may not be suitable for medium-scale systems. However, a series of wire mesh bins could work well if that is the most readily available material. Mesh size and rigidity are important considerations. Large mesh will not contain the small particles of composted material and rust and corrosion could be a problem.

Plastic – This is the most common material used in the commercial compost bins. It is durable and effective, but may become expensive if many bins are needed. Some style may be more durable than others for this application. If this is the route you choose, shop around.

Concrete – Probably only practical for larger systems. For systems where impermeable or extremely well-drained soils are a concern or where machinery will be used regularly this may be the best option. Many concrete manufacturers have pre-fabricated barriers (jersey type) that can be lain together to make three-sided containment bins. A poured concrete floor and bin wall system is probably the most durable of all systems.

B. <u>Availability</u>. Clearly it makes sense to use materials that are readily available. Local suppliers may be willing to help your project with donations or discounts. Relative costs should also be considered here. If searching for appropriate materials becomes confusing, you can set up a ratings chart that includes all the attributes most important to you.

5. *<u>Construction</u>*

Your compost system need not be elaborate to work well. Keeping in mind the basic needs of a compost pile, you can decide what your system will look like. For the scale on which most kennels and shelters will be working some sort of containment bin system is most practical. Free standing units will work well as will a series of several adjacent bins. Consider the following:

A. <u>Volume</u>. Based on how much waste you have you may need only one or as many as ten bins. A box-type bin built 3 feet deep, 3 feet wide, and 3 feet high will hold a cubic yard (yd^3) of material. Remember to account for the volume of mixed material and not just the manure. If you have 5 yd^3 of waste each year bins should accomodate at least 10 yd^3 of material. Each active pile should compost for at least a month, but longer is better. If a total of 10 yd^3 of material is anticipated , three 1 yd^3 bins should be enough to handle your waste. They can be filled consecutively so that by the time you need room for a fourth batch the material in the first bin is ready to be moved to a curing pile. Make your bins sufficiently smaller if you have much less waste than this and remember to make sure the size of the bins is consistent with your management technique (by hand with tool, with machinery, etc.).

B. <u>Access</u>. It is good to have easy access both for placing the material in a bin and for mixing it when necessary. Stand-alone units should have an access door or should be able to sit untouched until the compost is nearly done. Bin systems with three sides and an open front work fine, but you can also have a removable or hinged front face.

C. <u>Cover</u>. It is important to keep excess moisture out of your compost piles and to keep them from drying out in the sun. Any type of cover that provides whatever protection your piles need is fine. If you have several connected bins you may want to build a roof. However, even a plastic tarp should do the trick. There are commercially available fabric pile covers that will allow excess steam to escape but not allow rain or snow into a pile (similar to waterproof/breatheable rain coats). See appendix C.

D. <u>The floor</u>. Consider the ease with which the finished compost can be removed. Self-contained composters are easy. With a bin system mud may be an issue, especially where machinery is involved. If mud is a concern, consider hardening the compost area with packed soil, gravel, or even concrete. Again, the pad floor should be slightly angled (~2%) to move liquids away from the pile. It is not important to remove every scrap of compost from a bin so the floor need not be smooth and flat. Residual compost can help inoculate a fresh pile with the organisms it needs.

Finding a Mixture Recipe

The mixture, or *recipe*, will depend on what materials are available. The nitrogen source is taken care of by the feces, but a carbon source will likely need to be brought in from somewhere outside the facility. There are numerous possibilities for carbon sources including, but not limited to:

- ✦ Shredded Bark
- ✦ Hay or Straw
- ✦ Saw Dust or Wood Shavings
- ✦ Dry Leaves
- ✦ Shredded paper
- ✦ Finished Compost

Each of these items will supply the needed carbon to your pile, but each will behave differently once mixed.

If no carbon sources are available on site at the facility ask around your community for places that might have some. Sawmills, landscapers, stables, farms, and municipal transfer stations (for leaves and yard waste) are all potential sources of bulk materials. A composting program that offers to take the leaves from a local neighborhood each autumn may be an appealing proposition to community members. Sources will vary with region, but there are a few key things to remember when selecting a carbon source:

1. C:N ratio. It is possible to find the actual ratios for various materials in the reference books mentioned, but it is probably not necessary. A little experimentation up front will likely produce a decent recipe in little time. Start out mixing 1:1 (e.g. 1 bucket waste:1 bucket shredded bark). If this looks really sloppy or too coarse adjust your recipe up or down accordingly. Initial C:N of 25-30:1 is ideal. Some typical C:N ratios and %N are available in appendix A. They can be used to get a general C:N comparison of ingredients. If necessary, use them in the following equation to find a mix ratio. (Source: On Farm Composting Handbook). However, don't be intimidated by what may seem like complex mathematics. Remember that composting is also an art. Parts of ingredient A per part of ingredient B:

$$\text{Parts ingredient A} = \frac{\%\text{N ingredient A}}{\%\text{N ingredient B}} \times \frac{(\text{desired C:N ratio} - \text{C:N ratio ingredient B})}{(\text{C:N ratio ingredient A} - \text{desired C:N ratio})}$$

2. Density and Porosity. Make sure that there is plenty of air space in the pile, but not so much so that there isn't any contact among particles. Shredding hay, straw, or dry leaves can help with this aspect.
3. Moisture. Again, similar to a moist sponge, *50-60%*. Examine the pile occasionally during the process. Moisture should be consistent throughout the pile. A soggy pile will lay flat and start to smell in short order, while a dry pile will sit inactive for as long as it stays dry. In this case it may seem that the compost is finished when it may be far from it. If necessary, moisture content can be found by weighing a portion of an ingredient as it will be used and then drying it in an oven for thirty minutes or more (don't bother to do this with the feces). By comparing the wet weight with the dry weight, the % moisture can be determined:

$$\%\text{ moisture} = \frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}}$$

Pile Maintenance

Once the site is prepared and all materials are on hand it is time to begin composting. As simple as the process is, however, attention to detail is a little more important when working with raw materials that are potentially hazardous. **Remember, to effectively eliminate pathogens, thermophilic temperatures are necessary.** With just a few simple tools you will be saving money and creating a valuable soil amendment.

Starting the pile.

There are a few basic tools needed to make and maintain a compost pile.

- Shovel, turning fork, or other tool for mixing
- Long-stemmed thermometer
- Bucket or other container for water

In order to achieve adequate temperatures, the microbes must have enough food to consume and reproduce quickly. This means that the pile must be started with a good amount raw waste available. There are probably many ways to go about this, so experiment until a good and reliable method is found.

1. Line the bottom of the bin with a thick layer of carbon source. Each time waste is collected add it directly to the pile and cover it with sufficient carbon material. When the bin is full put a 2-3 inch insulating layer of the carbon material over the entire pile and do not add more raw waste to this pile. Add water to the pile as necessary to maintain good moisture.

-OR-

2. Collect the waste in containers and either transfer it to a larger container or leave it in the several smaller containers until there is enough for a batch. Mix the raw waste and carbon material together either in the containers or in the bin until it is relatively homogeneous. Cover the entire pile (the bin should be lined on bottom with bedding material) with carbon source to provide insulation. Add water to the pile if necessary.

If conditions are good, a compost pile should start to heat up and "cook" within a few days of being built. This is where diligent monitoring of the pile becomes important. At this point the biggest concern is temperature. In order to eliminate pathogens from the compost every bit of waste material must be subjected to the temperatures necessary for PFRP (Process for Reduced Pathogens). Those conditions are:

- **131ºF (55ºC) for 3 consecutive days (72 hours).** These could be anytime in the life of the compost pile, but will generally occur within the first two weeks. All portions of the pile must be exposed to this temperature.
- **145ºF(60ºC) eliminates pathogens and weed seeds.** Even several hours at this temperature will kill pathogens. A pile can reach 170ºF, but this temperature will kill even beneficial organisms.

Since the center of the pile is usually the hottest, it may be difficult to expose all the raw material to the right temperature. If necessary the pile should be mixed several times in the first two weeks of composting. If in doubt, extend the composting period.

Monitoring the pile.

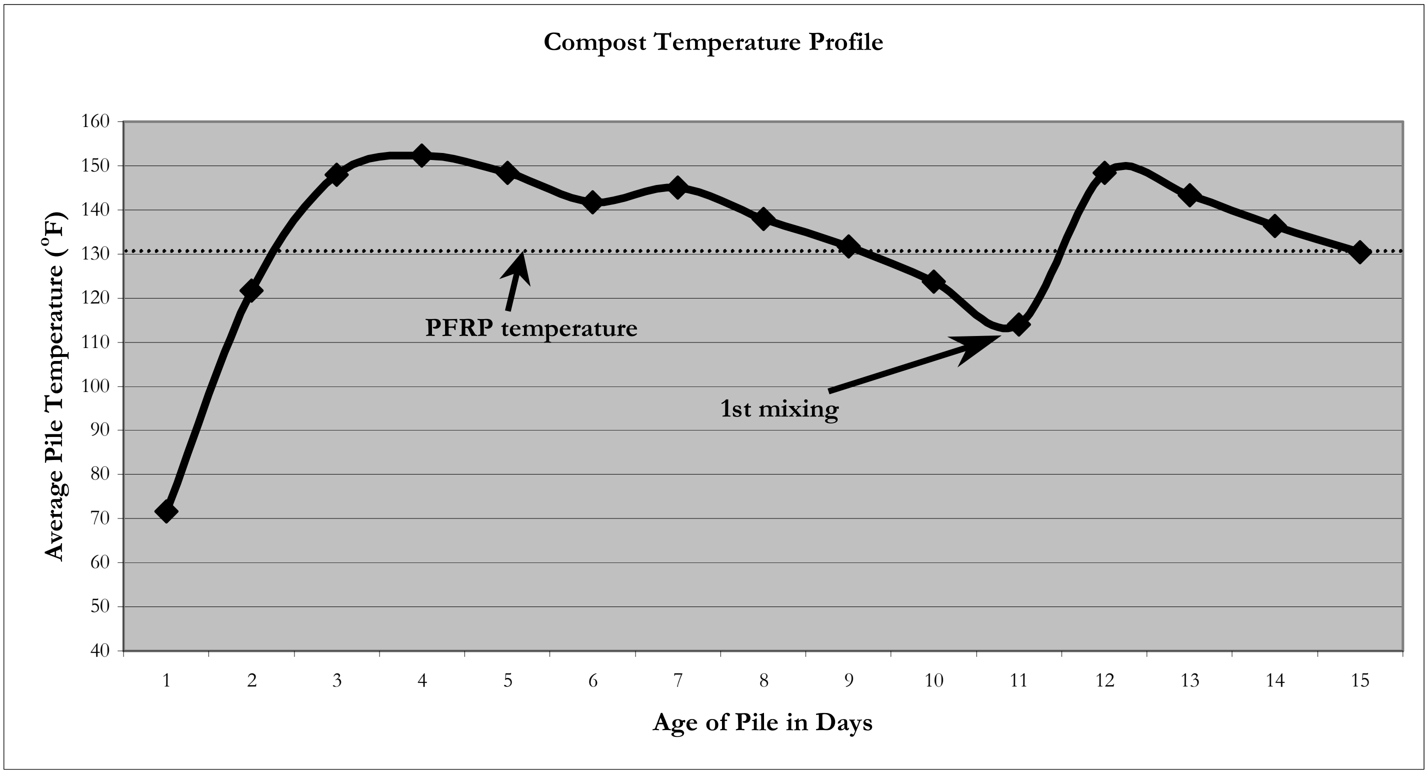
Set up a simple data sheet to record your observations.

Bin #________________ Start Date_________________ Initials_________________

Date/Time	Pile Temperature	Comments/Observations/Activity

Temperature. Start monitoring the temperature the day after the pile is built. It should start rising steadily within the first few days. If it doesn't, the recipe may need to be adjusted. Always check the temperature with the long-stemmed thermometer in several places throughout the pile to make sure that the whole pile is heating up and not just the core. It is also possible for a compost pile to become to hot and essentially pasteurize the pile. If this happens (~170ºF, >70ºC) the temperature of the pile will drop dramatically until the pile is again hospitable for the microbes. While high temperatures will certainly kill pathogens they will also kill the friendly microbes, which slows down the composting process. Though this is not likely if your initial recipe is close, it can be remedied by simply turning the pile to release some of the heat.

Remember: all portions of the pile containing animal waste must reach PFRP temperatures. An inslulating layer aroung the pile will allow for high temperatures to reach further outside the center of the pile.



Moisture. Moisture is easiest to check when mixing or turning the pile. Add water or more dry carbon source as necessary to maintain the moist sponge appearance. The proper moisture of a pile will often be a judgment based on simple observation. If in doubt, take a handful of the material in a **gloved** hand and squeeze it tightly in a fist. Some liquid should seep between the fingers. If no liquid comes out it is too dry; if liquid drips readily from the hand it is too wet. After using this method many times, it may be easier to make a judgment by eye.

Mixing or Turning the pile.

After a few days or a week, microbes begin to use up the food source in their immediate vicinity, metabolism of wastes slows, and the temperature of the pile starts to decrease. When this happens the pile should be turned. The easiest way to do this by hand is with a turning fork. Make sure when you are turning the pile to move material from the outside margins closer to the center so that it is exposed to greater temperatures. This can be done in the bin several times before the compost is moved for curing and storage. Check the moisture level and add liquid or dry material as needed.

Curing

When a compost pile no longer heats up even when conditions are good (moisture, etc.) it is very close to finished. At this point compost can be set aside for a curing stage. In curing, decompostion slows and any further composting occurs at mesophilic temperatures, so turning is no longer necessary. The location of the curing pile should be convenient and since this pile no longer needs protection from excess moisture it can be outside the bin area. However, curing is a necessary step in the life of each separate compost batch so curing piles should be kept separate just as the active piles are unless no compost will be used for six months or more. After curing, the compost should be completely stable and inactive.

Troubleshooting a compost pile

Symptom	Probable Cause	Remedy
Pile does not heat up	Too little Nitrogen source	Add more raw waste
	Pile is too small	Increase pile size
	Too little or too much moisture	Add liquid or dry materials
Significant odor present	Too much raw waste	Add carbon source
	Too much moisture	Add dry materials
Temperature too high	Pile too large	Split the pile into smaller piles
	Too much nitrogen	Turn the pile and add carbon
Flies and other pests	Raw materials exposed at surface	Cover pile with finished compost or more carbon source

Other Considerations

Safety

Since potential for exposure to pathogens is significant when working with dog and cat feces several precautions are advised. Workers with pre-existing medical conditions such as asthma or with otherwise compromised immune systems should use appropriate specialty gear (including masks) or avoid working with the piles.

- Consider wearing protective gloves and clothing when handling raw wastes.
- Keep all tools and equipment confined to the compost area or assigned storage area.
- Always wash hands after working in the compost area.
- Have a sample of the finished compost tested for pathogens before it is used. College, University, or High School laboratories may be able to do this for free. Government or private laboratories are also available.

Contaminants

Wastes such as broken glass, latex gloves, hypodermic needles, and other non-compostable items should be kept out of the compost waste collection system. They may be hazardous to workers and create extra work in the process.

Storage of raw wastes.

In areas where it is impractical or impossible to compost during winter wastes can still be stored outside or even placed in the compost pile. Once spring temperatures thaw the pile, it will begin to compost automatically. Remember that since it will not compost for several months, extra space will be used.

Alternative cat litters

Conventional clay and clumping litters do not compost well and can impede the process. Look for alternative organic litters such as pelletized sawdust, newspaper, or wheat and other grass litters. There are many alternative litters available and some manufacturers offer special incentives for kennels and shelters. Some of these are listed in the appendices. Some are listed in the appendices.

Worms for further composting

Some research suggests that worms such as red wigglers added to a compost pile will further reduce pathogens and expedite the compost process. It is important that worms not be added to an active thermophilic pile where temperatures will kill them. Though the use of worms in a compost system will add another process (removing worms from finished compost) it may also be an added value. Worms are beneficial in gardens and might be sold for composting or as fishing bait.

Uses for finished compost

The benefits of compost as a soil builder are well known. When mixed with other materials it improves water-holding capacity, soil porosity, and adds essential nutrients. It can be used for such applications as:

- Top dressing for lawns.
- A potting soil additive.
- Improving flower gardens.
- A mixing medium for further composting.
- Soil reclamation and remediation.
- A bedding for litter boxes and other cages.*

Depending on how much compost is produced each year it can be used on-site, made available to staff and the local community, or even sold as a soil amendment. It is crucial that people are aware of the nature of the compost and that it may harbor pathogens. Here again it is helpful to have the finished product tested for pathogen content.

*By using compost in the litter boxes and cages a waste loop can be closed and the raw waste inoculated with beneficial organisms. If, however, the compost is not pathogen-free animals may be further exposed.

A note on treatments and medications.

Feces from animals that are treated with wormers and other medications can affect the microbes in a compost pile. Unless this is a significant portion of the waste, however, there should be no major problems.

Final Comments

With a little work up front, composting can have many benefits for animal shelters and kennels. It will reduce the amount of waste that is hauled to a landfill or other waste facility, save money and energy, produce a valuable amendment for lawn and garden soils, and it will show a commitment to environmental responsibility to the larger community.

The appendices included offer some additional specific information on recipes, calculations, product manufacturers, and other useful references.

Selected References and Web Sites

On Farm Composting Handbook

Edited by R. Rink and published by the Northeast Regional Agricultural Engineering Service (1992). Contact NRAES:

Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701
(607) 255-7654, NRAES@CORNELL.EDU

The Humanure Handbook

Written by J.C. Jenkins and published by Chelsea Green Publishing (1994). Contact:

Chelsea Green Publishing
P.O. Box 428
White River Junction, VT 05001
(802) 295-6300, www.jenkinspublishing.com

BioCycle Journal of Composting and Recycling

Magazine and other books published by The JG Press, Inc. Contact:

The JG Press, Inc.
419 State Avenue
Emmaus, PA 18049
(610) 967-4135, www.biocycle.net

www.mastercomposter.com. Mastercomposter site includes guidance for products, methods, links, and an interactive message board.

www.composting.org. The University of Maine Cooperative Extension Compost School site. Includes links, contacts, school information and two interactive message boards.

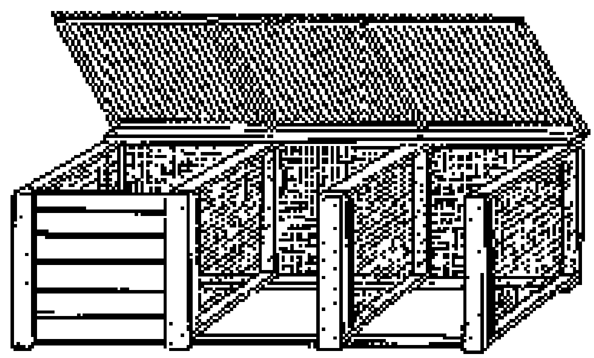
www.epa.gov/owm/bio. The U.S. Environmental Protection Agency site includes general and federal regulatory information about composting biosolids (human waste residuals) and related materials.

Appendix A. *C:N ratios and % N of common materials (Source: The Humanure Handbook, p. 40 and On Farm Composting Handbook, p.112).*

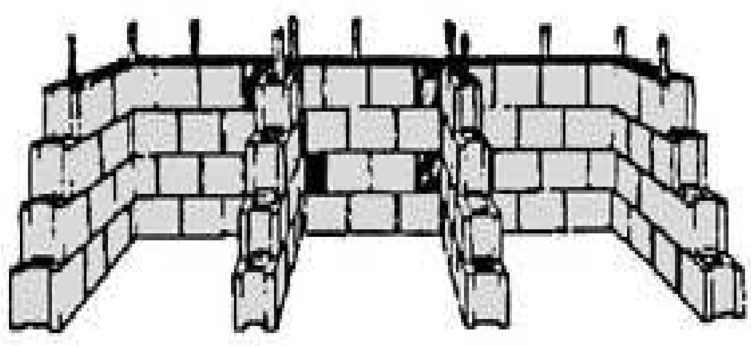
Material	%N	C:N ratio
Urine	15-18	0.8
Human/Dog feces	5-7	5-10
Sawdust	0.11	511
Wheat straw	0.3	128
Hay	0.85	58
Wood chips (average)	0.09	~600
Leaves (average)	0.9	54
Grass clippings (average)	3.4	17
Farmyard manure	2.3	14

Appendix B. *Various compost bin styles*

Manufactured tumbler type



Three bin wood and wire type



Three bin concrete block type

Wire mesh type

Appendix C. *Products and manufacturers.*

Long-stemmed compost thermometer:

ReoTemp. 800-648-7737, www.reotemp.com/compost, compostinfo@reotemp.com. Also available through various garden supply retailers.

Pile cover fabric:

Compsotex compost cover. Texel, Inc. 245 Ten Stones Circle, Charlotte, VT 05445. (802) 425-5556

Compost bins:

Covered Bridge Organics. P.O. Box 91, Jefferson, OH 44004. www.cboinc.com. (440) 576-5515

The Earth Machine. Norseman Plastics. www.earthmachine.com. 800 267-4391.

Appendix D. *Methods for volume and weight determination*

A. Kennel and shelter staff members were asked to identify the main components in the compostable (organic) waste stream. The main purpose for identifying the wastes separately is to understand the relative C:N ratio in the total mass. The components are:
   - ✦ Dog waste (manure) (N)
   - ✦ Cat waste (N)
   - ✦ Other cage waste (bedding (C) and manure (N) from small animal cages)
   - ✦ Food waste (including uneaten dry pet food (N) and paper food trays (C) used for cats.

B. 6 gallon buckets with lids were labeled with each of the main components and a staging area was set aside where the buckets could sit for a week. At each cleaning, wastes were collected in their respective buckets and stored in the staging areas.

C. Once per week for five weeks the buckets were weighed (in pounds making sure to account for the weight of the bucket) and the volumes were measured relative to how much of the 6 gallon bucket they occupied (half a bucket is 3 gallons, etc.).

D. Results for 5 consecutive weeks were tabulated on a tally sheet and the totals for a year were calculated. Here it is important to account for seasonal fluctuations in kennel population. For this study population was estimated as a function of how much of the total kennel capacity was occupied.

	Dog Waste		Cat Waste		Other Cage Waste		Food Waste	
Date	Volume (gal.)	Weight (lbs)	Volume (gal.)	Weight (lbs)	Volume (gal.)	Weight (lbs)	Volume (gal.)	Weight (lbs)
3/25/00	8.8	32.6	2.0	10.8	13.0	18.7	9.0	36.4
4/1/00	11.8	45.3	3.5	18.1	10.0	19.4	8.5	42.1
4/10/00	9.0	29.0	4.8	24.0	11.0	22.2	9.0	43.7
4/17/00	6.5	25.6	2.0	9.9	45.0	43.0	7.0	33.5
4/24/00	11.0	41.7	4.0	21.3	11.0	20.9	4.0	19.1
Total	47.0	174.2	16.3	84.1	90.0	124.2	37.5	174.8
		Annual Totals		9.92 yd^3	2.9 Tons			

Since simplicity is always a goal, this method for volume determination may not be necessary in all situations. However, underestimating the volume of manures coming into a composting system can have unpleasant consequences. If you can guess confidently, by all means do so. It is probably best to find an estimate and then add a little extra to the design.

Appendix E. *Some Useful Conversions*

1 gallon = 0.134 cubic feet = 0.005 cubic yards
1 cubic yard = 27cubic feet = 202 gallons
ºF = (ºC+32)*1.8

1 pound = 0.4536 kilograms
1 kilogram = 2.205 pounds
ºC = (ºF-32)/1.8