

BEST MANAGEMENT PRACTICES (BMPs) FOR INCORPORATING FOOD RESIDUALS INTO EXISTING YARD WASTE COMPOSTING OPERATIONS



**THE U.S. COMPOSTING COUNCIL
RALEIGH, NORTH CAROLINA, USA**



US Composting
Council

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Preface

"It is important to view compost feedstock as a usable product, *not* as waste requiring disposal. When developing and promoting a composting program and when marketing the resulting compost, program planners and managers should stress that the composting process is an environmentally sound and beneficial means of recycling organic materials, *not* a means of waste disposal." ¹

According to the US Environmental Protection Agency's *Municipal Solid Waste in the United States: 2007 Facts and Figures*, ² Americans generated more than 254 million tons of waste in 2007. Using different methodology, BioCycle Magazine's annual report *The State of Garbage in America* ³ estimates that figure to be nearer *413 million tons*. Using EPA's data, 89% could have been recycled and/or composted, but *only 33% was*. The remainder was landfilled or incinerated. With the average waste disposal cost at \$43 /ton ⁴, that's \$6.12 billion spent to treat resources as trash, and 142 million tons of reusable resources unnecessarily buried or burned. Not to mention the greenhouse gasses and emissions generated from doing so.

In response to soaring waste management costs, diminishing landfill space, and the escalating need for more environmentally-responsible practices, EPA is working to promote more integrated solid waste management practices. Within that framework, EPA Region 3, in cooperation with the US Composting Council, established the goal of creating this Best Management Practices (BMPs) document *to assist yard waste composting facilities in expanding operations to include food residuals*. These BMPs serve as a guide for that purpose, emphasizing planning and operational considerations as gleaned from experienced industry professionals, and *is not intended as a comprehensive technical guide to composting*. By simplifying what is involved in composting food residuals, it is hoped that more composting will occur; and occur in a safe and sustainable manner.

To embark on this guidance document it will be useful to define what is meant by "organic materials", "organics", and "food residuals". There is confusion with the term *organic*, as it holds different meanings in different applications. For the purpose of discussing integrated waste management practices, organic(s)/organic materials will be defined as *materials derived from living origins--in other words, if it once grew or was derived from something which grew*. Fruits and vegetables, leaves, grass and yard debris are all "organics", as well as paper items (derived from trees), pasta and breads (derived from grains), egg shells and other by-products from food processing facilities, hair and fur, seafood and shells, and animals and their wastes (including human). This also includes items *manufactured from organics*, such as bags, utensils, plates, cups and bowls made from corn and potato starch, bagasse, and PLA. (These items will be discussed in Section 2.) Therefore, for the purpose of this document, "Food Residuals", will refer to *all pre- and post-consumer foods and food by-products, as well as organic items which may accompany food--such as manufactured organics and soiled paper products (napkins, paper cups, cardboard, etc.)*



Figure 1--Illustration of "food residuals": Pre- and Post-consumer food wastes, cardboard, and manufactured compostables.

This definition will exclude remaining organics of yard and wood wastes, pre-butchered animals (carcasses and mortalities), and animal wastes (including human). It also excludes all non-organic items which may accompany foods, such as (but not limited to), plastic utensils, plastic or other packaging, recyclables and trash. For health and safety (and sometimes, regulatory) reasons some items classified as organics should be excluded from composting. This topic will be discussed in Section 3.

Because this document is produced for EPA Region 3 it will speak to audiences within DE, DC, VA, MD and PA, and does not generally address special regional concerns such as extreme cold or hot weather, or the potential for bears to be included among pests. However the guidance provided herein is likely to be useful for any region, as overall concerns, obstacles and advice relevant to successful composting are independent of location or climate.

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For more information on the USCC, visit www.compostingcouncil.org or call 301-897-2715.

All photos provided by Earthtenders, unless otherwise noted.

Disclaimer

This document was constructed as a "How To" guide, designed to present the reader with information compiled from experienced professionals on issues relevant to composting food residuals. Though specific companies are named, they are included for the sake of illustration. Neither the USCC, nor any of its employees, contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, equipment, product, or process discussed herein. Reference to any specific commercial product, process, or service by trade name, manufacturer, or otherwise, does not constitute or imply its endorsement or recommendation by the USCC or US EPA.

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Introduction

Best Management Practices for Incorporating Food Residuals into Existing Yard Waste Composting

Operations is designed as a written tour guide for composters embarking on the process of expanding into managing food residuals. Information is presented in four Sections, with a summary at the conclusion of each sub-section. Readers are encouraged to review summaries but not rely upon them as being comprehensive. Expanding into food residuals composting involves many facets which cannot be fully understood by reading only the summaries.

In Section 1, *Moving Toward Composting Food Residuals*, the reader is guided through the planning phase. It starts by presenting economic and environmental reasons *why* a facility should compost residuals, and is followed by a checklist of considerations and actions needed to move forward. The discussion turns to identifying potential sources of food residuals, and demonstrates how to estimate the volume a source may generate. The Section concludes by providing guidelines for working with generators to establish diversion programs, and includes discussion on collection and transport options. Section 1 investigates topics the composter should consider during the planning phase.

The second Section, *Operational Considerations--Things to Know Before Residuals Arrive*, addresses operational topics which should be considered *before* materials arrive at the site. As a reminder to what enables composting without ongoing odors and pests, a review of composting basics leads the Section. Then, because understanding the differences between various materials is imperative to successfully composting them, information on physical characteristics of feedstocks is presented, including an overview of manufactured compostables. The section then demonstrates how to plan a composting recipe based on physical characteristics of feedstocks. It concludes by comparing process methods--turned windrows versus static piles with forced aeration--and discusses how a facility can avoid and remedy odors throughout the process. The second Section guides the reader through the daily process of composting food residuals.

Section 3, *Health, Safety and Regulations*, is an overview of practices for maintaining worker and public safety. This section delineates how to manage residuals to avoid pests and pathogens, thereby protecting public health. Regulatory issues, too, are addressed to make the composter aware that the rules for composting food residuals are generally different from those for composting yard waste only. The third Section guides the user through health, safety, and compliance with regulatory guidelines.

Finally, in Section 4, *Case Studies*, the reader is presented with information from two composting facilities successfully processing food residuals with yard waste. Each case study is both an overview of the facility--size, inputs, sources, etc--and also a compilation of experience and advice offered from the owners of the two sites. The experience of others is often invaluable information, and is for this document a fitting conclusion for a publication designed to guide composters with Best Management Practices.

Section 1: Moving Toward Composting Food Residuals

1.1 Why Incorporate Food Residuals?

Many municipal, farm and small commercial composting facilities overlook the potential of incorporating food residuals because of the perception that the additional concerns may outweigh the benefits. Collection and transport is needed to obtain them. Risk of odors, pests, pathogens, and water contamination may become more significant, along with the possibility of public complaint should any of these occur. However, with modest preparation (discussed in Sections 2 and 3), an existing yard waste composting facility can anticipate these challenges and be well-prepared to *avoid* them before they arise. For a well-managed site, the resulting benefits from incorporating food residuals can easily outweigh concerns.

“Up to 70 percent of the MSW waste stream is organic material. Yard trimmings alone constitute 20 percent of MSW. Composting organic materials can significantly reduce waste stream volume and offers economic advantages for communities when the costs of other options are high.”⁵

Because landfills fill, incinerators reach lifecycle capacity, and both disposal methods generate an array of environmental concerns, reducing materials bound for landfill or incinerator offers multiple benefits. Diverting organics, and other recyclables conserves diminishing landfill space for items unable to be recycled. Buried organics generates methane (CH₄), a greenhouse gas 21 times more potent than CO₂, hence diverting organics reduces GHG emissions⁶. When composted, the organic matter and nutrients in these materials are recaptured and recycled into valuable soil amendments. Disposing of them as trash buries these important assets and in turn generates the need to produce and utilize more chemical fertilizers. Less landfilling means fewer tipping fees paid, or means that fees can be shifted to composting facilities. Whether the facility is municipally or commercially run, diverting organics directs funds to more sustainable practices, generates revenues from tipping fees and product sales, and thereby expands the tax base. Finally, incorporating food residuals into yard waste compost piles produces a more nutrient-rich end product and can increase product value. For a multitude of environmental and economic reasons, diverting and composting organics is beneficial.

1.1 Summary--Why Incorporate Food Residuals:

- Preserves landfill space;
- Reduces greenhouse gasses;
- Recycles soil organic matter and nutrients for reuse (reduced need for fertilizers);
- Reduces tipping fees, and redirects funds to sustainable waste management practices;
- Produces a higher-value, more nutrient-rich compost product.

1.2 Getting Started--A Checklist of Objectives

Below is a checklist of objectives to guide the composter toward and through the process of incorporating food residuals into an existing facility. Refer as well to *Section 4: Case Studies* for advice on preparation and operations provided by successful composters.

Figure 2--Check list:

- ✓ Outline program objectives. Does the composter's organization seek to reduce waste? Save tipping fees? Reduce emissions? Promote greener activities? Increase profits? Identify the target;
- ✓ Visit existing successful composting programs. This enables first hand observations, and conversation with those experienced in processing food residuals. Facilities can be located by contacting the state's waste management authority, agriculture authority, and by searching "find-a-composter"--a database created by *BioCycle Journal of Composting and Recycling*, wherein any facility may add itself and its information;
- ✓ Pursue political support for changing the community's waste management approach, and to augment current composting activities (if program will be municipal);

- ✓ Determine what volume of food residuals can be processed successfully. Determination should be based on site size, technology and equipment being used, bulking agent reliably available and regulatory restrictions. Incorporating food residuals at 10-20% of total volume is a reasonable start, and the composter can expand from there *if feasible*.
- ✓ Identify potential sources of food residuals. Location and volume affects hauling and program logistics;
- ✓ Approach potential generators. Begin to form relationships and discuss objectives and concerns;
- ✓ Determine program logistics. Who will be responsible for program design, set-up, training and execution?;
- ✓ Establish written contracts with generators (see, *Appendix F--Contract to Accept Organic Wastes*). A contract clarifies the responsibilities of everyone involved;
- ✓ Prepare the composting facility to process food residuals. Make alterations, if needed, and have sufficient and appropriate bulking materials available;
- ✓ Launch the diversion project;
- ✓ Receive the first loads. Examine materials for contaminants then properly manage materials for composting;
- ✓ Provide feedback to generators. This will help ensure future loads will be equally (or more) clean and free from contaminants.

1.3 Potential Sources of Food Residuals

To identify potential generators in a given region, examine the flow of food. Ask, Where is food grown? Where is it processed? Where do people purchase it? And perhaps most important, Where is food consumed? Answering these questions and tracing the trail from producer to consumer will direct the composter to an array of potential new resources.

Food is *grown* and raised on farms, from small to corporate scale. Though some agricultural operations reincorporate or reuse residuals, many generate excess waste which must be disposed of offsite. Foods are *processed* in many locations, some of which are near the source of the food. For example, coastal regions host seafood processing facilities which much dispose of shells and unsatisfactory or spoiled stock. When thinking of food processors remember liquid consumables, too. Breweries, juice makers, and vineyards generate food wastes of hops, fruit and grape mash, respectively. Food is *purchased* in super markets, local markets and farmers' markets. These venues discard organics unsuitable for sale (broken or bruised fruits and vegetables, etc.), expired and/or spoiled items (pasta salads, breads, and the like), waste paper and cardboard, and possibly seafood and meat wastes. Finally, food is *consumed* in many, many locations. Restaurants and cafes are usually abundant. Hospitals, correctional facilities and educational institutions all have cafeterias, as will many corporate buildings. Hotels, sporting and entertainment arenas, ski lodges, golf courses and other recreational sites all serve food. And don't forget temporary generators--fairs and festivals all produce large volumes of food residuals. *Anywhere food is grown, processed, purchased or consumed is a potential source for food residuals.*

Selecting which generators to target depends, in part, on how much volume the composting facility is prepared to manage (*Collection and Transport Options are discussed below, in this section; Regulatory restrictions are discussed in Section 3*). Yard waste composting facilities should accept only the volume of food residuals for which they have sufficient bulking materials and space to process. *Food residuals cannot be stockpiled like leaves or wood, as odors, pathogens and pests will emerge.* Approach generators who yield volume the facility can safely manage.

1.3 Summary--Potential Sources of Food Residuals:

- Identify generators by observing where food is grown, where it's processed, where it's sold, and where it's consumed;
- Select generators yielding volume the facility can safely manage.

1.4 Determining Diversion Volume

As a general rule, the larger the venue (relative to other similar venues), the more food residuals they generate. A cafe serving breakfast, lunch and dinner will generate more volume than one only serving dinner. Knowing how much to expect is part of being prepared to avoid the issues of concern delineated above. If the facility anticipates volume correctly, appropriate mixing materials can be kept readily available.

Since generators of food residuals may currently dispose of them as waste, the composter may have to *estimate* volume likely to be diverted. This is not as difficult as it may sound. While food processing facilities and farms are more likely to be aware of the volume of organics they generate, other venues may require a brief *waste audit*. In this the composter can learn from the venue's manager the size of the waste containers and how often they're emptied, as well as review historic data from the venue's waste hauler tallying tonnage and/or volume removed from the venue. Add up a weekly, monthly or yearly total, and this is the first piece of information needed to estimate diversion volume.

Example: *A restaurant has one 10-cubic yard ("cy") trash dumpster, which is emptied twice per week.*
The weekly tally is: $10\text{cy} \times 2 = 20\text{cy}$,
The monthly tally is: $20\text{cy} \times 4\text{ weeks} = 80\text{cy}$,
The yearly tally is: $20\text{cy} \times 52\text{ weeks} = 1,040\text{cy}$

Next, one can roughly estimate what percentage is food residuals by viewing the venue's waste. Percentage will differ depending on the type of venue (restaurant, versus hotel, versus supermarket, etc.). Review the definition of "food residuals" in the Preface (above) for what should be included in the estimate, and assess the percentage *by volume* (i.e., how much space it requires as part of the whole container).

Example: *If the above referenced dumpster appears to have (or the manager indicates it normally has) about 75% residuals and 25% waste, calculate 75% of the previously tallied total volume.*
The weekly estimate is: $.75 \times 20\text{cy} = 15\text{cy}$
The monthly tally is: $.75 \times 80\text{cy} = 60\text{cy}$
The yearly tally is: $.75 \times 1,040\text{cy} = 780\text{cy}$

This is the volume the composter can anticipate diverting. As examples, several audits conducted by the author are as follows.

Examples: A brewery and 170-seat restaurant serving lunch and dinner daily fills a 10cy dumpster with trash 3 times a week, 8cy dumpster of cardboard (recycled) 2 times a week, and (8) 96-gallon Toters with co-mingled recyclables twice a week. Since recycling is fully activated, the 10cy dumpster of trash is high in organics--about 80%. From the 30cy of trash per week, 24cy is food residuals. That's 1,248cy per year.

A coffeehouse and cafe generate 2cy per week of trash and 2cy per week cardboard. First they eliminated half their waste by switching to washable plates, in-house coffee mugs, and compostable serving ware and containers. After the switch there was almost *no trash remaining*--less than 5% of original volume--and all remaining waste was food residuals--about 1cy per week.

A national chain hotel offering 200 guest rooms, one restaurant, one lounge and 4 conference rooms generates 80-100cy of trash, 24cy of cardboard (recycled), and (20) 96-gallon of co-mingled recyclables a month. Current recycling efforts fall short of capturing all recyclables, and the hotel generates a lot of packaging and miscellaneous debris and trash. Percent of food residuals is only about 40%. That's about 36cy a month and 432cy a year.

1.4 Summary--Determining Diversion Volume:

- The larger the venue (relative to others of similar function), the more food residuals they are likely to generate;
- The composter may have to estimate volume likely to be diverted based on waste disposal records and a brief audit of waste materials;
- Whether or not the generator is fully executing waste reduction and recycling affects the savings possible from organics diversion.

1.5 Working with Generators

The composter can determine how involved in the diversion process (s)he wants to be. Options range from simply receiving materials at the request of the generator, to setting up a complete diversion program at the venue. A complete program could include installing collection bins, instructional signage, training of staff, providing hauling, and even generating publicity so that the community will know of the venue's efforts to reduce waste. While this degree of effort is not required, *the more education and training the venue receives, the greater the chance for success in diverting food residuals with little contamination.*



Figure 3--Average contaminants include plastic or latex food processing gloves, plastic wrap, plastic or mesh packaging on supermarket foods, aluminum or plastic food containers, snack bags (chips, etc), and condiment packages from restaurants.

Regular feedback and periodic re-education are also very important. The composter is creating a *team effort* between themselves and the generator to divert and compost organics. A small investment of time goes a long way toward meeting the team's objectives.

Whatever level of involvement the composter chooses, it's important to establish a contract delineating what services will be provided, under what circumstances, and for what price (as example see, *Appendix F--Contract to Accept Organic Wastes*). It should also outline program policies, repercussions for infractions against policies, and program goals. Policies should precisely indicate what is permitted in the loads, and include citation from state regulations on what is forbidden (e.g., no hazardous wastes, no waste petroleum products, or, where applicable, no meats, etc.). Penalty for transgression against the rules, and the number of "warnings" which precede penalty, should be concise. Finally, goals ought also be outlined to enable a mechanism by which to measure successes and shortcomings of the program. Establishing a contract which clearly defines the responsibilities of each party involved is important to the team effort.

1.5 Summary--Steps for Working with Generators (some may be unnecessary depending on circumstances):

- Identify potential generators in your region;
- Contact the generator(s) you feel may produce a volume your facility can manage;
- Meet with the generator(s) to discuss the concept of diverting organics. The discussion should address:
 - why* you wish to divert the generator's organics;
 - how you envision the program being designed/launched/operated;
 - what's in it for the generator (Will they save money on trash removal? Are they looking for "greener" options?);
 - when the program might begin;
 - what the program objectives are.

This meeting is also to gain feedback from generators, to learn of their objectives, obstacles to recycling organics (if any), concerns, etc. If the generator agrees to participate, move to the next step.

- Conduct the waste audit; or, where generators have already assessed organics to be diverted collect that data;
- Plan logistics necessary to execute the program (depending on your level of involvement, this may be done instead by the venue):
 - determine the number, size and location of collection bins needed inside the venue;
 - will the bins need compostable liners, or will the composter accept plastic?
 - create signage for each bin clearly illustrating what to *include* and what to *exclude*;
 - train staff who will utilize the bins and/or gather food residuals;
 - set a date for program launch;



Figure 4--Working with generators of food residuals, from kitchen, to outside storage, to composting facility.

- Establish a hauler (will it be you? a small hauler-for-hire? a waste collection company? see, “Collection and Transport Options”, below);
- Prepare a contract with the generator;
- Ensure sufficient bulking or mixing materials are available in anticipation of the first load’s arrival;
- Launch the program;
- Receive food residuals, and manage the load safely and expeditiously (*details below, in Section 2*);
- Provide feedback to the generator on successes and shortcomings so that if there are contaminants (and there will be), they can be reduced in the next load. Ask for their feedback

1.6 Collection and Transport Options

Choosing which venues to work with may also depend upon the ability to collect and transport the materials. The estimated size of the loads may determine what type of hauler is needed. If the venue generates a large volume of food residuals each week, it would be unlikely a small truck would suffice. A dumpster or compactor may be needed, along with a waste collection vehicle (run by a municipal or commercial hauler). Conversely, if the venue is very small it may be possible to place bagged materials into Toters (64- or 96-gallon containers on wheels with attached lids, as shown in Figure 4, above), and either use a small truck and hauler to remove the bags, or use a rear- or side-loading waste collection vehicle to mechanically empty them. Both collection options have benefits and limitations.

<i>Figure 5-Pros and Cons of Storage Using Dumpsters vs. Toters Containers</i>		
	Pros	Cons
Dumpsters	Commercial hauler removes materials--saves time and effort Less space needed than for numerous Toters Loads are usually scheduled (enables pre-arrival preparation)	Hauling price Need special dumpster which holds liquids Corporate haulers are often unwilling or unable to move organics
Toters	Freedom to choose small <i>or</i> corporate hauler; or self haul Toters fit into small alleys, where dumpsters may not Mobile--can be wheeled into venue for easier materials removal Leak-proof, and easily washable	Limits volume possible for diversion More Toters may be needed to manage volume than space is available Start-up cost to purchase containers may be expensive

With dumpsters, the composter won't generally collect the residuals (saves time), one dumpster may require less space than a dozen small containers (where storage space is an obstacle), and materials will likely arrive on a regular schedule. Challenges include price (if only one venue is on the haul route, it may be expensive), the need for a dumpster/compactor which will hold leaching liquids, and the scarcity of corporate haulers transporting organics.

Toters enable the freedom to choose whether a small, local hauler (or the composter), will retrieve the materials, or if a waste collection vehicle will be used. It may be easier to store Toters at the venue than an additional dumpster. Also, unlike dumpsters, Toters are mobile and can be wheeled into the venue to collect materials. Additionally, Toters won't leak, and can be washed regularly. Unfortunately, using Toters limits volume unless frequent pick-up is possible. Sometimes, too, there is not space for the number of Toters needed to accommodate large venues. Finally, purchasing Toters costs \$50-100 each, which may deter participants (unless the composter can make them available for lease).

When considering which generators to work with, collection and transportation options should be examined as part of the decision making process.

1.6 Summary--Collection and Transport Options:

- The ability to collect and transport the materials is a factor in selecting which generators to work with;
- Volume anticipated and frequency of hauls possible helps determine which storage method to use; and subsequently which hauling method;
- Large volumes may require dumpsters or compactors, whereas smaller volumes may be managed with Toters;
- If there is freedom to choose whether to use a dumpster versus Toters, examine space available at generator's site, and discuss pros and cons of each storage method with generator;
- Identify haulers capable of managing the anticipated volume and type of container(s), and contact them for pricing structure and availability.

Section 2: Operational Considerations--Things to Know Before Residuals Arrive

2.1 Review of composting basics

Because composting food residuals requires more attention than yard waste alone, and because there is a greater likelihood for odors, pests and pathogens when managing food residuals, this section begins with a review of composting process basics. Reviewing the basics will enable the composter to remedy--or altogether avoid--problems not necessarily encountered by composting leaf and grass debris. **NOTE:** In order to troubleshoot and remedy problems which may arise in the process, records should be kept which indicate the contents and arrival date of each load of organics being processed, along with recipe used to mix each pile.

As this document is directed toward those already composting yard waste, the following is intended strictly as a review of the basics, and is in no way presented as a complete guide to composting. To locate more complete instructions, please refer to documents listed in the References section at the end of this document.

What to include, and exclude.

What a composter can include into their piles will depend, in part, on state regulations and permitting requirements. This section addresses only process concerns. Regulatory issues are addressed in Section 3.

- All organic materials *can* be composted; *however*, it is not advisable to include certain items. Oils (even vegetable oils), dairy and fatty products can deter the process, attract pests and create odors by hindering airflow. While these items *can* be composted, they should be *limited to 5% of total volume*. Meats, bones and seafood are more likely to attract pests, too, though can safely be composted if pile temperatures regularly exceed 131°F to kill pathogens; and if the piles are carefully managed to prevent odors.
- Otherwise, all other organics (as defined above in *Preface*), may be composted.

Know the factors important to the process. Compost "factors" are conditions that can be altered to affect or enhance the composting process, and help ensure creation of a usable end product. They are *particle size, oxygen, moisture, and carbon-to-nitrogen ratio*; and temperature is the indicator of success. Here's why each matters:

- **particle size**--The smaller the materials, the faster the organisms can break them down. Grinding materials is not necessary, but may speed the process if needed. *However, grinding makes small pieces of everything in the pile--including contaminants--hence screening the compost may be more challenging. Large branches, storm debris, and other large items will not decompose quickly, but will enable air to circulate better than if the pile consists strictly of small-particle materials.*
- **oxygen**--Favorable composting microbes need air to survive. If the pile becomes too compacted or too wet, air won't reach all the microbes. Additionally, if the pile contains too many nitrogen-rich materials, oxygen will be too quickly consumed by the microbes and deplete the pile. *Anaerobic* microbes will take over, and odors will occur. Alcohols may also form, which are toxic to growing plants. To avoid anaerobic decomposition, turn the pile as needed, incorporate stiff bulking agents to increase porosity throughout the pile, or insert an aeration pipe into the center of the pile. See also, "*carbon-to-nitrogen ratio*", below, to ensure a favorable mixture of pile ingredients.
- **moisture**--Ideal moisture content is around 50%, meaning that if you pick-up a handful of compost (taken from a couple of inches inside the pile) and squeeze it, a drop of moisture should fall from your hand. *Barely* a drop. If the pile is too dry, the microbes go dormant. If the pile is too wet, the pile can go anaerobic due to lack of oxygen circulation. Add water or dry materials as needed, and stir the pile to mix moisture throughout. An equation for calculating moisture content of individual ingredients is offered in, "*Planning Your Recipe*", below.
- **carbon-to-nitrogen ratio**--The "recipe" of ingredients used to compel the microbes to compost quickly and completely. Get the mixture right and the microbes work faster. Get it *wrong*, and either the process will slow significantly or the pile will start to smell. Carbon serves as the energy source for the microbes, and nitrogen is the protein source for cell building and reproduction. One without the other doesn't work. While scientifically "carbon-to-nitrogen ratio" (C:N ratio), is calculated on an elemental weight basis, operators can more simply consider the term as a reference to the proportion of high-carbon materials versus the proportion of high-nitrogen materials, on wet weight or bulk volume basis (such as "three parts leaves to one

part grass”, or “one ton of sawdust to one ton of food residuals”). It isn’t sufficient to have the right ingredients in the pile. They must be in the right proportions to ensure the microbes will work quickly and effectively to produce a usable end compost product. *More on determining compost recipe and the physical characteristics of select feedstocks, below.*

- **temperature**–Ideal temperature is between 131-160°F (55-70°C), and should be determined by inserting a composting thermometer horizontally into the center of the pile. Temperature is an indication that the organisms are working well, releasing energy as they break apart organic compounds. Maintaining temperatures within this range is important because the composter *must ensure that all pathogens are being killed*. If temperature is too low, one or more of the above factors is out of whack. Examining the pile for particle size, air circulation and moisture, and review the pile recipe to determine why the pile temperature is low. If temperatures exceed the ideal range, aerate the pile, and add moisture if needed.

2.1 Summary--Composting Basics:

- In order to troubleshoot records should be kept regarding arrival date(s) of feedstocks, pile content and dates of pile turnings (when applicable);
- Oils and fats should be limited to 5% by volume, and meat and bones can be included into piles where temperatures above 131°F are well-maintained;
- Conditions that can be altered to affect a successful composting process are *particle size, oxygen, moisture, and carbon-to-nitrogen ratio*;
- Temperature indicates microbial activity in the pile, and ideal pile temperature is 131-160°F.

2.2 Characteristics of Select Feedstocks

To plan a successful compost recipe the composter should become acquainted with physical characteristics of various feedstocks. Of particular interest are the C:N ratio and moisture content. Sometimes this information can be gained through observation and experience (for example, it is readily observable that food residuals possess more moisture than sawdust), and that which may not be obvious can be acquired from established compost research. Carbon-to-nitrogen ratios have been derived by a variety of academic and scientific bodies, and a formula to specifically determine moisture content in given feedstocks is also available. For the purpose of this document, data on C:N ratios and moisture content for both food and non-food items have been compiled into charts. See, *Appendix A: Carbon to Nitrogen Ratios for Select Waste Items*, and *Appendix B: Moisture Content of Select Feed Stocks*. A formula to calculate an ideal mixture of the feedstocks utilizing these data is presented below in “*Planning Your Recipe*”.

2.2 Summary--Characteristics of Select Feedstocks:

- Refer to *Appendix A: Carbon to Nitrogen Ratios for Select Waste Items*;
- Refer to *Appendix B: Moisture Content of Select Feed Stocks*.

2.3 Manufactured Compostables--Process Guidelines and Requirements for Success

One option for reducing trash and facilitating more widespread composting of food residuals is the use of *manufactured compostables (MCs)*. Food service and trash management items which have historically been plastic are readily available made from compostable materials instead. The selection includes utensils, straws, hot and cold beverage cups, plates and bowls, and trash can liners of all sizes. Items are constructed from corn or potato starch, sugarcane bagasse (from fiber remaining after sugarcane is pressed), recycled unbleached paper, and PLA (polylactic acid, a biodegradable thermoplastic made of corn in the US, and sugarcane elsewhere). To receive the official Biodegradable Plastics Institute (BPI) label of “compostable” (not to be confused with “biodegradable”), each product is tested according to the American Society for Testing Materials (ASTM) for biodegradability, disintegration and eco-toxicity, under specific conditions deemed typical for commercial composting facilities.⁷ Using MCs in food diversion programs greatly reduces the amount of plastic contaminants, reduces remaining trash, and enables food residuals to be received in bags which need not be removed.



Figure 6--PLA beverage cups, paper cups, paper napkins and bagasse plates, left; PLA beverage cups beginning to degrade after composting 30 days, above.

Manufactured compostables are increasingly popular and can be very useful, hence the composter should become acquainted with requirements to successfully process them. According to the manufacturers of these products, being “compostable” means composting will occur *under average conditions at a commercial composting facility*. “Average conditions” include UV exposure, 50% moisture content, average temperatures of 140°F, and *aerobic* conditions (Anaerobic processes were found to be insufficient). Being derived from different materials, items require different processing times:

Figure 7--Manufactured Compostables: Materials, Items and Processing Time

Material	Typical Items	Processing Time
sugarcane bagasse	bowls, plates, cups--hot and cold use	90 days
corn PLA, for cold uses	cold cups, straws and deli-style food containers	180 days
corn PLA, heat-resistant	soup cups, hot use utensils	6-12 months
corn or potato starch	utensils, hot and cold uses	6-12 months
corn starches, resins and polymers	trash bags	30-90 days
corn starch	packaging peanuts	< 30 days

Chart data compiled from information provided by US manufacturers of each type of product

Utilizing manufactured compostables can reduce contaminants in loads of food residuals and enabled more extensive composting of post-consumer food residuals.

2.3 Summary--Manufactured Compostables Process Guidelines and Requirements for Success:

- One option for reducing trash and facilitating composting of food residuals is the use of *manufactured compostables (MCs)*;
- Utensils, straws, beverage cups, plates, bowls, and trash can liners are constructed from corn or potato starch, sugarcane bagasse, recycled unbleached paper, and PLA;
- Items decompose in compost piles when exposed to UV rays, 50% moisture, average temperatures of 140°F, and aerobic conditions;
- Processing times vary depending on material of construction;

- MCs are increasingly popular, hence the composter should become acquainted with processing needed to successfully compost these items.

2.4 Planning Your Recipe

Note: There are a number of free spreadsheets and software available on the internet useful for calculating C:N ratio, moisture content and bulk density. A spreadsheet to simultaneously calculate C:N ratio and moisture content is available from Cornell University at <http://compost.css.cornell.edu/download.html>, and “Compost Calc” is available from Green Mountain Technologies at <http://www.compostingtechnology.com/probesandsoftware/compostcalc/>. The composter should, however, become acquainted with feedstock characteristics and compost recipes in order to troubleshoot and avoid problems throughout the composting process. This subsection discusses recipe planning without the use of software.

When working with a complex array of ingredients, recipe is paramount. With diverse feedstocks, such as varying types of manure, food residuals and such, the composter must pay more attention to the carbon, nitrogen and moisture available in individual ingredients. For example, it's insufficient to form a recipe using “food” as a nitrogen source. Post-consumer plate scrapings are *much* higher in nitrogen than apple pomace (apples after pressing, from cider mills), hence the composter would need less carbon to mix with the low-nitrogen foods than the high-nitrogen food. Using data compiled in *Appendix A: Carbon-to-Nitrogen Ratios of Select Waste Items*, the following equation demonstrates how to calculate the target ratio between 30:1-45:1:

Figure 8--Determining C:N Ratio for a Given Mixture of Feedstocks (wet weight or bulk basis):⁸

2 parts leaves	2 x (60:1)* =	120:2	
1 part <i>apple pomace</i>	1 x (48:1) =	<u>+48:1</u>	
		168:3	or, 56:1 (<i>too much C</i>)
OR,			
2 parts leaves	2 x (60:1)* =	120:2	
1 part mixed food waste	1 x (15:1)* =	<u>+15:1</u>	
		135:3	or, 45:1 (<i>acceptable</i>)
* average value			

The same can be said of moisture content. If the composter is incorporating bakery wastes, versus waste from a market selling produce, both are “food”, but the bakery items will likely be drier than the produce. Using trial and error generally works if the composter is informed as to the approximate moisture contained in the materials (*see, Appendix B: Moisture Content of Select Feed Stocks*). However for those wishing to calculate moisture content until they become better acquainted with feedstocks, the following equation illustrates how to plan a recipe with 50-60% moisture content:

Figure 9: Calculating Moisture Content for A Given Mixture of Feedstocks⁹

$$G = \frac{(Q_1 \times M_1) + (Q_2 \times M_2) + (Q_3 \times M_3) + \dots}{Q_1 + Q_2 + Q_3 + \dots}$$

in which:

Q_n = mass of material n (“as is”, or “wet weight”)

G = moisture goal (%)

M_n = moisture content (%) of material n

Knowing what materials are available, in what volume, and how frequently are all factors to consider. Use what's available to calculate a mixture resulting in an initial C:N ratio of about 30:1-45:1, and moisture content of approximately 50-60%. If what's available doesn't create a successful recipe, it may be necessary to seek out other feedstocks. Because composting food residuals is more complex than composting yard debris, preparing a more detailed recipe and referring to the composting basics will enable the composter to successfully avoid odors, pathogens and pests.

2.4 Summary--Manufactured Compostables Process Guidelines and Requirements for Success:

- Plan a recipe which takes into account the C:N ratios of available feedstocks (see figure 8, above; and *Appendix A--Carbon to Nitrogen Ratios of Select Waste Items*);
- Also consider moisture content of organics when determining the mixture (see figure 9, above; and *Appendix B--Moisture Content of Select Feed Stocks*);
- Initial recipe should aim for a 30-45:1 C:N ratio and a 50-60% moisture content;
- Because composting food residuals is more complex than composting yard debris, preparing a more detailed recipe and referring to the composting basics will enable the composter to successfully avoid odors, pathogens and pests.

2.5 Processing Materials in Turned Windrows Versus Forced Aeration in Static Piles

The majority of yard waste composting facilities utilize the turned windrow method for ease and (generally) lower capital required. When composting food residuals, however, the risk of odors and excess moisture is more significant, and temperatures sufficient to kill pathogens must be ensured. Comparing operating methods can be useful when making a transition into incorporating food residuals. Below is an overview of the turned windrow and forced aeration methods of composting organics, followed by a summarized list comparing the pros and cons of each system to the other.

Turned Windrows

The turned windrow method is commonly used in yard waste composting facilities as a versatile, lower-tech method which can be adapted to changing conditions. In this method, organics are mixed according to C:N ratio and moisture content and placed into long rows. The height of the rows depends not only on the machinery used to stack materials, but also on the materials' likelihood to aid or hinder air circulation (piles with greater percentage of moist materials, such as dairy manure or food residuals, should be made smaller than piles containing bulkier yard debris which permits greater air flow). Aeration occurs two ways: Primarily by convection, when heat vapors rise through and exit the piles drawing fresh air in behind; and secondarily by direct exposure when piles are mechanically turned inside out, clumps are broken apart and materials are fluffed thereby improving circulation. Because the piles are repeatedly agitated, the recipe can be adjusted if needed in response to changing conditions or odors. Turning windrows also ensures materials are evenly mixed and exposed to high temperatures in the pile's core. If odors emerge after turning, windrows can be covered with a 3-6" layer of finished compost. Because of the versatility and facility of operations, turned windrows are as useful for composting food residuals as for composting strictly yard waste.

There are several factors to consider when using turned windrows to process food residuals. Being aware of these will help the composter avoid odors, pests and pathogenic contamination. Because these materials may contain more moisture and/or nitrogen-rich ingredients than yard waste, decomposition may occur more rapidly in the first several weeks. Excessive moisture and rapid decomposition can lead to odors. Odors attract pests, and may also cause problems with local residents. Piles with food residuals may need more frequent turning initially than those with yard waste alone, and will likely decrease in size more rapidly. While smaller windrows enable greater air circulation, they also lose heat faster. *Maintaining temperatures in excess of 131°F is necessary to kill pathogens in food residuals.* Therefore it may prove useful to combine adjacent windrows after the initial rapid decomposition phase is complete. Though these factors can present challenges not previously encountered with composting yard waste, they are minor and infrequent if piles are managed in accordance to processing basics delineated earlier in this Section. Using turned windrows to manage food residuals is a versatile system that can be easily adjusted to accommodate changing conditions.

Forced Aeration

With the forced aeration method, air is supplied to decomposing materials via perforated pipes embedded in or under each windrow. A blower moves the air, either by suction to pull air through the pile and into the pipe ("negative pressure"), or by forcing air from inside the pipe outward through the piles ("positive pressure"). The blower can operate continuously or intermittently, on a timer or thermostat. Since negative pressure collects air into the pipe, odors can be filtered out before discharge. Positive pressure eliminates the possibility of filtration using the pipe, yet covering the pile with a layer of finished compost should suffice (*more on odor management next, in this section*).

With positive pressure, however, air flow is better and can be more effective at drying wet materials and cooling excessively hot piles if needed. Whereas the turned windrow method moves the *materials* to expose them to air, the forced aeration method moves the *air* so that it is distributed throughout the materials.

Since piles are not turned during the process, the mixture and set-up are important to ensure even air distribution and composting. Organics are mixed, then set atop a base of porous materials (such as wood chips, chopped straw, or such), in which the pipes are located. Initial pile height can be up to 8', providing the porosity of the composting materials is sufficient to allow air to move between particles. If compostables are particularly wet it may be necessary to use a bulky carbon source of corn cobs, wood chips, crop residues, shellfish shells, or similar, to increase porosity in the mixture. It is also useful to cover the pile with a 3-6" layer of finished compost to maintain moisture on the pile surface, discourage pests, insulate against heat loss, and prevent odors from leaving the pile. In turned windrows air distribution results from natural convection and mechanically moving the materials, while with forced aeration the air is actively circulated. In each case texture, recipe and formation of the piles is critical.

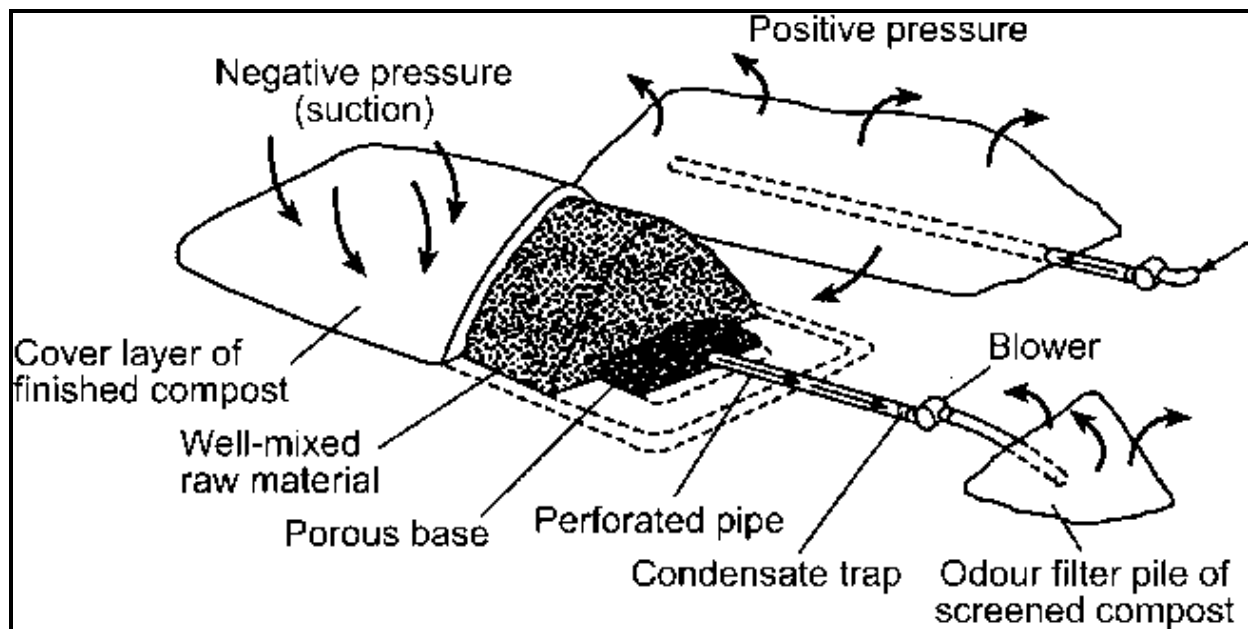


Figure 10--Diagram of Aerated Static Piles ¹⁰

In-vessel Aerated Static Piles (ASP)

The use of covers as complement to the above forced aeration system can increase the effectiveness of this type of system. Many problems associated with windrow and static pile systems result from environmental and climatic influences. With excessive rain or drought conditions, either system can become compromised. Pests have easy access as well. Leachates, odors and emissions must be monitored and controlled. The use of protection by being inside a building or using synthetic pile covers enables greater control over environmental factors, and may make the investment to obtain such protection worthwhile in the long run. Additionally, the use of in-vessel systems gives greater protection against vectors (including bears), hence may justify the extra capital outlay. Finally, in-vessel systems enable greater control over leachates, odors and emissions--increasingly important with local and state regulators. While the cost may be prohibitive for some composting facilities, the value gained from using in-vessel systems may justify the investment for others.

Clearly no one method addresses all processing needs and concerns for all circumstances. The composter must choose the method which most favorably addresses local conditions, organics being processed, available budget and labor, and individual preferences. Whichever method used, the *facility should keep records of how and when aeration occurred* (i.e., when piles were turned, or times when aeration blower ran).

2.5 Summary--Turned Windrows-vs-Forced Aeration:

- Windrows are low/no-tech, while forced aeration requires a blower system, and personnel to maintain and repair it (*costs*);
- In turned windrows, the recipe and pile structure can be adjusted after piled, while forced aeration requires proper mixing before placing piles (*versatility*);
- Windrows can be turned and moved at will, while a forced aeration system must be disassembled before moving materials (*versatility*);
- Negative pressure forced aeration can help control odors by collecting air into the suction pipe, enabling filtration before discharging. Windrows require turning to aerate and can release odors as the pile is opened (*odor , pest and public management*);
- Positive pressure forced aeration can eradicate excess moisture and excessively high temperatures by pumping higher volumes of air into the pile than the negative pressure system can pull in. Turned windrows must be turned repeatedly, or mixed with drier materials, to reduce moisture and temperature (*moisture control, temperature control; odor , pest and public management*);
- During dry weather periods, windrows will hold moisture better than piles processed with forced aeration;
- Forced air piles can built as an extended pile, reducing the size of the “footprint” needed to process a given amount of material;
- Forced air systems need an engineer to design the system to assure the air flow will be sufficient for the amount to be composted;
- Utilizing covers and in-vessel systems can greatly reduce risks associated with both systems.

2.6 Odor Prevention and Remedy

While preventing and remedying odors occurs once residuals have arrived, the operator should be well-prepared to manage odors *before* materials arrive. The key to preventing odors is to observe the “Factors” of Composting Basics delineated above. The Factors are the basic scientific principals which enhance and enable the process to occur without problems, including odors. If materials are mixed so that the C:N ratio is within acceptable range, moisture content is between 45-60%, and materials are not compacted and have proper aeration (via whichever method is chosen), odors should not be an ongoing problem.

Odors *are* present when initially receiving and mixing piles, after turning piles (if applicable), and in response to changing conditions, however, and the composter should be prepared to remedy the situation as quickly as possible. The first step is to determine the reason for odors. Too much nitrogen relative to carbon? Too much moisture? Not enough air circulating? Consider the circumstances, check records for aeration history and recipe, and examine the physical characteristics of the pile. *Odors may emerge, but they need not be problematic.* The following illustrates several possibilities for odors, and the respective solutions.

Figure 11--Troubleshooting Odors

Problem: *Residuals smell upon arrival.*

When food residuals first arrive on site they will naturally smell--mainly because they have likely been contained without air for some time, and because the residuals are yet to be mixed with a high-carbon source.

Solution: Know when residuals will arrive so that personnel can be available to mix and pile or windrow them immediately. Odors will dissipate quickly after materials have been managed.

Problem: *After many days of rain the sun has emerged, and piles smell.*

Though piles may have been mixed to appropriate moisture content, weather can change that! In fact, weather can have great influence on whether or not odors appear. In this case excessive rain occurred which likely raised the moisture content of the piles to beyond what is favorable for aerobic decomposition. The sun will eventually help alleviate this, but in the short run is only exacerbating the problem by heating food residuals exposed on the pile's surface.

Solution: Turn the pile daily, or increase forced aeration frequency, until favorable moisture content is once again achieved. With turned windrows odor may escape briefly while turning, but can be contained after by covering pile with a 3" layer of finished compost.

Problem: (For turned windrows) Two weeks after food residuals arrived and were mixed, odors randomly emerge. Even when piles containing food residuals are mixed to the right C:N ratio, have the right moisture content, and have not generated odors for the first week or so, odors can emerge. Recall that food residuals may be higher in nitrogen and/or moisture content than yard waste, and may also decompose faster than yard waste alone. In this case it is likely that aeration has been hindered--either by compaction of moist materials, or resultant of rapid decomposition which caused rapid depletion of oxygen in the pile.

Solution: Turn the piles, and add additional carbon-rich materials if needed.

When processing food residuals, odors need not be an ongoing problem. Anticipating potential problems which could arise, and becoming well-acquainted with the Factors to successful composting will enable the composter to troubleshoot as issues occur, and avoid long term problems altogether.

2.6 Summary--Odor Prevention and Remedy:

- Be observant of the 4 Factors of Composting Basics;
- If odors emerge in an existing pile consider site conditions, check records for aeration history and recipe, and examine the physical characteristics of the pile;
- If odors are present when organics arrive or when piles are turned, add sufficient carbon-rich materials or layer of finished compost as a bio-filter.

Section 3: Health, Safety and Regulations

3.1 Safe Handling of Food Residuals When They Arrive

Manage Liquids First. Because food residuals release liquid while awaiting transport and processing, the composter should *prepare to receive the materials in advance of their arrival*. Aside from causing odors, these liquids contain nutrients and pathogens hence should not be allowed to travel away from the compost pile. Depending on arrangements with generators, materials will arrive in one of several forms: In compostable bags, in plastic bags (which will require some method of de-bagging), or loose and mixed in a dumpster-type container. Whatever the form, a fair amount of foul-smelling liquids will accompany the organics. Therefore, it's highly recommended to cover the receiving area with a 6-12" layer of absorbent carbon-rich materials onto which the residuals can be placed. (The "receiving area" can be a dedicated location constructed to contain and manage food residuals, or can simply be an area adjacent to the pile where organics will be incorporated.)



Figure 12--Organics release liquids while awaiting transport--a 20cy load can produce 30 gallons or more. The liquids smell and may contain pathogens, therefore it's important for the composter to be prepared to receive food residuals. Preparation includes spreading a bed of absorbent materials to capture liquids and being ready to mix materials as soon as they arrive.

(photo courtesy of Barnes Nursery, Inc.)

Leaves are insufficient for this purpose, but sawdust, wood shavings (not chips), horse manure with bedding, chopped hay or straw, or waste paper work well. The absorbent bed helps prevent nutrients and pathogens in liquids from leaching away from piles and potentially into surface or ground waters. It will also keep those nutrients and pathogens with the compost, and ensure pathogens are exposed to microbial activity and temperatures required to kill them. *Pre-arrival preparation of the receiving area with absorbent material is the important first step.*

NOTE: Depending on individual site conditions and local regulations, it may be necessary to construct an impervious pad on which food residuals will be received, or construct a system to collect leachates into a processing pond. Ensuring leachates are absorbed before they can migrate may help avoid more expensive surface water management approaches.

Next Manage Odors. To successfully manage odors and hence avoid attracting birds, insects and other pests, food residuals require *immediate* management upon arrival at the composting facility. The absorbent bed will stop odorous liquids from *spreading*, and residuals can now be mixed and incorporated into the piles. Refer to “Composting Basics”, and “Planning Your Recipe” to determine formula. If mixing isn’t immediately possible, start by covering the load with a layer of high-carbon materials or finished compost until mixing and incorporating into permanent piles is feasible. *It is not recommended to leave food residuals unmixed for more than 24 hours, as liquids will continue leaching until carbon-rich materials are added. Pests (including rats) will likely be attracted.*

Figure 13--Newly arrived food residuals are immediately covered with ground yard waste at Barnes Nursery, Inc. (see, Section 4--Case Studies).



All the While Protecting Health. Because food residuals contain human pathogens, fungi and bacteria, safeguarding people in contact with these materials is important. When processing food residuals, workers should wear protective gloves (and eye wear to protect from splatter, if workers are directly in contact with materials), and keep hands away from face—especially the mouth and eyes. Hands should be cleaned with antibacterial wipes or soap after contact with residuals. Shoes should be checked for contamination and cleaned as needed. Equipment, too, should be washed after handling food residuals, as bacteria and pathogens can spread into finished piles if touched with contaminated equipment. Don’t forget the thermometer used to read temperatures in food residual piles: Wash it after every use, and wash the hands holding it, too. *Living contaminants can easily be managed by taking precautions and enforcing sanitation.*

Part of protecting health is proper management of the compost piles. Ongoing odors will attract disease-carrying pests, and poorly managed piles may generate temperatures too low to kill pathogens. As previously stated, piles must sustain temperatures of at least 131°F to kill living contaminants. Piles should be monitored for temperature and results should be recorded (every few days for the first month; and weekly thereafter). The US Composting Council recommends that facilities handling food residuals meet the time and temperature requirements of EPA’s *Process to Further Reduce Pathogens (PFRP)*. This process, first developed for composting sludge into biosolids, assures that virtually all human pests and pathogens are destroyed. PFRP requirements vary depending on whether the operator is using windrows or static piles:

- *For turned windrows:* Maintain 131°F (55°C) for at least two weeks, with at least 5 turns over that time;
- *For aerated static piles:* Maintain a minimum of 131°F (55°C) for three days. This assumes that the pile is covered with insulation, such as 6" of finished compost, so that the whole mass reaches the critical temperature.

Not meeting PFRP guidelines means pathogens or pests could be spread via the finished compost. *Proper management of the compost piles will keep away most pests, and will help ensure that all pathogens are eradicated before finished compost is used.*

NOTE: At facilities open to public use, it is best to segregate food residuals management activities away from public areas. Doing so prevents exposure to pathogens, and also puts some distance between visitors and potential odors.

3.1 Summary--Safe Handling of Food Residuals When They Arrive:

- Because food residuals release liquid while awaiting transport and processing, the composter should *prepare in advance* to receive the residuals. Cover the receiving area with a 6-12" layer of absorbent carbon-rich materials onto which the residuals can be placed;
- To manage odors and discourage pests food residuals require *immediate* attention upon arrival at the composting facility. Either mix and incorporate residuals into the pile, or cover the load with high-carbon materials or finished compost until mixing and incorporating is feasible;
- Food residuals contain human pathogens and bacteria. Protect health of those in contact with residuals by enforcing proper sanitary practices (delineated above);
- Pathogens can survive the composting process if piles are not well managed. Proper management of the compost piles will keep away most pests, and will help ensure that all pathogens are eradicated in the finished compost;
- It is not recommended to leave food residuals unmixed for more than 24 hours, as liquids will continue leaching until carbon-rich materials are added. Pests (including rats) will likely be attracted;
- At facilities open to public use, it is best to segregate food residuals management activities away from public areas. Doing so prevents exposure to pathogens, and also puts some distance between visitors and potential odors.

3.2 Is Your Yard Waste Facility *Ready* to Process Food Residuals?

A facility's volume capacity may be pre-determined by their state's regulations, by the facility's status (commercial, municipal or on-farm) or their permit (where required). *Total* capacity may not be regulated, but *percentage of volume permissible to be food residuals* may be. A permit may not be required to compost yard waste, yet is *likely required to process food residuals* of various categories. Each facility should consult with their state's solid waste regulating authority for limitations--usually the Department of Environmental Services or Environmental Protection. Check, too, with local authorities to make sure importing and processing food residuals is permissible under local codes and zoning. *Because this document is produced for facilities within EPA Region 3, contact information for each of the Region's state authorities is compiled in Appendix C.*

Regulatory issues are not the only concern in preparing to incorporate food residuals into an existing yard waste composting facility. The composter must take into consideration all that has been discussed in this document, examine the facility and determine whether any special accommodations will be needed to avoid future health or environmental concerns. Is the site located on sandy soil which might allow liquids from food residuals to rapidly percolate into the soil? If so, building a concrete receiving area may be a responsible preparation. Will the additional space needed to process additional materials encroach on previously-distant surface waters? If so, precautions should be taken to keep compost leachates away from surface water--such as creating a vegetative buffer strip between the process area and the waters. A retention pond to capture and filter leachates may also be useful (in which case local and/or state regulatory agencies may require engineered plans), and a simple berm of compost to keep fines out will help keep the pond from going anoxic and becoming an odor source itself.



Figure 14--Retention pond at Barnes Nursery (see, Section 4: Case Studies). This facility is graded at approximately 3%, leading toward the pond, so that rain water and leachates will be collected. Sediment settles to the bottom, and collected water can be applied to piles when moisture is needed.

A well-managed and responsible composting facility makes supporters of local residents while a messy, potentially hazardous environment quickly gains enemies. Assessing the site's capacity to *responsibly* manage food residuals, and making adjustments in advance of accepting the first loads will help secure the facility's future--even if problems arise. See, *Section 4: Case Studies* for advice on important considerations as offered by successful composters.

3.2 Summary-- Is Your Yard Waste Facility Ready to Process Food Residuals:

- Inquire with State agencies as to whether additional permitting or licensing is required to manage food residuals, and if limitations apply;
- Ask local agencies about zoning and ordinances which may apply;
- Review the facility in its current conditions and determine what, if anything, will be needed to safely and responsibly manage residuals so as to avoid health and environmental risks in the future.

Section 4: Case Studies of Successful Yard Waste Composting Facilities Incorporating Food Residuals

Because there is much to be learned from experience, this document will now examine two cases of composting facilities successfully processing food residuals with yard waste. While there are many examples of large facilities successfully composting food residuals with yard waste, biosolids, paper mill sludge and the like, the purpose of this document is to guide *average* yard waste composting facilities into incorporating food residuals. The following cases were selected as representative of the target audience in size (small to medium facilities), and materials accepted (mainly yard waste in addition to food residuals). They were also chosen because each has existed for more than 5 years and neither has had odor complaints or environmental infractions filed against them.

Each facility was provided a list of questions relevant to topics covered in this document. What follows is documentation of their experiences and advice, in their own words.

see, *Appendix D--Case Study: Earthtenders;*
Appendix E--Case Study: Barnes Nursery, Inc.

Conclusion

Because food residuals are a resource and should not be viewed as waste in need of disposal, EPA is working to promote more composting of these valuable materials. The Best Management Practices described in this document are designed to guide the composter through the process of expanding existing yard waste composting operations to incorporate additional materials of food residuals. The rationale is both environmental and economic, and with guidance provided within this document it is hoped the transition can be both simple and sustainable. For more extensive reading on many of the topics covered in this publication, please refer to documents contained in the References section.

References:

- ¹ United States Environmental Protection Agency. "Decision Makers Guide to Integrated Solid Waste Management, Vol. II." EPA530-R-95-023. August 1995. www.epa.gov. 18 May 2009. <http://www.epa.gov/osw/nonhaz/municipal/dmg2.htm>.
- ² USEPA, Office of Solid Waste. "Municipal Solid Waste in the United States: 2007 Facts and Figures." EPA530-R-08-010. November 2008. www.epa.gov. 20 April 2009. <http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw07-fs.pdf>.
- ^{3,4} Goldstein, Nora. "The State of Garbage in America, 2008 Report." BioCycle Dec. 2008: 22- . www.jgpress.com. 26 April 2009. http://www.jgpress.com/archives/_free/001782.html.
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- ⁶ California Integrated Waste Management Board. "Compost Emissions Study." Publication 432-07-003. copyright 2007. www.arb.ca.gov. 18 May 2009. <http://www.arb.ca.gov/cc/compost/compost.htm>.
- ⁷ www.BPIworld.com
- ⁸ Cornell Waste Management Institute. Master Composter Resource Manual. Ithaca: 1998.
- ⁹ Cornell Composting: Science and Engineering. Cornell Waste Management Institute/Cornell University. 20 June 2009. http://compost.css.cornell.edu/calc/moisture_content.html.
- ¹⁰ Cornell--Natural Resource, Agriculture, and Engineering Service (NRAES). "Field Guide to On-Farm Composting" NRAES-114. 1999. Food and Agriculture Organization of the United Nations. "On-Farm Composting Methods." Rome 2003. <http://www.fao.org/docrep/007/y5104e/y5104e07.htm>
- ¹¹ Carbon to Nitrogen Ratios of Various Waste Materials. North Country Organics. 12 June 2009. <http://www.norganics.com/applications/cnratio.pdf>.
- ¹² Cornell--Natural Resource, Agriculture, and Engineering Service. "On-Farm Composting Handbook; appendix A, table A.1." NRAES-54. copyright 1992. http://compost.css.cornell.edu/Composting_Homepage.html. 4 May 2009. <http://compost.css.cornell.edu/OnFarmHandbook/apa.tab1.html>.

Appendix A: Carbon-to-Nitrogen Ratios for Select Waste Items ^{11, 12}

Apple filter cake	13	Mussel waste	2.2
Apple pomace ^a	48	Newspaper ^a	400-850
Apple processing sludge	7	Olive husks	30-35
Aquatic plants ^a	15-35	Paper (from domestic refuse) ^a	125-180
Blood meal ^a	3	Paper fiber sludge ^a	250
Broiler manure	14	Paper mill sludge ^a	55
Cardboard (corrugated) ^a	560	Paper pulp ^a	90
Castor pomace ^a	8	Paunch manure ^a	20-30
Cocoa shells ^a	22	Pig manure ^a	14
Coffee grounds ^a	20	Potato tops ^a	28
Compost ^a	15-20	Potatoes (culled) ^a	18
Corn silage ^a	35-45	Potato processing sludge	28
Corn stalks	60-73	Poultry carcasses	5
Corn wastes ^a	60-120	Rice hulls ^a	110-130
Cottonseed meal ^a	7	Sawdust	442
Cow manure ^a	10-30	Sawmill waste ^a	170
Crab/Lobster wastes	4.9	Seaweed ^a	5-27
Cranberry filter cake	31	Sheep manure	16
Cranberry plants	61	Shrimp wastes ^a	3.5
Fish wastes	3.6	Shrub trimmings	53
Fish--breeding crumbs	28	Slaughterhouse wastes ^a	2-4
Fish--processing sludge	5.2	Softwood bark ^a	100-1000
Food wastes ^a	14-16	Softwood chips, shavings ^a	200-1300
Fruit wastes ^a	40	Soil ^a	12
Grass clippings	17	Soybean meal ^a	4-6
Hardwood bark ^a	100-400	Straw, general	80
Hardwood chips, shavings ^a	450-800	Straw, oat ^a	60
Hay, general	15-32	Straw, wheat ^a	127
Hay, legume ^a	15-19	Telephone books ^a	772
Hay, non-legume	32	Tomatoe processing waste	11
Hoof and horn meal ^a	3	Tree trimmings ^a	16
Horse manure	30	Turkey litter ^a	16
Laying hen manure	6	Vegetable wastes ^a	11-19
Leaves	40-80	Water hyacinths (fresh)	20-30

figures in italic are average values

Source: NRAES-114, 1999. see References.

^a Source: North Country Organics. See References.

Appendix B--Moisture Content of Select Feed Stocks ¹²

Material	% by wt (wet)	Material	% by wt (wet)
Apple filter cake	60	Newsprint	3-8
Apple pomace	88	Paper (from domestic waste)	19
Apple processing sludge	59	Paper fiber sludge	66
Breading crumbs	10	Paper mill sludge	81
Broiler litter	37	Paper pulp	82
Cattle manure	81	Paunch manure	80-85
Cocoa shells	8	Potato processing sludge	75
Corn cobs	15	Poultry carcasses	65
Corn silage	65-68	Rice hulls	14
Corn stalks	12	Sawdust	39
Corrugated cardboard	8	Seaweed	53
Cranberry filter cake	50	Sewage sludge	72-84
Crab and lobster wastes	47	Sheep manure	69
Cranberry plant parts	61	Shrimp waste	78
Cull potatoes	78	Shrub trimmings	15
Fish processing sludge	94	Slaughterhouse waste	10-78
Fish processing waste	76	Straw	12
Food waste	69	Swine manure	80
Fruit wastes	80	Telephone books	6
Grass clippings	82	Tomatoe processing waste	62
Hay-general	9	Tree trimmings	70
Horse manure w/bedding	72	Turkey litter	26
Laying hen manure	69	Vegetable produce	87
Leaves	38	Water hyacinth, fresh	93
Mussel waste	63		

Appendix C--Contact Information for Departments of Environmental Services or Protection:

DC: District Department of the Environment

51 N Street, NE 6th Floor
Washington, DC 20002
Main line: (202) 535-2600
www.ddoe.dc.gov

DE: Division of Air and Waste Management

89 Kings Highway
Dover, DE 19901
Main line: (302) 739-9400
www.awm.delaware.gov

MD: Department of the Environment

1800 Washington Boulevard
Baltimore, MD 21230
Main line: (410) 537-3000
www.mde.state.md.us

PA: Department of Environmental Protection

Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101
Main line: (717) 787-2814
www.depweb.state.pa.us

VA: Department of Environmental Quality

629 East 629 East Main Street
Richmond, Va. 23219
P.O. Box 1105
Richmond, VA 23218
(804) 698-4000
(800) 592-5482 (toll free in Virginia)
www.deq.state.va.us

WV: Department of Environmental Protection

601 57th Street
Charleston, WV 25304
Main line: (304) 926-0480
www.wvdep.org

Appendix D--Case Study: Earthtenders

Earthtenders is a commercial composting facility, education center and consulting firm located in Farmington, NH. In addition to organics recycling, the company teaches community outreach programs on waste reduction and natural resources conservation, and consults on projects of waste management and agricultural nutrient management. The site is open to the public and processes 3,000-5,000 tons of organics a year of leaf and yard debris, manure and pre- and post-consumer food residuals. They have been in business 8 years, accepting food residuals for 7, and manage materials via turned windrows. Earthtenders has only 1 full-time employee and several part-time employees. The site occupies 17 acres, of which approximately 6-8 are used for composting. Compost products are sold in bulk on-site, and in bulk and bags at retailers.

Regulatory Status:

- Level 3 Solid Waste Operator certificate and Permit-by-Notification required to compost food residuals;
- Maximum 20% of total volume may be food residuals (though this facility has been given a waiver to exceed that limit).

Sources of Food Residuals:

- Supermarkets, restaurants, special events (fairs, weddings, conventions, etc.) and food processing plants

Collection and Transportation Methods:

- Depends on arrangements with generators;
- Supermarkets and food processors generally have their own collection and transport programs in place, usually placing loose materials into dumpsters or compactors, hauled by commercial waste companies;
- Restaurants and cafes often need help executing complete training and set-up programs, and usually collect organics in compostable bags and store them in Toters containers until the facility retrieves them;
- Special events require varying arrangements, and generally include arranging for one-time pick up of Toters or roll-off container.

Average contents of each load:

- "Food processors deliver 100% of whatever material they're processing (bread crumbs, fish waste, etc), in large un-bagged loads. Few contaminants.
- Our supermarket clients compost their cardboard, hence loads are 30% cardboard and waste paper (though it consumes about 50% of *space* because it's bulky), 50% fruits/vegetables/flowers/plants, and 20% butcher waste. Un-bagged loads. Frequent contaminants, such as twist ties on produce, packaging on produce and floral wastes, and food containers from deli. *Note: Contamination from the supermarkets is markedly higher when no feedback is provided.*
- Our restaurants and special events generate about 20% pre-consumer (vegetative trimmings, excess pre-made foods, etc), and the remainder is post-consumer plate scrapings of meat, fish, vegetables, breads, coffee grounds, paper items, and manufactured compostables. Most arrive in compostable bags. Depending on how involved Earthtenders is in training for these programs, and on whether manufactured compostables are used, contamination ranges from low to moderate."



Figure 15--Residuals from bakery cafe: Coffee grounds and filters, bread items, vegetative waste, MCs and waste paper.

Is there a special receiving area for their arrival and/or processing? "No. Large loads of non-bagged food residuals are received and mixed adjacent to windrow of destination, incorporated into that windrow, then covered with a 3" layer of carbon materials. Residuals in compostable bags are incorporated directly into piles, with no additional cover needed."

How are additional liquids resultant of food residuals managed? “Residuals are emptied onto an absorbent layer of horse manure and bedding about 8” deep. We don’t move the bedding until liquids have been soaked up. These loads (mainly from supermarkets or food processors), bring with them about 20-30 gallons of liquids for an approximate 20cy load, so preparing in advance to capture them is important.”

Do you find in processing food residuals there are more instances of odors? Pests? If so, how do you manage them?

“In our 8 years Earthtenders has *never* had an odor complaint—partly because we schedule receipt of food residuals and mix them immediately. They really *stink* upon arrival, so we first add as much carbon as needed to halt odors. Then, after materials have been exposed to air and most liquids absorbed, we add whatever nitrogen is needed to correct the C:N ratio. *Adding high-nitrogen items to a high-moisture load would only exacerbate the odor problem.*”

Odors manifest a chain of problems and significantly tarnish a site’s reputation. Pests accompany odors, too, so if odor is managed pests are minimal. We *do* see an increase in “intruders” during winter months—raccoons, foxes, and such sometimes invade piles where food is incorporated, but they don’t linger year-round. When food piles are being turned, an occasional rat has also been spotted, though only 3-4 times in 8 years. I think this is unavoidable as we are surrounded by woods.”

General recipe used: “Our recipe is slightly different depending on whether food residuals arrive in compostable bags, or loose in a dumpster compactor. We don’t normally use horse manure and bedding in our piles, but find it necessary for absorbency with the loose residuals. It’s used as the preparation layer only, so the liquids absorb into the bedding and decompose it faster. With these loads our recipe is generally (*using the equation provided in figure 8*):

20cy food residuals (30%=6cy cardboard @ 560:1, 50%=10cy food scraps @15:1, 20%=4cy butcher waste @ 3:1)
+5cy horse manure, as preparation, @ 30:1
+ 4cy x 17:1 = 68:4 grass and mixed green yard waste (added after one week)

215:5 or 43:1

Methodology for incorporating food residuals into piles: We receive food residuals onto absorbent bed then mix to recipe described above. After about one week we add the high nitrogen items, then incorporate the load onto the end of a working windrow. We also cover the windrow, as needed for odor, with a 2-3” layer of either compost or leaf waste.

“Lessons learned” and advice on composting food residuals:

- It’s been fairly easy—not much more difficult than managing yard waste, accept loads require more urgent attention;
- Public outreach has proven *really useful*, as people are more willing to overlook any odors which periodically arise; and they actually send us clients! We publicize every program we launch. The more people know of the facility’s efforts to reduce waste—as opposed to just make and sell compost—the more support we’ve gained;
- Hauling is the hardest part (in our region, at least). Small local haulers have been very helpful;
- Composting manufactured compostables requires more moisture than usual, but they work;
- Once one generator diverts residuals for composting, many others wanted to join (especially with restaurants and hotels);
- When accepting materials from food processors, put in writing that the residuals can *contain no preservatives* (we once received loads of breadcrumb coatings from a fish processing plant which is still composting, 4 years later....);
- Providing feedback to the generators, regarding non-compostable contaminants in loads, produces fantastic results. Photos are the best tool;
- Keeping the site tidy is very important to public perception, and keeping grass mowed helps keep pests away from piles. A messy site seems to imply (rightly or wrongly) that compost may also be poorly managed;
- (In observing others in our region) Eight years of odor-free management makes it so people don’t realize the composting facility exists, whereas 1 week *with* odors means *people will never forget you are there....and should be monitored.*

Contact information: www.earthtenders.com

(Responses provided by company owner, and author of this document, Eva Christensen)

Appendix E--Case Study: Barnes Nursery, Inc.

Barnes Nursery, Inc. is a family owned nursery, garden center, landscaping company and composting facility located in Huron, Ohio. In addition to making compost they produce various soil and mulch products. The composting facility is open to the public, and processes approximately 20,000 tons of materials--about 8,500 tons of yard waste, 500-1,000 tons of food residuals, with the remainder wood and aggregate materials. The composting facility has been operational since 1992 (though the company has been in business about 60 years), and processing food residuals for more than 2 years. Materials are managed via turned windrows using a collection of grinders, conveyors, bucket loaders and screeners. The site employs 4 people full-time and 3 part-time, and anticipates the need for more as inputs increase. The site occupies 35 acres of which 20 are used for composting. Compost, soil and mulch products are sold bulk and bagged, at their retail center and others.



Regulatory Status:

- Site must meet requirements of a Class II composting facility;
- Site must register with the State and pay a license fee based on maximum daily allowable waste;
- Recordkeeping required;
- No limits on percentage food waste

Sources of Food Residuals:

- Supermarkets, resorts, hospitals, schools and food processing plants

Collection and Transportation Methods:

- Depends on arrangements with generators;
- Generally use self-contained compactors or 10cy roll-off containers, both transported by roll-off trucks;
- Packer trucks are also used;
- Barnes collects much of their own yard and wood wastes with their own trucks, but cannot collect food residuals efficiently due to weight limits on Ohio roadways.

Average contents of each load:

- Our supermarket loads contain approximately 30% vegetative and meat waste, and 70% cardboard and other packaging. All materials are pre-consumer and include waste paper;
- Resort waste is similar because it's all kitchen scraps (no plate scrapings);
- The facility also accepts food residuals co-mingled with yard waste from a neighboring community's curb side collection program. Those loads are 75% yard waste, 15% packaging, and 10% food waste;
- "Special wastes" include loads of source separated fish wastes--100% food.

Is there a special receiving area for their arrival and/or processing? "Yes. All food residuals are received and processed on an area covered with pressed ground black top (as opposed to paved), separate from yard and other wastes."

How are additional liquids resultant of food residuals managed? "Arriving materials are tipped on the hard surface (described above), where free water is absorbed with shredded yard waste". (The food receiving area is covered with a 12"-20" deep bed of freshly shredded yard waste before receiving residuals.)

Do you find in processing food residuals there are more instances of odors? Pests? If so, how do you manage them?

"Yes, and it is the greatest threat to the success of outdoor windrow composting. Barnes cover the material upon arrival, shreds it immediately (or with several hours), places the material in a windrow and covers with a biofilter of shredded yard waste. After covering the odor is mitigated, but during that processing step odor can be an issue."

General recipe used: "We mix as little bulking as possible--just enough to capture free water. We've found that if we mix too much bulking into a pile that already has 75% cardboard the pile dries out too fast and slows the composting process. We cover the windrows with shredded leaves, as they have additional moisture (and block odors). We've had issues with food waste being over bulked (too much Carbon) and becoming too dry to generate proper temperatures."

Methodology for incorporating food residuals into piles: "Food residuals are processed (as described above), and added to the end of an existing unfinished food residuals windrow in the food residuals area. We do not mix our food residuals windrows with our straight yard waste material."

"Lessons learned" and advice on composting food residuals: "We are learning a lot right now, but this is what I know for sure:"

- "Arriving food residuals should have a hard surfaced/covered area in which to tip. This avoids putrescent water soaking into clay soils and leaving behind odors. This odor issue *will* occur eventually, even when tipping on a bed of shredded material. The hard surface will help to keep odors from migrating off site while mixing and shredding (or whatever preprocessing) is done before the material is windrowed";
- "There needs to be a clear method for collecting water that leaches from windrows and arriving materials--either a drain or path to a collection pond. Free water is an issue with food and there needs to be a process in place to deal with it effectively";
- "Time the turnings, especially if a site is close to residential or commercial properties. Never turn close to or on a holiday weekend in the spring, summer or fall. Observe the wind direction. Be SENSITIVE to the neighbors";
- "The more food waste a facility agrees to manage, the higher technology they need to plan to employ. Large volumes of mixed food residuals will eventually be problematic at an outdoor, windrow composting site that does not have improved surfacing and a closed area to manage putrescent waste";
- "Before incorporating food residuals, visit a site currently processing them";
- "Be tough about only taking clean materials free from contamination";
- "Do not take food without having (at least) an improved surface (on which to receive residuals)";
- "Understand the politics of transportation";
- "Be certain there is enough bulking material (carbon-rich materials) on site and do not over bulk";

Special Note: Barnes Nursery also indicated that in their county they must pay a \$5/ton fee on food residuals diverted from the county landfill, as the county needed to recoup revenues lost resultant of diversion. While the county wants to be supportive of waste reduction efforts, it loses money by doing so. Sharon Barnes noted that in diversion programs it's essential to find a win-win situation for all involved--for the generators, the haulers, the landfill and the composter. Otherwise, diversion programs won't be sustainable over the long run.



Figure 16--Windrows at Barnes Nursery, Inc., above.
Hazel removes contaminants from windrows daily, right.



Contact information: www.barnesnursery.com
(responses provided by Sharon Barnes, Owner)

Appendix F--Contract to Accept Organic Wastes (sample)

This contract, as presented to [residuals generator] ("client"), from [compost company], serves to establish a waste diversion and composting program, the objective of which is to reduce [residuals generator's] monthly weight of trash hauled to landfill by 30%. [Compost company] offers services under the following terms:

1. Definition/Terms: [compost company] agrees to serve as overall program manager, and agrees to [accept/collect] and process *food residuals* (herein referred to as "organics"), received from "your location", for a fee. "Food residuals" shall be defined as fruit/vegetable wastes, baked goods (ie, bagels, muffins, croissants, etc), pasta items, coffee grounds and filters, paper service items (paper plates, cups, napkins), and starch-based utensils and service items. "Food residuals" does NOT include fried foods, fat, or fryer grease, beyond trace amounts of oils found on sandwiches or salads. Food residuals may also contain juices and other liquids, but *must be accommodated separately*. Organics *must* be contained in starch-based trash bags (such as eco-bags), and be free from plastic bags and utensils, wrappings, all non-paper containers, and all other items considered "recyclable". Significant repeat infractions against these terms will result in financial penalties, as delineated below (see Section 2--"Fees; Financial Penalties").

2. Fees: Organics will be hauled, and processed for a two-part fee: The tipping/processing portion, and the collection/hauling portion. [compost company] will receive and process client's organics for the tipping/processing fee of \$x per week, based on one collection per week of no more than x totes per collection (client has elected to purchase their own totes). The fee for collection/hauling is \$x per week, based on x collection(s) per week of no more than x totes per collection.

Both fees will be combined into one invoice and must be paid in full on a monthly basis in response to monthly invoices. Fees not paid within 60 days of invoice will accrue late fees (at a rate of 18% APR), interest (US prime rate, at time of delinquency), and if necessary, legal fees, should collection become necessary. *ALL fees related to past due collections shall be the sole responsibility of client.*

Financial Penalties--Upon excessive infraction against *Section 1--Terms*, client will be given written notice. Any time client accrues (3) written notices within a 9-month period, a financial penalty shall be attached with the 3rd notice. The penalty will be equal to 25% of one month's tipping fees, and must be paid with that month's invoice.

3. State Compliance: Waste shall not include anything specifically prohibited by NH Env-Sw 2305.02(e), including (but not limited to) hazardous waste, non-"organics" mixed solid waste, wastewater treatment byproducts ("sludge" or "biosolids"), septage or grey water, demolition debris, paint, engine fluids, cleaning chemicals or chemicals of ANY sort; *or* any type of recyclable material such as aluminum, plastics, or glass.

4. Exclusivity: In that [compost company] has made a "good faith" investment, supplying consulting services to create an organics recycling program for this store, including (but not limited to) conducting research, orchestrating the program, publicizing the client's efforts and educating client's staff, [compost company] shall have *exclusive rights to perform the organics recycling program for client for a period of no less than one year*, and thereafter, shall be granted a 30-day notice should client decide to switch program providers. Should client decide to end the organics recycling program entirely, they shall provide [compost company] a 30-day written notice of their intent. Failure to uphold this clause will result in a fee of \$500 to reimburse [compost company] for initial consulting services, and will be due payable with final invoice.

Client understands that any breach of sections 1 and 3 ("Terms" and "State Compliance", respectively), is considered an offense against state and federal regulation for waste management facilities. Transgressors will be fined and prosecuted to the fullest extent of the law, and will be held financially responsible for damages caused by transgressions.

As offered by: [compost company]
address,
phone number

To: [residuals generator]
address,
phone number

signature [compost company]

signature [residuals generator]

date

date