RECYCLING YARD TRASH:

Best Management Practices Manual For Florida

by FORA
FLORIDA ORGANICS RECYCLERS ASSOCIATION

In Conjunction with the Florida Center for Solid and Hazardous Waste Management

for the DEPARTMENT OF ENVIRONMENTAL PROTECTION FLORIDA

Recycling Yard Trash: Best Management Practices Manual for Florida

By
Florida Organics Recyclers Association

In conjunction with the
Florida Center for Solid and Hazardous Waste Management

For the
Florida Department of Environmental Protection

May 1996

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Secretary

May 15, 1996

Mr. Mitch Kessler, Chair
Florida Organics Recycling Industry
1015 US 301S
Tampa, Florida 33619

Dear Mr. Kessler:

Embracing Governor Chiles' commitment to reduce regulatory burdens on Florida citizens, the Department decided last year that solid waste permits would no longer be required for yard trash composting facilities provided certain criteria were adhered to. To implement this approach, the Department solicited the help of the Florida Organics Recyclers Association (FORA) to develop a guidance manual establishing best management practices for yard trash recycling facilities. The manual's purposes are to:

1. Offer advice on how to set up new facilities;
2. Help facilities avoid or solve problems; and
3. Distinguish between recycling and disposal.

FORA is commended for accepting this challenge and developing a manual that reflects Florida expertise and conditions. The Center for Solid and Hazardous Waste Management, the organic recycling industry, and the other parties who participated are also to be commended.

The Department appreciates the tremendous efforts and dedication provided by FORA's membership. Your support, dedication and hard work were invaluable. We look forward to working with FORA in the future to promote the production and marketing of organic materials.

Sincerely,

John M. Ruddell

John M. Ruddell, Director
Division of Waste Management

JMR/fj

FLORIDA ORGANICS RECYCLERS ASSOCIATION

BEST MANAGEMENT PRACTICE MANUAL FOR YARD TRASH PROCESSING FACILITIES IN FLORIDA

The Board of the Florida Organics Recyclers Association (FORA) wishes to acknowledge the dedication and commitment of the numerous volunteers who contributed to the production of this manual. The collaborative effort in which this manual was produced is a tribute to individuals who spent countless hours researching and writing this document.

The Board recognizes and is particularly indebted to the efforts of four individuals who served as editors of the manual. Their commitment to complete this project was remarkable. Also, appreciation is extended to their employers who allowed the time needed to complete this project. A sincere thank you to Joan Bradshaw of the Pinellas County Extension Service, University of Florida Institute of Food and Agricultural Sciences; Thomas Lehmann of the City of St. Petersburg Sanitation Department; James Ragsdale, Jr., of the City of St. Petersburg Sanitation Department; and Christopher Snow of the Hillsborough County Solid Waste Department. The Board and the entire organic recycling industry appreciate your efforts in authoring and editing this manual.

The Board would like to thank Bill Hinkley of the Florida Department of Environmental Protection (FDEP), and John D. Schert of the Florida Center for Solid and Hazardous Waste Management (FCSHWM), for their visionary leadership which enabled the project to proceed. The Board would also like to particularly thank Anita Kugler of the FCSHWM and Francine Joyal of the FDEP, for their efforts throughout the project.

We wish to acknowledge and thank the many people who contributed to this manual by attending public workshops and submitting comments. Each of your contributions made the document possible.

The FORA Board of Directors

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FLORIDA ORGANICS RECYCLERS ASSOCIATION

December 1, 1995

Mr. John Ruddell, Director
Division of Waste Management
Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: Acknowledgement of Public-Private Partnership

Dear Mr. Ruddell:

The Florida Organics Recyclers Association (FORA) would like to acknowledge your Department's commitment and leadership in forming a public-private partnership with the yard trash processing industry in Florida. Your leadership role is clearly established through your precedent setting and parallel actions of removing the permitting and monitoring requirements on yard trash processing facilities while providing funding to FORA through the Florida Center for Solid and Hazardous Waste Management to develop a Best Management Practice Manual for Yard Trash Processing Facilities in Florida.

FORA intends to continue to provide assistance to the FDEP in its efforts to expand yard trash recycling opportunities in the State of Florida while ensuring the protection of the environment. FORA looks forward to a long and mutually beneficial public-private partnership with the State of Florida in the area of organics recycling. Again, a sincere thanks to the FDEP for your visionary leadership on this issue

Sincerely,

Florida Organics Recyclers Association

Mitch Kessler
Chair, on behalf of the
Board of Directors

MK/bsp

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Introduction

The Best Management Practices Manual for Yard Trash Management (BMP) is intended to provide industry-generated and peer-reviewed operating recommendations for yard trash processing facilities in Florida. The BMP manual represents the industry's response to the Florida Department of Environmental Protection (FDEP) challenge to operate yard trash processing facilities in an environmentally sensitive manner without permitting requirements.

The recommendations in this manual are not rules, but are intended to be guidelines for establishing industry standards. These guidelines recognize the flexibility required for the many existing facilities and processes that create marketable products without adversely affecting the environment.

Definitions

This manual deals solely with the processing of two types of material, yard trash and clean dry wood. Marketers of yard trash products consider this material as a resource, not as a waste product. Therefore, they prefer to describe the material with more positive terms, such as yard trimmings. However, the term "yard trash" is used throughout this manual to avoid confusion with the language contained in Florida statutes and rules, which define yard trash and clean dry wood as follows:

> "Yard trash" means vegetative matter resulting from landscaping maintenance or land clearing operations and includes materials such as tree and shrub trimmings, grass clippings, palm fronds, trees and tree stumps. [Rule 62-709.200(15), Florida Administrative Code (1989)]

> "Clean dry wood" means wood (including lighter pine), lumber or tree and shrub trunks, branches, and limbs which are free of paint, penthachlorophenol, creosote, tar, asphalt, or other wood preservatives and which when burned do not emit excessive visible emissions. [Rule 62-256.200(5), Florida Administrative Code (1994)]

Scope of this Manual

This BMP manual is intended to provide the parameters for operating a facility in Florida in a safe and environmentally sensitive manner. It is not intended to serve as an all-inclusive technical "how to" guide on establishing and operating a yard trash processing facility. A number of operating manuals are available that provide detailed procedures on producing compost, including <u>Compost Facility Operating Guide</u> (Composting Council, 1994) and <u>On-Farm Composting Handbook</u> (Rynk, 1992).

Although this manual does not include detailed information on source reduction of yard trash at the point of generation, it is important to acknowledge the environmental benefits and cost-savings associated with source reduction. Educational efforts by the Florida Cooperative Extension Service, counties, municipalities, and others have targeted residential, municipal, and commercial generators of yard trash and encouraged backyard composting, leaf mulching, and on-site recycling of grass clippings. An example of the success of those efforts can be found in Pinellas County, which documented the on-site recycling of approximately 40,000 tons of grass clippings in one year. A copy of Pinellas County's methodology for estimating the tonnage of recycled grass clippings is included in Appendix B.

Background

Florida's warm climate provides a nine-month growing season. Heavy applications of water-soluble nitrogen fertilizer and scheduled irrigation practices contribute to the growth of lush landscapes. The abundance of high-maintenance landscapes results in the generation of more than 3.4 million tons per year of residential and commercial landscape yard trash (FDEP, 1996).

Recognizing the large volumes of organic material that were being generated, FDEP took several measures to encourage resource recovery and recycling. In 1989, FDEP established Chapter 62-709, Florida Administrative Code (F.A.C.), to regulate the production and use of compost products. Any yard trash processing facility that did not identify itself as a composting facility was not subject to the permitting and operating requirements of Chapter 62-709, F.A.C. The FDEP regulation dealing with yard trash composting created confusion by exempting from the rule other types of yard trash recycling facilities.

To prolong the life of the state's lined landfills, Florida in 1992 prohibited the disposal of yard trash in lined landfills. This increased the need for alternative methods of collecting and processing yard trash. Source separation of yard trash from the municipal solid waste stream presented a new set of opportunities and challenges for counties and cities across the state. An increasing number of facilities were established to process yard trash in a controlled, accelerated fashion using natural processes of decomposition.

In 1995, based upon several years of operating history, FDEP acknowledged the limited environmental risk posed by the operation of yard trash processing facilities, whether they produce compost, mulch or other products. In the spirit of cooperation with the yard trash processing industry and the acknowledgment of the limited environmental risk associated with yard trash processing facilities, FDEP proposed removing the permitting and monitoring requirements for yard trash composting facilities. However, FDEP will continue its monitoring and enforcement authority for yard trash facilities that operate in a manner that could cause an environmental problem or do not provide for the timely movement of material off-site (Ruddell, 1995). A copy of the May 10, 1995 memo by John M. Ruddell, director of FDEP's Division of Waste Management, is included in Appendix A.

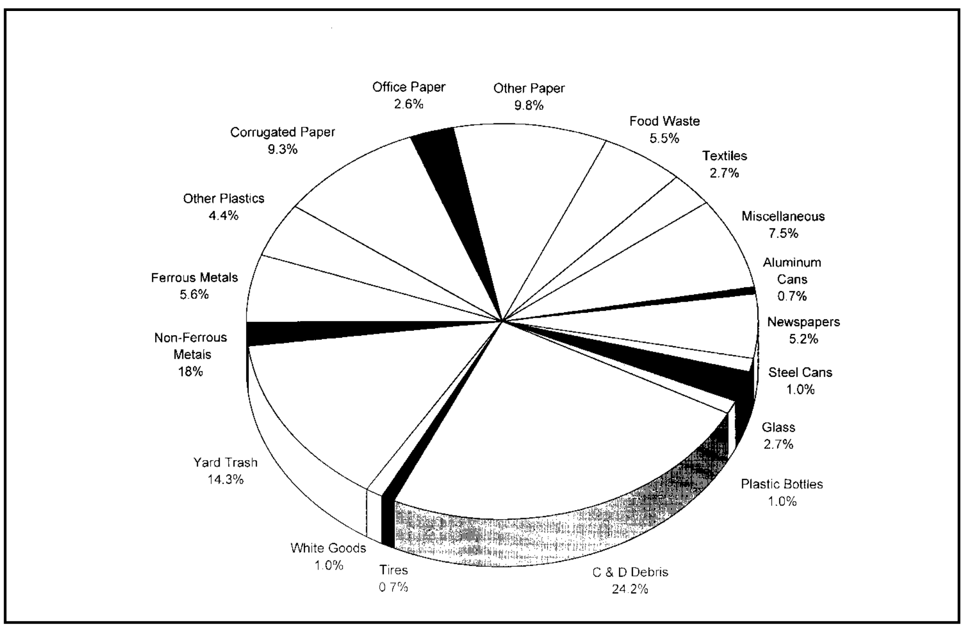
Chapter 1

FLORIDA YARD TRASH COMPOSITION AND CHARACTERISTICS

Florida Municipal Solid Waste Composition

Mild year-round temperatures, lush vegetation, and an abundance of natural resources make the Sunshine State an ideal location for 14 million citizens, with new residents arriving at the rate of about 1,000 per day. In addition, 37 million tourists visit Florida each year. This rapid growth in population has placed pressures on the management and disposal of about 65,000 tons of solid waste generated per day. In 1994-95, Florida's waste stream totaled 24.3 million tons, of which yard trash represented 14.3%, or about 3.4 million tons (figure 1.1) (FDEP, 1996).

Figure 1.1 Florida MSW Composition



Source: Florida Department of Environmental Protection (1996).
Solid Waste Management in Florida.

An important first step in planning and building a yard trash processing facility is to determine the annual volume of yard trash in the local solid waste stream. This information is essential in making the following strategic decisions:

- Site location and size
- Site design
- Selection of processing alternative
- Selection of equipment size and type
- Distance to market

The most common method of determining the tonnage of yard trash available is through the use of a waste composition study that provides the percentage of yard trash in the solid waste stream. Although the statewide average for yard trash in 1994-95 was 14.3%, the percentage varies by county. Table 1.1 shows the extent to which yard trash percentages in county solid waste streams may vary.

Table 1.1 Yard Trash Percentage for Selected Counties

County	Percentage	County	Percentage
Washington	0	Orange	13
Liberty	1	Dade	14
Walton	1	Broward	17
Gilchrist	1	Brevard	19
Jackson	2	Martin	20
Lafayette	3	Putnam	20
Columbia	3	Saint Lucie	21
Madison	3	Pinellas	22
Calhoun	5	Franklin	28
Desoto	7	Monroe	30

Source: Florida Department of Environmental Protection (1995).
Solid Waste Management in Florida.

Another method of determining yard trash volume within the solid waste stream is to study generation-rate data from the source of collection. Factors that affect generation rates include:

- Population density
- Demographics
- Seasonal fluctuations

While composition studies indicate the total amount of yard trash in a community, capture-rate forecasting is necessary to determine how much is likely to be recovered for processing. Yard trash comprises an average of 15-20% of the solid waste stream on an annual basis and may be as high as 50% during the summer growing season. Communities that have segregated curbside collection of yard trash can expect to receive 60-80% of the total yard trash generated. Communities that do not offer curbside collection of segregated yard trash but provide drop-off sites can expect to receive 10-25% of the total yard trash generated.

Florida Yard Trash Composition by Region

While a composition study provides information on the percentage of yard trash in the waste stream, it also is important to study the specific composition of the yard trash component itself. This information will identify the feedstocks available for mixing and blending into the final product. Because of the diversity of the vegetative materials grown in the northern, central, and southern regions of Florida, regional composition studies are recommended. Table 1.2 shows the results of a yard trash composition study of materials received from residential curbside and commercial sources in Pinellas County. The protocol for the Pinellas County study is included in Appendix B.

Table 1.2 Pinellas County Yard Trash Composition Study (% by Weight)

Waste Group Breakdown	Commercial	Mixed Commercial	Residential Curbside Average	Composite
1. Grass	30.0	35.0	51.5	38.8
2. Leaves (see #9)	0.0	0.0	0.0	0.0
3. Tree Cuttings 6'	0.0	2.6	0.0	0.9
4. Logs 10"dia.	0.0	0.7	1.3	0.6
5. Tree Cuttings 4-10"dia.	3.4	3.8	0.9	2.7
6. Tree Cuttings 0-4" dia.	3.8	7.4	5.0	5.4
7. Brush & Shrub	28.4	25.0	32.7	28.7
8. Palm Fronds	20.5	6.2	8.0	11.6
9. Small Veg. Debris	11.4	14.0	0.0	8.5
10. Contamination	2.5	5.3	0.6	2.8
Total	100.0	100.0	100.0	100.0

Source: Pinellas County Department of Solid Waste Management (1991).

Table 1.3 shows the results of a yard trash composition study for materials collected in a drop-off program as utilized in the City of St. Petersburg.

Table 1.3 City of St. Petersburg
Brush Site Yard Trash Composition

Description	Cubic Yard	Weight
Grass Clippings	2%	4%
Tree Cuttings >1inch dia.	9%	28%
Brush <1inch dia.	55%	54%
Palm Fronds	30%	10%
Small Vegetation	3%	3%
Sand & Dirt	1%	1%

Source: City of St. Petersburg Sanitation Department (1991).

Weight and Volume Characteristics

A facility operator needs to know the weight and volume characteristics of different types of yard trash feedstock. The density of various components of yard trash is dependent on the degree of compaction, moisture content, and the bulk density of the material. Table 1.4 shows the most common reported densities.

Table 1.4 Landscape Waste Densities (lbs./cu.yd.)

Material	Loose	Compacted
Leaves	200	400
Grass	400	800
Brush	300	900

Source: Illinois Department of Energy and Natural Resources (1989). Office of Solid Waste and Renewable Resources.

A knowledge of the bulk density ranges is important due to their effect on the operational parameters of production, inventory, and shipping. The weights presented in Table 1.5 are typical weights based on the experience of the City of St. Petersburg.

Table 1.5 Bulk Density in Stages of Processing for Yard Trash Material (lbs./cu.yd.)

Material	Processing Stage	Weight
Mixed compacted yard trash	before grinding	500-550
Loose mixed brush	before grinding	100-250
Mixed yard trash	after grinding	350-400
Mixed logs only	after grinding	425-550
Mulch 60 days old	after windrowing	550-650
Screened compost	after windrowing	800-1000

Source: City of St. Petersburg Sanitation Department (1995).

Note: The densities are affected by particle size from processing equipment, age, processing method, moisture content, and compaction.

Chapter 2

YARD TRASH RECYCLING ALTERNATIVES

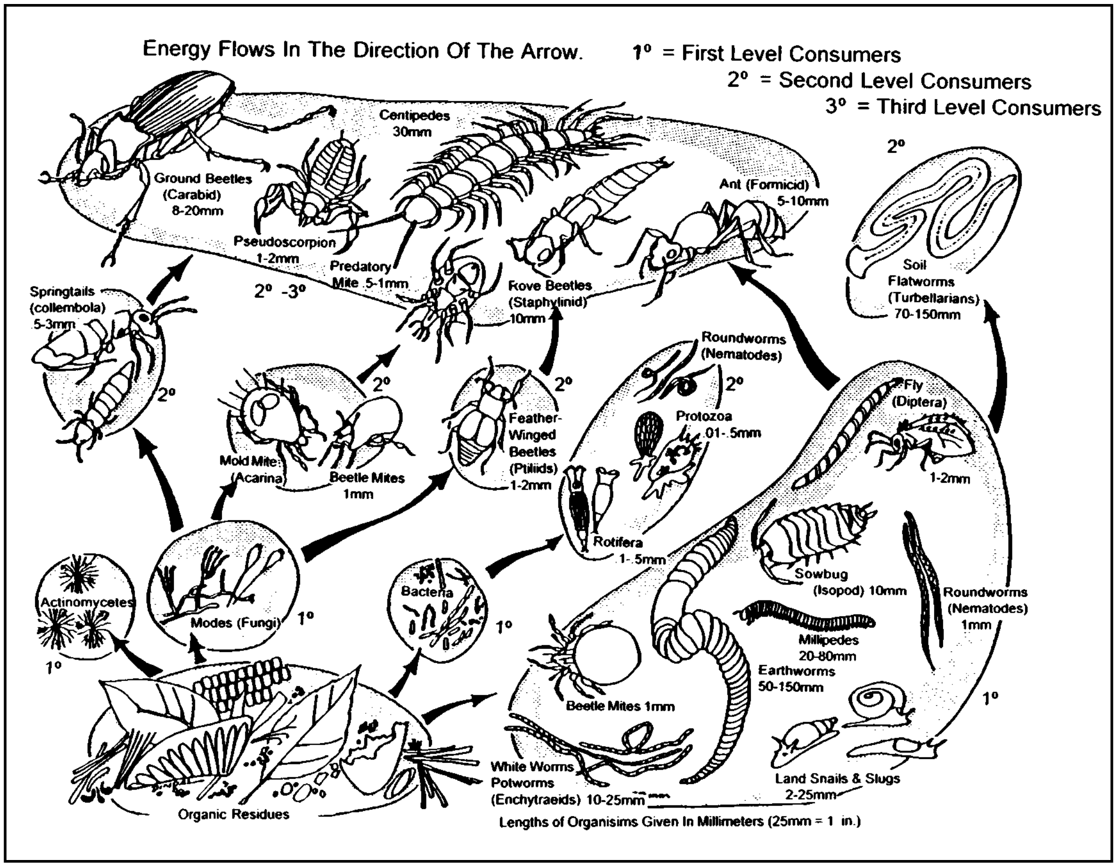
Solid waste management in Florida primarily consists of landfilling, recycling, incineration, and source-reduction activities. Options for yard trash management primarily include composting, mulching, fuel production, direct land application, landfill cover amendment, and source reduction. In 1992-93, approximately 1.3 million tons of yard trash in Florida were recycled, of which 749,350 tons were processed into mulch, 308,000 tons were processed into compost, and 255,245 tons were recycled by construction and demolition debris recyclers and utility companies. (Florida Department of Commerce, (1994).

Composting

From a solid waste management perspective, composting yard trash can greatly reduce the amount of solid waste that requires disposal. Composting can be a cost-effective and environmentally sensitive way to manage a community's yard trash. Quite simply, composting is a biological process in which microorganisms convert organic matter into a soil-like material that has many horticultural benefits.

Controlled decomposition occurs as the result of the activities of macro- and microorganisms. Bacteria, actinomyces, and fungi are the primary microorganisms involved in decomposition. To grow and multiply, microorganisms have four requirements: carbon, an energy source; nitrogen, a protein source; moisture; and oxygen. Enzymes, produced by bacteria, assist in breaking down complex carbohydrates into simpler forms which bacteria can use for food. The nutrients that become available during decomposition remain in the compost within the bodies of the new microorganisms and as humus. Not all decomposition is microbial; macroorganisms assist in the process by digging, chewing, and mixing compostable materials. Examples of macro- organisms include earthworms, grubs, millipedes, spring tails, and centipedes. Figure 2.1 illustrates the food web of a compost pile.

Figure 2.1   Food Web Of The Compost Pile



Source: Dr. Daniel Dindal, cited in Michigan Department of Natural Resources (1989). ***Yard Waste Composting Guide***

The composting process does not stop at a specific point but continues until the remaining nutrients are consumed by the last remaining organisms and until most of the carbon is converted into carbon dioxide and water (Rynk, 1992).

The point at which the active composting processes should be interrupted depends on the ultimate use for the compost and on how soon it will be used (Rynk, 1992). Compost is considered stable when it has reached the requirements of its end use. Common indicators are a respiration rate where the demand for oxygen by the microbes is reduced, compost piles that do not reheat when moisture and oxygen are reintroduced, and a smell that is earthy and not pungent.

Compost has many beneficial uses. Compost improves soil aeration, soil drainage, the water-holding capacity of sandy soils, the percentage of organic materials in soils, and the ability of soils to absorb and hold nutrients.

Mulching

Another method of solid waste management is the recycling of yard trash into mulch. Any material applied to the soil surface for protection or improvement of the area may be considered a mulch. Mulches frequently are applied around plants to modify the soil environment, to enhance plant growth, and for aesthetic value (figure 2.2).

Figure 2.2   Landscape Application Of Mulch

The production of mulch generally requires less time, less land, less quality control, less windrow processing, minimal screening, and lower cost compared to the production of compost. The benefits of using mulch include prevention of water loss from the soil by evaporation, weed suppression, uniformity of soil temperature, improvement of soil structure, and enhancement of landscape appearance.

Fuel Production

Processing yard trash for fuel is similar to composting and mulching. Fuel produced from yard trash, also known as biomass fuel, is a valuable renewable energy resource. One of the most important benefits of fuel production is that it provides a major market for the large volume of yard trash generated in Florida.

Fuel production is a relatively low-cost option that frequently requires only size reduction and distribution. End users may require the material to be screened to remove the fines and contaminants.

Direct Land Application

Direct land application of vegetative matter is a traditional method of recycling farm-generated wastes. For present-day farmers, land application of yard trash can be a method of improving the soil quality of farm land. While yard trash has a low nutrient content, its principal benefit to agriculture is the addition of organic matter to the soil. Direct on-farm recycling of yard trash involves incorporating yard trash into agricultural land as part of an overall agricultural management system to enhance soil chemical and physical properties. Addition of organic matter increases the nutrient and water retention characteristics of the soil. Decomposition of the yard trash is enhanced by tillage and incorporation and by management of soil moisture.

It should be noted that the application of yard trash directly to agricultural land should be done as part of an overall agricultural management plan, and therefore, the approach needs to be compatible with the cropping practices, management goals, and aesthetic sensibilities of the farmer or land manager. Yard trash application rates should be based on predicted decomposition rates, target levels of soil organic matter, size of available equipment, and timing of the cropping sequence. In addition, a well thought-out plan for yard trash application should have provisions for irrigation, weed control, tillage, and incorporation of the yard trash into the soil. It also is important to have a plan for removal of oversized yard trash, plastic, and other contaminants before application. Weed control may be particularly important in areas of Florida where noxious, exotic weeds are a part of the yard trash stream.

Cooperating farmers and other land managers should know that the addition of yard trash to their soil may change it’s fertility. Available nitrogen for plants will be affected by this practice. Release of nitrogen from organic matter applied to soil is controlled primarily by the carbon-to-nitrogen ratio (C:N) of the organic matter and the capacity of the physical environment to support biological activity. Temperature and the moisture content of the soil are the two primary factors influencing the rate of organic decomposition.

A “rule of thumb” is that material with a C:N ratio above 20:1 will immobilize nitrogen, while a C:N ratio at or below 20:1 will allow release of nitrogen to the soil environment. Because yard trash typically has a C:N ratio much higher than 20:1, it will initially immobilize nitrogen. During this period, nitrogen will be used by microorganisms to degrade the yard trash. Organic nitrogen that is mineralized is only sparingly available to plants because the bacteria are better competitors in the carbon-rich environment. However, as organic carbon is converted to CO_2 and lost to the atmosphere, the C:N ratio is reduced and eventually approaches the 20:1 level where nitrogen is “released” to the soil and can be used by crops.

Landfill Cover Amendment

Another important use of yard trash is for landfill cover amendment . The cost benefits of this use include avoiding landfill disposal for yard trash, substitutions of compost for cover dirt, and the avoidance of post-processing costs associated with marketing a compost product.

The use of composted yard trash, co-composted yard trash and sludge, or mixtures of composted yard trash and soil, may be acceptable as daily cover, if it can be demonstrated that the material performs the functions of daily cover. The FDEP position on the use of compost and mulch as daily cover is addressed in FDEP's August 16, 1990, interoffice memorandum, a copy of which is included in Appendix A. The term “daily cover” is defined as “initial cover” in Rule 62-701.200(40), F.A.C. (1994).

To be used as daily cover, materials must suppress vectors and odors, must be an effective fire barrier, and must be stable with regard to stormwater runoff. The determination of whether composted materials are acceptable will be made by the FDEP district offices on a case-by-case basis. Composted yard trash which is found to be acceptable and is used as daily cover can be considered to have been recycled and counts toward the Florida's recycling goal.

Slope Stabilization

One alternative for slope stabilization is blending fresh ground or sanitized yard trash with soil at a 1:1 ratio. When applied on a slope, the mixture stabilizes the slope's cover material to provide erosion control by reducing washout of the cover material. The 50/50 mix slows down the speed of water by diverting it into parallel streams and reduces erosion in areas prone to washout. Figure 2.3 illustrates application of a mulch/soil mix on a slope.

Grass seed can be applied, and when established, will further stabilize the slope surface. A seed-cover layer of 1/4-inch compost or hay is recommended to reduce the loss of seed due to birds and rainfall.

Figure 2.3 Application Of Mulch/Soil Mix On Slope

Wetlands Mitigation

The primary benefits of using compost rather than mined muck for wetlands plantings are its absence of nuisance weed seeds, its high organic content, its ability to retain moisture, and its ability to grow some types of aquatic plants in a shorter time frame.

Aquatic plants will reestablish themselves on wetlands amended with compost after mitigation and restoration work. This increased growth blocks the reestablishment of nuisance plants, and the substitution of compost eliminates the transport of weed seeds, such as cattails, found in mined muck (Heller, 1993).

Muck comes from peat that was once high in organic matter and which has decomposed. The physical and chemical parameters necessary to facilitate vegetative growth when using compost as a substitute for muck are pH, organic content, nitrogen level, and soil particle size.

Firewood

While Florida experiences mild winter months, a demand for firewood exists for use in home fireplaces and wood stoves. In addition to being aesthetically appealing, efficient fireplaces and wood stoves can be low-cost supplements to more expensive heating systems.

In the production of firewood from yard trash, factors that should be considered include moisture content, wood variety, and Btu value. Seasoned wood is considered to have no more than 20-25% moisture and may take from six months to two years to adequately dry (Twitchell, 1980).

Chapter 3

FUNDAMENTALS OF COMPOST PRODUCTION

Composting grass clippings, shrub prunings, leaves, and other green materials has been practiced for centuries. In natural settings, such as under forest canopies, composting occurs as leaf litter decomposes into humus. Humus is the rich, dark brown to black colored remains of the composted plant material and is considered an excellent soil conditioner. In the United States, the importance of humus has all but been ignored as the agricultural industry increasingly has relied upon manufactured fertilizers to improve crop yields. Interest in the production and use of compost is on the upswing because more farmers, homeowners, private companies, and municipalities recognize its benefits to soil and crops, as well as the reduction in landfilled waste.

A thorough understanding of the composting process is necessary to ensure that a facility is operated in an environmentally safe manner and that the end product will be beneficial to the plants and soils to which it is applied. This chapter presents information applicable to a typical compost site. Depending on the type of yard trash and bulking agent available, facility operators should make adjustments to optimize decomposition.

Contamination

One of the most important factors in producing quality compost is the exclusion or removal of undesirable materials prior to composting. Undesirable materials include plastics, metals, glass, paper products, construction wastes with nails, and woody plant materials which have not been reduced in size. The best methods for avoiding contaminants include knowing the source of materials, inspecting materials carefully before processing, and paying attention to composting conditions. Kitchen wastes, manures, biosolids (wastewater residuals) and other organic solid wastes are compostable, but those processes are not within the scope of this manual.

Feedstock Preparation

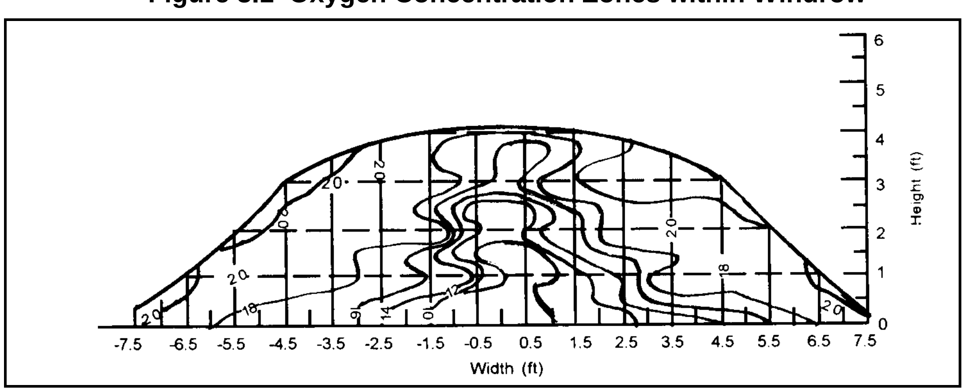
Feedstock preparation is an important first step to ensure that the composting process is optimized. Moisture content, carbon, nitrogen, and micronutrients are the raw materials that will determine the formulation of the mix. In general, a feedstock of organic materials high in carbon, such as brown leaves, ground branches, and twigs, should be mixed with nitrogen-rich materials, such as grass, weeds, and green leafy materials. A mixture ratio of 2 to 3 parts brown material (carbonaceous) to 1 part green material (nitrogen) is ideal. In some locations in Florida, it may be necessary to store high volumes of carbonaceous materials (in windrows) to be added to nitrogen-rich materials during a different season. Facilities without a source of high-nitrogen materials to balance with high-carbon materials must extend the processing time needed to produce a mature and stable compost. The ratio of carbon to nitrogen is an important quality factor and is discussed in more detail later in this chapter.

Many subtropical plants found in Florida have characteristics that differ from the characteristics of temperate plant varieties. For example, live oak leaves, magnolia leaves, and palm fronds grown in Florida are more difficult to degrade than leaves of temperate tree varieties, such as maple, oak, and poplar. The feedstock of northern states' yard trash compost primarily consists of grass and leaves, while Florida composts grass, leaves, palm fronds, pine needles, brushy material, and smaller woody branches. Because of the woody nature of Florida's yard trash and the leathery nature of many leaves, grinding may be required as a pretreatment to composting (Barkdoll, 1991).

Oxygen and Aeration

Successful composting depends on the availability of a sufficient supply of air to the materials in the compost pile. Oxygen is essential for microbial activities and for adequate decomposition to take place. While composting with adequate aeration proceeds more rapidly, decomposition of plant materials can proceed, but more slowly, anaerobically, (without oxygen). Composting with adequate aeration generates higher temperatures (113-158°F, compared with 59-131°F for anaerobic composting), less methane, and more carbon dioxide than anaerobic composting (Wiles, 1978). Anaerobic composting is desirable in specialized operations, such as methane generation for energy, but composting with adequate air generally produces a higher quality compost for agricultural use. Composting without adequate aeration may result in the production of objectionable odors. Figure 3.1 illustrates different oxygen concentration zones within a windrow.

Figure 3.1 Oxygen Concentration Zones within Windrow



Source: Diaz, L.F., et al. (1993). Reprinted with permission from *Composting and Recycling Municipal Solid Waste.*

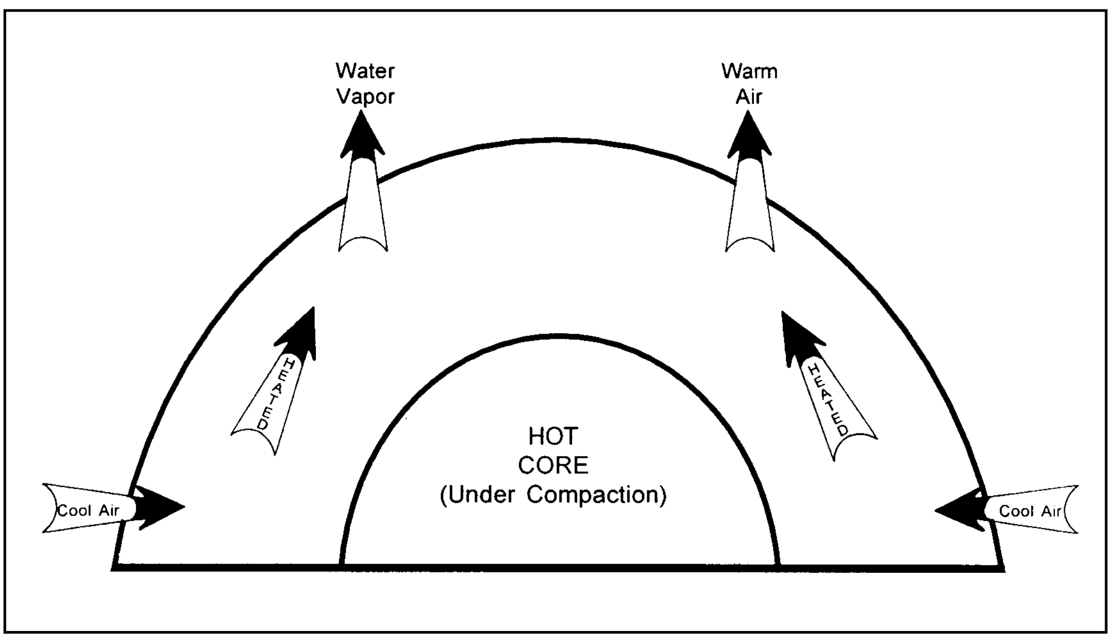
The height and age of the compost windrows may affect the rate of decomposition. Windrow height can contribute to compression, resulting in anaerobic conditions. Oxygen may be introduced into the composting process by turning the pile with a window turner or front-end loader. Other methods of introducing oxygen into a windrow include forced-air static piles, in-vessel, and tunnel; however, facilities that process only yard trash generally do not use these methods. Oxygen meters can be used to determine when piles should be turned. Other indications that oxygen levels are low and the windrow should be turned include odors, the collapse of the windrow, and the lack of vapor at the top of the pile. Piles should be turned when oxygen levels drop to 5-10%.

Particle Size and Surface Area

Particle size is critical to the size and structure of the windrow because of its effect on pile aeration (Golueke, 1978; Poincelot, 1978). Large, brushy yard trash should be reduced in volume for uniformity of size and to obtain a particle size that will promote air flow in the composting pile. The ground material provides a greater surface area for the microorganisms (e.g., fungi, bacteria, and actinomyces) which will promote decomposition.

The pile should be constructed with a variety of particle structures that permits the chimney effect to occur within the pile. The chimney effect allows cool air to be drawn into the bottom of the pile and heated air to be vented through the top, providing the necessary oxygen for microbial activity. In a properly constructed pile, this venting is apparent when the area along the ridge of the pile is giving off visible vapors. Figure 3.2 illustrates the chimney effect in a pile.

Figure 3.2 Chimney Effect In Windrow



Source: City of St. Petersburg Sanitation Department, 1995.

Maintaining a balance between larger and smaller particles is essential. Too many fine particles will close off air channels and reduce oxygen levels. Too many large particles will allow overaeration and cooling of the pile. Overaeration will reduce moisture content through evaporation.

Moisture Content

Moisture to support microbial activity is required for optimum decomposition to occur. Water provides the medium for the chemical reactions and nutrient transport. If the moisture level is too low, decomposition slows down. However, a moisture level that is too high causes anaerobic conditions and odors. An optimum range for moisture content is 40-65% depending on the particle size and structure.

A quick (but subjective) field test for moisture content is the “squeeze test.” This test involves taking a handful of organic material and squeezing it. If organic matter clumps in a ball and water does not freely drain out, a proper moisture content has been achieved. If water is released, the material is too wet. If it does not feel moist, it may be too dry for composting. Other methods of determining moisture content include the use of a potentiometer that measures current flow and the oven moisture drive-off test. These tests are more time consuming but provide a higher degree of quality control. With time and experience, facility operators will be able to determine the correct moisture levels.

Factors affecting moisture content include ambient conditions and type of material. The moisture content of materials coming into the site will vary. Leaves gathered during the rainy season and wood chips obtained from fresh material will arrive at the site with a higher moisture content than leaves collected after a dry period or wood chips obtained from old or dried brush. Grass and green leaves will contain moisture within plant cells and the moisture will be released slowly as the material decomposes.

If the material is dry and brown and the temperature of the material is low, the moisture content is probably insufficient. It is recommended that moisture be added as necessary to maintain the optimum moisture level in the piles. This can be accomplished by using soaker hoses, fire hoses or sprinkler systems.

Carbon/Nitrogen Ratio

The ratio of carbon to nitrogen (C:N ratio) in compost piles has been used as an indicator of compost maturity, compost quality, and suitability for application to agricultural fields. Microorganisms use carbon for energy and growth, while nitrogen is essential for protein and reproduction (Rynk, 1992). Excessive or insufficient carbon or nitrogen will affect the composting process.

The optimum range of the C:N ratio is from 20:1 to 30:1. The more the C : N ratio deviates from this range, the slower the decomposition process becomes. With a ratio of greater than 40:1, nitrogen represents a limiting factor and the reaction rate slows (Massachusetts DEP, 1989).

Woody materials often have C:N ratios as high as 600:1. Nitrogen-rich materials such as grass clippings may be mixed with these high-carbon materials to accelerate rates of composting. It is the growth and death of the microorganisms that lowers the C:N ratio in composting materials. The C:N ratio is no longer considered the ultimate “rule-of-thumb” in compost maturity or acceptability for agricultural use.

Analyses for C:N ratios are considered variable, notoriously inaccurate, misleading, and often contain gross generalizations. Better indicators of compost maturity and stability are being developed at various universities, consulting laboratories, and the U.S. Department of Agriculture. Anticipated advances in this field will help compost producers to determine reliable production parameters more easily.

Temperature

The act of composting attempts to control the natural biological process of decomposition by creating an environment with accelerated microbial activity that breaks down organic waste and converts it into a humus material. Heat, carbon dioxide, water vapor, and compost are by-products of this process. The amount of heat generated by microbes increases with the amount of available nutrients. Also contributing to pile temperature is the self-insulating nature of the compost pile that accumulates and holds heat as the material ages and its bulk density increases. When measuring temperatures, the optimum efficiency range for decomposition is between 104 -122°F. The target temperature is 113°F (Composting Council, 1994). As temperatures rise above 140°F, microbial activity diminishes; at 158°F, significant activity stops. Turning the compost pile will cool the pile.

Measuring the temperature provides a facility operator with an indication of what is occurring within the pile. Of primary concern is maintaining a temperature high enough for a long enough time to kill pathogens, neutralize vectors (flies), and to render weed seeds non-viable. The target temperature should be a minimum of 131° F for three days (Michigan DNR, 1989). The effectiveness of destruction will depend on the area of the pile that is exposed to high temperatures. The piles should be turned to eliminate the potential for hot and cold spots. This will give the best distribution of heat and oxygen and will help produce a higher quality compost in the shortest possible time. Figure 3.3 (on page 18) presents some of the possible causes of low and high temperatures and possible corrective actions. It may be necessary to use a combination of corrective actions to properly manage pile temperatures.

Figure 3.3 Corrective Actions for Low and High Pile Temperatures

LOW PILE TEMPERATURE (BELOW 90°F)

POSSIBLE CAUSES	POSSIBLE ACTION
* Low oxygen	* Turn pile
* Low moisture	* Add moisture
* Low nitrogen	* Add nitrogen
* Low pile	* Increase pile height
* Composting completed	

HIGH PILE TEMPERATURE (ABOVE 150°F)

POSSIBLE CAUSES	POSSIBLE ACTION
* Low oxygen (insulation)	* Turn pile
* High nitrogen	* Add carbon
* High pile (compaction)	* Lower pile

Source: Environmental Hazards Management Institute, (1994).

pH

The pH of compost can vary widely depending on feedstocks, contaminants, and the maturity of the compost. Likewise, the desired pH will vary with the intended use of the compost. Therefore, facility operators should monitor the pH of their compost and make this information available to their customers.

Pathogens

Conditions that occur during the active phase of properly managed yard trash composting operations generally provide a reasonable assurance that weed seeds and plant pathogens will not present an environmental problem in the finished products. Heat is the most recognized method for controlling weed seeds and pathogens. A regimen of temperature control and monitoring in conjunction with frequent turning to maximize exposure of the yard trash materials to elevated temperatures can ensure a sanitized finished product. As a general rule, attainment and maintenance of temperatures higher than 131°F over a three-day period should eliminate most pathogens and seeds.

Compost Stability

The stability level of compost is an important consideration for the end use of the product. Stabilization refers to the oxidation of organic matter to the extent that the remaining organic matter is very resistant to microbial attack; this material is commonly called humus (Haug, 1993). However, the level of stability needed is variable depending on the use to which the compost will be applied.

Testing for the level of stability is an evolving science, and with a range of tests currently are being used. The most widely used tests include plant bioassays, reduction of organic matter, C:N ratio, oxidation, and reheat potential. However, current testing methods have significant drawbacks. Many universities and the scientific community continue to search for reliable methods of testing that can be easily and inexpensively accomplished under field conditions.
Two texts that provide thorough descriptions of the various testing methods are Science and Engineering of Composting (Hoitink and Keener, 1993) and The Practical Handbook of Compost Engineering (Haug, 1993).

Chapter 4

FUNDAMENTALS OF MULCH PRODUCTION

One of the most common alternatives for yard trash recycling in Florida is mulch production. Webster's dictionary defines mulch as "a protective covering spread or left on the ground especially to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds, or enrich the soil."

Florida's tropical landscapes provide a woody brushy feedstock. After volume reduction, brush maintains its structure as a useful and recognizable mulch. Mulch is relatively easy and cost effective to manufacture and the process has been adapted by a variety of communities in the state.

Types of Mulch

There are typically three types of mulches made from yard trash: fresh mulch made from heterogeneous ground yard trash, sanitized mulch made from fresh mulch that has been windrowed and allowed to heat up, and log mulch made from logs and large branches.

Characteristics

The characteristics of mulch as an end product will depend upon the preference of the end user. Table 4.1 presents general parameters for mulch products in Florida.

Table 4.1 General Parameters for Mulch Products in Florida

Color	Golden brown to dark brown	
Size	1/2 inch to 4 inches	
pH	6.0 to 8.0	
Odor	Little or no odor	
Moisture	25-45%	
Structure	Loose and fairly course	
Foreign Matter	Less than 1% by weight	
Weight	Fresh ground mulch:	350 to 400 lbs./cu. yd.
	Windrowed mulch:	450 to 650 lbs./cu. yd.
	Log mulch:	425 to 550 lbs./cu. yd.
	(Note: Density, moisture content and age affect the weight.)	

Source: City of St. Petersburg Department of Sanitation (1995).

Fresh Mulch

Fresh mulch is made from freshly ground yard trash. This product has little or no decomposition, and may contain seeds, plant pathogens, plant propagules, and insects. Fresh mulch is suitable for uses in which these limiting parameters are not a concern, such as for erosion control at landfills, landfill cover, bulking agents for sludge composting, projects that encourage phytotoxicity, and other low-risk mulching projects.

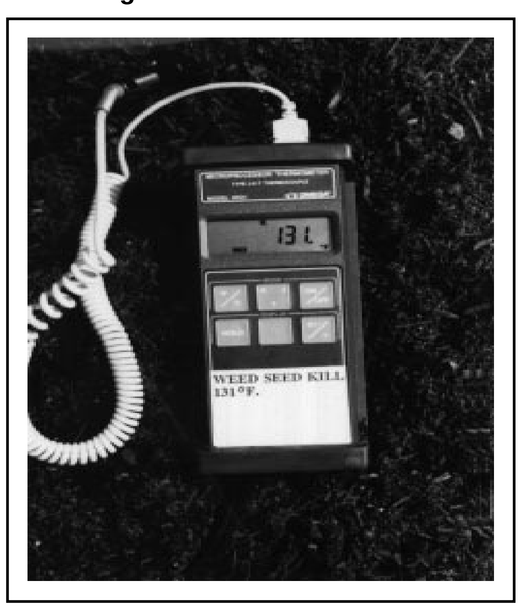
Sanitized Mulch

Operators of yard trash processing facilities in Florida have found that fresh mulch is difficult to market because of its potential contamination by seeds, plant pathogens, plant propagules, and insects. Sanitizing the fresh mulch improves its acceptability and marketability.

Sanitized mulch is a product made from freshly ground yard trash that has gone through the windrow process long enough to attain the heat necessary to destroy the unwanted characteristics of fresh mulch. Because Florida is home to many exotic and invasive plants, care must be taken to avoid distributing the seeds or viable vegetative parts of these plants with compost or mulch. A list of Florida's most invasive species of exotic plants is included in Appendix B.

Studies by Shiralipour and McConnell (1991) indicate that high temperatures and phytotoxins produced during the composting period have an inhibitive effect on the germination of weed seeds. Even the most heat resistant weed seeds failed to germinate after they were exposed to 131°F for 48 hours (Shiralipour and McConnell, 1991). The higher temperatures also are desirable because they destroy more pathogens, diseases, weed seeds, and insect larvae. Figure 4.1 shows a temperature reading on a digital thermometer with a 3-foot probe extended into the pile.

Figure 4.1 Thermometer In Pile



The windrowing of mulch creates an environment that promotes microbial activity which produces heat in the piles. The main difference between composting and windrow mulching is that in mulching, decomposition is not the goal. The goal is to increase microbial activity, thereby raising temperatures to the point necessary to destroy the undesirable characteristics of fresh mulch. Once these temperatures are reached, the piles should be turned. In composting, microbial activity is encouraged to reach the optimum state of decomposition, then turning is required.

The shape of the windrows gives the microbes needed air flow and insulates to contain temperatures. Windrow size can vary depending on the type and density of the ground material, its moisture content, aeration, and ambient temperature. Temperatures can be controlled by pile size. Piles containing a higher nitrogen content can reach acceptable sanitizing temperatures at a lower pile height than piles with a lower nitrogen content. When nitrogen content is high, windrows will typically reach acceptable temperatures at a height of 4-8 feet. When nitrogen is lower, the height of mulch windrows typically ranges from 8-12 feet. Figure 4.2 shows a mulch windrow that is higher due to the low nitrogen content of the yard trash material.

Figure 4.2 Mulch Windrow

As microbial activity proceeds, the temperature inside the pile increases. After temperatures reach 131°F for three days, the pile should be turned to expose the exterior of the pile to the high internal temperatures. This procedure of reaching and maintaining a minimum temperature of 131°F for three days should occur at least three times to expose the windrowed material to the target temperatures. If pile temperatures begin to drop due to reduced moisture content, moisture should be added during the turns.

Log Mulch

Log mulch is made from grinding whole logs, limbs, and branches 5 inches or larger and does not include palm trees or stumps. The addition of palm logs and stumps diminishes the aesthetic value of log mulch. To ensure that log mulch remains clean and free of contaminants, the log material should be separated from other incoming brush material and should be kept free of debris, leaves, dirt, and palm tree logs. Log mulch has a brighter brown color and maintains its original appearance longer than other yard trash mulches. Log mulch can be compared to commercially produced landscape mulches, such as cypress and eucalyptus. Figure 4.3 illustrates the production of mulch from logs.

Figure 4.3 Production of Mulch from Logs

Cautionary Note about Applying Mulch to Plants

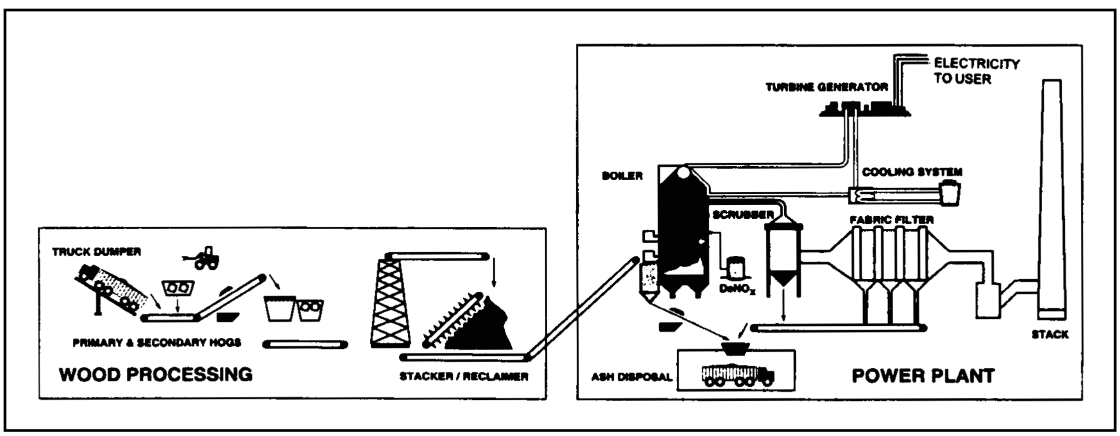
The production of mulch from yard trash is a viable recycling alternative, but a word of caution is offered. If recycled wood chips are applied around plants soon after processing, they may cause damage by “suffocating” plants and “starving” them of soil nitrogen. The problem is due to an imbalance in the C:N ratio in demolition ground wood and recycled tree and shrub waste. The solution is to reduce the C:N ratio to 60:1 or less, which can be accomplished through microorganism activity. When this method is applied correctly, a “mantle of ‘punky’ dark brown wood will surround the lighter, more solid tissue in the center of the wood chips. Although the chips are not thoroughly composted, the outer mantle of decaying wood fiber will retard the competition for soil nitrogen when the material is used as a mulch” (Gouin, 1992, p. 99).

Chapter 5

FUNDAMENTALS OF FUEL PRODUCTION

Biomass fuel is vegetative waste that is used as a source of fuel. Yard trash and other clean woody wastes can be processed to a uniform size and burned as boiler fuel to recover energy. To ensure the acceptability and marketability of biomass fuel, basic management practices should be followed. Figure 5.1 illustrates the material flow through a facility that utilizes yard trash as fuel.

Figure 5.1 Fuel Facility Flow Chart



Source: Ridge Generating Station (1995).

Wood fuel is purchased on the basis of available heat content, or Btu value. The two things that most affect Btu value are the moisture content and the amount of soil or other non-combustibles in the vegetative material. Therefore, yard trash should be stored in a manner that allows the materials to dry and minimizes contamination.

All biomass fuel markets provide written specifications for material to be purchased. Although they vary among fuel users, the basic specifications usually include the following provisions.

Material Description

Almost any type of vegetative material can be considered for fuel including yard trash, scrap wood from construction and demolition, commercial tree trimmings, land-clearing debris, pallets, etc. Research on the combustion characteristics of yard trash has suggested, however, that if large quantities of grass clippings and other fine trimmings are included in the material, screening may be required.

The material should contain a significant proportion of woody material, such as larger diameter trees or construction wood. Fuel users have found that fuel consisting solely of unscreened curbside-collected residential yard trash is not as desirable because of its chemical content and ash composition.

Particle Size

Generally, 95% of the material should pass through a screen with 3 inch round holes, and no pieces should be larger than 6-8 inches in any direction. The amount of smaller material less than 1/4 inch (often referred to as the "fines") should be limited for efficient combustion.

Most fuel markets prefer that the fines content be limited to less than 5-10% by weight. For yard trash, this is a difficult specification. Care should be taken in the grinding process or the fines may need to be removed by screening before shipping.

Product Storage

Prolonged product storage is not recommended, especially if the material contains a high percentage of green vegetative waste. If the material continues to decompose, it may be necessary to rescreen the material before shipment. Ideally the material should be shipped within five to 30 days after size reduction.

Non-wood Contamination

Materials such as plastic, metal, dirt, concrete, etc., should be limited to less than 1-5% by weight, depending on specifications. Removal of plastic bags may be required. Metal should be removed not only because of the fuel specifications, but also for operational safety and decreased maintenance costs.

Moisture Content

Specifications generally require a moisture content of less than 50%. At higher moisture levels, the combustion process becomes very inefficient, and emissions become difficult to control. Through the use of effective management practices, operators of yard trash facilities should try to achieve a moisture content as low as 25-35%.

Ash Content

Ash is what will not combust when the material is burned. The ash content is directly related to the amount of soil in the incoming material. If the material has been properly processed, the ash content will range from 8-12%. Yard trash collected through curbside programs generally contains 8% ash in the form of soil picked up with clippings. Clean wood waste can have an ash content as low as 1.5%.

Btu Value

Btu is the measurement of energy available in the material that is being combusted. The Btu measurement indicates the fuel value. Btu values for yard trash typically vary from 3000 to 4500 Btu per pound after subtracting the heat loss associated with the evaporation of moisture. The Btu value will vary depending on the type of yard trash and the amount of non-combustibles in the materials.

Chapter 6

FACILITY SITING AND DESIGN

Facility siting and design are the keys to operating a yard trash processing facility that will have a minimal impact upon the surrounding community and the environment. Proper siting and design will minimize the costs of operation and the potential for complaints from neighbors or the regulatory community. This chapter describes several important siting and design considerations for yard trash processing facilities.

Location

The ideal location would be as close as possible to yard trash generators to reduce collection costs (which can be the single highest cost of a segregated yard trash program). The facility should also be as close as possible to end-user markets.

Due to increased traffic, outside storage, use of heavy equipment, and the nature of the feedstock, a facility should be located close to other agricultural, public utility, or industrial uses. A facility near a residential area should provide a greater degree of operational controls to prevent traffic, dust, odor, or noise problems. The location should conform to applicable zoning and comprehensive plan designations. The developer of a facility should meet with adjacent property owners, community groups, and applicable regulatory agencies early in the planning and siting process.

Permitting Requirements

Most states, especially those in the central and western United States, do not have specific permitting or siting requirements for facilities that process yard trash. Two states, Delaware and Michigan, have expressly exempted yard trash processing facilities from permitting or siting requirements. Pennsylvania has yard trash composting guidelines that exempt facilities from permitting if they are complying with the guidelines.

In Florida, developers of a yard trash processing facility should consult with their local, regional, and state regulatory agencies to determine their development requirements. The facility may fall under the jurisdiction of local zoning and building requirements, local environmental agencies, regional water management districts, and the FDEP.

Local Zoning and Building Requirements

City and county zoning and building codes regulate specific land uses. Requests for zoning or special use permits may be required before a developer can proceed with the site plan approval and building permit process.

Local Environmental Agencies

Some counties and cities have environmental review agencies that perform a function similar to that of FDEP. Local environmental agencies may need to review and approve applications and site plans.

Water Management Districts

The management and storage of surface water is regulated by either the water management district or the FDEP district depending on facility location. Permit requirements address three areas of surface water manage ment: (1) water quantity/quality; (2) 100-year floodplain; and (3) environmental considerations. Consult both the regional water management district and the Regional FDEP district office early in the approval process.

Florida Department of Environmental Protection

FDEP regulates yard trash composting facilities under Chapter 62-709, Florida Administrative Code (F.A.C.). An FDEP memorandum dated May 10, 1995 removed the permitting requirements (Ruddell, 1995). FDEP still maintains the enforcement provisions of Chapter 62-709, F.A.C., for yard trash composting facilities. The processing of yard trash into other usable materials such as mulch is not considered composting and is not regulated pursuant to Rule 62-709.300(10), F.A.C.

Setbacks

When designing a site, local zoning and environmental agencies should be consulted concerning setback and buffer requirements. Current Federal Aviation Administration guidelines prohibit siting any type of solid waste facility, including composting facilities, within 10,000 feet (almost 2 miles) of an airport (EPA, 1994). Yard trash composting facilities must comply with FDEP's siting requirements for solid waste facilities specified in Chapter 62-701, F.A.C.

Based on industry experience during the past five years, there have been no adverse environmental impacts from yard trash processing facilities with respect to the setbacks requirements.

These setbacks are specified in Chapter 62-701, F.A.C., and are adopted by reference in Chapter 62-709, F.A.C. FDEP will discuss modifying setback applications to all, some or none of the solid waste composting facilities.

Buffers

Yard trash processing facilities should have buffers or setbacks to properly control fugitive dust, and odors. Types of buffers include distance, vegetation (trees), bodies of water, and structures (berms). Visual screens should be considered at facilities in urban or suburban settings. Protecting the aesthetic integrity of the neighborhood will help to reduce opposition to a yard trash facility.

The buffers needed will depend on the location, the materials received, and site management. Following the operational recommendations in Chapter 7 of this manual can reduce the distance needed for buffers.

During the site design, the direction of the prevailing wind should be noted and the buffer zone extended in that direction. This will help to minimize the transport of odors and bioaerosols downwind of the facility (EPA, 1994).

Entrance and Exit Requirements

The facility should be easily accessible from major transportation routes. Travel through a residential neighborhood should be avoided. Entrance and exit roads should not create any major pedestrian or vehicular conflicts. The approach to the entrance and exit should be from a road with adequate capacity and turning capabilities.

Road design should support any anticipated high traffic volume or heavy vehicles. A traffic study may be performed to determine anticipated traffic volume.

The entrance road should be designed to avoid delay and back-up of vehicles entering the site. This can be accomplished by designing a circular traffic flow, along with adequate turning and dumping areas. The entrance and internal road network should provide access for fire trucks and other emergency vehicles. The facility should have direct access to hard surface roads. The preferred access road should be one that is able to be used during wet weather, especially in the rainy season.

Storm Water Control

Florida’s extended rainy season requires that a site design provide for proper stormwater management. Extended ponding of direct rainfall and runoff in the staging, processing, storage and screening areas is not recommended. These conditions not only impede production, but also increase the on-site sediment burden delivered to stormwater treatment facilities. Continuous saturation of windrows or curing and finished product piles can result in nuisance conditions in the form of strong odor. Runoff from adjacent lands should be diverted around or away from processing and storage areas to avoid the introduction of undesirable materials into end products.

Similar to any other new development activity a yard trash processing facility is required to provide adequate stormwater treatment and attenuation prior to off-site discharge. Swales and swale blocks in combination with retention and/or detention systems can be used to provide adequate runoff control at most facilities. Design considerations for stormwater control include percolation rate, slope, percent impervious cover, rainfall characteristics and local or regional stormwater quality treatment and allowable peak discharge limits. In addition, the hydrologic characteristics of off-site areas can influence the capacity to prevent run-on from impacting the facility.

Percolation

The site should be located on moderately to well-drained soil. If there is no hard surface, the soil should be permeable enough to ensure that excess water is absorbed during heavy precipitation and that the upper layers of soil do not become waterlogged, resulting in ponding and limiting vehiclar access (EPA, 1994). However, excessively drained sandy soils and karst areas should be avoided.

Slope

The surface should be graded to avoid standing pools of water. The ideal slope for Florida is a 2-3% grade with a 1% minimum. It is recommended that windrows be parallel to the direction of the slope to direct runoff and avoid ponding. However, as an alternative, windrows could be at an angle to the direction of the slope such that the effective slope along each windrow is effectively reduced.

Retention or Detention Areas

Runoff from impervious surfaces should be directed to adequate retention or detention areas to control the off-site release of storm water. Storm water runoff from the delivery area should not flow into storage/curing or processing areas, which could reintroduce pathogens, insects, and weed seeds. Swales and berms are the most common methods of detaining and retaining water.

Land Area Requirements

The most important factors in determining the amount of land needed for a yard trash processing facility are the type and quantity of products to be produced. Other factors include:

- Level of processing technology, (height of windrows, space between rows, and rate of volume reduction)
- Rules for setbacks, storm water control, and land use
- Storage time before grinding
- Market demand for products
- Buffers
- Internal traffic circulation

Projections for Site Capacity and Layout for Composting and Mulching Facilities

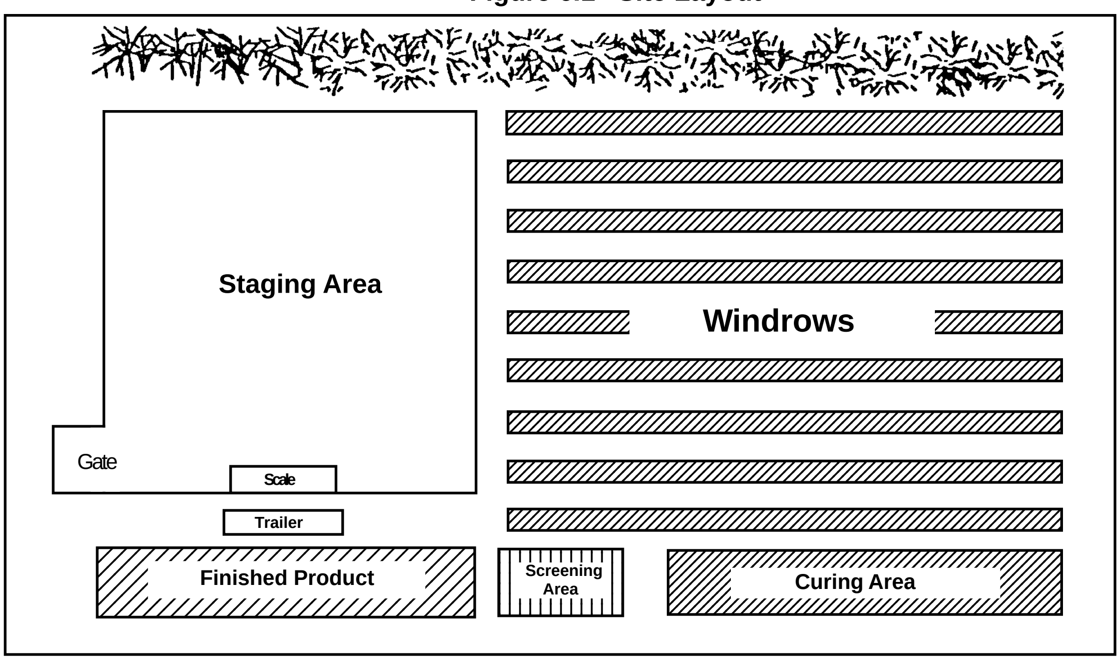
The land area of a composting or mulching facility must be large enough to handle present and projected volumes. Ideally, a facility should have enough acreage to accommodate an entire year's projected volume of incoming feedstock (Richard, et al., 1990). Based on an informal national survey, processing site capacities range from 1,500 to 3,000 tons per year per acre (Schroeder, cited in Hoitink and Keener, 1993). One of the most useful and practical guidelines on calculating the land area requirements for a compost facility is found in the On-Farm Composting Handbook (Rynk, 1992).

When designing a mulching or composting facility and assigning land area to the three operational phases of staging, processing, and storage, the plan should consider the relationship between volume-reduction and material-handling equipment. One survey of eight yard trash composting facilities across the United States showed volume reductions ranging from 50-80% (EPA, 1989). One formula used in mulch production to assign land space to the areas needed for operations uses the following percentages (Lehman, 1995):

- 25% for the staging area
- 50% for the processing (sanitizing) area and
- 25% for the storage and screening area

Figure 6.1 shows an example of typical site layout.

Figure 6.1 Site Layout



Source: Michigan Dept. of Natural Resources (1989). *Yard Waste Composting Guide.*

Staging Area

The staging area is dedicated to receiving, weighing, unloading, inspecting, debagging, mixing, and grinding yard trash. The size of the staging area is related to the volume received and the period of storage before grinding.

Tub grinding equipment produces the largest reduction in volume by a ratio of 3 to 1. Grinding will reduce 100 cubic yards of incoming brush and shrubbery by 66%, rendering it to 34 cubic yards. As indicated in the site layout (figure 6.1), the staging area should be less than half as large as the composting pad in the processing area. At 25% of the total area, this will allow for stacking, drying, and the initial start-up of the decomposition process.

Processing Area

Windrow construction and turning occur in the processing area. Windrows should parallel the slope to allow water to run off between the piles rather than through them and to minimize ponding between piles. Factors that determine the size of the processing area include:

- Level of technology
- Volume of material received
- Character of feedstock
- Pile height
- Products to be produced and marketed

The windrow area is half of the total site area but is enough when the compaction factor is taken into consideration. Windrows of 10 feet will compact up to 20%, allowing the site to accept more volume. Volume reduction in this phase ranges from 15 to 30% over a three- to six-month period. The processing area should be close to the staging area with rows perpendicular to the staging area to reduce transfer distance.

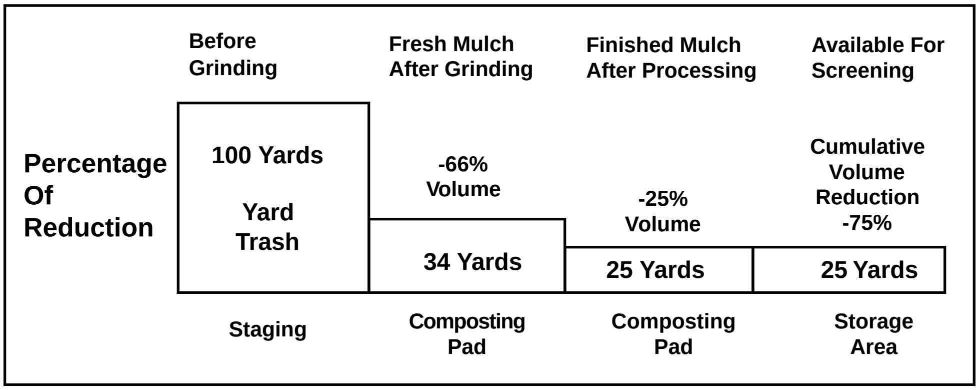
Storage and Curing Area

Activities in the storage and curing area include post-process screening, stockpiling finished product, and loading for shipment. The size of this area is determined by:

- Storage pile height, size, and volume
- Estimated length of time between seasonal market demand. Allow approximately six months' capacity, based on the time between the two peak seasons, spring and fall.

The storage area should be assigned 25% of the total site. As a result of a 75% volume reduction caused by the composting process, less land is required to store large quantities of finished product. Figure 6.2 illustrates the reduction of material as it undergoes processing.

Figure 6.2 Volume Reduction During Processing Phases



Source: City of St. Petersburg Sanitation Department, (1995).

Internal Traffic Circulation

Internal traffic circulation is an important consideration in laying out a site and determining land area requirements. Adequate access to the staging, processing, and storage areas must be provided for the equipment utilized on-site as well as for the flow of the traffic from customers delivering yard trash materials or picking up finished products. Local fire officials should be consulted concerning the layout of the site, internal circulation, and separation between piles to ensure that fire codes and proper fire-fighting procedures are followed. The staging area should be designed to facilitate quick and easy drop-off of yard trash. Circular traffic patterns are suggested where feasible.

Site Surface and Sub-Surface

Paved or hard-surface areas are ideal for staging, processing, and storage areas due to the amount of rainfall in Florida. However, a firm surface with moderately- to well-drained soils may be satisfactory. Where soil conditions are not acceptable, a pad constructed of 6 inches of compacted and graded sand, gravel, or shell works well (Rynk, 1992).

However, a paved surface is recommended for several reasons:

- It improves productivity and operational efficiency during the rainy season.
- The repetitive motion of heavy equipment when operating on organic material and soil produce an uneven work surface, ruts, and ponding.
- Surface soils can mix with yard trash, introducing undesirable materials into the end products.
- Less dust.

The minimum separation distance commonly recommended between surface soils and the water table is 2-5, feet based on the seasonal high-level ranges of the water table. A soil investigation should be conducted by a soil scientist, possibly through the assistance of the Soil Conservation Service (Rynk, et al., 1992).

Utilities

Yard trash processing facilities need access to utilities including water, wastewater, telephone and electricity. The addition of water is necessary to maintain the proper moisture levels for mulch and compost production. Options include potable water, reclaimed water, retention pond or lake water, and rain water. Water that will be used in processing should be tested to ensure that it will not affect the quality of the final product. Water also is needed for fire safety.

Security

Yard trash processing facilities should have adequate security to limit the access of vandals or illegal dumpers.

Signage

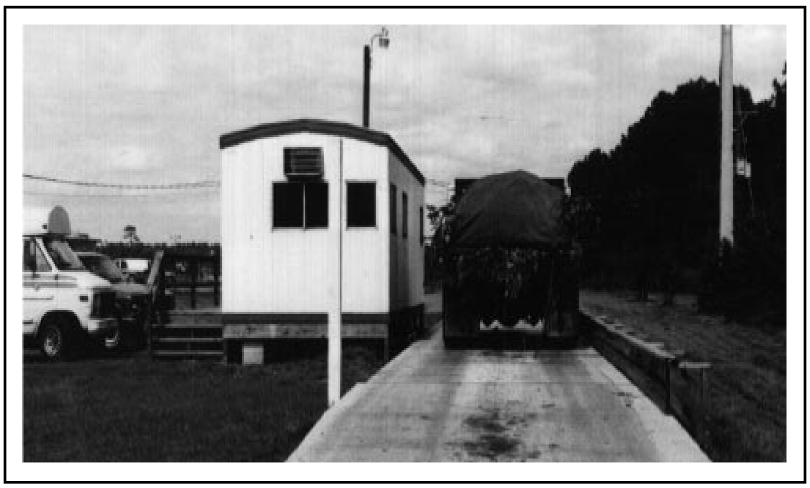
Proper entrance and exit signs should be posted to ensure safe traffic control, including separate areas for commercial and public access where possible. Signs should be posted to direct vehicles to unloading areas, to indicate traffic circulation patterns, and to indicate areas where specific materials, such as leaves, grass, logs, and other materials, should be unloaded. Additionally, signs should provide information on the operator of the site, the hours of operation, emergency contact phone numbers, and materials that are and are not accepted at the facility. Figure 6.3 shows an example of an entrance sign.

Figure 6.3   Entrance Sign

Material Measurement

Scales are recommended to ensure proper recordkeeping and management of the incoming material and the outgoing products (figure 6.4). Due to variations in yard trash, densities and weights may be difficult to track on a volume basis. Note that Section 403.706 (18), F.S., requires scales at solid waste facilities owned or operated by or on behalf of a local government.

Figure 6.4 Truck on a Scale



Chapter 7

OPERATIONAL CONSIDERATIONS

The goal of every yard trash processing facility should be to operate in a manner that does not create an adverse impact on the environment or on the community around the facility. Three factors greatly influence a facility's potential to create such an impact:

- *Location of the facility and proximity to neighbors.* The recom mendations in Chapter 6 for the siting of a facility can reduce the operational requirements that need to be followed. Greater dis tances from the nearest neighbor will reduce the recommended noise, odor, dust, and process time considerations.

- *The amount and type of materials received for processing.* The amount and type of material processed will often dictate the area requirements of the facility, the intensity of processing required, and the time frames required to produce the end product.

- *The end products produced from the incoming material.* Yard trash composting requires larger processing and storage areas than the production of fuel.

When applying the following operational guidelines to a specific facility, the factors should be taken into consideration. An operational parameter that is acceptable at one site may create a problem at another site.

On-Site Personnel

Each site should have staff monitoring the receipt of each load and inspecting the load for foreign matter or contamination. On-site personnel should also be present to control traffic and to direct loads of different types of materials to separate receiving areas.

Incoming Material Considerations

The receipt of material must take into consideration the following variables:

- Type and number of vehicles delivering material (for a high-traffic facility, commercial and residential traffic should be separated.)
- Type of material and whether it is in bags
- Site operator control of collection of material

Separation by Material Type

Loads should be identified and directed to separate areas for different product streams. For example, compost feedstock that does not require grinding, such as grass, leaves, and wood chips from tree services, can go to windrow areas; hardwood logs (excluding palm trees) can go to log mulch areas; and shrubbery, brush, and palms can go to fresh or sanitized mulch areas. Also, material too large for the rated capacity of the grinding equipment on-site should be separated and left for periodic grinding by outside contractors using land-clearing equipment.

Plastic and Paper Bags

Yard trash materials delivered to processing facilities in bags need to be effectively managed. Household waste and other undesirable materials can be hidden in plastic and paper bags.

Concerns with yard trash collected in plastic bags include the potential for odors during debagging and initial processing, litter caused by shredded plastic bags, and maintaining the marketability and quality of the end products. Grass that will be processed into products other than fuel should be removed from plastic bags soon after entering the site; 24-48 hours is recommended, depending upon the proximity of neighbors. Plastic debagging systems are available, but their ability to remove all of the plastic in a cost-effective manner is still a question for site operators to consider on an individual basis.

Yard trash delivered in paper bags can be used in a composting operation without the need for debagging, because the bags will decompose with the yard trash during normal processing. Paper bags should not be used in a mulching operation because they will not decompose within the shorter processing time required for mulch production.

Grass

Loads containing primarily grass, whether in bags or collected in bulk, need to be specially managed on-site so as to minimize odor and the release of nitrogen. Grass should be mixed with a sufficient amount of a carbon source and incorporated into windrows to provide a proper amount of moisture, a preferable C:N ratio, and adequate availability of oxygen.

Contaminants

Loads need to be inspected for household hazardous waste and for other foreign materials such as glass, metal, plastic, construction and demolition debris, and other undesirable materials. Storage containers should be provided on-site for removal of contaminants in accordance with state and local requirements.

Storage Parameters

Storage parameters and processing times depend upon the materials being received, the products to be produced, the size of the facility, and proximity to neighbors. Facilities receiving large quantities of grass should process the loads of grass in the time frames discussed above. However, some facilities receive greater percentages of limbs, brush, and palm fronds, which do not require time-sensitive processing.

The amount of material allowed to accumulate on-site is another consideration. It may not be economical to process material without a minimum tonnage build-up prior to bringing the suitable processing equipment on-site. Raw yard trash that can be consolidated with a front end loader can take up very little area. However, compaction of yard trash materials is discouraged because it may cause loading and fire safety problems. One acre of storage area can hold 750 tons if properly managed.

It is recommended that no more than 1,500 tons of material be allowed to accumulate before size reduction. This amount can be increased if there is sufficient storage capacity and the site is located a sufficient distance from neighbors so as not to generate complaints.

Size Reduction

In many locations where the yard trash is comprised mostly of leaves and grass, no further volume reduction may be needed. In most situations, however, volume reduction equipment is needed to control the brushy mixture of incoming materials.

Yard trash must be managed to optimize space and must be standardized to produce a marketable product. Size reduction is necessary to increase the surface area, which allows increased microbial activity, or to create end products of a desired size and aesthetic value, such as log mulch or fuels.

Tub grinders that have been adapted and modified from the agricultural industry are the predominant method of accomplishing size reduction of yard trash materials. Other equipment is also available to process yard trash, such as horizontal feed grinders, chippers, and high- and low-speed shredders. Facility operators should review their specific needs based upon the type and amount of material to be processed and the level of contamination.

In a small operation handling 5-10 tons of material per day, a hand-fed chipper may satisfy volume reduction needs. This machine has a low capital cost, but its use results in low production with a high investment of manual labor. The material that comes out of a chipper has a smooth clean edge. When placed in the landscape this mulch has a tendency to float and provides only a small amount of moisture retention.

Larger facilities requiring more equipment to keep up with incoming material should consider a tub grinder or a shredder. The tub grinder, the most commonly used machine, is available in different sizes ranging from power units that hook up to a tractor to self-powered units of more than 800 horsepower. Tub grinders generally have a high capital cost and are high in production, low in labor, and high in maintenance costs. The brushy nature of the yard trash can require a wide-feed system to accommodate oversized materials ranging from palm fronds to tree limbs and stumps. The large bowl opening and the rotation of the inside walls of the tub grinder offer an efficient means of handling bulky materials. A tub grinder produces an end product that is shredded and has rough surfaces (figure 7.1). This product tends to remain in place in the landscape without floating. It holds moisture better but will decompose faster than a chipped product.

Figure 7.1 Tub Grinder Size-Reducing Yard Trash

Processing Times

Processing times depend on the desired end product and the level of effort needed to manage and accelerate the natural process. For example, mulches made from clean wood, large limbs and trunks of hardwoods are finished end products that require no additional processing after size reduction.

The time required to process yard trash materials into a stable compost product will vary depending upon the level of management used in the process.

There are three intensity levels of technology that can be used in composting yard trash: minimal level, low level, and intermediate level. High level technologies generally are not used in yard trash facilities due to their high cost.

Minimal Level: This is a low-cost approach to composting yard trash using leaves and grass, materials that typically do not require volume reduction. The material is blended and placed into a windrow. Turning is limited to once per year and anaerobic regions may develop within the piles. This method re quires large land areas with significant buffer zones from neighbors. The pile is not managed and the materials may be wet in some areas and dry in others with large anaerobic zones. When these piles are turned or disturbed, they may generate objectionable odors. Because of the uneven decomposition, this method may require up to three years to produce a finished compost.

Low Level: This method requires a higher level of management than the minimal level. Yard trash is size-reduced to a uniform size, maximizing the surface area for microbial activity. The material is placed in windrows and is monitored once a week for temperatures. Windrows are turned once per month with moisture added when piles dry and microbial activity slows down. Organic materials at the bottom center of the piles may emit odors when turned because of possible anaerobic conditions. This technology may produce a finished compost in six months to a year.

Intermediate Level: This method of yard trash composting requires volume reduction and weekly turning of windrows. The piles are managed to optimize oxygen and moisture levels and temperature distribution. Feedstocks are blended to obtain the proper mixture of carbon material and nitrogen material. This method may produce a finished compost within three to six months.

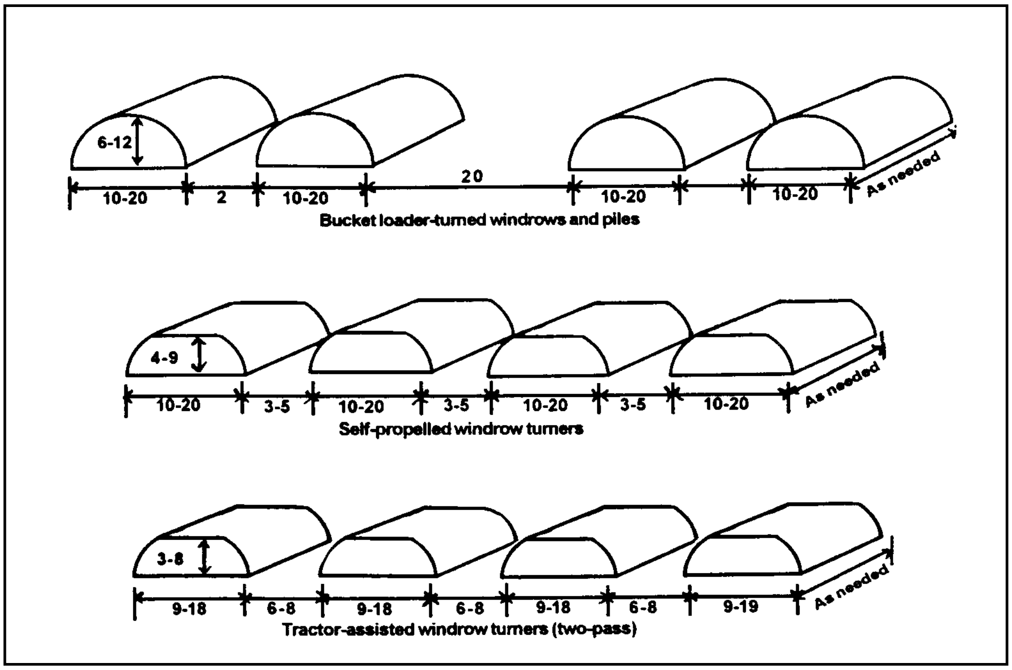
Pile-to-Alley Relationship

Pile-to-alley relationship refers to the space between the windrows. Local fire officials should be consulted concerning pile-separation requirements to ensure that fire codes and proper fire-fighting procedures are followed. The following distances are recommended to allow for processing equipment access:

- A distance of 3-5 feet is recommended for self-propelled windrow turners.
- A distance of 6-10 feet is recommended for tractor-assisted windrow turners and front-end loaders.

Windrows formed in pairs that will later be combined should have a minimum of 2 feet between piles. A lane sufficient for loader operations should be left between pairs of windrows. It is recommended that a 20-foot lane be left around the perimeter of a processing area. Figure 7.2 illustrates several pile-to-alley relationships.

Figure 7.2 Dimensions and Spacing for Windrows and Piles



Source: Rynk, R. (1992). Reprinted with permission from *On-Farm Composting Handbook.*

Dust Control

Air quality at composting facilities is generally not a problem, with the exception of dust and occasional odors. Dust may be especially a problem at composting facilities in the dry months. Dust is generated from dry, uncontained organic materials, especially during windrow turning, screening, and shredding operations, and from vehicle traffic over unimproved surfaces (EPA, 1994). A method of testing for dust particulates escaping from the site is provided in Appendix B.

A facility manager can follow a number of operational procedures to reduce fugitive dust and provide for worker safety:

- Irrigate at the end of the conveyor of the tub grinder.
- Irrigate before turning windrows.
- Irrigate when turning windrows.
- Restrict activities when the wind direction is unfavorable.
- Locate a high dust activity in a remote area of the site.
- Dampen roads and areas that generate dust.
- Require employees to use goggles and filter masks.
- Use equipment with an enclosed operator cab with air conditioning that has a replaceable air filter system.

Bioaerosols

Bioaerosols are microorganisms that may have the potential to cause adverse health effects. In 1993, a workshop sponsored by the Composting Council, the U.S.

Environmental Protection Agency, and the U.S. Department of Agriculture brought together scientists and engineers to review the potential health risks associated with composting facilities. Those experts determined that “composting facilities do not pose any unique endangerment to the health and welfare of the general public” (Composting Council Fact Sheet, p. 6). A copy of the executive summary of the workshop’s conclusions is included in Appendix B.

Odors

Odor problems are the single biggest threat to a yard trash processing operation. Nothing is more persistent than an angry neighbor seeking to shut down a composting operation because of odors. In theory, aerobic composting does not generate odorous compounds as anaerobic processes do. However, objectionable odors can come from certain raw materials or the process itself if conditions are not right. The primary sources of odors at a yard trash processing facility are odorous raw materials, ammonia lost from high-nitrogen materials, anaerobic conditions within windrows or the composting process, and organic acids (Cochran, et al., 1995).

Anaerobic conditions can be minimized by proper management techniques, which include using a good mix of raw materials, avoiding overly wet mixes, monitoring temperatures, and turning to aerate the materials regularly. Bad odors can be controlled by providing extra carbon. Strong-smelling raw materials are the most common cause of odors at a composting site. The odors come to the site with the materials and do not dissipate until the composting process begins (Cochran, et al., 1995).

The initial breakdown of grass normally releases high amounts of ammonia which, in combination with very high temperatures, can produce unpleasant odors. The mixing of the grass with other types of yard trash, the frequent aeration, and maintaining of temperatures in the optimal range are by far the best weapons against odors. The turning of windrows that have become anaerobic at the bottom will inevitably cause odors and should be done only when the wind is blowing away from residential areas (Jensen, 1995).

Noise

Noise is measured in units of relative loudness called decibels. Sound levels decrease with distance from the source. For each doubling of the distance from a single source, noise levels decrease by 6 decibels because the sound waves diverge from the source (Composting Council, 1994). A tub grinder hammermill can generate about 90 decibels at the source (EPA, 1994).

Noise Regulations

Noise generated by a yard trash processing facility is regulated in two ways:

- Occupational Safety and Health Administration (OSHA) requirements specify noise exposure limits for facility employees. For example, at levels between 85 and 90 decibels, certain hearing conservation precautions must be taken.

It is important to be aware of the OSHA requirements that may be relevant to yard trash processing operations.

- City or county noise ordinances often specify acceptable noise levels at property boundaries or at the nearest residence. Such ordinances usually base acceptable sound levels on the time of day, the land-use classification of the source, and the nature of the receptors. For example, a receptor in an industrial area would be weighted differently from one in a residential area (Composting Council, 1994).

Noise Reduction Measures

Noise generated by a yard trash processing facility can be mitigated in the following ways:

- Provide a buffer zone of vegetation, tall shrubs or trees around the facility's perimeter that will lower noise levels.
- Install mufflers and noise hoods on equipment engines.
- Construct a berm at the source of noise.
- Restrict noise-generating activities when wind direction and weather conditions are unfavorable.

Pest and Insect Control

Properly managed yard trash processing facilities do not attract rodents or birds due to the lack of a food source. The biological activity and the turning and management of the piles prevent the creation of habitats for birds and rodents.

Insect control is important because Florida's climate provides an ideal habitat for insects. The surface of the initial windrows may attract flies and other insects, especially in warm climates (Jensen, 1995). However, insect control normally is not a problem as long as windrows are turned frequently. The key is to bring the larvae that are in the outer 9 inches of the windrow into the middle where the temperature will kill them. The turning frequency must therefore be shorter than the time it takes the larvae to be transformed into insects. There is a common misconception that yard trash products may contain populations of pest insects such as roaches, flies, mosquitoes, fleas, and termites. Although such pests may be delivered to a processing site, they will be eliminated early in the shredding and windrow management processes.

Data on actively managed yard trash mulch windrows indicate that most insect populations are found within the top 6 inches of the windrow where the temperatures range from 80-105°F. Insect populations decrease exponentially, beginning at 6 inches at 115°F and cease at 12 inches at 125°F (Smith, 1991).

The following measures are recommended to control insects:

- Limit the time grass stays in the staging area to limit the hatching of fly larvae.
- Turn windrows frequently early in processing to maintain temperatures that kill insects.
- Store the finished products a considerable distance from fresh, unprocessed feedstock.
- If the final product is stored for long periods, inspect periodically for insects and turn to reheat if necessary.

Fire Prevention

While fires are rarely a problem in well-managed yard trash processing operations, facilities do receive large quantities of potentially combustible material. This represents a potential fire hazard, especially in the receiving area, and proper precautions should be taken. For example, the piles should be constructed in a windrow shape with a separation or spacing between piles for fire containment. Possible ignition sources are discarded cigarettes, lightning, vandalism, and spontaneous combustion.

There is also a potential for surface fires in finished mulch which may occur at ground level under drought or extremely dry conditions. Finished material generally burns on the top few inches of surface where it is driest, where there is an ignition source, and where there are strong prevailing winds.

Equipment fires also may result from an accumulation of dust and wood chips left on a hot engine, bearing, or component part that has not been cleaned regularly. (National Fire Protection Association, 1991).

Fires can also ignite from spontaneous combustion inside the piles. However, a rare set of conditions must occur before this type of fire is possible. The conditions are: 1) rate of heat generated, 2) air supply and insulation properties of immediate surroundings, and 3) moisture.

First, there must be vegetation with ample nitrogen to fuel bacterial populations that generate heat. Since most microbes cannot live at temperatures above 160-175°F, the continued heating of vegetation to their ignition temperature is thought to be due to rapid oxidation initiated after bacterial preheating (National Fire Protection Association, 1991). The material has to heat to more than 200°F for an extended period of time (Dickson, n.d., cited in Simpson & Engel, n.d.).

Second, heat loss must be limited for fires to develop in piles. One of the ways in which heat loss is limited is through compaction in piles that are too high. Sufficient air must be available to permit oxidation, yet not so much air that the heat is carried away by convection as rapidly as it is formed. For example, a high pile of log chips, without a large percentage of fines, will not ignite where there is air space between the chips that vents heat (National Fire Protection Association, 1990, 1991).

Third, the moisture content of vegetative material affects spontaneous heating by microbes. Spontaneous combustion becomes a possibility as the material dries out to a moisture content range of 25-45%. In piles over 12 feet high, it is possible for the internal heat of the compost pile to initiate chemical reactions which then lead to spontaneous combustion (Rynk, 1992).

Operational procedures to minimize spontaneous combustion for storage of yard trash should include the following:

- Incoming unprocessed materials should be stored in windrows or piles with a clear area around each pile that is equal to the height of the pile.
- Mixing new material with older material on the site should be avoided, and an area should be thoroughly cleaned before starting a new pile.
- Storage sites should be level and on firm ground.
- Temperatures of older storage piles should be monitored.
- Concentrations of fine materials during pile build-up should be avoided.
- Employees should be aware that vehicle exhaust systems can cause fires.
- Pile compaction should be avoided.

Fire Fighting

Local fire departments generally respond with methods that are counter-productive. They typically apply large quantities of water to storage piles, which has the effect of spreading the fire, generating runoff, and saturating compost that might have been suitable for marketing.

A more appropriate method is to breakdown the pile or windrow to separate the burning materials, then spread the burning materials out in a layer on the ground. Frequently the fire will simply go out in the thin layer. However, the use of water is recommended at this time to quickly extinguish the remaining fire to prevent sparks from spreading the fire to other windrows or piles.

Employee Safety and Health

A yard trash processing facility can operate on an industrial scale where heavy equipment manipulates and moves large quantities of material. Such operating conditions require that management concern itself with the industrial health and safety of employees by providing protective equipment, training in safe equipment operation, and practicing fire prevention procedures.

The following uses of employee safety equipment are recommended:

- Hearing protection should be worn at levels of 85 decibels or above. Ear muffs are more effective than ear plugs (Cochran, 1995).
- Safety goggles should be worn to protect the eyes from dust or projectiles.
- Leather gloves should be worn to protect the hands.
- A dust respirator should be worn to protect against airborne dust. A disposable respirator that filters particles down to 1 micron in size is recommended.
- Tub grinder and screening areas may require hard hats and/or protective screens to shield workers from projectiles.

The following safety training measures are recommended:

- Conduct regular safety meetings.
- Instruct all employees on the safe operation and maintenance of all equipment.
- Instruct all employees on proper safety procedures.

Employees should be trained with regard to equipment hazards and the potential conditions that cause accidents, including the following:

- Know the safe operation and design of equipment that has pinch points, wrap points, cutting points, and entanglement risks from free wheeling parts (Cochran, 1995).
- Monitor for pinhole leaks in hydraulic lines.
- Volume reduction equipment has a “hot” zone where projectiles may be thrown. The direction of the rotation and the distance objects travel should be observed. A safety zone of up to 250 feet from the size-reduction equipment is recommended for unauthorized personnel.

Material Turning

In Florida, front-end loaders are often used to turn windrows. A loader is versatile and can move large piles up to 10-12 feet high. A disadvantage is a lower production rate, but this can be compensated for by using oversized buckets. Figure 7.3 depicts a front-end loader turning a windrow.

Figure 7.3   Front-End Loader Turning A Windrow

Another type of equipment used to turn windrows is a tractor-power-assisted machine or a self-powered turner towed by a tractor. The advantage of this type of equipment is greater volume movement and more consistent turning. A disadvantage is that windrow height may be limited to 3-8 feet and width is limited to 9-18 feet, and more land is required to accommodate smaller rows.

The highest production windrow turner is the self-propelled model that straddles a windrow.   This equipment is used most often where the material being composted is high in moisture and there is greater potential for odor production, as in operations processing municipal solid waste and biosolids compost. Disadvantages include the high cost of the equipment and its inability to manage the larger piles. Windrow height is limited to 4-9 feet and width may be limited to 10-20 feet. Figure 7.4 depicts a self-propelled windrow turner turning a windrow.

Figure 7.4 Self-Propelled Windrow Turner

Material Screening

Several types of screens are primarily used in yard trash processing operations. A portable trommel screen is used primarily for its high production in the separation of fines. The design includes a charge hopper that feeds into a rotating drum. The tumbling motion of material forces fine particles to be collected and stacked to the side and oversized material to be discharged out the end of the drum. Figure 7.5 is an example of a portable trommel screen.

Figure 7.5 Trommel Screen

A shaker screen is a slanted vibrating deck where material rolls down and drops off. It is used for scalping to separate logs, stumps, and demolition debris from soil. Two different screen sizes generally are stacked in combination on two decks. Other types of screens also are available to fit the particular needs of a specific facility.

Chapter 8

PRODUCT CONSIDERATIONS

Quality assurance is an essential component of a yard trash processing operation. Quality assurance begins at the source of yard trash generation with public education. Information should be provided to the community explaining the characteristics of yard trash that are acceptable for recycling and how it should be separated from other solid waste to prevent contamination.

Quality assurance procedures should extend throughout the entire process to ensure that the final product is safe and will have no adverse impact on the environment. Quality assurance procedures can reduce the likelihood of creating nuisance conditions that adversely affect the facility's relations with the surrounding community.

Compost Products

Compost can be used in a variety of ways and when incorporated into the soil provides the following benefits:

- Reduces loss of nutrients and pesticides due to attenuation
- Improves soil structure and texture, serving as a soil builder
- Improves soil aeration
- Increases the soil's capacity to hold water
- Loosens compacted soils
- Promotes soil fertility
- Creates a favorable environment for microorganisms and macroorganisms
- Supplies plant nutrients, improving crop yield and production

While compost has many benefits, it should be noted that when initially applied in planting beds, nitrogen may temporarily be "locked up" resulting in symptoms of nitrogen deficiency in seedling and immature plant materials. An application of nitrogen fertilizer at this time may be necessary. If immature or unstable compost is incorporated into the soil it may have a detrimental effect on plants. A site operator may reduce detrimental effects of unstable or immature compost by frequently turning and irrigating windrows.

Consistent and predictable product quality is an essential factor affecting the marketability of compost. The level of quality assurance will determine the level of demand for the product. The Composting Council has compiled a list of minimum suggested chemical, physical, and biological parameters for compost. Table 8.1. presents the rationale for testing for each of those parameters.

Table 8.1. Suggested Compost Parameters Summary

Compost Parameters	Rationale for Inclusion
pH	Effect on pH adjustment
Soluble Salt Content	Phytotoxicity, effect on watering regime
Nutrient Content	Effect on fertilizer requirements
Water Holding Capacity	Effect on watering regime
Bulk Density	Estimation/conversion of application rates & container media
Moisture Content	Product handling and transportation
Organic Matter Content	Determination of application rate
Particle Size	Determine usability in specific applications

Compost has numerous agricultural, horticultural, industrial, and forestry uses. Potential users are residents, farms, top soil companies, nurseries, public works and parks departments, golf courses, cemeteries, landscapers, and developers. The development and use of compost specifications ensures the production of a high quality compost for a variety of end-users. Table 8.2 provides the quality parameters from a typical yard trash compost facility in Florida. It should be noted that the quality of the compost will vary depending on the geographical area and type of feedstocks within compost.

Table 8.2 Typical Florida Yard Trash Compost Technical Data
(Wet Weight Basis)

Quality Parameters	Typical Yard Trash Compost	Typical Florida Soil Ranges
pH	7.6	5 - 8
Soluble Salts	.88 mmhos/cm	0.2 - 1.0 mmhos/cm
Nitrogen (N)	15 ppm	25 - 150 ppm
Phosphorous(P)	80 ppm	12 - 60 ppm
Potassium (K)	768 ppm	50 - 225 ppm
Calcium	1100 ppm	500 - 5000 ppm
Magnesium	236 ppm	50 - 500 ppm
Iron	2.6 ppm	2.5 - 25 ppm
Manganese	2.7 ppm	2.5 - 25 ppm
Zinc	9.0 ppm	2.5 - 25 ppm
Copper	.2 ppm	1.2 - 5 ppm
Boron	1.0 ppm	0.5 - 2.0 ppm
Sulfur	6 ppm	15 - 200 ppm

Source: Composite Test Results, City of St. Petersburg (1995);
Soil Ranges A & L Agricultural Laboratories Technical Standard (n.d.). (generic - non crop specific).

A yard trash compost producer who intends to market compost to state agencies must follow the standards established by the Florida Department of Agriculture and Consumer Services (FDACS) in its Compost Use Guidelines. These specifications were developed for governmental procurement of yard trash compost for the following applications:

- Horticultural substrate (growing media) component
- Soil amendment for reforestation
- Soil amendment for turf establishment
- Soil amendment for vegetative crop production
- Growing media for sod
- Soil mulch for erosion control

For more information, refer to Development of Suggested Compost Parameters and Compost Use Guidelines (FDACS, 1995).

For Florida yard trash compost producers to meet market requirements they must formulate the end-product according to each customers' specifications. The parameters required by a variety of markets requires a diversity of product formulations. A consistent requirement of all compost markets is that the end-product be free of weed seeds, plant pathogens, and toxic substances.

Other characteristics of yard trash compost that are required by most markets are uniformity of color, absence of contaminants, and uniform particle size. Compost should have a dark brown color similar to peat moss, be free of lumps, and not contain identifiable pieces of leaves or wood. The moisture content should be below 50% for ease of handling. Quality compost should have a earthy scent.

Mulch Products

In the processing of yard trash into mulch, it is important that the end-product have qualities sufficient to function as a protective ground cover. Mulch produced from yard trash should:

- Prevent erosion of soil in heavy rains
- Reduce evaporation of soil moisture
- Suppress weed growth
- Serve as a protective ground cover
- Maintain consistent soil temperature throughout the year

Mulch has many benefits, but it should be noted that when applied in planting beds, nitrogen may temporarily be "locked up," resulting in signs of nitrogen deficiency in immature plants. A slow release nitrogen fertilizer may be applied to the soil surface before mulch is applied.

When used in landscape beds and in creating paths, driveways, and parking areas, mulch should be free of weed seeds and should have low levels of fines and adequate physical structure to provide coverage for approximately three to six months. To many end-product users, the color and size consistency of mulch are important elements in the overall aesthetics of the landscape. When applying yard trash mulch in parks and play areas, caution should be taken to ensure contaminants such as sharp metal objects, plastic, or glass are not present.

Fuel Products

Quality assurance also is an important component in yard trash fuel production. Acceptable yard trash materials for a fuel generation station include:

- Vegetation and woody material resulting from landscaping maintenance
- Tree and shrub trimming
- Palm fronds
- Wood waste derived from processing residential yard trash

Characteristics of yard trash that affect its use in fuel generation are particle size, moisture content, and the presence of non-wood materials or contaminants.

Particle Size

While the preferred particle size of yard trash used for fuel production is 1 to 3 inches, a wide range of particle sizes may be acceptable as reflected in Table 8.3. As indicated in the table, 100% of the materials delivered for fuel must pass through a 4-inch screen. It should be noted that each power generating plant will specify its requirements for product characteristics.

Table 8.3 Acceptable Fuel Size Gradations

Delivered	Pass Screen Size
100%	4"
95%	3"
50%	1/2"
5%	1/4"

Moisture Content

Moisture content affects the energy content of yard trash when burned and the amount of combustion required to achieve desired heat or steam outputs. Yard trash harvested from the forest or from landscaping activities has a moisture content ranging from 25-50% (wet basis) and an energy content of approximately 5500 Btu per pound. For yard trash to be used as fuel, the feed stock should consist of woody material, which offers greater Btu value than grass and leafy materials.

Contaminants

Fuel generation plants that burn yard trash have specific standards on the quality of incoming material. These standards are related to the plants operating permit. Quality standards affect the feed mechanism which delivers the fuel to the burner and the ash content of the yard trash materials. At a minimum, yard trash should be free of plastic, garbage, dirt, and metal contamination. Contaminants may impede fuel feeding and combustion equipment and may affect ash quantity and quality.

Recordkeeping

The importance of recordkeeping cannot be overstated. In some cases, records may be required by local or state regulatory agencies. It is a good practice to keep a log to track volumes or weights of incoming and outgoing yard trash and its origin. This data is useful in:

- Developing estimates of the amount of compost or mulch that will be produced
- Determining the adequacy of the site for handling projected amounts of yard trash
- Isolating the origin of contamination problems
- Monitoring costs

Records should be kept of any problems that occur and the steps taken to identify and resolve the problems. The records may be valuable in responding to inquiries about the facility's operations. Ambient temperature monitoring and weather conditions also should be recorded. This information is beneficial for recognizing trends as indicators of when windrows need to be turned.

Historical records should be maintained on windrow construction. Each windrow should be individually identified by date of formation. Written or computer records should be maintained on the following quality assurance monitoring efforts:

- Windrow formation dates
- Windrow temperatures
- Windrow turning dates
- Ambient temperatures
- Windrow irrigation dates
- Windrow removal dates
- Product testing dates
- Rainfall levels

Product Testing

To ensure quality, compost and mulch producers may choose to conduct laboratory tests on their end-products. The importance of product testing is two-fold. Facility operators may choose to have a variety of laboratory tests performed to monitor production of a quality end-product, and end-users may require tests to ensure that the end-product meets their specification.

Operators monitoring for quality assurance may choose to test for soil nutrients, bioassay, pH, soluble salts, inerts, moisture content, bulk density, and organic matter content. End users may require facility operators to furnish the results of a variety of environmental and biological tests performed by a state-certified laboratory.

Laboratory testing requires capturing a representative sample of the yard trash product. A composite sample is made by taking many small samples from different locations in the curing pile and then using a cone and section method to reduce the material to a size acceptable for laboratory testing. Off-site laboratory tests are available to determine the concentration of plant nutrients and toxic compounds. The compounds tested for will depend on the feedstock and any applicable regulations. The presence of viable weed seeds and the effects of phytotoxic compounds should also be monitored.

Pesticides and herbicides that may be present in yard trash feedstock are usually broken down and diminished over time during the composting process. When detected, they are well below the U.S. Department of Agriculture food tolerance level. However many studies have indicated insignificant levels of heavy-metal residues in yard trash compost and mulch (EPA, 1993).

Representations of Product

In the marketing of mulch or compost, facility operators must make every effort to clearly state the quality of the finished product. It is not recommended that products made from yard trash be represented as a fertilizer or soil amendment. The Florida Commercial Fertilizer Law clearly states that any products labeled as a “fertilizer” must have one or more of the following characteristics:

- Contains one or more recognized plant nutrients and promotes plant growth
- Controls soil acidity or alkalinity
- Provides other soil enrichment
- Provides other corrective measures to the soil

Facility operators should familiarize themselves with the provisions of the Florida Commercial Fertilizer Law (Chapter 576, Florida Statutes) which regulates any mention of the fertilizer value in a product. Portions of the law are included in Appendix A.

Marketing Guidelines

Compost and mulch have the unique characteristics of being generated from large portions of the municipal solid waste stream and being processed into versatile end-products with a variety of end-uses. As the production of yard waste compost and mulch increases, so must the development of new markets and user confidence. Market guidelines are driven by a diversity of end-users. Several organizations have published guidelines to address the multitude of end uses of recycled yard trash products. Marketing guidelines are available from the Compost Council, the Florida Department of Agriculture and Consumer Services, and the Florida Recycling Markets Advisory Committee.

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Glossary

Aerobic Decomposition The oxidation of organic matter into carbon dioxide and water by microorganisms in the presence of air. (Compost Council, 1994)

Anaerobic Decomposition Decomposition occurring in the absence of oxygen, as in anaerobic respiration. (Compost Council, 1994)

Clean Dry Wood Wood (including lighter pine), lumber or tree and shrub trunks, branches, and limbs which are free of paint, penthachlorophenol, creosote, tar, asphalt, or other wood preservatives and which when burned does not emit excessive visible emissions. (Rule 62-256.200(5), Fla. Administrative Code)

Compost "Solid waste that has undergone biological decomposition of organic matter, has been disinfected using composting or similar technologies, and has been stabilized to a degree which is potentially beneficial to plant growth and which is used or sold for use as a soil amendment, artificial top soil, growing medium amendment or other similar uses." (Rule 62-709.200(2), Fla. Administrative Code)

Contamination Unwanted material. Physical contaminants can include sharps, metal fragments, glass, plastic, and stones; chemical contaminants can include trace heavy metals and toxic organic compounds; biological contaminants can include pathogens. In excessive amounts, a contaminant can become a pollutant. (adapted from Composting Council, 1994)

Curing The last stage of composting that occurs after most of the readily metabolized material has been decomposed or stabilized. It provides additional biological stabilization. (Composting Council, 1994)

Fresh Yard Trash Unprocessed vegetation that has not gone through the windrow sanitization process for pathogen kill, weed seed destruction and insect kill.

Heavy Metals Trace elements with concentrations that are regulated because of the potential for toxicity to humans, animals, or plants. Trace elements include copper, nickel, cadmium, lead mercury, and zinc if present in excessive amounts. (Composting Council, 1994)

Humus A complex amorphous aggregate, formed during the microbial decomposition or alteration of plant or animal residues and products synthesized by soil organisms; principal constituents are derivatives of lignins, proteins, and cellulose combined with inorganic soil constituents; dark or black carbon-rich relatively stable residue resulting from the decomposition of organic matter. (Composting Council, 1994)

Inorganic A substance in which carbon-to-carbon bonds are absent; mineral matter (Composting Council, 1994).

Landfill Cover (Initial) "'Initial cover' means a 6-inch layer of compacted earth, used to cover an area of solid waste before placement of additional waste, intermediate cover, or final cover. The term also includes other material or thickness, approved by the Department, that minimizes disease vector breeding, animal attraction, and moisture infiltration, minimizes fire potential, prevents blowing litter, controls odors, and improves landfill appearance." (Rule 62-701.200(40), Fla. Administrative Code (1994))

Landfill Cover (Intermediate) "'Intermediate cover' means a layer of compacted earth at least one foot in depth applied to a solid waste disposal unit. The term also includes other material or thickness, approved by the Department, that minimizes disease vectors, odors, and fire, and is consistent with the leachate control design of the landfill." (Rule 62-701.200(41), Fla. Administrative Code (1994))

Macronutrients Nutrients used by plants in high quantities.

Mature Compost Material that has gone through the windrow process for "sanitization" and has been sufficiently cured for stability so as not to introduce phytotoxic acids. Mature compost will not deplete soil nitrogen to support additional biological decomposition but will be beneficial to soil and plants grown in the amended soil. (Adapted from Composting Council, 1994)

Micronutrients Nutrients required by plants in small quantities but toxic at high levels, including boron, chlorine, copper, iron, manganese, molybdenum, and zinc.

Mulch A soil surface cover used to retain moisture by retarding evaporation, discourage weed growth, stabilize temperatures by insulating the soil, and stabilize the soil against erosion from rainfall (adapted from Composting Council, 1994).

Organic Matter Any carbonaceous material (exclusive of carbonates) of animal or vegtable origin, large or small, dead or alive, consisting of hydrocarbons and their derivatives.

Pathogens Organisms or microorganisms, including bacteria, mold, fungus, virus, and protozoa capable of producing an infection or disease in a susceptible host. Measures to control pathogens include industrial hygiene, effective design and operation for biodegradation of pathogen nutrients and for adequate and uniform aeration and temperature/time to assure pathogen destruction. (adapted from Composting Council, 1994).

Phytotoxins Toxins that may endanger plant viability or functionality (Composting Council, 1994).

Primary Plant Nutrients Plant foods, including total nitrogen, available phosphoric acid or phosphorous, and soluble potash or potassium (Composting Council, 1994).

Screening A production step to mechanically classify materials by size through the use of screening equipment which results in a uniform size.

Soil Conditioner A soil supplement that physically stabilizes the soil, improves resistance to erosion, increases permeability to air and water, improves texture and resistance to crusting, eases cultivation, or otherwise improves soil physical quality (Composting Council, 1994).

Stability A level of biological activity in a moist, warm, and aerated biomass sample. Unstable biomass consumes nitrogen and oxygen to support biological activity and generates heat, carbon dioxide, and water vapor. Unstable, active compost demands nitrogen if applied to the soil and can cause nitrogen deficiency in the soil mix and be detrimental to plant growth, even causing death of plants in some cases. (Composting Council, 1994)

Vector A carrier such as an animal, air current, and/or water stream that ingests or conveys garbage, odor, microorganisms, and/or pathogens from one location to another. (Composting Council, 1994)

Water Table The upper surface of ground water. (Composting Council, 1994)

Windrow An elongated formation of yard trash material where the dimension of construction, the particle size, and the manner of rotation provides a state to control temperatures. Windrows have a large exposed surface area which encourages passive aeration and drying.

Yard Trash Vegetative matter resulting from landscaping maintenance or land clearing operations and includes materials such as tree and shrub trimmings, grass clippings, palm fronds, trees and tree stumps. (Rule 62-709.200 (15) Fla. Administrative Code)

Appendix A

Policies and Regulations
Appendix A

Table of Contents

Florida Department of
Environmental Protection

Memorandum

TO: Waste Program Administrators

FROM: John M. Ruddell, Director
Division of Waste Management

DATE: May 10, 1995

SUBJECT: Yard Trash Composting Facilities

On January 10, the Policy Coordinating Committee approved the Division's request to eliminate the permitting requirements for yard trash composting facilities that are currently regulated by Chapter 62-709, Florida Administrative Code (F.A.C.), the Department's Compost Rule. This exemption will apply strictly to those facilities that compost yard trash, clean dry wood as defined in Rule 62-256.200(5), F.A.C., or those materials received at facilities which have obtained approval of alternative procedures and requirements allowing such materials to be treated as yard trash (all of which are referred to as yard trash for purposes of this memo). The Compost Rule now requires owners and operators of facilities that compost yard trash to obtain a general permit if they process less than 3,000 cubic yards per year. Yard trash facilities processing more than this amount are required to obtain a regular permit. While the rule changes will eliminate the permitting requirements, the rule will also address minimum facility standards to help differentiate between disposal facilities and those facilities processing yard trash into compost, mulch or fuel. We are also considering a voluntary notification process supplying information on location, contact, what products are produced, and the volume produced. After these changes are put in place, inspections at these facilities will only be done in response to complaints or if there is reason to believe that the facility is disposing of waste on site, accepting materials other than yard trash, or otherwise violating Department rules.

Department staff will also inspect facilities at the request of facility representatives for technical assistance. The Bureau of Solid and Hazardous Waste has initiated rulemaking for Chapter 62-709, F.A.C., in order to incorporate these changes and to address other types of composting operations in more detail. The Bureau also intends to contract with the Florida Organic Recycling Association (FORA) to write guidelines and best management practices for facilities processing yard trash into compost, mulch or fuel that will cover the recommended design, operation and materials handling for these types of facilities. We anticipate these guidelines will be completed prior to the rest of rulemaking for Chapter 62-709, F.A.C.

Therefore, in order to reduce the number of times that this rule must be amended, the following policy for facilities that compost yard trash will be in effect while this initial rulemaking is in progress:

1. No solid waste permits or general permits will be required for facilities that compost yard trash.

2. The prohibitions found in Rule 62-701.300(1) through (3), F.A.C., continue to apply to facilities that compost yard trash. A copy of these provisions is attached.

3. The design and operating provisions (see attachment for full text) in Rules 62-709.500(4)(a), (d), and (f), 62-709.510(1)(b) and (e), and 62-709.515(1), and (3), F.A.C., still apply for facilities that compost yard trash, specifically:

   - The sites shall have an effective access barrier.
   - Dust control methods shall be used as needed to control problems.
   - There shall be fire protection and control provisions to address the potential for accidental burning.
   - Disease vectors and odors shall be controlled.
   - More that half of the compost at the facility shall be removed from the site within each year beginning with the third year after facility startup.
   - The composting material shall be turned at least once in a 12-month period.
   - The particle size of larger items shall be reduced.

4. The testing, record keeping and reporting requirements of Rule 62-709.530, F.A.C., do not apply for facilities that compost yard trash. While record keeping provisions will not apply, facilities should be encouraged to keep appropriate records on the amount of material received and processed into compost, and the amount of compost removed for use or disposal, in order to demonstrate that the facility is not operating as a disposal facility.

5. Compost from yard trash shall have unrestricted distribution.

6. When such facilities close, all residuals, solid waste, compost and recyclable materials shall be removed and recycled or disposed of.

Existing permitted facilities may continue to operate in accordance with their permit conditions, although routine compliance inspections will no longer be conducted. If the facility operator wishes to surrender its permit and operate in accordance with this memo it may do so. District staff should contact permitted facilities and inform them of this new policy. If a currently permitted facility is under enforcement for major operational or design violations, the permit cannot be surrendered until the violations are resolved. In this case, other current rule requirements would still apply such as the testing and reporting requirements. If enforcement action has been initiated solely for operating without a permit, that action will be closed. This policy does not affect enforcement actions concerning disposal of yard trash where a majority of the material at the facility is not sold, used or reused within a year.

Once the remainder of Chapter 62-709, F.A.C., changes are ready for adoption by the Environmental Regulation Commission, the guidelines developed by FORA will be incorporated into the Department's compost program and the permitting requirements for yard trash facilities will be removed from the rule.

JMR/fjr

Attachment

GENERAL PROHIBITION

62-701.300 Prohibitions.

(1) General prohibition.

(a) No person shall store, process, or dispose of solid waste except at a permitted solid waste management facility or a facility exempt from permitting under this chapter.

(b) No person shall store or dispose of solid waste in a manner or location that causes air quality standards to be violated or water quality standards or criteria of receiving waters to be violated.

(2) Disposal. Unless authorized by a Department permit or site certification in effect on January 6, 1993, no solid waste shall be stored or disposed of by being placed:

(a) In an area where geological formations or other subsurface features will not provide support for the solid waste;

(b) In any area where the absence of geological formations or subsurface features would allow for the unimpeded discharge of waste or leachate to ground or surface water. A person may dispose of solid waste in such an area upon demonstration to the Department that permanent leachate control methods will result in compliance with water quality standards under Chapters 62-302 and 62-520, F.A.C.;

(c) Within 500 feet of an existing or approved potable water supply well unless disposal takes place at a facility for which a complete permit application was filed or which was originally permitted before the potable water supply well was in existence. This prohibition shall not apply to any renewal of an existing permit that does not involve lateral expansion, nor to any vertical expansion at a permitted facility;

(d) In a dewatered pit unless the pit is lined and permanent leachate containment and special design techniques are used to ensure the integrity of the liner;

(e) In an area subject to frequent and periodic flooding unless flood protection measures are in place;

(f) In any natural or artificial body of water including ground water;

(g) Within 200 feet of any natural or artificial body of water, including wetlands within the jurisdiction of the Department, except bodies of water contained completely within the property boundaries of the disposal site, which do not discharge from the site to surface waters. A person may dispose of solid waste within the 200 foot setback area upon demonstration to the Department that permanent leachate control methods will result in compliance with water quality standards under Chapters 62-302 and 62-520, F.A.C. Stormwater control methods shall meet stormwater requirements of Chapter 62-25, F.A.C. However, nothing contained herein shall prohibit the Department from imposing conditions necessary to assure that solid waste disposed of within the 200 foot setback area will not cause pollution from the site in contravention of Department rules.

(h) On the right of way of any public highway, road, or alley; and

(i) Within 1000 feet of an existing or approved potable water well serving a community water system as defined in Rule 62-550.200(9), F.A.C., unless disposal takes place at a facility for which a complete permit application was files or which was originally permitted before the water well was in existence. it is the intent of the Department that this provision shall be repealed on the effective date of any rule promulgated by the Department which regulates wellhead protection areas generally. This prohibition shall not apply to any renewal of an existing permit that does not involve lateral expansion, not to any vertical expansion at a permitted facility.

(3) Burning. Open burning of solid waste is prohibited except in accordance with Rule 62-701.520(2), F.A.C. Controlled burning of solid waste is prohibited except in a permitted incinerator, or in a facility in which the burning of solid waste is authorized by a site certification order issued under Chapter 403, Part II, F.S.; clean vegetative and wood wastes may be burned in an air curtain incinerator in accordance with Rule 62-2.500(1)(e), F.A.C.

REQUIRED COMPOST CRITERIA

62-709.500 Design Criteria.

(4) The facility site shall be provided with operational features and appurtenances necessary to maintain a clean and orderly operation. These minimum features are:

(a) An effective barrier to prevent unauthorized entry and dumping into the facility site;

(d) Dust control methods where needed to control problems;

(f) Fire protection and control provisions to deal with accidental burning of solid waste or compost at the facility; and

62-709.510 Operation Criteria.

(1) The following operation requirements apply to all composting facilities.

(b) The facility shall be operated in a manner, with any needed measures taken, to control vectors and odors.

(e) More than half of the compost stored at the facility shall be used or sold for use within each year beginning the third year after facility startup. Further, any compost remaining at the facility for three years after it was produced shall be disposed of pursuant to the requirements of Rule 62-701, F.A.C., or shall be reprocessed so that it can be sold or used.

62-709.515 Special Operation Criteria for Minimal Technology. The following operation requirements apply to composting facilities that process only yard trash or manure using minimal technology:

(1) The composting material is turned at least once during a 12-month interval;

(3) Particle size of larger yard trash items such as limbs, trees, and tree stumps are reduced to promote composting;

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

Interoffice Memorandum

TO: District Waste Program Administrators

FROM: William Hinkley, Administrator, Solid Waste Section

DATE: August 16, 1990

SUBJECT: The Use of Mulched Yard Trash as Daily Cover

This memorandum summarizes the consensus reached at the August 2 teleconference regarding the use of mulched yard trash as daily cover. The Department has had recent requests to use mulched yard trash as daily cover from Sarasota County and Gulf Coast Disposal, Inc. of Lee County.

1) The use of mulched yard trash as daily cover is not acceptable. It is not an effective fire barrier, which is one of the key functions of daily cover. Additionally, using mulched yard trash as daily cover is contrary to the provisions of 403.708(15)(c), F.A.C., which prohibits the disposal of yard trash in lined landfills after January 1, 1992.

2) The use of mulched yard trash to stabilize side slopes, or when used as a soil admixture, in the top portions of intermediate and final cover is acceptable. Furthermore, mulched yard trash used in this capacity is considered to have been recycled and counts towards the 30% recycling goal required by the 1988 Solid Waste Management Act.

3) The use of composted yard trash, co-composted yard trash and sludge, or mixtures of composted yard trash and soil, may be acceptable as daily cover, if it can be demonstrated that the material performs the functions of daily cover--i.e., that it is an effective fire barrier, suppresses vectors and odors, and is stable with regard to stormwater run-off. The determination as to whether composted material is acceptable will be made by the districts on a case-by-case basis. Composted yard trash which is found to be acceptable and is used as daily cover can be considered to have been recycled and counts towards the 30% recycling goal.

cc: ✓Rick Wilkins
Barry Swihart
Chris McGuire
John Reese
Francine Joyal
Ron Henricks

RECEIVED
AUG 20 1990
DIVISION OF
WASTE MANAGEMENT

FLORIDA COMMERCIAL FERTILIZER LAW

If yard waste compost is represented to promote or stimulate plant growth, such a claim falls within the jurisdiction of the Florida Statutes Chapter 576.011, Florida Department of Agriculture and Consumer Services, Florida Commercial Fertilizer Law.

Of particular importance is compliance with the definitions found under fertilizer statutes when using the following terms or making claims of enhanced plant growth.

576.011(11) “Fertilizer” means any substance which:

(a) Contains one or more recognized plant nutrients and promotes plant growth, or
(b) Controls soil acidity or alkalinity, or
(c) Provides other soil enrichment, or
(d) Provides other corrective measures to the soil.

For the purposes of this chapter, the term “fertilizer” does not include unmanipulated animal or vegetable manures, peat, or compost which make no claims as described in paragraphs (a)-(d).

5E-1.002(1)(c) The term “compost” means a substance derived primarily or entirely from decomposition of vegetative and/or animal organic material, which is sold or offered for sale for the purpose of promoting or stimulating plant growth, and to which no inorganic fertilizer materials have been added other than to promote decomposition. Such products shall contain not more than twelve percent (12%) total plant nutrients.

5E-1.002(1)(d) The terms “soil amendment,” “soil conditioner,” or “soil additive,” means any substance or mixture of substances sold or offered for sale for soil enriching or corrective purposes, intended or claimed to be effective in promoting or stimulating plant growth, increasing soil or plant productivity, improving the quality of crops, or producing any chemical or physical changes in the soil, except amendments, conditioners, additives and related products derived solely from inorganic sources containing no recognized plant nutrients.

Appendix B

Supplemental Information
Appendix B

Table of Contents

DON’T BAG IT
GRASS CLIPPINGS RECYCLING PROGRAM

Pinellas County Department of Solid Waste

Since grass clippings constitute almost 11% by weight of the residential waste stream in Pinellas County, not bagging clippings is one of the easiest and most beneficial waste reduction strategies. The “Don’t Bag It” program shows residents that they can enjoy a healthy, aesthetically-appealing lawn as well as drastically reduce waste, and water and fertilizer usage. While the demonstration program described below has been completed, an education program to encourage residents and businesses not to recycle grass clippings continues.

a. BACKGROUND. In order to reduce the amount of grass clippings that are being disposed of in the waste stream, a grass clipping recycling or “Don’t Bag It” project was initiated by the Pinellas County Cooperative Extension Service in late 1990. This two-and-one-half year project was funded by recycling grant funds. In order to use grant funds, the project guidelines and methodology were approved by the Florida Department of Environmental Regulation (now DEP).

DEMONSTRATION PROJECT:

b. METHODOLOGY. Two hundred demonstration homes volunteered for the program. Half of those bagged clippings and half did not. Soil samples were taken from both at the beginning and end of the year. This was to see whether there were positive effects to the soil of not bagging clippings. A complete description of the project is available by contacting the Pinellas County Department of Solid Waste Operations at (813) 464-7565.

c. RESULTS. The two-and-one-half year demonstration project on recycling grass clippings was completed in March 1993. The data collected by the project indicates that the average lawn is approximately 5,000 square feet and generates almost 1,500 pounds of grass clippings per year. This means that the single-family and duplex/triplex households in Pinellas County (286,026) generate 214,520 tons of grass clippings. The results of the 1995 telephone survey indicate 62 percent of single-family households responded that they leave their clippings on the lawn.

The calculation for tons of grass clippings not entering the waste stream (excluding moisture content) which the state Department of Environmental Protection has approved for use in the recycling goals worksheet is 39,901 tons. See the table on the next page, “Calculation for Estimating Tons of Grass Clippings Recycled” in the “Don’t Bag It” program.

1995 PINELLAS COUNTY, FLORIDA
CALCULATIONS FOR ESTIMATING
TONS OF GRASS CLIPPINGS RECYCLED

A. Number of homes	286,026*
B. Percentage of single-family homes responding affirmatively to leaving grass clippings on the lawn	62%**
C. Number of single family homes recycling grass clippings countywide (A x .62)	177,336
D. Average # of tons of grass generated per single-family household per year @ 1,500 lbs./yard) (avg. 5000 square feet of yard)	133,002
E. Total number of tons not entering the waste stream	133,002***
F. Moisture content of grass (70%); (E x .30), total amount of grass recycled/waste reduced	39,901 Tons

* This is an estimate which includes duplexes, triplexes and single family homes - all of which have grass that needs to be mowed.

** Results from the 1995 Annual Telephone Recycling Awareness Survey conducted for Pinellas County by Suncoast Opinion Survey of 500 Pinellas County adults.

*** This is also a conservative number because it does not account for many of the commercial properties (golf courses, condominiums, shopping centers, etc.) which also participate in the “Don’t Bag It” program.

PINELLAS COUNTY YARD TRASH CHARACTERIZATION STUDY

Introduction

Pinellas County, Florida is a 280-square mile peninsula located on the northern extreme of the subtropical zone and experiences a temperate climate. It is Florida's most densely populated urban county. The population density was 3,042 people per square mile when this study was conducted in August 1991 during the peak growing season.

Sampling Analytical Protocols

During the yard trash characterization study, random samples of yard waste, totalling 18.2 tons, were taken from commercial, mixed commercial, and residential collections. Residential routes were selected in cities offering citywide segregated curbside collections. Commercial and mixed commercial sources of yard waste were targeted and identified prior to disposal at the landfill. They were inspected for acceptable content and degree of contamination, then directed to a selected study site located on a paved surface for hand sorting.

At the study site, cone and sectioning procedures were followed to produce a manageable sample size. The following equipment was utilized during the study: 1 roll-off truck; 4 low profile roll-off containers; front-end loader with clamshell bucket attachment; 500-pound rated scale and landfill truck scale; 20 44-gallon buckets; pitchforks; flat point shovels; safety equipment; and wood caliper measuring tools. Personnel consisted of four to six temporary laborers.

Generator Categories

1. Residential Curbside

Four cities with citywide weekly curbside residential collection of segregated yard trash each selected a representative residential route and directed that vehicle on collection day to the study site at the landfill. Yard trash from this source represented an 80% capture rate based on full citywide collections. The separation efficiency is estimated to be 78% based on collection policies that permit grass to be commingled with household solid waste. A total of 27.97 tons of yard trash was received for the characterization study. This sample was coned and sectioned, reducing it into a final test sample section of 4.01 tons. The 27.97 ton sample represented 28.21% of the total tons delivered to the yard trash recycling project on the day of the study. A team of six people required 6 hours to classify the 4.01 ton sample.

2. Mixed Commercial

This component of the study represented commercial landscape and lawn maintenance businesses, as well as materials received from residential dwellings. The yard trash source consisted of 68% from single family dwellings, 26% from commercial businesses, and 6% from multi-family dwellings. Participants in the study consisted of 53% commercial lawn maintenance enterprises and 47% residents of single-family dwellings. The test sample size of 8.82 tons represented 27% of the 32 tons delivered to the county landfill on the day of the study. The entire 8.82 tons captured was studied for composition and size by a team of 8 people that required 7 hours to classify the sample.

3. Commercial

This component of the study represented lawn maintenance and landscape companies that predominantly serviced commercial accounts. Approximately 90% of this material was delivered by commercial lawn service enterprises and 10% from governmental facilities. A sample size of 5.38 tons was identified and diverted to the study site for sizing and classification. This portion represented 24.64% of all yard trash delivered from this generator source on the day of the study. A team of 7 people required 5 hours to classify the 5.38 ton sample.

4. Results

One finding from the study was that small debris (less than 1 inch) when combined with grass comprises 47% of the total weight reflecting the impact of grass on the yard waste stream during August in peak growing season.

Source: Ragsdale, J. V., Rudd, M. J., Bradshaw, J., & Stasis, P. Yard waste composition and effects on compost and mulch production. Paper presented at the Second U.S. Conference on Municipal Solid Waste Management, Arlington, Virginia, June 2-5, 1992.

TARGET TEST PROTOCOL FOR FUGITIVE DUST

When it is suspected that fugitive dust is leaving the site in the direction of neighbors and might cause a nuisance, a target test can be conducted to determine the level of dust escaping.

A target test will determine the level of dust particulates by sampling the air quality at the border of the site upwind from neighbors. This test will capture airborne particulate matter for measurement.

1. Implement the test when operations are generating dust and the wind speed reaches 10 miles per hour upwind of a neighbor .

2. Use a target paper 1 square foot in area. Fly paper works well, or use thick white construction paper with a thin layer of grease spread over the surface.

3. Place the target paper on a pole and elevate to 10 feet above ground level. Station it downwind at the border of the site in line with the source of dust generation and the adjacent off-property neighbor. The time required to capture a sample is 10 minutes.

4. If the paper captures particles on more than 15% of the surface area, cease or modify operations to eliminate the activity that is releasing dust upwind.

Source: Michael Rudd, Director, Pinellas County Department of Solid Waste Management

BIOAEROSOLS ASSOCIATED WITH COMPOSTING FACILITIES

Overview and Executive Summary

OVERVIEW

by Workshop Sponsors

Composting has been a long-accepted and practices means of processing organic materials into useful products that are being beneficially recycled in the environment. Because of an increased number of questions about possible adverse health effects that persons might experience from living near a composting facility, the Composting Council, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA) assembled, in January 1993, a group of international experts on bioaerosols, risk assessment and composting. These experts were drawn largely from regulatory agencies, including EPA, USDA, the National Institute of Occupational Safety and Health (NIOSH) and the Department of Health of the State of New York. The composting industry, consultants, academia, and environmental groups were also represented.

During that intensive two and one-half day January meeting, the twenty-five scientists and engineers reviewed, discussed, analyzed and debated the concerns, facts, and current status of the question: **Do bioaerosols associated with the operation of biosolids or solid waste composting facilities endanger the health and welfare of the general public and the environment?**

The workshop participants attempted to examine the full spectrum of potential bioaerosol agents and impacts, including actinomycetes, bacteria, fungi, arthropods, protozoa, and organic constituents of microbial and plant origin and not just those that might arise from the fungus *Aspergillus fumigatus.* To the best of our knowledge this is one of the first attempts at viewing the comparative health impacts of such a broad spectrum of bioaerosols from different sources of decomposing organic materials, (e.g., grass clippings, wood chips, food and household wastes, agricultural wastes, and biosolids) in the environment. As such, the report on this effort helps establish a scientifically-reasoned basis for evaluation of health impacts from bioaerosols associated with the processing and handling of biologically degraded materials at composting facilities compared with other sources, and helps set the stage for future advances in knowledge about this important subject.

During the twenty-one month period of time following the workshop, participants and other reviewers scrutinized a number of iterative versions of the report resulting in the following state-of-the-knowledge document entitled *Bioaerosols Associated with Composting Facilities.* Relevant data that became available during this period — such as that from the yard waste

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composting site study in Islip, New York — were incorporated into the report which has been edited and guided by Dr. Patricia Millner of USDA.

This state-of-the-knowledge report cites examples of individual case findings of allergic responses as well as more serious disease that have resulted from occupational exposure to some types of bioaerosols in a wide variety of organic dusts. In spite of the fact that some types of bioaerosols can cause occupational allergies and diseases, and that some of the same types of bioaerosols are present in the air at facilities that compost organic materials, the expert participants did not find epidemiological evidence to support the suggestions of allergic, asthmatic, or acute or chronic respiratory diseases in the general public at or around the several open-air and one enclosed composting sites evaluated.

Thus, in response to the question initially posed to the expert participants at the workshop, the answer that emerged was: **Composting facilities <u>do not</u> pose any unique endangerment to the health and welfare of the general public.** The major basis for this conclusion was the fact that workers were regarded as the most exposed part of the community and where worker health was studied, for periods of up to ten years on a composting site, no significant adverse health impacts were found. In addition, the measured concentrations of targeted bioaerosols in residential zones around composting facilities showed that the airborne concentrations of bioaerosols were not significantly different from background (i.e., as if the composting facility were not there). A likely reason that the bioaerosol levels were not significantly different from ambient is because the naturally decomposing self-heating organic matter on which these subsequently aerosolized microbes thrive are widely distributed throughout the environment.

Considering the wide range of potential respiratory responses to organic dusts, it was also the consensus of the participants that additional research be conducted to more clearly define the nature and health impacts of bioaerosols from composting facilities compared with all other environmental sources. Specifically, they recommended that assessments be made of "annoyances" and irritants at and around compost sites and that these be coupled with determinations of ambient concentrations of targeted bioaerosols from sites up- and down-wind of composting facilities and other sources that occur naturally in the environment. Furthermore, the participants recommended operational steps that could be taken at composting sites to reduce the generation and dispersal of, and consequently potential for exposure to, bioaerosols.

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EXECUTIVE SUMMARY

Recycling of biosolids and the organic fractions of municipal solid waste is increasing because of the benefits that can arise and because the alternatives, e.g., landfilling and incineration, are unpopular, too costly or legislatively restricted. Composting is one of the major treatment processes used to transform wastes into agriculturally useful products. The potential health risks associated with exposure to biological aerosols (hereinafter referred to as bioaerosols) generated from the processing and handling of composted organic materials are an important concern in jurisdictions evaluating existing compost installations or planning new ones. Other potential health concerns associated with composting of biosolids, municipal solid wastes, and certain industrial wastes, such as plant uptake of heavy metals and worker exposure to synthetic and volatile organic and inorganic compounds, have been reviewed and evaluated by numerous other investigative teams, and are thus not part of the assessment reported here.

In January 1993, the Composting Council assisted the U.S. Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA), and National Institute of Occupational Safety and Health (NIOSH) in convening a 2 1/2 day workshop at which 25 scientists and engineers reviewed, discussed, analyzed and debated the concerns, facts, and current status of the question:

Do bioaerosols associated with the operation of biosolids or solid waste composting facilities endanger the health and welfare of the general public and the environment?

The collaborative efforts of that workshop and subsequent reviewers' comments have led to the development of this report.

Bioaerosols of concern during composting consist of microorganisms (actinomycetes, bacteria, and fungi), arthropods, protozoa, and organic constituents of microbial and plant origin. While much public concern has focused on the fungus *Aspergillus fumigatus* (AF), workshop participants recognized that other biological constituents in compost feedstocks and compost could be of concern. Such other biological constituents have led to significant exposure effects in workers in other occupational settings where organic materials and dusts are aerosolized in large quantity and often are of greater concern where ventilation is limited. The reporting of the occupational exposures by the workshop is included as an important point of reference and is not meant to imply in any way that the levels of exposure or response from composting operations and compost will be of similar magnitude and effect.

Risks from secondary pathogens like AF, respiratory irritants, and allergenic components are the major emphasis in this document, since the risks associated with primary pathogens, like bacteria, viruses and helminth ova, have been reviewed and evaluated by others.

Significant amounts of research data on exposure concentrations and responses to airborne endotoxins (i.e., the cell walls of gram-negative bacteria), thermophilic actinomycetes, and other fungal spores in occupational settings exist. Such reports are featured in this review to provide a more inclusive (but by no means exhaustive) picture of the exposures and responses that are possible in worst case occupational settings. Limited information is available on inhalation exposures and responses to β-1,3 glucans (constituents of the cell walls of fungi) and mycotoxins, but these entities are included because they augment other response processes associated with organic dust exposure syndromes. The bioaerosols mentioned above are also found outside of the occupational setting in dust generated from a wide variety of organic wastes including grass clippings, wood chips, food/household wastes, agricultural wastes, and biosolids, even in the absence of planned, high temperature, aerobic composting.

Neighborhood exposure to bioaerosols from composting operations is generally less than occupational exposure. However, the biological constituents in commercially prepared composts are of similar type to those in homeowner and non-commercial endeavors. Hence, the potential responses that may result from inhalation of bioaerosols from composts are the same as those that can result from inhalation of a variety of other organic dusts. The responses can vary and are host- and dose-dependent, i.e., some individuals may respond to concentrations that do not affect others. The responses can range from mild cases of inflammation, to allergy, or to serious tissue or systemic infection by secondary pathogens. There are several responses that intergrade between the mild/benign and the serious extremes. Inflammation responses can be stimulated non-immunologically by irritants or immunologically by immune system mediators. Inflammation reactions can be mild and localized as with Mucous Membrane Irritation (MMI), or more generalized, as with Organic Dust Toxic Syndrome (ODTS), or more intense, as with Hypersensitivity Pneumonitis (HP). The intense HP responses result from respiratory exposure to extremely high spore concentrations, e.g., $10^8/m^3$, after a period of sensitization, which may consist of repeated exposures to much lower concentrations, e.g., 10^5-10^6 spores/m^3. The HP response is characterized by an allergic component as well.

Allergenic responses also involve mediators that stimulate inflammation, consequently the distinction between inflammation and allergy is less certain. Like inflammation responses, allergic responses can also present a broad range of symptoms, e.g., mild itching, watery eyes/nose, to coughing and sneezing, to wheezing or more severe respiratory distress, as with asthma. Saprophytic fungi and pollen are well known types of aeroallergens involved in respiratory allergy and asthma. Allergic rhinitis (i.e., nasal congestion due to immune system sensitivity to allergen(s)) is a common, benign response in which a wide variety of airborne allergens have been implicated.

At present, neither minimum threshold levels nor dose-response data are available for AF, β-1,3-glucans, mycotoxins, or enzymes that stimulate inflammatory, allergic, asthmatic, or infectious processes in humans. However, individual cases that involve such agents in adverse respiratory reactions have been reported in the medical literature. These are considered as verified observations that warrant attention in the evaluation of health effects and in the design of future response studies, but they are not predictive about what will happen at the community or population level. For evaluation at that level, statistically well-designed epidemiologic study results would be needed to help establish dose-response impacts and allocate risk among the various sources of environmental exposure.

The verified health effects data that have been observed for occupationally-exposed individuals have shown that infection (i.e., invasive growth of pathogenic microorganisms into body tissues, organs, or systems) caused by opportunistic (secondary) pathogens indigenous to organic dusts from any source is **extremely rare**, even among workers who are exposed continuously to high concentrations of various bioaerosols. When such invasive or systemic, opportunistic infections occur they usually occur in individuals whose immune defense systems are very severely compromised (functionally abnormal) because of genetic or acquired conditions. Such individuals are at risk to infection from microbes in the general environment, which contains natural sources of these organic dusts and associated microbes. Immunocompetent, corticosteroid-managed asthmatics are susceptible to a specific response Allergic Bronchopulmonary Aspergillosis which involves the growth of *Aspergillus* species in the airways (but not the lung tissue *per se*).

None of the published or unpublished reports to which this work group had access either directly or through computerized databases such as Medline, Toxline, Agricola, CAB abstracts, Biological abstracts, Biosis, and CAIN, provided any dose-response data for AF, other fungi in composts, β-1,3 glucans, mycotoxins, enzymes, viruses, or bacteria in terms of inflammation, allergy, asthma, or opportunistic infections. However, based on considerable volumetric air sample data involving indoor, occupational endotoxin exposures and responses, the International Committee on Occupational Health has suggested threshold response ranges for gram-negative bacterial endotoxin as follows: 1000-2000 ng/m^3, organic dust toxic syndrome (ODTS); 100-200 ng/m^3, acute bronchoconstriction; and mucous membrane irritation, 20-50 ng/m^3. These endotoxin exposures are relatively high in comparison with outdoor non-occupational settings, such as in a residential community. In the absence of threshold response ranges for AF and other constituents of composts, we examined what some typical community and neighborhood exposures might be.

Published airspora* studies contain both qualitative and quantitative data confirming that the microorganisms found at compost sites, in the compost products, and their various feedstocks are also found in the ambient air environment, and, as such, should be considered as part of the total airspora. The quantitative studies show that, although concentrations may be higher at compost sites during vigorous movement of the compost, certain natural sources as may be encountered by the public during daily activities may generate very high concentrations of certain fungi and actinomycetes, notably *Aspergillus fumigatus* (AF) and *Thermoactinomyces vulgaris*. Outdoor airspora concentrations, including AF, vary seasonally; peak seasons differ by locality. Reported concentrations of AF in outdoor air range from 0-686 colony-forming units (CFU)/m^3. In general, the outdoor airspora is dominated by the saprophytic fungi, i.e., *Alternaria*, *Cladosporium*, *Aspergillus*, and *Penicillium*. The concentration of thermophilic actinomycetes in outdoor air is typically so low that any concentrations above 10 CFU/m^3 strongly suggests that self-heating organic material had been aerosolized nearby the sampler site. For this reason, thermophilic actinomycetes can be regarded as indicator organisms in studies of aerial dispersion of compost bioaerosols.

Indoor air, while somewhat seasonally variable, can also contain high levels of bioaerosols dominated by *Penicillium* and *Aspergillus*, during interior housekeeping; and bioaerosols increase during indoor housekeeping activities. Indoor occupational exposures in agricultural environments where organic dusts are generated, i.e., grain elevators, barns with moldy hay, and mushroom production facilities, represent the most intense exposure situations. It is noteworthy that even these extreme exposures have not led to any increased infectious diseases by AF in exposed worker populations.

Bioaerosol monitoring data from several biosolids-composting operations, which differ in design and feedstock, were compared to each other and to the ambient natural airspora data. The highest concentrations of aerobic bacteria, thermophilic (heat-loving) fungi, and AF were detected directly on the composting sites during peak operations. As expected, concentrations of these microorganisms in air downwind from the centers of the composting sites were less than the peak values on-site, and in most cases less than or nearly similar to those at the upwind sites (i.e., not significantly different from normal ambient exposure, as if the composting site were not present). Yard waste composting sites also produce AF and thermophilic actinomycetes aerosols that on average are similar to those from outdoor biosolids composting facilities. There is almost no data on other bioaerosol constituents downwind of any composting site whether it be for processing biosolids, yard waste, or other organic material.

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* fungal and actinomycete spores/propagules collected from the air; identified by microscopic morphology, by in-vitro culture method(s), and/or biochemical/serotaxonomic characteristics.

To the extent that it is desirable to mitigate bioaerosols, design, siting, and operational factors are important tools. Controlling temperature and moisture of actively composting materials and stored compost and feedstocks, and timing and minimization of mechanical agitation during favorable atmospheric conditions will abate dust and minimize the growth and proliferation of bioaerosol agents. Site enclosure, biofilters, compost scrubber piles, and site topographic and landscape design may be used in various combinations to abate bioaerosol transport downwind. Buffer distances to the surrounding community will depend on facility size, design, and operational factors. Current bioaerosol monitoring data and data from a few experimental studies provide the basis for estimating source strengths, and downwind concentrations associated with particular design and operational parameters. Models are helpful for predicting downwind concentrations of bioaerosols from area sources of bioaerosols, but are not overly precise.

Several conclusions reached by the working group included:

1) The general population is not at risk to systemic (i.e., whole body, generalized, as in circulatory, lymph etc.) or tissue infections from compost-associated bioaerosol emissions.

2) Immunocompromised individuals are at increased risk to infections by various opportunistic pathogens, such as *A. fumigatus*, which occurs not only in compost but also in other self-heated, organic materials present in the natural environment.

3) Asthmatic and 'allergic' individuals are at increased risk to responses from bioaerosols from a variety of environmental and organic dust sources, including compost. *A. fumigatus* is not the only or even the most important bioaerosol of concern in assessment of risk for ODTS, MMI, and HP (extrinsic allergic alveolitis) associated with exposure to dust from organic materials. The amounts of airborne allergens that sensitize and subsequently incite asthmatic or allergic episodes cannot be defined with current information available, especially given the wide variation in host sensitivity, the numerous sources of natural environmental exposure, and the diversity of constituents and bioaerosols. Prospects for such precise definition are limited in the short-term because of these factors.

4) In spite of the fact that some types of bioaerosols can cause occupational allergies and diseases, and that some of the same types of bioaerosols are present in the air at facilities that compost organic materials, available epidemiological evidence does not support the suggestions of allergic, asthmatic, or acute or chronic respiratory diseases in the general public at or around the several open-air and one enclosed composting sites evaluated.

Hence, the answer that emerged to the question posed at the beginning of the workshop is: **Composting facilities <u>do not</u> pose any unique endangerment to the health and welfare of the general public.** The major basis for this conclusion was the fact that workers were regarded as the most exposed part of the community and where worker health was studied, for periods of up to ten years on a composting site, no significant adverse health impacts were found. In addition, in most cases the measured concentrations of targeted aerobic bacteria, thermophylic (heat-loving) fungi, and AF bioaerosols in residential zones around composting facilities showed that the airborne concentrations of bioaerosols were not significantly different from background (i.e., as if the composting facility were not there). A likely reason that the bioaerosol levels were not significantly different from ambient is because the naturally decomposing self-heating organic matter on which these subsequently aerosolized microbes thrive are widely distributed throughout the environment.

EXOTIC PEST PLANTS

The table below lists Category 1 exotic pest plants that invade and disrupt Florida native plant communities. The category designation is given without regard to the economic severity or geographic extent of the problem.

Category 1 Exotic Pest Plants

Scientific Name	Common Name
Abrus precatorius	Rosary Pea
Acacia auriculiformis	Earleaf Acacia
Ardisia crenulata (syn. A. crenata)	Coral Ardisia
Ardisia elliptica (syn. A. humilis)	Shoebutton Ardisia
Asparagus densiflorus	Asparagus Fern
Bischofia javanica	Bischofia
Brachiaria mutica	Para Grass
Calophyllum calaba (syn. C. inophyllum of auth.)	Mast Wood, Alexandrian Laurel
Cassia coluteoides (syn. Senna pendula)	Climbing Cassia, Christmas Cassia, Christmas Senna
Casuarina equisetifolia (syn. C. litorea)	Australian Pine
Casuarina glauca	Suckering Australian Pine
Cestrum diurnum	Day Jasmine
Cinnamomum camphora	Camphor Tree
Colocasia esulenta	Taro
Colubrina asiatica	Lather Leaf
Cupaniopsis anacardioides	Carrotwood
Disocorea bulbifera	Air Potato
Eichhornia crassipes (P)	Water Hyacinth
Eugenia uniflora	Surinam Cherry
Ficus microcarpa (syn. F. nitida, F. retusa var. nitida)	Laurel Fig
Hydrilla verticillata (P)	Hydrilla
Hygrophila polysperma (P)	Green Hygro
Hymenachne amplexicaulis	West Indian Marsh Grass
Imperata brasiliensis (syn. I. clindrica)	Cogon Grass
Ipomoea aquatica (P)	Water Spinach
Jasminum dichotomum	Gold Coast Jasmine
Jasminum fluminense	Jasmine
Lantana camara	Lantana

Ligustrum sinense	Hedge Privet
Lonicera japonica	Japanese Honeysuckle
Lygodium japonicum	Japanese Climbing Fern
Lygodium mycrophyllum	Old World Climbing Fern
Macfadyena unguis-cati	Cat's Claw
Melaleuca quinquenervia (P)	Melaleuca
Melia azedarach	Chinaberry
Mimosa pigra (N)(P)	Catclaw Mimosa
Nandina domestica	Nandina, Heavenly Bamboo
Nephrolepis cordifolia	Sword Fern
Neyraudia reynaudiana'	Burma Reed, Cane Grass
Oeceoclades maculata	Ground Orchid
Paederia foetida	Skunk Vine
Panicum repens	Torpedo Grass
Paspalum notatum	Bahia Grass
Pennisetum purpureum	Napier Grass
Pistia stratiotes	Water Lettuce
Psidium guajava	Guava
Psidium littorale(syn. P Catteranum)	Strawberry Guava
Pueraria montana (syn. P. lobata)	Kudzu
Rhodomyrtus tomentosus	Downy Myrtle
Rhoeo spathacea (syn. R. discolor)	Oyster Plant
Sapium sebiferum	Popcorn Tree, Chinese Tallow Tree
Scaevola taccada var. sericea (syn. S. frutescens, S. sericea)	Scaevola, Half-Flower, Beach Naupaka
Schefflera actinophylla (syn. Barassaia actinophylla)	Schefflera
Schinus terebinthifolius	Brazilian Pepper
Solanum torvum (N)	Turkey Berry
Solanum viarum	Tropical Soda Apple
Syzygium cumini	Jambolan, Java Plum
Tectaria incisa	Incised Halberd Fern
Thespesia populnea	Seaside Mahoe
Tradescantia fluminensis	White-flowered Wandering Jew

Total Category I Species = 60

Source: Florida Exotic Pest Plant Council (EPPC). (1995).
Florida Exotic Pest Plant Council's most invasive species.