MORE than 6.6 million tons of compostable grocery residuals are disposed of each year in the United States at a cost of $482 million, according to recent estimates by the Grocery Industry Committee on Solid Waste. In contrast, supermarkets participating in composting programs report saving upwards of 30 percent on disposal costs. Full-scale organic grocery debris composting projects in Washington, Maine, Michigan and New Hampshire show the feasibility of using low technology approaches similar to methods for yard trimmings composting. However, for many facilities to successfully implement this approach, a higher level of process management is required. In general, low tech composting relies on windrow turning for aeration, utilizes an uncovered composting area, and limits the use of capital equipment.

Physical and chemical characteristics of produce residuals differ significantly from yard trimmings. Overall, produce residuals have a higher nitrogen, moisture, and readily available carbon (sugars, starches and proteins) content than yard trimmings. Consequently, there is a greater potential for odor generation, nuisance animal and insect attraction and leachate/surface water production when composting organic grocery debris.

The nonrecyclable cardboard content of organic grocery debris presents another challenge. Including nonrecyclable cardboard (especially wax coated) as a composting feedstock is a relatively new practice, so there is limited information available. Questions include preprocessing requirements, suitability as a bulking material, rate of decomposition and potential trace metal and organic compound content.

In recognition of the potential obstacles to implementing grocery waste composting programs, the Clean Washington Center (a Division of the Washington State Department of Economic Development) commissioned a project to address these issues and develop a “Best Management Practices Manual for Composting Grocery Wastes Using a Low Technology Approach.” The project included a pilot study involving a yard trimmings composting facility at Iddings, Inc. in Kent, Washington.

The results of the pilot project as well as the operational experience at Iddings clearly indicate facilities using a low tech approach need to incorporate a higher level of process management when composting organic grocery debris. In particular, leachate generation, odor production and nuisance pest attraction need to be addressed through process management. The manual pays significant attention to procedures for limiting environmental impacts; the most pertinent aspects are summarized in the following sections.

INITIAL PROCESSING AND MIXING

A crucial aspect of organic grocery debris composting is the receipt of feedstocks and their initial handling. Feedstocks arriving at a composting facility need to be mixed with bulking material immediately and placed into windrows. The storage of organic grocery debris at the composting facility should be limited to very short periods.

Release of free water after organic grocery debris is unloaded at the facility onto the composting pad can cause a number of problems including: wet, anaerobic conditions in adjacent piles; unnecessary BOD and nutrient loading on the surface water collection system; attraction of nuisance insect and animals; and odor generation. Free water can be controlled by unloading the produce waste onto a layer of relatively dry, absorbent bulking material, i.e. mixed waste paper, yard debris and dust. These materials are immediately mixed to maximize the absorption of free water. Additional bulking agent is added to the mix as required. Initial mixing should be conducted in a dedicated area that provides for the collection of free water.

There is little, if any, benefit from grinding or shredding the vegetative organic grocery debris prior to initial mixing. Due to its
MORE than 6.6 million tons of compostable grocery residuals are disposed of each year in the United States at a cost of $482 million, according to recent estimates by the Grocery Industry Committee on Solid Waste. In contrast, supermarkets participating in composting programs report saving upwards of 30 percent on disposal costs. Full-scale organic grocery debris composting projects in Washington, Maine, Michigan and New Hampshire show the feasibility of using low technology approaches similar to methods for yard trimmings composting. However, for many facilities to successfully implement this approach, a higher level of process management is required. In general, low tech composting relies on windrow turning for aeration, utilizes an uncovered composting area, and limits the use of capital equipment.

Physical and chemical characteristics of produce residuals differ significantly from yard trimmings. Overall, produce residuals have a higher nitrogen, moisture, and readily available carbon (sugars, starches and proteins) content than yard trimmings. Consequently, there is a greater potential for odor generation, nuisance animal and insect attraction and leachate/surface water production when composting organic grocery debris.

The nonrecyclable cardboard content of organic grocery debris presents another challenge. Including nonrecyclable cardboard (especially wax coated) as a composting feedstock is a relatively new practice, so there is limited information available. Questions include preprocessing requirements, suitability as a bulking material, rate of decomposition and potential trace metal and organic compound content.

In recognition of the potential obstacles to implementing grocery waste composting programs, the Clean Washington Center (a Division of the Washington State Department of Economic Development) commissioned a project to address these issues and develop a “Best Management Practices Manual for Composting Grocery Wastes Using a Low Technology Approach.” The project included a pilot study involving a yard trimmings composting facility at Iddings, Inc. in Kent, Washington.

The results of the pilot project as well as the operational experience at Iddings clearly indicate facilities using a low tech approach need to incorporate a higher level of process management when composting organic grocery debris. In particular, leachate generation, odor production and nuisance pest attraction need to be addressed through process management. The manual pays significant attention to procedures for limiting environmental impacts; the most pertinent aspects are summarized in the following sections.

INITIAL PROCESSING AND MIXING

A crucial aspect of organic grocery debris composting is the receipt of feedstocks and their initial handling. Feedstocks arriving at a composting facility need to be mixed with bulking material immediately and placed into windrows. The storage of organic grocery debris at the composting facility should be limited to very short periods.

Release of free water after organic grocery debris is unloaded at the facility onto the composting pad can cause a number of problems including: wet, anaerobic conditions in adjacent piles; unnecessary BOD and nutrient loading on the surface water collection system; attraction of nuisance insects and animals; and odor generation. Free water can be controlled by unloading the produce waste onto a layer of relatively dry, absorbent bulking material, i.e. mixed waste paper, yard debris and dust. These materials are immediately mixed to maximize the absorption of free water. Additional bulking agent is added to the mix as required. Initial mixing should be conducted in a dedicated area that provides for the collection of free water.

There is little, if any, benefit from grinding or shredding the vegetative organic grocery debris prior to initial mixing. Due to its
do not pose a threat to humans or crops. Beneficial nutrients are present.

Biosolids were spread on the demonstration site to match the estimated crop nitrogen requirements, a level equal to 18 cubic yards/acre. With 70 acres receiving biosolids, 1,260 cubic yards were spread on the demonstration site.

SOILS AND YIELDS

The hay on the demonstration site was cut on June 3, 1993, and baled soon thereafter. Soil samples were taken at the demonstration site on June 23, 1993. Laboratory results on these soil samples, characterizing the soil quality after the 1992 biosolids application and subsequent 1992-1993 winter crop growth, show no significant difference from background soil samples taken from the proposed application sites throughout the subregional system in October, 1990 (Table 2). As can be seen from this comparison, the application of biosolids from the Laguna treatment plant at the agricultural demonstration site had no significant impact on soil quality.

A comparison of winter-annual oat hay crop yields at the demonstration site for the three years preceding the 1992-1993 season is presented in Table 3. It is apparent from the yields, in addition to the discussions with the farmer and direct observations, that the application of lime and biosolids greatly improved crop yields.

The annual water need for oat hay is about 13 inches per season. Rainfall in all four years more than met the crop requirement with growing season totals ranging from 19 to 34 inches. Based upon this analysis, it is concluded that the significant increase in oat hay crop yield obtained at the end of the 1992-1993 growing season was attributable primarily to the biosolids application.

LONG-TERM PROGRAM

Implementation of biosolids land application will be phased in over three years from 25 percent of the biosolids in 1993 to potentially 60 percent in 1995. Sites will include both private farmland and city-owned farmland (reclaimed water reuse areas). For the private land, contracts are negotiated with landowners to clarify the responsibilities of each party.

The costs of land application vary depending on the site location and the site lime requirement. For sites within five miles of the treatment plant with low lime requirements, the cost of land application is about 50 percent of the cost of land-filling. The current cost of landfilling is about $150/dry ton (hauling plus tipping fee).

For remote sites with higher lime requirements, the principal cost is lime purchase and spreading, biosolids hauling and biosolids spreading. For an estimated 15 tons/acre of lime, a haul distance of 25 miles, and a spreading cost of $8.30/dry ton, the cost breakdown is as follows: Lime cost, 84 percent; Hauling cost, 11 percent; Spreading cost, five percent. The potential for cutting the lime expenditure is being examined. Field trials are underway to evaluate reduction of lime use. Alternative lime suppliers are being pursued.

By diverting biosolids from the Sonoma County Central Landfill, not only is disposal capacity conserved, but benefits to farmland are observed. Biosolids application supplies the nitrogen requirements and enhances the structure and water holding capacity of the soil. Land application appears to be an inexpensive way for farmers in the area to increase profits by increasing the crop yield.

Ronald Crites is director of water resources with Nolte and Associates, Sacramento, California. Donald Fox is senior scientist with CH2M Hill in Redding, California. Dan Carlson is the utilities capital projects coordinator in the City of Santa Rosa. Work was done under contract between the City of Santa Rosa and Metcalf & Eddy Inc.
high energy content and relatively low fraction of structural fibers such as cellulose and lignin, produce waste readily decomposes without size reduction. In fact, the size reduction of vegetative organic grocery debris will release water, requiring additional bulking material and surface water management. At facilities composting unground vegetative debris using the turned windrow process, the various components of the produce residuals are observed to readily decompose within a short period.

An increasingly common source separation practice entails the commingled collection of produce residuals with nonrecyclable paper and cardboard. In this case, size reduction is recommended, as the decomposition of the paper and cardboard will be enhanced. However, the bulking material used for the commingled organic grocery debris should all be ground together, to maximize the absorption of the water released during grinding. Table 1 provides some recommendations for preprocessing organic grocery debris based on the equipment available and feedstocks collected.

Adequate mixing of the bulking material with the organic grocery debris, prior to windrow construction, is important. The composting process is compromised if large particle sized bulking materials are not adequately mixed with the wet, fine particle, high energy feedstocks. Inadequate mixing can result in anaerobic conditions, odor generation, and increased processing time.

**MIX RATIO DEVELOPMENT**

The provision of optimum composting conditions starts with the development of the initial compost mix. When composting organic grocery debris, air filled macro pore space volume (aeration voids) is the single most important component of an initial mix. A mix with insufficient aeration voids will impede the flow of air through the pile, limiting aeration. This is especially significant when using a low tech composting approach that relies entirely on windrow turning and convection for aeration.

Bulk density can be used as an indicator of aeration void volume. In general, the greater the density, the lower the aeration void volume. Table 2 shows the effect of density on compost pile oxygen levels and the generation of mercaptans, very odorous sulfur gasses produced under anaerobic conditions. In the two piles with high bulk densities, the concentration of oxygen is very low or nonexistent and mercaptan levels are high. As a general guideline, the bulk density of the initial mix should be less than 900 pounds per cubic yard.

Aeration voids in a compost mix are provided by large particle size materials such as chopped brush and wood chips. Grinding and shredding equipment should be adjusted to produce a coarsely ground feedstock. The two high density mixes presented in Table 2 are a result of the feedstocks being ground too fine. Moisture content also influences aeration because the effective or air filled pore space is reduced as the moisture content increases.

The optimum moisture content for composting is considered to range from 40 to 60 percent. However, the optimum moisture range is dependent on the moisture holding capacity and porosity of the mix, which can change during the composting process. For example, particle size reduction resulting from microbial and physical decomposition and the incorporation of soil and rocks from windrow turning on an unpaved surface will increase the density of the mix.

As a general rule of thumb, the initial mix carbon to nitrogen (C:N ratio) ratio should be approximately 30:1. A lower C:N ratio can result in the generation of odorous nitrogen containing compounds such as amines and ammonia during composting. At higher C:N ratios, nitrogen may not be sufficient for active, thermophilic composting. However, initial organic grocery debris mixes with C:N ratios as high as 60:1 have been noted to compost quite well. More significant than C:N ratio is the microbial availability of the carbon and ni-
Leachate generation, odor production and nuisance pest attraction need to be addressed through process management.

trogen. When food waste is composted with mixed yard trimmings at almost any ratio, there will typically be sufficient nitrogen available for the generation of thermophilic temperatures. An excessive nitrogen content is a greater concern when composting organic grocery debris.

In summary, the moisture content of the initial mix should be approximately 50 percent, and the bulk density should be less than approximately 900 pounds per cubic yard. If a mix of yard trimmings and produce waste has a moisture content of 50 percent, and a bulk density of 900 pounds per cubic yard, the other parameters such as nitrogen and available carbon content will fall in line. In general, a minimum of at least two parts bulking material should be added to each part organic grocery debris.

**BULKING MATERIAL SELECTION**

A number of bulking materials can be used effectively for composting organic grocery debris. The primary requirement of a bulking material is to decrease the density of this heavy, wet material, thereby increasing the aeration voids. To achieve this objective, the bulking material should have a significant structure and relatively low moisture content. In general, bulking materials that are less than adequate can be used if they are incorporated at high rates, i.e. 5:1 bulking material to produce waste. Alternatively, less than adequate bulking materials can be supplemented with dry, woody materials.

Yard trimmings are an excellent bulking material for produce waste. However, the physical and chemical characteristics of yard trimmings can change significantly between seasons. This must be taken into consideration when yard trimmings are being used as the primary or sole bulking ingredient. The chemical and physical characteristics of yard trimmings as well as the changes observed between seasons are regional in nature. Aeration voids provided by yard trimmings can be maximized by adjusting the shredding/grinding equipment to produce a coarser feedstock.

In the winter months, yard trimmings will have a lower nitrogen and readily available carbon content. Winter yard trimmings also have a significant structure and will typically provide sufficient aeration voids, even at a mix ratio as low as two parts yard trimmings to one part produce waste.

Yard trimmings collected during the spring and summer, however, typically have a significant amount of grass clippings, resulting in an inadequate bulking material. The amount of spring/summer yard trimmings used for bulking produce waste is dependent on the volume of grass clippings present. As a composting feedstock, grass clippings are similar to organic grocery debris, having a high nitrogen and readily available carbon content. Consequently, spring/summer yard trimmings as a sole bulking material may not be adequate and additional bulking materials such as chipped pallets and screen overs may be required.

It is recommended that a cache of a very porous bulking material such as chipped brush, wood chips or screen overs be stockpiled for use. These materials would be used to offset fluctuations of incoming bulking materials and grocery wastes. Relying on the materials that are delivered each week to produce a mix with adequate aeration voids is unreasonable and risky. A stockpile of bulking material can be used to adjust the initial mix density when the quantity or quality of the delivered bulking agent is inadequate.

### Table 2. Initial Mix Ratio and Bulk Density*, Oxygen, and Mercaptans

<table>
<thead>
<tr>
<th>Bulk Material*: Produce Debris</th>
<th>4.0</th>
<th>4.1</th>
<th>5:1</th>
<th>2.5:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprocessing*</td>
<td>None</td>
<td>None</td>
<td>Ground</td>
<td>Ground</td>
</tr>
<tr>
<td>Bulk density (lbs/cy)</td>
<td>300</td>
<td>500</td>
<td>1500</td>
<td>1400</td>
</tr>
<tr>
<td>Oxygen concentration (%)</td>
<td>19.9</td>
<td>18.8</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>Total mercaptans</td>
<td>0.2</td>
<td>0.5</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

* Determined three days after pile construction
* Yard debris and cardboard
* Ground in a hammermill with 3 inch triangle grates
* Determined at 2 foot depth and 3 foot height
* Determined with Kitigawa field gas detector from a sample collected at 1 foot depth in each pile.
COLLECTION • Overhauling Programs • Adding Materials • Lowering Costs With Dropoffs • Adjusting Frequency • Cocollection Techniques

COMMERCIAL • Entrepreneurial Opportunities • Recycling Methods At Stores, Offices And Institutions • Waste Reduction Systems

ECONOMICS • Commingled Vs. Source Separated • Innovative Financing Approaches • Cost Reduction Strategies

MRFs • Upfront Processing • Project Financing And Ownership Arrangements • Finding The Right Contractor

EQUIPMENT • Special Collection Vehicles • Automatic Sorting • Improving Quality Of Recyclables • Debagging Machinery

SPECIAL MATERIALS • C&D Recycling • Glass Cullet • Tires • Used Oil • Plastics • Appliances • Steel Cans

MARKET DEVELOPMENT • Procurement Initiatives • Remanufacturing Potential • Recycling Market Development Zones • Cooperative Approaches

CALL (610) 967-4135 OR MAIL FORM TODAY

THE BIOCYCLE GUIDE TO
MAXIMUM RECYCLING

Please send me ______ copy(ies) of THE BIOCYCLE GUIDE TO MAXIMUM RECYCLING at $55 per copy.

- Payment enclosed of $______ (Checks payable to BioCycle)
- Send invoice (Plus $4 postage/handling)

Bill me ☐ MasterCard ☐ Visa

Card No. ____________ Expires ____________

PA residents add 6% sales tax. Outside U.S. $60 per book. Checks payable in US funds only. Allow about three weeks for delivery.

Name __________________________

Affiliation _______________________

Address _________________________

City __________________ State ______ Zip ______

Phone Number ____________________

Satisfaction Guaranteed

If for any reason you are dissatisfied, return book within 15 days for full refund or credit.
Because of its high energy content and relatively low fraction of structural fibers, produce waste readily decomposes without size reduction.

Organic grocery debris (center) can contain a substantial amount of wax coated cardboard produce boxes compared to cafeteria food waste (below). At Washington compost site (upper right), yard debris, cardboard and produce waste are mixed.

Hammermill decomposed more rapidly than the unground WCC. After 85 days of composting, 88 percent of the ground WCC had decomposed compared to 56 percent in the unground WCC pile. After 163 days of processing, 98 percent of the ground WCC and 84 percent of the unground WCC had decomposed. The enhanced decomposition of the ground WCC was an apparent result of increased surface area available for microbial decomposition. The results clearly demonstrate that composting of unground WCC is feasible, but requires more time.

The addition of WCC at approximately 10 to 20 percent of the pile volume was noted to have extended the duration of 70°C temperatures. The wax appears to be a readily available source of energy. This observation is consistent with the results of a pilot project conducted by McGill University (1992) and bench scale decomposition studies conducted by Hantsveit (1990a, 1990b).

Questions have been raised regarding the trace metal and synthetic organic compound content of WCC. The project results indicated WCC did not increase the trace metal content of the compost products. To address these analyses and NCASI (1993), it is concluded that cardboard, as compost feedstock, contributes insignificant quantities of trace metals to the finished compost product.

The concentration of boron in WCC (Table 3) is noted to range between 23 and 29 mg/kg. These results suggest that the incorporation of WCC as a compost feedstock, even at a high rate, should not result in a product with plant toxic boron levels. Previous studies using compost as a plant growth medium indicate boron phytotoxicity does not occur when the boron concentration is below 50 mg/kg. A recent study, however (McGill, 1992), found plant toxic levels of boron in the compost product when cardboard was incorporated at a high rate. In this study, the concentration of boron in the cardboard composted was as high as 2,261 mg/kg. Compost producers should be aware that cardboard can contain high boron con-

---

Table 3. Trace Metal Analyses of Wax Coated Cardboard

<table>
<thead>
<tr>
<th>Sample Color</th>
<th># of Samples</th>
<th>As (mg/kg)</th>
<th>Ba (mg/kg)</th>
<th>B (mg/kg)</th>
<th>Cd (mg/kg)</th>
<th>Cr (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Ni (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>4</td>
<td>nd</td>
<td>8.2</td>
<td>25</td>
<td>nd</td>
<td>1.0</td>
<td>5.0</td>
<td>1.0</td>
<td>nd</td>
<td>6.6</td>
</tr>
<tr>
<td>Green</td>
<td>4</td>
<td>nd</td>
<td>9.0</td>
<td>27</td>
<td>nd</td>
<td>1.0</td>
<td>8.6</td>
<td>1.0</td>
<td>nd</td>
<td>7.5</td>
</tr>
<tr>
<td>Yellow</td>
<td>1</td>
<td>nd</td>
<td>9.2</td>
<td>29</td>
<td>nd</td>
<td>1.4</td>
<td>27</td>
<td>1.2</td>
<td>nd</td>
<td>11.1</td>
</tr>
<tr>
<td>Blue</td>
<td>4</td>
<td>nd</td>
<td>10.5</td>
<td>26</td>
<td>nd</td>
<td>1.2</td>
<td>28.1</td>
<td>1.0</td>
<td>nd</td>
<td>6.7</td>
</tr>
<tr>
<td>Red</td>
<td>4</td>
<td>nd</td>
<td>22.5</td>
<td>23</td>
<td>nd</td>
<td>1.0</td>
<td>6.5</td>
<td>0.8</td>
<td>nd</td>
<td>6.2</td>
</tr>
<tr>
<td>No Color</td>
<td>2</td>
<td>nd</td>
<td>9.5</td>
<td>24</td>
<td>nd</td>
<td>1.3</td>
<td>27.9</td>
<td>0.9</td>
<td>nd</td>
<td>7.1</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>nd</td>
<td>12.1</td>
<td>25</td>
<td>nd</td>
<td>1.1</td>
<td>10.8</td>
<td>0.9</td>
<td>nd</td>
<td>7.0</td>
</tr>
</tbody>
</table>

\( \text{aProduce boxes collected from 10 grocery stores located in the greater Seattle, Washington area} \)

\( \text{bColor of actual sample analyzed} \)
centrations. The product should be tested regularly to assure the boron content of the finished product does not pose a phytotoxicity problem.

Wax coatings used in WCC are produced from the distillation of lubricating oils. Consequently, there is a concern that the petroleum based waxes may contain volatile organic aromatics (VOAs) and polycyclic aromatic hydrocarbons (PAHs). These compounds are commonly found in other petroleum products such as gasoline and oil. One sample of WCC was analyzed for VOA compounds (EPA Methods 5030/8020) and polynuclear aromatic hydrocarbons (EPA Methods 3540/8310). None of the compounds analyzed were detected, suggesting these impurities are not present (at concentrations greater than the detection limit) in WCC. However, only one sample was analyzed and additional analyses should be performed to confirm these results.

AERATION REQUIREMENTS

The maintenance of aerobic conditions during composting is crucial for minimizing odor production and maximizing the decomposition process. Due to the high energy content of organic grocery debris, the aeration requirements for composting this feedstock are typically greater than for yard trimmings alone. The low technology composting approach relies on windrow turning and convection for aeration. Therefore, any increase in aeration will require increased turning frequency or a process modification to enhance convection.

Convection refers to the physical process where air is drawn into the pile base as a result of heat generated during the process escaping through the top of the pile. The ability of convection to provide oxygen to the pile can be enhanced by increasing the volume of aeration voids in the mix or reducing the size of the compost pile. As mentioned previously, aeration void volume can be improved by increasing the ratio of bulking agent and keeping a supply of dry, coarse materials such as screen overs, wood chips, chipped pallets on hand. A large portion of these materials are removed during the screening process, and can be reused continually. The addition of a dry feedstock and the subsequent reduction in the moisture content of the mix also will enhance air flow into the pile. Increasing the size of the shredded yard trimmings by increasing the size of the screen in the grinding/shredding equipment is another method of decreasing the density of the mix.

Convective aeration also can be enhanced by decreasing the size of the compost pile. The results of the pilot study indicated oxygen becomes limiting in a turned windrow at a depth of three feet. The volume of this oxygen limiting core can be decreased by reducing the cross sectional area of the pile. As-

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sensory Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>Composting material should feel moist, not wet or damp. When squeezed in a fist free water should not result. If a ball cannot be formed, the material is probably too dry.</td>
</tr>
<tr>
<td>Aeration</td>
<td>Sour odors indicate oxygen is limiting and the pile should be turned more frequently</td>
</tr>
<tr>
<td>Density</td>
<td>Sample should have a granular, chunky appearance. A fine texture is an indication the material is not sufficiently bulked.</td>
</tr>
<tr>
<td>Stability</td>
<td>Stable products should have a soil like or no odor and a dark color. Feedstocks such as grass, leaves, fruits and vegetables should not be readily identifiable.</td>
</tr>
</tbody>
</table>

Winter yard trimmings will typically provide sufficient aeration voids, even at a mix ratio as low as two parts yard trimmings to one part produce residuals.
Produce residuals have higher content of nitrogen, moisture and readily available carbon than yard trimmings.

Whole wax coated cardboard boxes are incorporated into experimental compost pile in Kent, Washington.

Produce waste. Oxygen is depleted very quickly after turning during the initial, active stage of composting. Extensive monitoring of turned windrow piles conducted by E&A Consultants, Inc. indicates oxygen limiting conditions will exist regardless of the windrow turning frequency. Turning should be conducted at a frequency that limits the persistence of anaerobic conditions. When anaerobic conditions persist, sour smelling volatile organic acids such as acetic, butyric and propionic acid are produced. The monitoring of these odors in the pile core is a reasonable method of determining if the pile should be turned. If sour odors are noted, turning is necessary. Temperature and oxygen monitoring also can be used to determine adequate windrow turning frequency. In general, compost piles containing produce waste should be turned at least twice a week during the first month of the process. For the following two months, the piles should be turned three to four times per month. However, factors such as intended market, proximity of neighbors, and desired processing time can affect frequency.

PROCESS MONITORING

Process monitoring provides the means to assess composting conditions and determine the need for activities such as pile turning and water addition. Monitoring entails the regular collection of data pertinent to the composting process. In addition, the data should be examined to determine if and what process adjustments need to be made. At a minimum, monitoring activities should include bulk density, moisture content, temperature and qualitative parameters (odor, color, texture). Process monitoring will provide for a rapid and comprehensive understanding of the process at the specific site.

Assessing the compost visually and by smell and feel can provide valuable insight to the process. It is recommended that the sample being assessed is taken from the pile middle with a front end loader. Table 4 provides some recommendations for using non-analytical measures to assess the composting process.

REFERENCES


Gerry Croteau and Joel Alpert are with E&A Consultants, Inc, with offices in Bothell, Washington and Canton, Massachusetts. This project was funded through the Clean Washington Center’s Technology Assistance for Business program. “A Best Management Practices Manual for Composting Produce Waste and Wax Coated Cardboard” is available through the Center’s publication hotline: (206) 587-5524.