Source separation and composting of organic municipal solid waste

by Mark Gould, Richard Garrison and Stephen Foster

Mark Gould and Richard Garrison of E&A Environmental/EMCON, Inc. (Canton, Massachusetts) planned and designed the East Hampton, New York composting facility. Stephen Foster of R. Cave and Associates, Ltd., (Oakville, Ontario) developed the wet/dry collection systems in Guelph, Ontario.

Composting system designers should determine the amount and type of organics in the waste stream, evaluate separation approaches and assess collection techniques.

A composting facility may fill any of several roles in a solid waste management program: yard waste composting, mixed solid waste composting or composting source-separated organic waste.

Yard waste composting. Many communities are initiating programs to compost leaves and other yard wastes, with relatively low risk and capital expenditure. Yard waste composting can divert 10 to 28 percent of the waste stream.

Mixed solid waste composting. Usually following the source separation of recyclables (achieving 10 to 15 percent recovery of materials), the remaining waste enters a composting plant. Much of the noncompostable material is removed by a combination of mechanical and manual sorting. Additional noncompostable material is removed after composting. Output is typically distributed as follows:

- Residuals produced 27-47 percent
- Compost produced 39-48 percent

Composting of source-separated organic waste. The compostable fraction of the waste stream can be kept separate for collection. This article reviews the status of source-separated organic waste composting, drawing primarily from studies, plant designs and operating facilities in Minnesota and New York in this country, two projects in Ontario, and existing facilities in Austria, Germany and the Netherlands.

When compared to mixed waste composting, source-separated organic waste composting offers the following potential advantages:

- The tipping area and pre-processing equipment are not sized for a large residual fraction, thus saving capital and operating costs.
- More value can be recovered from the recyclables in the noncompostable fraction since it is not soiled by food waste.
- The resulting compost is lower in heavy metals and visible paper and plastics. Thus, it may be more desirable.
- Source separation of organics is an additional demand on generators.
- Storage at the source is potentially odorous and requires additional space.
- Lower capture rates may be experienced, resulting in higher disposal costs.
- Separate collection entails additional costs.
- The quantity and consistency of the material entering the facility depends on the behavior of a large number of individuals, introducing greater uncertainty and technological risk.

The factors to be considered in developing a source-separated organics composting system are described.

The compostable fraction

Quantities of organic wastes materials. Using the results of three studies, Table 1 shows the relative size of various organic constituents expressed as percentages of the total waste stream.

New York City’s residential sector is primarily multi-family dwellings with high density. East Hampton, New York is a low density rural/suburban town and summer resort. Guelph, Ontario is a medium density city with a major university and industry. As would be expected, East Hampton and Guelph have much higher percentages of yard waste than does New York City, resulting in higher overall percentages of organic waste.

The percentage of organic waste is lower in the commercial sector and was estimated at 22 percent for New York City and 57 percent for East Hampton. Again, the large difference is due primarily to yard waste.

Organic waste characterization.
Separately collected organics include a number of materials. In the northern U.S., leaves are mostly generated in October and November. Collected separately, they can be stored for later composting. They will break down completely over time, are low in moisture, and have a high carbon/nitrogen ratio (C/N).

Grass is mostly collected May through September. Grass cannot be stored for later composting, as it decomposes quickly in storage with a severe odor potential. It is high in moisture and has a low C/N ratio.

Brush is commonly collected in all but the winter season. Brush chips can be stored and can act as a bulking agent in the composting of dense wet material, such as food and grass.

Food waste is variable, but generally is high in moisture. As with grass, it is difficult to store because it decomposes quickly.

Mixed paper may be included in the compostable waste or excluded, depending on the program design. It requires shredding and must be mixed with other materials that will supply additional water and nitrogen.

Disposable diapers consist of a non-compostable backing and liner that can be separated from the compostable filling in the initial screening and shredding stages. Recomp, a composting system vendor (see directory in this issue), has shown that drum conditioners will open up diapers, which are high in moisture and nitrogen.

Table 2 summarizes the characteristics of compostable materials.

<table>
<thead>
<tr>
<th>Component</th>
<th>New York City (1)</th>
<th>East Hampton (2)</th>
<th>Guelph (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard wastes</td>
<td>4</td>
<td>26</td>
<td>22</td>
</tr>
<tr>
<td>Food</td>
<td>14</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Mixed paper</td>
<td>11</td>
<td>13</td>
<td>5.5</td>
</tr>
<tr>
<td>Diapers</td>
<td>3.8</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td></td>
<td>3.6</td>
</tr>
<tr>
<td>Total</td>
<td>40.8</td>
<td>61.5</td>
<td>55.1</td>
</tr>
</tbody>
</table>

(1) New York City Department of Sanitation, Draft Source Separation Composting Report, prepared by Tellus Institute, October 1990.

The mix entering the composting process should fall within the following ranges:
- Solids content: 40-50 percent
- C/N ratio: 30-50 percent

Approaches to source separation
A number of source separation options exist for a community considering separated organics composting. Here are some examples.
East Hampton, New York. In the pilot program in this community, each participating household sorted its trash into four containers:
- Food and soiled paper to be composted along with yard waste
- Clean paper, including mixed paper, to be recycled
- Bottles and cans for recycling
- Residuals to be landfilled.

Table 3 summarizes the relative proportion of each waste in each container as projected by E&A Environmental/EMCON, Inc. This takes into account the weak market for mixed paper.

Guelph, Ontario. A number of collection schemes have been tested in this community, although generally they are of two types. Some householders were provided a three-stream collection program for compostables (food and yard waste), recyclables, and garbage. A second group was provided two-stream collection. "Wet" wastes included food and yard wastes plus food-contaminated paper, diapers, pet wastes, floor sweepings, and vacuum cleaner catchings. "Dry" recyclable and nonrecyclable materials were placed in a second container.

Table 2 — Characteristics of compostable waste

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Density (pounds per cubic yard)</th>
<th>Percent solids (2)</th>
<th>Percent volatile solids (2)(3)</th>
<th>Carbon/nitrogen ratio (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>300-400</td>
<td>90</td>
<td>96</td>
<td>7-202</td>
</tr>
<tr>
<td>Dry, composted</td>
<td>400-500</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Grass</td>
<td>400-800</td>
<td>25-35</td>
<td>93</td>
<td>10-20</td>
</tr>
<tr>
<td>Mixed greens</td>
<td>100-380</td>
<td>38</td>
<td>87</td>
<td>20</td>
</tr>
<tr>
<td>Chipped brush</td>
<td>600</td>
<td>60</td>
<td>92</td>
<td>21</td>
</tr>
<tr>
<td>Mixed paper</td>
<td>51-135</td>
<td>90</td>
<td>93</td>
<td>174</td>
</tr>
<tr>
<td>Paper food cartons (in trash cans)</td>
<td>48</td>
<td>94</td>
<td>93</td>
<td>290</td>
</tr>
<tr>
<td>Vegetable food waste</td>
<td>375</td>
<td>22</td>
<td>94</td>
<td>29</td>
</tr>
<tr>
<td>Meat scraps (cooked)</td>
<td>100</td>
<td>61</td>
<td>96</td>
<td>58</td>
</tr>
<tr>
<td>Mixed garbage (in trash cans)</td>
<td>500</td>
<td>28</td>
<td>84</td>
<td>14</td>
</tr>
<tr>
<td>(Table scraps)</td>
<td>800</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(Commercial)</td>
<td>630-1,000</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

(1) New York City Department of Sanitation, Draft Source Separation Composting Report, prepared by Tellus Institute, October 1990.
(3) Percent of dry weight, including fixed carbon.

The city undertook sub-sampling to determine if wheeled carts, regular trash cans, or plastic bags were most useful in storing and transporting the various materials.

Table 4 summarizes the key findings. The study showed that two-stream collection consistently rated higher than three-stream service in the ability to recover organics and recyclables. This is

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Programs to compost leaves and other yard waste have begun in many communities due partly to the low risk and low capital expenditure required.

due to the tendency of the third "garbage" stream to have an "appetite" for compostables and organics. The third stream appears to give residents an opportunity to "short-cut" some wastes. Approximately 60 percent of the "garbage" stream is either compostable or recyclable material, indicating a potential loss of large quantities of recoverable material in a three-stream system.

Collection systems
Collection and transportation typically amount to at least one-half of the total cost of solid waste management. Each stream that is source-separated requires a separate collection trip or compartment in the collection vehicle. This section discusses some collection options.

Drop-off facilities. In many small towns in New York and New England, there is a strong tradition of going to the "dump" in order to save the cost of collection, enjoy a measure of self-reliance and see what can be scavenged. In East Hampton, an estimated 65 percent of the residents self-deliver, accounting for 4

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percent of the tonnage, including commercial. Compostable waste will be self-delivered to either the central composting facility or to a satellite transfer station.

Dedicated collection vehicles. In areas of high population or high density or heavy commercial participation, trucks are filled quickly and the unit cost of collection is relatively low. In these situations, dedicated trucks may be cost effective. As shown in Table 2, the uncompacted density of food waste approaches the densities achieved in a packer truck.

Two-stream collection recovers more organics and more recyclables.

### Table 3 — Residential waste recovery and disposal rates in East Hampton

<table>
<thead>
<tr>
<th>Container</th>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Food/soiled paper</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Yard waste</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Mixed paper</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Diapers</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Recyclable paper</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Bottles and cans</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Remaining wastes</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Percent diverted: 62%


### Table 4 — Residential waste recovery and disposal rates in Guelph, Ontario

<table>
<thead>
<tr>
<th>Container</th>
<th>Material for two-stream</th>
<th>Percentage for three-stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>Food/other</td>
<td>24-25</td>
</tr>
<tr>
<td></td>
<td>Yard wastes</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>46-47</td>
<td>39</td>
</tr>
<tr>
<td>Dry</td>
<td>Paper, bottles, cans, plastics</td>
<td>21-22</td>
</tr>
<tr>
<td></td>
<td>Other dry materials</td>
<td>31-33</td>
</tr>
<tr>
<td>Garbage</td>
<td>Remaining wastes</td>
<td>—</td>
</tr>
<tr>
<td>Percent diverted</td>
<td></td>
<td>67-71</td>
</tr>
</tbody>
</table>


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with mixed waste. Compaction of food waste is likely to extract liquid without greatly improving density. Some compaction is possible with a high percentage of paper or yard waste, but not as much as with mixed waste.

**Multi-compartment vehicles.** The manufacturers of truck bodies are quick to respond to the challenge of collecting two streams on the same vehicle. Side loaders may be retrofitted by moving the packer body back and inserting a bin. Parallel side-by-side or top and bottom packer bodies are also available.

**Multiple bag system.** In Swift County, Minnesota, the bags containing dry waste and the bags containing compostable waste are collected in the same packer truck. Bags are dumped on the tipping floor and sorted by workers using pitchforks. When this operation is observed, there appeared to be little bag breakage, but some yard waste was thrown in loose. Bulky items that would break the bags would require separate collection. At the time of observation, the system was handling three tons per hour, limited by the capacity of the shredder. Two sorters with occasional assistance from a skid-steer loader operator could stay ahead of each truck delivery with little effort. East Hampton will use a similar system.

**Conclusions**

Mixed waste composting systems and "wet/dry" source separation systems both provide diversion rates exceeding 60 percent. The relative advantages of each were outlined above. The decision to utilize mixed waste composting, two-stream or three-stream source separation will depend on many locality-specific factors, including:

- Preference of the community
- Collection costs
- Residual waste disposal costs
- Compost markets
- Markets for recyclables.

Because of the sufficient experience with wet/dry source separation and composting systems, these systems should be considered in any analysis of composting options.

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**European examples of source-separate composting**

**Vienna**
- Two-stream sort
- Kitchen wastes are placed in communal waste containers at the street-side
- Participation is 65 percent
- Waste diversion is 10 percent
- Compostable waste is manually checked for contaminants, ground and composted in windrows.

**Netherlands**
- Includes separate collection of food and yard wastes, which represent about 50 percent of the residential waste stream
- Paper food and yard waste bags are deposited in communal containers.

**Numbering and Maintz, Germany**
- Paper bags containing organic waste are placed in communal bins
- Participation is 90 percent
- Coupled with a recycling program,

Waste diversion is nearly 70 percent in low-rise dwellings and 61 percent in high-rise buildings.

**Denmark**
- Food waste separation is mandatory for those generating at least 220 pounds per week
- Collection occurs three times per week.

**Munich, Germany**
- Two-stream collection.

**Ludwigsburg, Germany**
- Three-stream collection using two plastic bins: one for dry recyclables, one with two compartments for compostable materials and non-recyclable dry wastes.

Source: New York City Department of Sanitation, Draft Source Separation Composting Report, prepared by Tellus Institute, 1990.