Finding a formula for successful recycling collection

The public’s demand for recycling collection programs has never been greater. A nationwide survey for Parade Magazine found 81 percent of the respondents calling for “more comprehensive recycling programs in residential areas” and an amazing 80 percent saying “recycling should be mandatory.”

However, current state and local budgets are strapped just to maintain support for the basic areas of education, public safety and social services, let alone expanded recycling collection programs. At the same time, the voices of the recycling skeptics are rising, assigning a minor, and very expensive, role to residential recycling collection efforts in solid waste management. (For more information about the recycling naysayers, see two articles in the September 1992 issue, “The anti-recyclers: what’s their message” and “The anti-recyclers: who are they?”).

Unfortunately, examples abound of curbside recycling collection programs that are not cost-effective. One Midwestern community of 100,000 people pays $230 per ton for its weekly program, including $90 a ton for processing. This program siphons over $500,000 a year from its community’s general fund.

On the other hand, there are communities, such as Aiken, South Carolina and Las Vegas, Nevada, where governments and private haulers are initiating cost-effective curbside recycling collection programs, even with landfill tipping fees that are under $10 per ton. Cost-effective residential recycling collection programs are possible, although local conditions make each program unique.

This article looks at surveys and case studies of residential recycling collection programs for some insight into the factors that lead to success. (See “Curbside collection cost variables,” also in this issue, for the use of a computer model to analyze curbside recycling collection programs.)

Start with planning

A national survey of 264 recycling collection programs by David Fozl of the University of Tennessee and Joseph Hazlett of the University of Mississippi identified factors characteristic of programs with high diversion and participation rates and a low cost per ton (see “A national survey of local government recycling programs,” in the December 1990 issue).

Many of the reporting communities collected more than the basic materials — newspapers, glass bottles and metal cans. For example, mixed residential paper was recovered by one-third of respondents. About half of the cities collected yard debris as part of the recycling program.

The researchers distinguished between voluntary and mandatory recycling collection programs in their analysis. For voluntary recycling collection programs, Fozl and Hazlett found an association between programs that diverted more material and the establishment of a recycling goal higher than the modal 25 percent found in the survey.

Other characteristics of communities that were associated with higher material recovery levels in voluntary programs were:

- export of solid waste to out-of-county landfills
- high citizen participation rate
- involvement of environmental groups in program planning
- decentralized publicity and educational effort through community groups
- use of paid newspaper ads
- recycling coordinator’s years of experience.

As an example of a successful publicity effort, a block leader program in Cary, North Carolina signed up more than 600 volunteers who contacted two-thirds of the households in Cary’s curbside recycling collection service area. The program’s participation rate has topped 80 percent for the first year.
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The convenience of curbside recycling collection was the most important factor in cities that realized a high participation rate, according to Folz and Hazlett. The provision of free bins went hand-in-hand with the convenience of curbside collection.

To maximize the waste stream diversion in mandatory recycling programs, the important operating factors appeared to be:
- use of a truck with compartments
- high participation
- recycling coordinator’s experience.

Communities with high tipping fees also tended to have higher waste diversion results. Features of mandatory recycling programs with high participation rates are:
- the ability to issue sanctions for improper material separation
- the involvement of local educators in the design of the promotional campaign
- the degree to which waste collection fees (as opposed to state grants or taxes) were used to fund recycling programs.

Residents are more motivated to participate in a curbside recycling collection program when they receive monthly reminders of the cost of throwing materials away.

Socioeconomic characteristics were “comparatively unimportant” in accounting for differences in participation and diversion rates in cities with mandatory programs.

Current features of the recycling collection programs in 14 cities, based on interviews conducted by Resource Recycling, were generally consistent with Folz and Hazlett’s findings. Most of the programs had to meet recycling goals significantly higher than the researchers’ 25 percent baseline (see Table 1). And, with few exceptions, the goals were set by state law rather than local policy. Participation levels of 70 to over 90 percent were the norm (see Table 2). Total recycling program recovery rates ranged from 20 to 50 percent, unless a yard debris collection program had not been started (see Table 3).

**Overall program economics**

Folz analyzed the cost effectiveness of collection and processing in the surveyed

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**Research on successful recycling programs shows:**
- Yard debris collection is needed to attain higher recovery rates (over 30 percent).
- Targeting grades of scrap paper typically found in residential mixed paper is necessary to boost curbside recycling levels over 20 percent.
- Commingled recycling collection programs are not necessarily cheaper than complete separation approaches when processing costs and material sales are included.
- A well-designed curbside recycling collection program costs less, on a per-unit basis, than garbage collection.
- Money can be saved by changing the type or frequency of garbage collection service after a curbside recycling collection service is implemented.

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recycling programs (see Table 4). The per-ton cost of $36 for all recycling collection programs (including processing) compares quite favorably to the $107 per-ton cost of handling solid waste.

The per-ton average garbage collection and disposal cost is at the high end of the survey respondents are from the Northeast. For example, a national average for disposal is about $26 per ton, compared to the $43 per ton reported in the survey.

With an average net cost of $76 per ton for collection and processing, mandatory curbside recycling programs were a real bargain. They had the lowest cost-per-ton of all recycling programs, even when compared to drop-off recycling collection.

"The upfront costs to start a recycling collection program," Folz observes, "are not the best indicator of what works in a community. Pennywise and pound-foolish can summarize an approach that relies solely on drop-off sites." A higher diversion rate makes mandatory curbside recycling programs (i.e., for recyclables and compostables) more economical on a per-ton basis than their voluntary curbside or drop-off collection counterparts.

Other significant features of programs with lower per-ton recycling costs are:
- high participation rate
- collection of yard debris
- same-day collection of recyclables and garbage.

For example, Scott Kelly, chief of solid waste for Jacksonville, Florida, reports that participation in the curbside recycling program went up by 15 percentage points after launching a yard debris collection service. The city spent $200,000 to promote the new program and included information on curbside recycling as well.

On the other hand, programs associated with a higher cost-per-ton depended on billboard ads and contests.

### Table 1 — Characteristics of curbside recycling and solid waste collection programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Recycling goal (percent) (1)</th>
<th>Mandatory</th>
<th>Landfill ban</th>
<th>Volume-based garbage prices</th>
<th>Frequency of recycling collection</th>
<th>Same day as garbage</th>
<th>Containers</th>
<th>Number of material sorts (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken, SC (3)</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>Proposed</td>
<td>Weekly</td>
<td>Yes</td>
<td>1-14G bin</td>
<td>ONP,FG,GG,AC,P,GG</td>
</tr>
<tr>
<td>Danville, CA</td>
<td>50</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Every other week</td>
<td>Yes</td>
<td>60G or</td>
<td>Plastic bags, paper bag</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>20</td>
<td>No</td>
<td>Proposed</td>
<td>No</td>
<td>Weekly, alternate materials (4)</td>
<td>Yes</td>
<td>1 14G bin with expander</td>
<td></td>
</tr>
<tr>
<td>Cary, NC</td>
<td>40</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>Yes</td>
<td>30G plastic bags (8)</td>
<td></td>
</tr>
<tr>
<td>Columbia, MO</td>
<td>40</td>
<td>No</td>
<td>Yes (5)</td>
<td>No</td>
<td>Every other week</td>
<td>Yes</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Fair Lawn, NJ (6)</td>
<td>50</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>No</td>
<td>None</td>
<td>ONP, OCC, FG, GG, AG, C, P</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>35</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Semi-monthly</td>
<td>Yes</td>
<td>1-14G bin</td>
<td>AP, FG, GG, AG, C, O</td>
</tr>
<tr>
<td>Las Vegas, NV</td>
<td>25</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>No</td>
<td>3-12G bins</td>
<td>ONP, OCC, AC</td>
</tr>
<tr>
<td>Madison, WI</td>
<td>N.A.</td>
<td>Yes</td>
<td>Yes (7)</td>
<td>No</td>
<td>Weekly</td>
<td>Yes</td>
<td>20G plastic bags (8)</td>
<td></td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>N.A. (9)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>No</td>
<td>90G or</td>
<td>90G or 300G carts</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>25</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>No</td>
<td>10, 13 or 30 G plastic bags</td>
<td></td>
</tr>
<tr>
<td>Portland, OR</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Weekly</td>
<td>Yes</td>
<td>3-14G bins</td>
<td>Eleven</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>50</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Weekly</td>
<td>Yes</td>
<td>3-14G bins</td>
<td>ONP, RMP, AC</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>60</td>
<td>Yes</td>
<td>Yes (10)</td>
<td>Yes</td>
<td>Weekly</td>
<td>No</td>
<td>3-14G bins</td>
<td>ONP, RMP, AC</td>
</tr>
</tbody>
</table>

(1) Recycling goal is for total material recovery from entire municipal solid waste stream and is not limited to curbside recycling or the residential fraction of the waste stream.

(2) Sorting is done by resident unless an asterisk is present, which indicates a truckside sort.

(3) Aiken's goal is an informal one adopted by the public works department.

(4) One week mixed paper is collected in paper bags, and the next week commingled containers are collected in a plastic bag.

(5) Yard debris, tires and appliances.

(6) Fair Lawn's recycling coordinator has a goal to recycle as much as possible. An ordinance being considered by the town would expand the list of materials mandated for collection by the state from old newspapers, glass and metal containers to include all scrap paper, plastics, metal and tires.

(7) Dane County has banned yard debris and the materials that are currently collected by the curbside recycling service.

(8) Containers are placed in plastic bags; ONP and OCC are bundled separately by residents.

(9) The state requires cities to provide recycling collection, but no diversion goal is set.

(10) Yard debris is banned from landfill disposal. Yard debris is picked up on the same day as garbage.

(11) Driver sorts the glass bottles into three colors.

with prizes to promote recycling. Also, programs that relied heavily on state grants for funding may be less motivated to seek out operating efficiencies.

The researchers found that recycling revenues accounted for about 20 percent of the total cost. Higher revenues were achieved by those communities that solicited competitive bids for recyclables. Obtaining technical assistance in marketing materials from a state or regional organization, such as a cooperative marketing organization, also resulted in more favorable revenues. (Information on programs that relied heavily on state grants for funding may be less motivated to seek out operating efficiencies.

Favorable revenues. (Information on programs that relied heavily on state grants for funding may be less motivated to seek out operating efficiencies.)

Integrating recycling into solid waste

Before adding its curbside recycling collection service, Aiken, South Carolina considered raising the monthly household garbage charge of $7.50, but instead it dropped the fee to $6.35. The city replaced one of its two weekly garbage collection days with recycling collection. Savings were generated because recyclables were picked up at the curb, while garbage crews had to go a longer distance to the backyard. Further, each garbage truck used a four-person crew, while recycling collection vehicles operated with a two-person team.

Pittsburgh used the initiative of its curbside recycling collection program to hold the line on labor costs by reducing the crew size from three to two on all packer trucks used for recycling or garbage collection. Baltimore’s approach to collecting bagged recyclables, like Pittsburgh’s, allows the same garbage trucks to be used for both programs and minimizes upfront costs. (For a discussion of bag-based recycling collection programs, see “Bag-based recycling: a solution to collection blues?” in this issue.)

Portland, Oregon consolidated the private chaos of more than 70 residential haulers providing recycling collection, six with five haulers often on any given street at any given time, into franchised zones with exclusive contiguous collection routes. The savings were almost enough to accommodate an increase in the existing recycling collection program from monthly to weekly, distribution of two recycling bins to each household, and the addition of magazines and milk jugs to the program. A monthly yard debris collection system was also started.

The basic monthly rate for all services went up only 6 percent, even with a 10 percent increase in the tipping fee. However, recycling and composting volumes increased by 200 percent.

When Jacksonville, Florida started a recycling collection program, the city replaced two weekly garbage collection days with three weekly pickups for garbage, recyclables and yard debris. It also has a unique approach to controlling its costs. Recycling and solid waste are provided by both city crews and four private haulers under contract. Every three

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**Table 2 — Recovery of residential recyclables by curbside collection programs**

<table>
<thead>
<tr>
<th>Program</th>
<th>Number of households</th>
<th>Participation rate (percent)</th>
<th>Materials recovered</th>
<th>Volume (TPY)</th>
<th>Residential waste generated (TPY)</th>
<th>Recovery rate (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken, SC</td>
<td>7,800</td>
<td>80</td>
<td>ONP,G,A,S,PS,PM,PS,O</td>
<td>1,381</td>
<td>14,381</td>
<td>9.6</td>
</tr>
<tr>
<td>Anaheim, CA</td>
<td>56,000</td>
<td>98</td>
<td>RMP,G,A,S,PM,M</td>
<td>26,520</td>
<td>102,000</td>
<td>25.9</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>233,000</td>
<td>N.A.</td>
<td>RMP,G,A,S,PM,PS</td>
<td>19,000</td>
<td>32,424</td>
<td>5.8</td>
</tr>
<tr>
<td>Cary, NC</td>
<td>15,626</td>
<td>81</td>
<td>ONP,G,A,(2)</td>
<td>2,800</td>
<td>22,712</td>
<td>12.3</td>
</tr>
<tr>
<td>Columbia, MO</td>
<td>24,000</td>
<td>50</td>
<td>ONP,OM,G,A,S,PM,PC</td>
<td>1,344</td>
<td>29,404</td>
<td>4.6</td>
</tr>
<tr>
<td>Fair Lawn, NJ</td>
<td>12,000</td>
<td>95</td>
<td>RMP,OM,G,A,S,PC</td>
<td>5,000</td>
<td>18,772</td>
<td>26.5</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>200,000</td>
<td>N.A.</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>30,000</td>
<td>342,268</td>
<td>8.8</td>
</tr>
<tr>
<td>Las Vegas, NV</td>
<td>168,000</td>
<td>50</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>30,000</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Madison, WI</td>
<td>56,000</td>
<td>90</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>11,580</td>
<td>73,239</td>
<td>15.8</td>
</tr>
<tr>
<td>Phoenix, AZ (3)</td>
<td>25,000</td>
<td>N.A.</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>10,400</td>
<td>44,000</td>
<td>23.6</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>169,000</td>
<td>82</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>17,032</td>
<td>181,000</td>
<td>9.4</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>128,000</td>
<td>71</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>31,350</td>
<td>154,000</td>
<td>20.4</td>
</tr>
<tr>
<td>San Diego, CA (4)</td>
<td>83,000</td>
<td>70</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>24,000</td>
<td>127,000</td>
<td>18.9</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>148,500</td>
<td>N.A. (5)</td>
<td>ONP,OM,G,A,S,PM,PS,O</td>
<td>47,609</td>
<td>222,400</td>
<td>21.4</td>
</tr>
</tbody>
</table>

TPY = Tons per year.  
N.A. = Not available.  
ONP = Old newspapers.  
OMG = Old magazines.  
OCC = Old corrugated containers.  
OTD = Old telephone directories.  
RMP = Residential mixed paper.  
K = Kraft (brown) bags.  
G = Glass bottles.  

A = Aluminum cans.  
P = Plastics.  
PH = All high density polyethylene bottles.  
OM = Used motor oil.  
P = Plastic milk jugs.  
T = Textiles.  
PD = All polyethylene terephthalate bottles.  
PC = Plastic containers.  
PM = Plastic soft drink bottles.  
O = Used motor oil.  
G = Plastic film bags.  

(1) Based on residential solid waste generated by households eligible for curbside recycling collection.  
(2) Will be adding steel cans and high density polyethylene and polyethylene terephthalate plastic bottles in January 1993.  
(3) Phasing in curbside collection until all 285,000 households are served.  
(4) San Diego serves only 25 percent of the city’s households, with no plans to expand citywide with the current system.  
(5) Seattle does not report a participation rate; however, 88 percent of eligible households have signed up for curbside recycling collection.  

years, program costs are reported and an average fee is struck. Efficient operations get to keep savings for two years before a new median rate is calculated.

Curbside pulls its own weight
The conventional wisdom has been that material recycling costs less than collecting and disposing garbage. This wisdom has been challenged recently by recycling skeptics who say curbside recycling collection programs often run $120 to $200 per ton and divert at best 20 percent of the waste stream, not including the recovery of yard debris, which might allow a top goal of 35 percent. By comparison, garbage collection and disposal is cited as costing only $70 to $110 per ton.

However, it is easy to find curbside recycling collection programs whose economics do not compute out as-dismally as the skeptics would argue. It appears that curbside recycling collection efforts generally divert 10 to 20 percent of the residential waste stream from the households served (see Table 2). Greater recovery rates are realized when a high...
participation level is coupled with the addition of various grades of residential scrap paper. Five of the curbside programs examined have material recovery rates over 20 percent.

By comparison, the cost of these curbside recycling collection programs ranges from roughly $1 to $3 per household per month (see Table 5). This cost

### Table 3 — Recovery of residential recyclables, in tons

<table>
<thead>
<tr>
<th>Program</th>
<th>Curbside</th>
<th>Drop-off</th>
<th>Bulky items</th>
<th>Yard debris</th>
<th>Other</th>
<th>Total</th>
<th>Recovery rate (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken, SC</td>
<td>1,381</td>
<td>0</td>
<td>N.A.</td>
<td>4,454</td>
<td>0</td>
<td>5,835</td>
<td>40.6</td>
</tr>
<tr>
<td>Anaheim, CA</td>
<td>26,520</td>
<td>N.A.</td>
<td>N.A.</td>
<td>0</td>
<td>0</td>
<td>26,520</td>
<td>26.0</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>18,000</td>
<td>300</td>
<td>500</td>
<td>5,400</td>
<td>5,500 (1)</td>
<td>29,700</td>
<td>92.2</td>
</tr>
<tr>
<td>Cary, NC</td>
<td>2,800</td>
<td>200</td>
<td>75</td>
<td>2,070</td>
<td>22 (2)</td>
<td>5,167</td>
<td>22.8</td>
</tr>
<tr>
<td>Columbia, MO</td>
<td>1,344</td>
<td>1,450</td>
<td>80</td>
<td>4,262</td>
<td>1,410 (3)</td>
<td>8,575</td>
<td>29.2</td>
</tr>
<tr>
<td>Fair Lawn, NJ</td>
<td>5,000</td>
<td>500</td>
<td>300</td>
<td>2,400</td>
<td>0</td>
<td>8,200</td>
<td>43.7</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>30,000</td>
<td>N.A.</td>
<td>5,000</td>
<td>75,000</td>
<td>0</td>
<td>110,000</td>
<td>32.1</td>
</tr>
<tr>
<td>Las Vegas, NV</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>Madison, WI</td>
<td>11,580</td>
<td>200</td>
<td>1,490</td>
<td>17,440</td>
<td>47 (2)</td>
<td>30,757</td>
<td>42.0</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>10,400</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10,400</td>
<td>23.6</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>17,032</td>
<td>0</td>
<td>N.A.</td>
<td>0</td>
<td>0</td>
<td>17,032</td>
<td>9.4</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>31,350</td>
<td>4,428</td>
<td>0</td>
<td>10,000 (P)</td>
<td>7,905 (3)</td>
<td>53,683</td>
<td>34.9</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>24,000</td>
<td>N.A. (5)</td>
<td>0</td>
<td>20,500</td>
<td>150 (2)</td>
<td>44,050</td>
<td>32.2</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>47,609</td>
<td>10,000 (6)</td>
<td>N.A.</td>
<td>54,000</td>
<td>0</td>
<td>111,609</td>
<td>50.2</td>
</tr>
</tbody>
</table>

N.A. = Not available.
P = Preliminary.

1. Residential scrap metal recovered from waste-to-energy facility.
2. Old telephone directories.
3. Estimated quantity of glass, metal and plastic containers recovered under beverage container deposit legislation by curbside-eligible households.
4. Silver State Disposal would not provide these data.
5. Drop-off recycling at 42 sites for old newspapers and California redemption glass, metal and plastic containers.
6. Estimated volumes of residential recyclables from drop-off sites, buy-back centers and charitable groups.

represents about 10 to 20 percent of the monthly solid waste bill paid directly by the households or through taxes.

In eight of 12 communities, including Columbia, Missouri and San Diego, the unit cost of recycling was less than or equal to the unit cost of disposing of waste (see last column of Table 5). A ninth city, Baltimore, added a collection program for residential recyclables with no increase to its solid waste budget. Cities using automated collection systems for curbside recycling collection, such as Anaheim, California and Phoenix, Arizona, are at the top of the cost-benefit list. Two other cost-effective efforts with high diversion rates are Fair Lawn, New Jersey's mandatory collection service and Seattle, Washington's voluntary approach, which receives a serious assist from stiff volume-based garbage pricing rates.

The cost-benefit advantage of recycling over landfiling seems likely to improve even more with the average national disposal cost increasing, by about $2 per ton per year. Also, as recycling markets grow and market prices increase, net recycling costs are likely to go down.

### Table 4 — Cost benefit of recycling collection programs, in dollars per ton (1)

<table>
<thead>
<tr>
<th>Program</th>
<th>Cost (2)</th>
<th>Revenue</th>
<th>Net cost</th>
<th>Diversion rate (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curbside (all)</td>
<td>$129.71</td>
<td>$29.34</td>
<td>$100.37</td>
<td>N.A.</td>
</tr>
<tr>
<td>Mandatory</td>
<td>106.89</td>
<td>29.34 (3)</td>
<td>77.55</td>
<td>21.6</td>
</tr>
<tr>
<td>Voluntary</td>
<td>137.60</td>
<td>29.34 (3)</td>
<td>108.26</td>
<td>12.3</td>
</tr>
<tr>
<td>Drop-off</td>
<td>102.28</td>
<td>19.65</td>
<td>82.73</td>
<td>10.8</td>
</tr>
<tr>
<td>All recycling programs</td>
<td>122.25</td>
<td>26.39</td>
<td>95.86</td>
<td>N.A.</td>
</tr>
<tr>
<td>Solid waste (4)</td>
<td>107.11</td>
<td>0</td>
<td>107.11</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

N.A. = Not available.

(1) Survey of recycling and solid waste costs incurred during 1989 in 158 communities.

(2) Estimated operating and capital costs for collection and processing activities.

(3) Average revenue of $29.34 was used, because a breakdown by program type was not available.

(4) Garbage collection was $63.42 per ton (59 percent of the total cost) and disposal accounted for $43.69 per ton.


### New Jersey’s curbside experience

A 1992 survey of 567 municipalities for the New Jersey League of Municipalities by Richard Bishop Consulting, Ltd. of Sparta, New Jersey compares garbage and curbside recycling collection costs for the 71 percent that responded.

The average annual cost for garbage collection is $220 per household, with tipping fees averaging $91 per ton. The an-

### Table 5 — Cost benefit of curbside recycling collection

<table>
<thead>
<tr>
<th>Program</th>
<th>Cost of curbside recycling ($/HH/M)</th>
<th>Total waste system cost ($/HH/M)</th>
<th>Disposal fee ($/ton) (1)</th>
<th>Curbside cost to total system cost (percent)</th>
<th>Ratio of recovery rate to curbside cost fraction (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken, SC</td>
<td>0.75</td>
<td>6.35</td>
<td>0 (3)</td>
<td>11.8</td>
<td>0.81</td>
</tr>
<tr>
<td>Anaheim, CA</td>
<td>1.80</td>
<td>10.99</td>
<td>24</td>
<td>16.4</td>
<td>1.06</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>N.A. (4)</td>
<td>13.00</td>
<td>32</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Cary, NC</td>
<td>1.42</td>
<td>9.60</td>
<td>28</td>
<td>10.9</td>
<td>1.13</td>
</tr>
<tr>
<td>Columbia, MO</td>
<td>0.40 (5)</td>
<td>7.96</td>
<td>20</td>
<td>5.0</td>
<td>0.92</td>
</tr>
<tr>
<td>Fair Lawn, NJ</td>
<td>4.33</td>
<td>29.08</td>
<td>125</td>
<td>14.9</td>
<td>1.79</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>1.75</td>
<td>8.50</td>
<td>N.A. (7)</td>
<td>20.6</td>
<td>0.43</td>
</tr>
<tr>
<td>Las Vegas, NV</td>
<td>1.25 (8)</td>
<td>8.15</td>
<td>8</td>
<td>15.3</td>
<td>0.69</td>
</tr>
<tr>
<td>Madison, WI</td>
<td>2.11</td>
<td>12.50</td>
<td>26</td>
<td>6.0</td>
<td>3.62</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>0.75</td>
<td>12.50</td>
<td>26</td>
<td>6.0</td>
<td>3.62</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>1.97</td>
<td>7.77</td>
<td>35</td>
<td>25.4</td>
<td>0.37</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>2.95</td>
<td>17.30</td>
<td>75</td>
<td>17.1</td>
<td>1.19</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>1.80</td>
<td>9.00</td>
<td>26</td>
<td>20.0</td>
<td>0.95</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>2.25</td>
<td>14.98</td>
<td>46</td>
<td>15.0</td>
<td>1.43</td>
</tr>
</tbody>
</table>

$/HH/M = Dollars per household per month.

N.A. = Not available.

(1) Disposal fees are rounded off to the nearest dollar.

(2) For example, for the City of Aiken, its 9.6 recovery rate (from Table 2) is divided by 11.8 percent curbside cost fraction, for a ratio of 0.81. A ratio of 1.0 or higher indicates that the unit cost to recover recyclables is less than garbage disposal.

(3) The county charges a landfill tipping fee of $25 per ton for commercial accounts, but there is no charge for residential garbage at this time.

(4) No new recycling collection charges are incurred, because city packer trucks are diverted from garbage routes. Processing costs of $22 per ton for paper and $47.50 per ton for containers are incurred, the weighted average of which makes curbside recycling collection essentially a breakeven situation.

(5) Based on financial data for the 1000 1001 fiscal year.

(6) Average recycling and solid waste costs for Bergen County were used from the study by the New Jersey League of Municipalities.

(7) Jacksonville's landfill charges $35 per ton for commercial waste and nothing for residential waste. In essence, commercial waste tipping fees pay for residential solid waste and recycling programs, a situation that has stimulated commercial material recovery programs.

(8) An additional 18 percent ($1.25) was added to the previous trash-only fee ($6.90) to provide the services of curbside recycling and hazardous waste collection, as well as an adjustment to the company's union contract for solid waste and recycling employees.

nal cost for a curbside recycling collection program is $30 per household, however, or about 12 percent of the total system cost.

Although processing costs for the different recycling collection programs were not part of the league study, estimates from previous work for the New Jersey Department of Environmental Protection and Energy indicate that an average processing cost for all programs is $11 per household per year. Combining collection and processing yields total annual recycling program costs of $41 per household.

Using information from the two studies, the total system's annual cost for handling recyclables and garbage is $261 per household, of which the curbside recycling portion is 16 percent. This cost is comparable to the 12 to 18 percent recycling diversion from residential solid waste derived from data yielded by the earlier NJDEPE study.

Frequency rewards

The experiences of Fair Lawn, Portland and Seattle suggest that the convenience of weekly recycling collection improves participation and diversion. In the case of Fair Lawn, the city had twice-a-month recycling collection for three years. With no recycling collection on the fifth week of the month, residents were confused and materials were lost. Fair Lawn started weekly curbside recycling collection in 1992 and saw volumes jump 30 percent.

Data from the league study show that weekly recycling collection is about 25 percent more expensive on a per-household basis than twice-a-month service. Fair Lawn's experience suggests that part or all of that cost difference might be made up through increased material recovery.

Also in 1992, Portland moved from monthly to weekly curbside collection and saw its volume of recyclables increase by 120 percent. Participation also doubled. In addition to providing collection bins and adding the new materials mentioned earlier, other important steps taken by the city that might have contributed to the volume increase were collecting recyclables on the same day as garbage, starting volume-based garbage pricing and conducting an aggressive public outreach program.

Seattle is one of the few cities with two different approaches to curbside recycling collection. The north side of the city receives weekly collection and residents are asked to separate materials into three fractions — newspapers, mixed paper and containers. The south side households receive monthly curbside recycling collection and need to separate only the glass bottles from the remaining recyclables.

According to 1992 figures, the north side has a higher sign-up rate (94 percent versus 84 percent), greater monthly diversion per sign-up (64 pounds versus 57 pounds) and a lower cost of service ($78 per ton versus $84 per ton) than the south side.

An unpublished study by the Seattle Solid Waste Utility accounts for half of the differences between the north and south side programs, with demographic variables. Two factors that were unmeasured, but might account for the remaining difference, are that some residents find it difficult to remember a monthly collection date (so a drop-off site is used or no recycling takes place) and also that the large recycling carts appear to fill faster than the monthly collection cycle, so more recyclables may end up in the garbage.

The collector for the Seattle south side also operates a similar program outside the city and has switched to every-other-week collection, with a resulting increase in volume. Another example is Anaheim's cost-effective and substantial recovery of materials with an every-other-week collection schedule.

Experience suggests that a monthly program puts a strain on too many residents for maximum participation and material recovery to be realized. However, every-other-week collection for a household that is supplied with a sufficiently large container (e.g., 60 or 100 gallons) to handle the targeted materials appears to be a viable alternative to weekly recycling collection.

Multiple approach is best

In trying to maximize the recovery of residential recyclables, a diverse approach works best. For example, Jennifer Bagby, economist for the Seattle Solid Waste Utility, finds that although the curbside recycling collection program is very popular, the contribution of buy-back centers, drop-off sites and collections by charitable groups is critical. Combining the efforts of all programs results in every targeted material exceeding 50 percent recovery, with the diversion of steel cans the lowest at 55 percent (see Table 6).

However, there are a number of surprises. For example, private sector efforts account for half of the 86 percent recovery rate attained for old newspapers generated by residential households. On the other hand, the overall 72 percent recovery of aluminum cans is achieved with over 40 percent of the recovered material coming from curbside recycling collection. And, although the aluminum can is usually touted as the most popular recyclable, the glass bottle edged out the can by one percentage point, with strong showings in both public and private collection efforts.

Columbia and Portland not only have strong drop off recycling networks, but also received a substantial contribution from beverage container deposit legislation material (see Table 3). The material recovery rates for the deposit containers averaged 85 percent for Columbia and more than 95 percent for Portland.

However, it is a yard debris collection program that usually pushes a community's recovery level into the higher figures (see Table 3). Communities with a total recovery rate over 30 percent always have a yard debris collection program, and it usually accounts for about half of the total recovery.

Sorting versus commingling

A study by R.W. Beck and Associates for the City of Orlando, Florida found the total program cost for curbside recycling...
collection involving a curbside sort of separated recyclables was more economically attractive than the available commingled option. Collection costs by themselves are 20 percent cheaper for the commingled approach over the complete separation choice. However, that disadvantage for the complete separation scenario is more than offset by a lower processing expense and higher material revenues in curbside sort programs.

The consultants calculated complete separation for Orlando at $1.95 per month per household. Using the county's material recovery facility and offering commingled collection was found to cost each household $2.43 per month.

One key factor stressed by the consultants was that the county's material recovery facility (MRF) was not fully utilized. In general, a MRF that handles only 10 percent of the residential waste stream from a curbside recycling collection program will not offer the savings potentially available from a processing operation that takes materials from the institutional, commercial and industrial sectors as well. An integrated processing facility provides the approach with the lowest cost.

In the New Jersey League study, commingled recycling collection is preferred by 66 percent of the programs, with the remainder opting for complete separation at the source. However, even with the so-called commingled programs, secondary fiber is kept separate from the containers in the collection process.

The average collection cost per household in a commingled program is $28.14 per year. A complete separation program had a collection cost that was 19 percent higher, at $33.36 per year. Annual processing costs from the NJDEPE study, when broken down by type of collection, show $17 per household for commingled programs and no net processing cost for the average complete separation program.

The total cost for a household receiving commingled collection becomes $45 per year versus only $33 for units enrolled in complete separation programs. The NJDEPE study also found that complete separation programs in New Jersey appeared to recover about 15 percent more recyclables, by weight, than commingled separation programs (see "Keeping it separate or commingling it: the latest numbers," in the March 1991 issue).

The number and type of material sorts in the interviewed programs ranged from one for Phoenix and Anaheim to 11 for Portland (see Table 1). Half of the programs sorted glass bottles by color, including the revised collection program for the South side of Seattle, which initially had been fully commingled.

Conclusion
Collection programs that target residential recyclables can be designed to cost effectively divert quantities of materials that approach the ambitious goals set by many communities. Most of the programs surveyed have a unit recycling cost that is in line with or less than the cost to handle the equivalent unit as garbage.

Higher landfill costs and revenues from recyclable material sales, coupled with better program design, will provide recycling collection programs with a better economic margin. Programs are evolving in the number of materials targeted, with the collection of residential mixed paper, food scraps, plastics and textiles being...
part of the second generation of material recovery. The limited analysis in this article understates the benefits of recycling collection. Kenneth Cook, the public services superintendent for Aiken, notes that the county’s landfill realizes a 45 percent reduction in the volume of garbage, exceeding the 41 percent diversion as measured on a weight basis.

Creating a successful recycling collection program — one that diverts the maximum possible amount of marketable materials at a cost that is lower than handling the materials through the solid waste system — depends on evaluating each part of the recovery loop (i.e., collection, processing and markets). Further, integrating recycling collection into the solid waste system provides an opportunity to eliminate redundant or surplus services and maximize the use of resources, while minimizing the cost to the citizen.

Contrary to the beliefs held by the recycling skeptics, many residential recycling collection programs are carrying their economic weight and making a substantial dent in the residential waste stream.

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