Waste Prevention, Recycling, and Composting Options:

Lessons from 30 U.S. Communities

Acknowledgments

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The Institute for Local Self-Reliance is the source for all tables and charts in this report.

Notice

Readers interested in the details of community recycling operations are encouraged to obtain a copy of the case studies on which this report is based. These case studies are published as *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results,* a book available in three volumes: *Rural Communities, Suburbs and Small Cities,* and *Urban Areas.* These volumes are available from:

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Abbreviations

ANJR — Association of New Jersey Recyclers
ARA — American Rock & Asphalt
BFI — Browning Ferris Industries
CCA — Container Corporation of America
CCC — Community Conservation Centers, Inc.
CCRF — Camden County Recycling Facility
C&D — construction and demolition
C-E — Combustion Engineering
CEI — Citizens for Environmental Improvement
CFC's — chlorofluorocarbons
CMCMUA — Cape May County Municipal Utilities Authority
comm — commercial
CRC — Community Rehabilitation Center
CSEC — Central States Educational Center
cy — cubic yard
DEM — Department of Environmental Management
DEQ — Department of Environmental Quality
DO — drop-off
DOC — Department of Corrections
DPW — Department of Public Works
EDF — Environmental Defense Fund
ENCORE — Environmental Container Reuse
F — Fahrenheit
FCR — Fairfield County Recycling
FY — fiscal year
GPI — Glass Packaging Institute
HDPE — high-density polyethylene
ILSR — Institute for Local Self-Reliance
instit/inst — institutional
IPC — intermediate processing center
IPF — intermediate processing facility
lb — pound
LDPE — low-density polyethylene
MARC — Monroe Area Recycling Committee
MRC — Master Recycler/Composter
MRF — materials recovery facility
MSW — municipal solid waste
NA — not available

NARC — Naperville Area Recycling Center
NHRRA — New Hampshire Resource Recovery Association
O&M — operating and maintenance
OCC — old corrugated cardboard
ONP — old newspaper
OSCAR — Ocean State Cleanup and Recycling Program
PET — polyethylene terephthalate
PP —polypropylene
PRO — the Philadelphia Recycling Office
PRTC — Philadelphia Transfer and Recycling Center
PS — polystyrene
PSU — Portland State University
PVC — polyvinyl chloride
R — rural
RCC — Recyclables Collection Center
RFP — request for proposal
RRT — Resource Recycling Technologies
S — suburb or small city
Sa/R — salvage/reuse
SFCR — San Francisco Community Recyclers
SFRP — San Francisco Recycling Program
SLUG — San Francisco League of Urban Gardeners
SRMG — Sound Resource Management Group
SWA — Solid Waste Authority
SWMA — Solid Waste Management Authority
SWMC — Solid Waste Management Centers or Solid Waste Management Corporation
SWMP — Solid Waste Management Plan
TPD — tons per day
TPY — tons per year
TURF — Total Urban Recycling Facility
U.S. EPA — U.S. Environmental Protection Agency
WMI — Waste Management, Inc.

Chapter One
Introduction

Spurred by closing landfills and rising disposal costs, recycling and composting programs have swept the nation during the last 5 years. Nineteen states either require municipalities to pass mandatory recycling ordinances or to develop recycling programs. By the end of 1991, there were nearly 4,000 curbside recycling programs in operation—a growth of more than 250 percent since 1988. Yard waste is being diverted to more than 2,000 composting sites. As of the early 1990's, some communities have achieved recycling and composting levels of 40, 50 and even 60 percent. U.S. municipalities are embarking on a new phase in solid waste management in which materials recovery is increasingly becoming a center of activity rather than an afterthought.

This report analyzes the actual operating experience of 30 diverse communities—some with high materials recovery rates, others with model waste reduction initiatives—and draws lessons for communities wanting to strengthen their own programs. Most of the data presented in this report come from in-depth case studies of these 30 communities written by the Institute for Local Self-Reliance.[1] The 30 communities range from rural towns of 2,000 people to metropolitan areas approaching 2 million people. Eight are on or near the West Coast, another eight are in the Midwest, nine are in the Northeast, four in the South, and one in the mid-Atlantic region. Almost half were chosen because of their high recovery levels, either in the residential, commercial/institutional, or construction and demolition debris sector. The other communities were chosen because of their location, population density, or instructive program characteristics, including public or private collection, segregated or commingled set-out, sorting en route versus sorting at an intermediate processing center, curbside versus drop-off, bottle bill, mandatory or voluntary participation, volume-based or flat refuse collection rates. Communities studied included 4 counties and 26 municipalities; there were rural, suburban and urban, large and small communities. These case studies on which this report is based are published by the Institute for Local Self-Reliance as *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results*, a book available in three volumes: *Rural Communities, Suburbs and Small Cities*, and *Urban Areas*. Readers interested in the details of community operations are encouraged to obtain a copy of the case study reports.

Table 1.1 lists the communities studied, their populations, and materials recovery rates. Chart 1.1 displays their locations. The methodology and terminology utilized in this report are outlined in Appendix A. For instance, construction and demolition debris is excluded from municipal solid waste, and recovery rates for this type of waste are reported separately. Appendix B lists the community contacts who provided the information set forth in the case studies. Materials recovery rates were calculated by the Institute according to the uniform definitions in Appendix A and based on tonnage data provided by state and municipal recycling officials, private waste haulers, waste composition studies, and other community contacts. In a few instances, materials recovery rates utilized in this report differ from those calculated by communities. Appendix C lists any estimates made to calculate waste generation rates, and what waste, if any, was excluded from these calculations. This report considers both recycling and composting to be elements of materials recovery. Recycling refers to recovering discarded products for reuse and/or processing into new products, and composting refers to recovering discarded organic materials, such as leaves and brush, for processing into a soil amendment or mulch. The comprehensive tables throughout this report summarize program features for each community; the text highlights those select programs that provide the most instructive illustration of how communities can increase the recovery of recyclable and compostable materials.

Table 1.1
Selected Recycling and Composting Programs

Community	Population	Year Data Collected	Residential Recovery Rate	Commercial Recovery Rate	MSW Recovery Rate	Total Recovery Rate
Rural Communities						
Bowdoinham, ME	2,189	FY90	NA	NA	54%	53%
Fennimore, WI	2,378	1990	51%	25%	38%	NA
La Crescent, MN	4,305	1990	41%	9%	29%	41%
Monroe, WI	10,220	1989	32%	27%	28%	50%
Peterborough, NH	5,239	1990	42%	4%	19%	18%
Sonoma County, CA	388,222	1990	15%	10%	11%	11%
Upper Township, NJ	10,861	1990	50% (a)	34% (b)	NA	43%
Wapakoneta, OH	9,214	9/89-8/90	NA	NA	20%	NA
Suburbs/Small Cities						
Berlin Twnshp, NJ	5,620	1990	56%	61%	57%	NA
Boulder, CO	88,000	1990	33%	12%	22%	16%
Columbia, MO	69,101	FY90	11%	NA	NA	13%
Dakota County, MN	274,016	1990	29%	24%	28%	NA
King County, WA	991,060	1990	19%	36%	30%	NA
Lafayette, LA	90,000	FY90	13%	8%	11%	NA
Lincoln Park, NJ	10,978	1990	49%	70%	62%	NA
Naperville, IL	85,351	1990	32%	NA	NA	NA
Perkasie, PA	7,878	1990	52%	NA	NA	NA
Takoma Park, MD	16,900	1990	36%	NA	NA	NA
West Linn, OR	16,557	1990	NA	NA	50%	46%
West Palm Beach, FL	62,530	4/90-3/91	22%	0%	13%	12%
Urban Areas						
Austin, TX	465,622	FY89	7%	NA	NA	15%
Berkeley, CA	102,724	FY91	NA	NA	22%	38%
Lincoln, NE	191,972	1990	3%	25%	12%	52% (c)
Mecklenburg Co., NC	511,433	1990	7%	22%	16%	NA
Newark, NJ	275,221	1989	10% (a)	46% (b)	NA	30%
Philadelphia, PA	1,633,826	FY90	6% (a)	16% (b)	12%	11%
Portland, OR	440,000	1990	NA	NA	33%	NA
Providence, RI	160,728	1990	10%	13%	11%	NA
San Francisco, CA	723,959	1990	37%	18%	26%	27%
Seattle, WA	516,259	1990	45%	40%	40%	NA

Key: FY = fiscal year MSW = municipal solid waste NA = not available

Notes: Total waste is the sum of municipal solid waste and construction and demolition (C&D) debris. Recovery rates include material recycled and composted. MSW Recovery Rate may take into account tonnages that cannot be broken down into commercial and residential, such as bottle bill tonnages or landscapers' waste. All recovery rates represent proportions by weight. See Appendix A for definitions of recovery rates calculated above.

(a) Publicly collected waste.

(b) Privately collected waste.

(c) Based on 133,167 tons of C&D utilized as landfill cover. If this tonnage is excluded from waste recovered and disposed, recovery rate drops to 30%.

The case study approach allows us to gather specific information about the individual programs and to understand the interconnection of different program elements. However, the limited nature of our sample means that the lessons identified in this report should be viewed as tentative findings, not statistical conclusions.

One of our principal findings is that any program, even the best, can do better. Consider the Borough of Lincoln Park, New Jersey, which in 1988 reported a 40 percent materials recovery rate—a rate that increased to 53 percent in 1989, and to 62 percent in 1990. Lincoln Park continues to expand its recycling efforts.[2] Lincoln Park's success demonstrates that materials recovery rates of 60 percent and higher are technically achievable for communities that integrate the best features of the best programs.

Factors that contribute to reaching high recovery levels include targeting a wide range of materials for recovery, offering convenient service (curbside and drop-off collection are both important), employing collection and processing techniques that encourage resident participation as well as yield high-quality materials, establishing strong economic incentives—particularly volume-based refuse rates, collecting source-separated yard waste for composting, encouraging backyard composting, and extending programs beyond the residential sector to the commercial and institutional sectors.

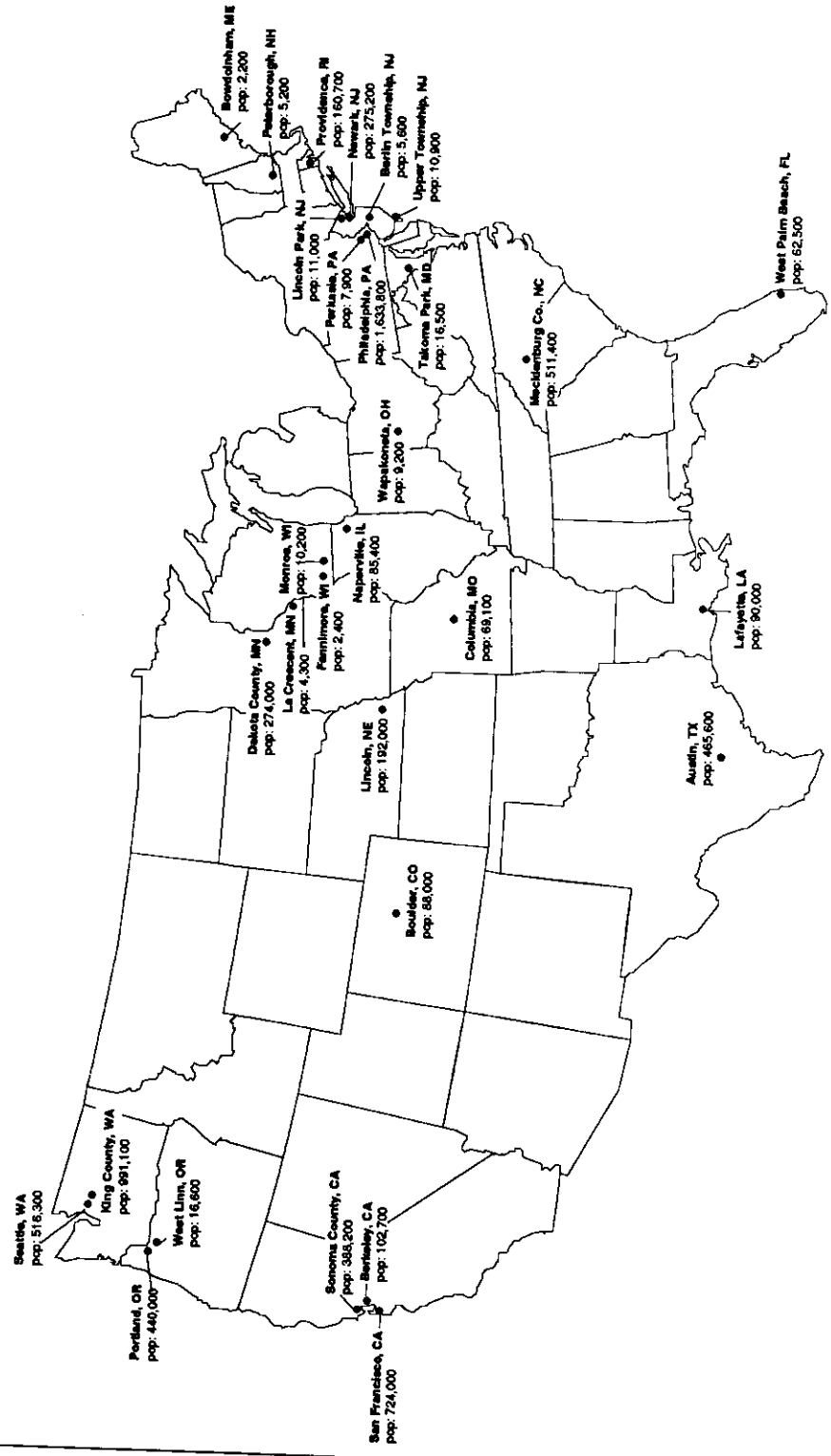
Market development is essential if collected materials are actually to be utilized. While this report does not examine marketing strategies, Appendix D describes local government programs to procure recycled goods. Today, conventional wisdom about recycling dictates that it can be connected to local economic development through remanufacturing, producing new products from recovered materials. While we strive to build a national scrap-based manufacturing industry, we must first ensure efficient, cost-effective recovery of materials from our waste stream.

Notes

[1]Data from the 30 communities is usually not referenced; data from other research are typically referenced and placed in side boxes within the text.

[2]In an effort to further increase its recycling rate and to augment its municipal drop-off collection program, Lincoln Park will begin curbside collection of a wide range of recyclable materials in August 1992.

Chart 1.1
Location of the Study's 30 Materials Recovery Programs



Chapter Two

Demographics and Materials Generation and Recovery Levels

Tables 2.1 and 2.2 present demographic information, including community type, population, average income, waste generation, and recovery rates for the 30 communities studied. These communities range in size from the rural Town of Bowdoinham, Maine, with a population of 2,189, to the large urban center of Philadelphia, with a population of 1.6 million. Nine are urban areas, ten are suburbs or cities with populations under 100,000, seven are rural towns, and the remaining four are counties, which contain either rural, suburban, and/or urban areas. Communities selected for study also represent widely divergent socioeconomic levels and geographical regions, from the small-scale manufacturing and agricultural community of Wapakoneta, Ohio to Naperville, Illinois, a wealthy suburb of Chicago. Income levels range from $8,000 per capita in Newark, New Jersey to $22,000 per capita in Peterborough, New Hampshire.[1]

Demographics and Yard Debris Affect Debris Generation Rates

Tables 2.2 and 3.1 (page 15) list per capita residential and municipal solid waste generation for each community in our study where available.[2] Waste generation rates vary greatly among communities.[3] The rural communities within our sample generally have the lowest waste generation levels. (See Charts 2.1 and 2.2.) Residents in rural communities may generate less waste due to different eating and buying habits. In such communities, residents may grow and prepare a good portion of their food at home, reducing the generation of packaging waste. Most of the rural communities in our sample also have volume-based refuse collection rates (which provide residents with an incentive to reduce waste generation), have extensive backyard composting programs, and in some cases, burn waste in yards and fireplaces. For example, in the rural community of La Crescent, Minnesota, waste burning is permitted for residents living on more than 40 acres.

The waste generation levels of suburban communities and small cities vary greatly. Those generating large volumes of yard debris—particularly those with mature deciduous trees, spacious yards, and extensive landscaping—tend to have higher per capita residential waste generation. Suburban residential waste generation rates range from 1.8 pounds per capita per day in the sparsely vegetated community of Boulder, Colorado, to 6 pounds per capita per day in West Palm Beach, Florida and in the heavily foliated community of Berlin Township, New Jersey. Communities in the south, such as West Palm Beach, may have higher than average waste generation levels due to the year-round generation of yard debris. A high percentage of yard debris in the waste stream offers the potential to reach high composting levels. Indeed, both Berlin Township and West Palm Beach have high composting rates.

Smaller Communities Recover More of Their Solid Waste

Chart 2.3 provides information on the relationship of community demographics to the percentage of materials recovered from residential, commercial/institutional, and overall municipal solid waste.[4] The suburban communities of Berlin Township and Lincoln Park, New Jersey; Perkasie, Pennsylvania; and West Linn, Oregon; and the rural communities of Bowdoinham, Maine and Upper Township, New Jersey have the highest recovery levels among the 30 communities. Almost 80 percent of the 13 communities with residential, commercial, MSW, or total recovery rates above 40 percent have populations under 20,000. Although most of the communities with the highest levels of

Table 2.1
Demographic and MSW Recovery Data

Community	Type (a)	Population	Population Density (People/ Sq. Mile)	Per Capita Income (b)	Median Household Income (b)	Year Data Collected	MSW Generated (TPY)	MSW Recycled (TPY)	MSW Composted (TPY)	MSW Recovered (TPY)	% MSW Recycled (By Wt.)	% MSW Composted (By Wt.)	% MSW Recovered (By Wt.)
Austin, TX (c)	U	465,622	2,509	$16,000	$29,700	FY89	NA	68,079	8,418	76,497	NA	NA	NA
Berkeley, CA	U	102,724	5,707	$16,522	$34,200	FY91	103,975	20,366	3,000	23,366	20	3	22
Berlin Township, NJ	S	5,620	1,606	$11,420	NA	1990	7,889	2,177	2,339	4,517	28	30	57
Boulder, CO	S	88,000	3,826	$21,740	NA	1990	62,809	11,402	2,325	13,727	18	4	22
Bowdoinham, ME	R	2,189	95	$10,809	NA	FY90	606	261	68	329	43	11	54
Columbia, MO (c)	S	69,101	1,546	$11,078	NA	FY90	NA	NA	NA	NA	NA	NA	NA
Dakota County, MN	S/R	274,016	480	NA	NA	1990	229,986	46,724	16,602	63,326	20	7	28
Fennimore, WI	R	2,378	1,189	$14,046	NA	1990	1,279	322	169	491	25	13	38
King County, WA	S/R	991,060	486	NA	$37,500	1990	1,370,084	305,237	100,545	405,782	22	7	30
La Crescent, MN	R	4,305	1,957	$12,374	NA	1990	1,792	368	144	512	21	8	29
Lafayette, LA	S	90,000	2,195	$14,154	$23,961	FY90	73,656	5,565	2,211	7,776	8	3	11
Lincoln, NE	U	191,972	3,000	$16,067	$38,561	1990	220,184	25,108	2,302	27,410	11	1	12
Lincoln Park, NJ	S	10,978	1,582	$15,616	NA	1990	14,234	4,603	4,283	8,886	32	30	62
Mecklenburg Co., NC	U/R	511,433	942	$14,470	$27,656	1990	719,751	112,691	1,176	113,867	16	0	16
Monroe, WI	R	10,220	2,555	$15,565	$20,063	1989	12,660	3,163	417	3,580	25	3	28
Naperville, IL	S	85,351	2,845	$18,691	$60,690	1990	NA	NA	NA	NA	NA	NA	NA
Newark, NJ	U	275,221	11,280	$7,622	NA	1989	NA	NA	NA	NA	NA	NA	NA
Perkasie, PA	S	7,878	2,918	NA	NA	1990	NA	NA	NA	NA	NA	NA	NA
Peterborough, NH	R	5,239	146	$22,000	NA	1990	5,001	967	0	967	19	0	19
Philadelphia, PA	U	1,633,826	12,013	$10,266	NA	FY90	2,060,133	238,243	1,571	239,814	12	0	12
Portland, OR	U	440,000	3,188	16446	$23,238	1990	612,694	180,695	19,054	199,749	29	3	33
Providence, RI	U	160,728	8,459	NA	NA	1990	147,677	NA	NA	16,900	NA	NA	11
San Francisco, CA	U	723,959	14,775	$15,137	$28,530	1990	718,868	177,843	8,885	186,728	25	1	26
Seattle, WA	U	515,259	5,612	$21,137	NA	1990	738,910	241,148	53,188	294,336	33	7	40
Sonoma County, CA	R	388,222	244	$11,809	NA	1990	465,142	50,890	1,972	52,862	11	0	11
Takoma Park, MD	S	16,900	7,682	NA	NA	1990	NA	1,273	1,206	2,479	NA	NA	NA
Upper Township, NJ	R	10,861	170	$13,337	NA	1990	12,611	NA	NA	NA	NA	NA	NA
Wapakoneta, OH	R	9,214	205	$9,867	$36,600	9/89-8/90	9,253	1,369	455	1,824	15	5	20
West Linn, OR	S	16,557	2,365	$16,961	$30,111	1990	7,904	2,365	1,552	3,917	30	20	50
West Palm Beach, FL	S	62,530	1,421	NA	NA	4/90-3/91	120,717	2,983	12,434	15,417	2	10	13

Key:

NA = Not available R = Rural S = Suburban TPY = Tons per Year U = Urban

Notes:

MSW figures above exclude construction and demolition debris. See Appendix C for description of waste generation calculations and Appendix A for definitions of terms used above. Due to rounding, numbers may not appear to add to totals. In the cities of Upper Township, Philadelphia, and Newark waste is publicly or privately collected. Publicly collected waste consists primarily of residential waste and small business waste, privately collected waste includes waste from larger businesses, C&D debris, and in some cases, waste from large apartment buildings.

(a) Cities with populations greater than 100,000 are classified as urban.

(b) Per capita and median household income figures represent the lastest year for which data are available.

(c) Commercial/institutional waste disposed contains C&D and industrial waste. Thus, an MSW recovery rate cannot be calculated.

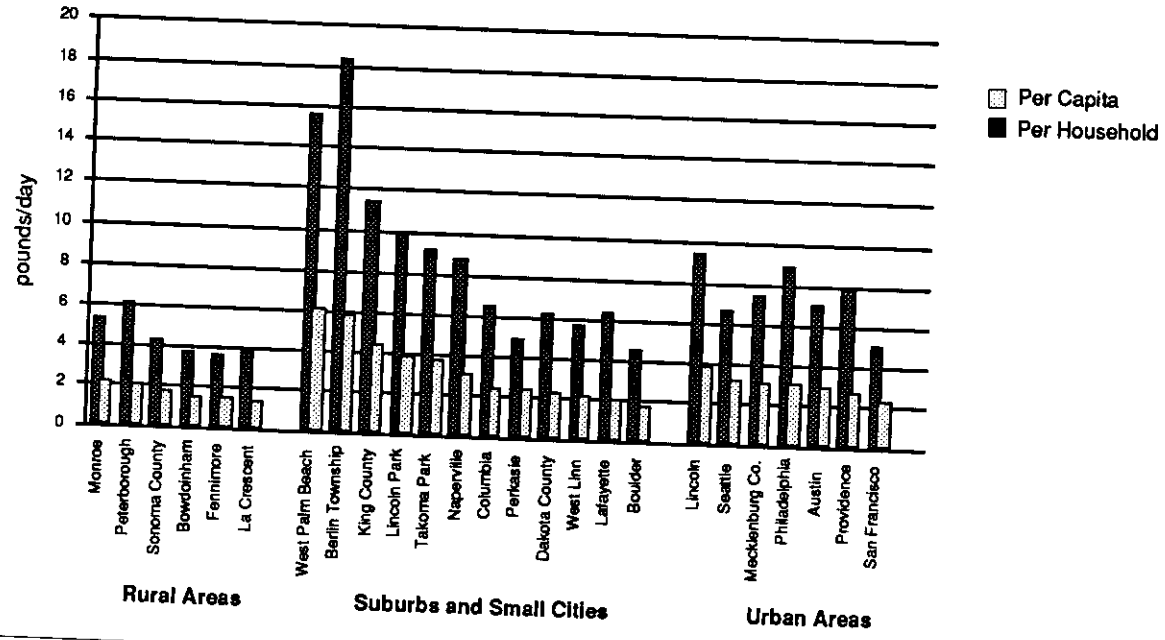
Table 2.2
Residential, Commercial, and C&D Materials Generated and Recovered

Community	Per Capita Residential Waste Generation (lbs/day)	Residential Waste Generated (TPY)	Com/Inst Waste Generated (TPY)	C&D Generated (TPY)	Total Waste Generated (TPY)	% Residential Materials Recovered (By Wt.)	% Com/Inst Materials Recovered (By Wt.)	% C&D Recovered (By Wt.)	% Total Waste Recovered (By Wt.)
Austin, TX	3.0	254,464	NA	NA	526,791	7	NA	0	15
Berkeley, CA	NA	NA	NA	59,626	163,601	NA	NA	66	38
Berlin Township, NJ	5.9	6,035	1,853	0	0	56	61	0	NA
Boulder, CO	1.8	29,204	33,605	26,766	89,575	33	12	1	16
Bowdoinham, ME	1.5 (b)	NA	NA	12	618	NA	NA	0	53
Columbia, MO (a)	2.4	30,857	51,971	NA	84,118	11	13	NA	13
Dakota County, MN	2.3	113,487	114,010	NA	NA	29	24	NA	NA
Fennimore, WI	1.5	648	631	NA	NA	51	25	NA	NA
King County, WA	4.4	646,109	541,116	NA	NA	19	36	NA	NA
La Crescent, MN	1.4	1,109	683	919	2,711	41	9	65	41
Lafayette, LA	2.1	34,651	39,005	NA	NA	13	8	NA	NA
Lincoln, NE	3.9	135,360	82,989	206,146	426,330	3	25	94	52
Lincoln Park, NJ	3.9	7,750	4,608	NA	NA	49	70	NA	NA
Mecklenburg Co., NC	3.1	292,897	425,678	NA	NA	7	22	NA	NA
Monroe, WI	2.2	3,802	8,858	6,142	18,802	32	27	96	50
Naperville, IL	3.2	39,020	NA	NA	NA	32	NA	NA	NA
Newark, NJ	NA	146,654	195,556	NA	342,210	10	46	NA	30
Perkasie, PA	2.4	3,133	NA	NA	NA	52	NA	NA	NA
Peterborough, NH	2.1	2,003	2,998	NA	NA	42	4	NA	NA
Philadelphia, PA	4.0	928,054	1,132,079	431,684	2,491,817	6	16	5	11
Portland, OR	NA	NA	NA	NA	NA	NA	NA	NA	NA
Providence, RI	3.0	80,677	67,000	NA	NA	10	13	NA	NA
San Francisco, CA	2.3	308,099	392,764	27,504	746,372	37	18	45	27
Seattle, WA	3.2	256,219	397,315	NA	NA	45	40	NA	NA
Sonoma County, CA	1.8	124,845	340,297	131,501	596,643	15	10	11	11
Takoma Park, MD	3.8	6,889	NA	NA	NA	36	NA	NA	NA
Upper Township, NJ	NA	6,879	5,733	NA	12,612	50	34	NA	43
Wapakoneta, OH	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Linn, OR	2.1 (b)	NA	NA	1,977	9,881	NA	NA	30	46
West Palm Beach, FL	6.1	69,713	51,004	11,966	132,683	22	0	0	12

Key:
C&D = Construction and Demolition Debris
NA = Not Available
Com = Commercial
TPY = Tons per Year
Inst = Institutional
Wt. = Weight

Notes:
Total waste is the sum of residential, commercial/institutional, and C&D waste. See Appendix A for definitions of terms used above and Appendix C for description of waste generation calculations. Due to rounding, numbers may not appear to add to totals. In Philadelphia and Upper Township, figures for residential waste actually represent waste handled by the public sector (and may include some commercial waste), and figures for commercial/institutional waste actually represent waste handled by the private sector (and may include some residential waste).
(a) Columbia's total waste recovery rate represents recycling rates as yard waste tonnages were not available.
(b) Bowdoinham's per capita residential waste generation rate is based on MSW generation which contains material from 15 businesses; West Linn's per capita rate is based on estimates provided by the City's recycling coordinator on the percentage of MSW disposed that is residential.

Chart 2.1
Per Capita and Per Household Residential Waste Generation in Rural, Suburban, and Urban Communities



materials recovery are suburban or rural, Chart 2.3 shows that urban communities can also achieve significant recovery levels. Seattle, with a population of half a million, recovered 40 percent of its municipal solid waste stream and 45 percent of its residential waste in 1990. San Francisco is not far behind with a 1990 residential recovery rate of 37 percent. While Newark, New Jersey's public sector or residential recovery rate is fairly low at 10 percent, its private sector rate is significant at 46 percent. Several factors contribute to reaching high recovery rates: targeting a wide range of materials for recovery, establishing economic incentives, collecting source-separated yard waste for composting, extending program service beyond single-family households to apartment buildings and to the commercial and institutional sectors, and securing high levels of participation (through such strategies as offering convenient curbside and drop-off service, mandating recycling, and establishing economic incentives). While the few communities that have integrated these key strategies tend to be small towns, large cities have also implemented them. (See Chapters 4, 5, and 6 for discussions on how communities reach high recovery levels.)

Large Cities Build On the Experience of Smaller Communities

Large metropolitan areas may consist of one or two relatively large and dense central cities and dozens or even hundreds of smaller suburban or even rural communities. The same, of course, is true for counties. The reader might find it useful to approach the information contained in this report and in the case study volumes by thinking of his or her metropolitan area or county not as a single entity but as dozens of small cities. Thus, the experience of a community like Berlin Township, New Jersey, may be instructive for a suburb outside Los Angeles, or even a neighborhood in Atlanta. New York City is currently conducting an intensive recycling project in a medium density, ethnically-mixed neighborhood of Park Slope, Brooklyn. The City is currently recovering 35 percent of the waste

generated in the pilot area, and has a goal of recovering 60 percent. By comparison, the citywide recovery level is only 6 percent. (For more information, see side bar, "New York City's Intensive Recycling Project," in Chapter 4.)

There are, of course, major differences of scale, demographics, and public service operations between small towns and large urban areas. Suburbs and rural areas tend to be more homogeneous, with most residents living in single-family homes. Urban areas have a more diverse socioeconomic mix, more residents living in multi-unit buildings, and generally a higher proportion of commercial and institutional waste. Cities that want to build on the experience of the successful recovery programs in small towns will need to take these differences into account.

Densely populated communities may, for example, have to use special outreach materials to encourage the participation of their non-English-speaking and transient residents in recycling programs. Providence, Rhode Island doubled participation in its curbside recycling program (from 30 to 60 percent) in certain multi-lingual neighborhoods by using special educational programs and foreign-language informational brochures on recycling.

Urban areas have tremendous potential for restructuring their solid waste systems and redirecting investment from disposal systems towards materials recovery. Large cities can secure dependable markets by guaranteeing brokers and end users large, steady quantities of secondary materials. Commercially generated recyclables, which are abundant in urban areas, can be a stable source of high-quality materials, depending on collection systems. Urban areas can also attract end users of such material to locate within or near their jurisdictions, especially if they demonstrate to potential investors a serious and long-term commitment to recycling. Since Philadelphia passed its mandatory recycling ordinance in 1987, at least 35 recycling companies have started up or expanded operations in the greater metropolitan area.

High Disposal Costs Lead to Higher Recovery Levels

Disposal costs in the form of tipping fees at landfills vary widely across the country.[5] Chart 2.4 compares MSW recovery rates with landfill and incinerator tipping or disposal fees among our 30 communities. With some exceptions, which are discussed below, those with the highest recovery rates also tend to have the highest tipping fees, while those with low tipping fees tend to have low recovery levels. In many cases, high disposal fees have spurred the initiation of comprehensive materials recovery programs. Lincoln Park, New Jersey, for example, has the highest MSW recovery level—62 percent in 1990—among our 30 communities; it also had the highest disposal fee for refuse in 1990—$119 per ton. Nowhere in the country has the effect of shrinking disposal capacity and rising disposal fees been felt more profoundly than in the Northeast. (Five of the six

Chart 2.2

Average Per Capita Residential Waste Generation in Rural, Suburban, and Urban Communities

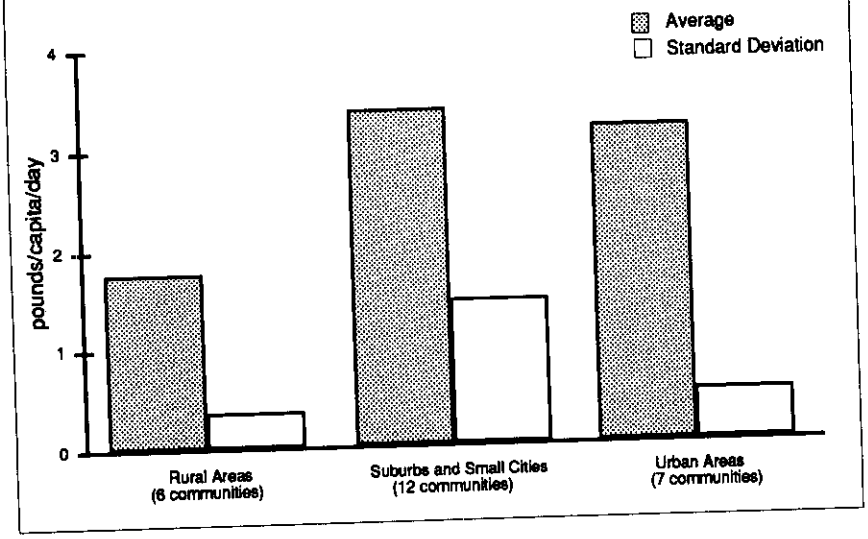
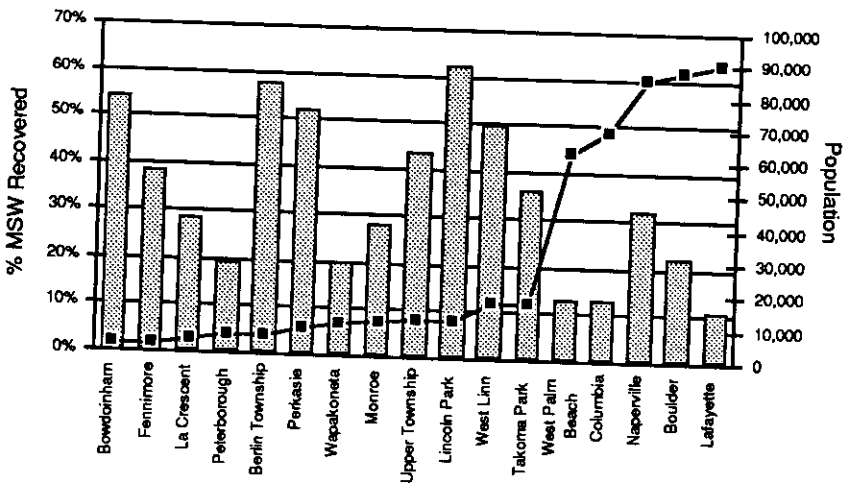


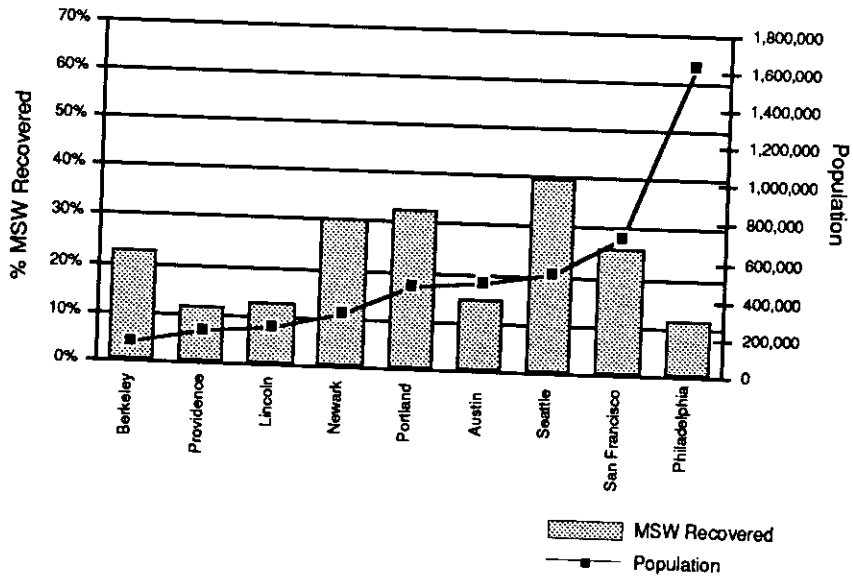
Chart 2.3

Population and MSW Recovery Levels

Rural Areas, Suburbs and Small Cities



Urban Areas



Notes: Total waste recovery levels are utilized for Upper Township, Columbia, Newark, and Austin as C&D cannot be separated from MSW. Residential recovery levels are utilized for Perkasie, Takoma Park, and Naperville as data on commercial waste generated and recovered are not available.

communities with the highest disposal fees are in the Northeast.) As a result, many of the most successful programs currently operating are in the Northeast region, and many of these are in New Jersey.

While communities in other parts of the country, such as the South, have been shielded from high disposal fees and thus have been slower to initiate programs, many of their programs show great promise and are already increasing recovery levels. Disposal fees are rising in many areas of the country not previously affected. West Palm Beach, Florida, for example, paid $47 per ton to dispose of waste in a local landfill in 1989. In 1990, when the City began to incinerate its waste, tipping fees jumped to $84 per ton. The Palm Beach County Solid Waste Authority is giving the development of recycling, composting, and source reduction programs top priority. Thus, we might expect recovery rates in West Palm Beach to increase in the near future.

In some communities, such as Monroe and Fennimore, Wisconsin and Naperville, Illinois, tipping fees are low but recovery rates are fairly significant. Landfill bans on certain recyclable

materials and State recycling requirements have provided impetus for recovery activities in these cases. The need to extend the life of its landfill has also spurred recycling activities in Monroe.

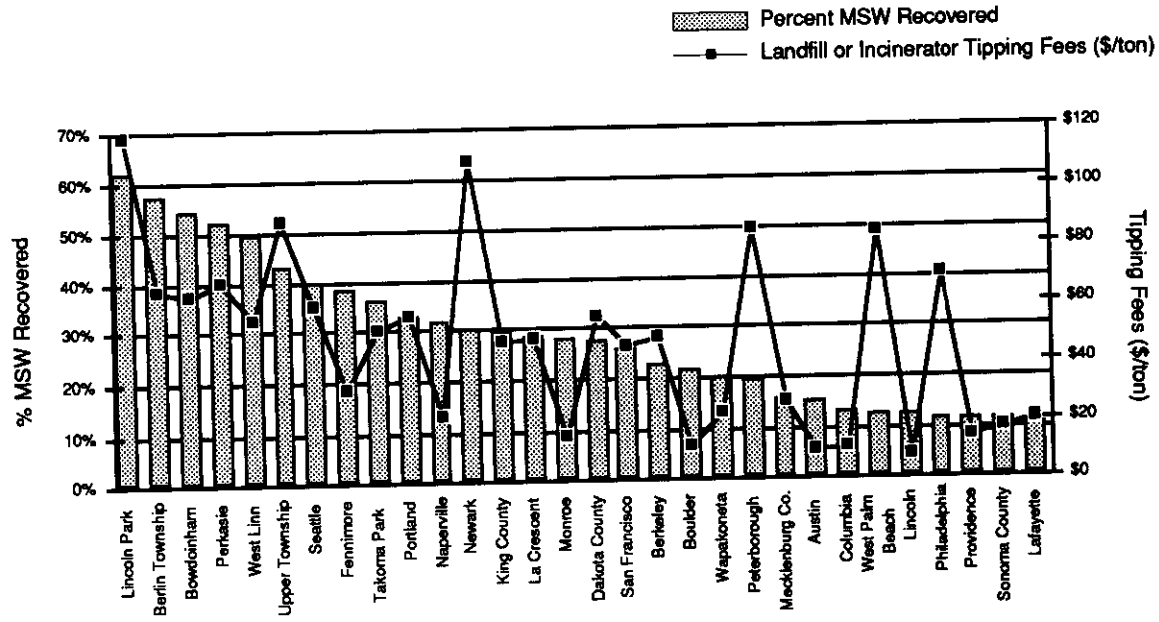
While Newark and Philadelphia have comparatively low overall MSW recovery levels and high disposal costs, these cities are actively implementing recycling programs. Newark's private sector is recovering 46 percent of the waste it handles, and the public sector provides curbside collection to approximately 90,000 households, or about 90 percent of total households in the City.[6] The City of Philadelphia offers curbside service to 169,000 households—more than any other municipality in our study. Taken together, the public and private sectors in Philadelphia are recovering more than 260,000 tons a year—an amount close to Seattle's yearly tonnage recovered. While Peterborough, New Hampshire's high disposal costs have not led to a high overall MSW recovery rate, the Town's residential recovery level is significant at 42 percent in 1990.

Conclusion

Residential waste generation varies widely from community to community. Rural areas appear to generate far less waste per person than suburban and urban areas. Yard waste contributes to high waste generation levels in many suburban communities; several of these have achieved high composting levels. While most of the half dozen communities recovering 50 percent or more of their residential or municipal solid waste have populations under 20,000, larger cities can also implement the key strategies contributing to high recovery levels. The following chapters describe these in more detail.

Chart 2.4

Landfill and Incinerator Tipping Fees and MSW Recovery Rates



Notes: Percent of total waste recovered is used for Austin, Columbia, Newark, and Upper Township; and percent of residential waste recovered is used for Naperville, Perkasie, and Takoma Park. MSW recovery rates are not available for these communities.

Notes

[1]1990 per capita income figure for Naperville is not available. Naperville's 1987 per capita income was $18,691; its 1990 median household income was $61,000.

[2]While Table 3.1 provides both per capita *residential* and *municipal solid waste* generation, we use only per capita and per household *residential* waste generation in Charts 2.1 and 2.2, as residential waste is directly dependent on population, unlike commercial/institutional waste. Readers interested in comparing waste generation levels to the national average of 4 pounds of waste per capita should use the *municipal solid waste* figures provided in Table 3.1. By and large, waste generation rates are based on tonnage figures provided by recycling coordinators and other local officials, who may have estimated the data or relied on other sources, such as private haulers. In several cases, communities measure materials in cubic yards and use conversion factors to calculate tonnage figures. In a few cases, ILSR staff have estimated tonnage recovered using commonly accepted conversion factors. In addition, figures may exclude untracked components of the waste stream. Residential waste handled by the private sector, for example, is sometimes excluded from residential figures. Total waste generation figures are divided by that portion of the population generating such material to arrive at per capita figures. See ILSR's *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results* for detailed information on how tonnage figures were derived. Appendix C in this report provides a community-by-community summary of which figures were estimated and how, and what, if any, component of the waste stream may be excluded.

[3]One factor affecting the wide variation in per capita residential waste generation is the different methodologies local officials or haulers use to measure waste generation figures. ILSR staff have gone to considerable effort to make sure that figures for residential waste (as well as for commercial/institutional and overall municipal solid waste) include all the waste generated in that category. As mentioned above, any estimates or untracked/unmeasured components of the waste stream are identified in Appendix C.

[4]See Appendix A, Data Definitions and Methodology, for definitions of and methodology for determining residential, commercial, MSW, and total waste generation and recovery rates.

[5]Tipping fees tend to vary by region. The National Solid Waste Management Association's 1990 landfill tipping fee survey (based on almost 4 percent of the country's landfills) showed that average tipping fees were $65 per ton in the Northeast, $41 per ton in the mid-Atlantic, $23 to $26 per ton in the West and Midwest, and $11 to $17 per ton in the Southeast, Southwest, and the Plains. (Source: *1990 Landfill Tipping Fee Survey,* National Solid Waste Management Association, Washington, DC, 1991.) This survey is based on 219 landfills. By the end of 1991, there were 5,812 landfills in the country.

[6]Newark has already noticed an increase in the amount of residential material collected since it increased recyclables pick-up from biweekly to weekly in October 1991.

Chapter Three
Waste Prevention Strategies

Overview

Although the current solid waste problem is depicted principally as a waste disposal problem, it is also a waste generation problem. The United States is generating more waste now than ever before. From 1960 to 1990, total U.S. MSW generation increased 123 percent, from 87.8 million tons to 195.7 million tons per year, while per capita generation increased nearly 59 percent, from 2.7 to 4.3 pounds per person per day. At current levels, the amount of waste generated is expected to reach 222 million tons in 2000, or 4.5 pounds per person per day.[1]

At the root of this problem are the types and amount of products and materials we use and discard. Single-use products, which are designed to be thrown away after one use, constitute a substantial portion of total MSW. In 1990, 33 percent by weight of all municipal solid waste consisted of packaging and containers, and an additional 27 percent consisted of nondurable products, including paper products, plates, cups, books, magazines, and clothing.[2]

Preventing waste generation saves money in waste hauling, disposal, and recycling fees; conserves valuable landfill space; and reduces energy and resource use.

EPA considers source reduction—the reduction of the volume and toxicity of waste—as the preferred waste management strategy. Preventing waste generation saves money in waste hauling, disposal, and recycling fees; conserves valuable landfill space; and reduces energy and resource use. While recycling diverts waste from disposal, source reduction eliminates the amount of material entering the waste stream.

This chapter describes and, where information is available, evaluates the strategies that have been implemented by communities in our study to reduce waste generation. (Table 3.1 lists per capita waste generation rates and the source reduction programs of the 30 communities.)

To date, the success of these programs has been difficult to measure. Few communities conduct annual waste generation studies.[3] The quantification of waste reduction is also difficult because total and per capita waste generation or composition rates are on the rise. Waste reduction should be considered in terms of reduction below future rates as well as below existing rates. In addition, certain source reduction programs, particularly education programs, may not lead to changes in individual purchasing and waste generation behavior until a few years after initiation. It takes time for residents to develop new purchasing practices, and manufacturers time to redesign products. States and communities would benefit by expanding the type of source reduction programs offered as well as by improving their methods of quantifying such achievements.

Few communities have established comprehensive source reduction programs, partly because source reduction is more difficult to measure than waste diversion through recycling and composting. States' waste reduction goals, which frequently determine local goals, rarely include measurement of source reduction. In many instances, communities do not receive credit toward their state waste diversion goal for implementing source reduction programs. In addition, communities frequently lack control over decisions regarding product design and manufacture, and have little guidance on how to bring about changes in the waste stream.

Nevertheless, communities can play an active role in diverting materials from disposal and reducing waste generation rates. A few communities, such as Berkeley, California, have set source reduction goals, and a number have implemented programs to reduce waste, which include:

- educating citizens about source reduction, emphasizing change in purchasing practices and product reuse;
- implementing a backyard composting program;
- establishing or encouraging the establishment of salvage and reuse operations;
- implementing volume-based refuse collection fees; and
- regulating packaging or other materials sold and/or used within their jurisdiction.

What actually constitutes source reduction is not well defined. True waste prevention literally means that we do not generate waste. This involves using reusable and durable rather than disposable products, and using less resources per product at the manufacturing level. Little has actually been done to avoid generation of waste on a community wide level, although individual businesses have undertaken successful efforts. While salvage/reuse operations and backyard composting are often considered forms of source reduction, these strategies do not actually prevent the generation of discards. We include backyard composting as source reduction because organic materials composted in backyards never enter the municipal waste stream. We also include examples of salvage/reuse operations because, by extending the useful life of products, they may result in the use of fewer total products, thus indirectly preventing waste generation.

Source Reduction Education

Local communities are implementing source reduction education programs to teach citizens about general solid waste issues, as well as specific changes in their purchasing and disposal practices. Communities are also supporting local organizations that promote source reduction concepts. Source reduction education can target children through in-school curricula, consumers through supermarket shelf labeling and informational brochures, and businesses through waste audits and other technical assistance. A number of communities, most notably Berkeley and Sonoma County, California; Newark, New Jersey; Boulder, Colorado; and Monroe, Wisconsin, have implemented such education programs. Source reduction and environmental shopping programs have been well received by citizens, and some manufacturing and retail companies are responding to consumer demand for "environmentally preferable" products. (See side bar "The Environmental Consumer Movement.")

In 1989 the City of Berkeley implemented a large-scale campaign, known as "precycling," to urge consumers to prevent the generation of waste through environmentally minded purchasing. The Berkeley precycling program encourages residents to purchase products packaged in recyclable materials, avoid purchase of disposable products and products in multiple layers of packaging, and buy in bulk. Residents are also encouraged to reuse and repair products. Drawing on information provided by local environmental and recycling groups, the Berkeley Department of Public Works promotes the precycling concept through fliers and newspaper advertisements. The City also encourages local merchants to offer discounts to customers who bring their own containers, and use reusable napkins and silverware.

Other communities, such as Newark and Boulder, have initiated precycling campaigns modeled after Berkeley's program. Based on responses from 2,000 shoppers, Boulder's precycling campaign successfully increased consumer awareness about ways to reduce waste generation. Of the shoppers surveyed, 84 percent claimed they were familiar with the program, 54 percent could identify precycle concepts, and 74 percent said the campaign helped them reduce waste.

Information disclosure at the point of purchase, including shelf and product labeling, encourages consumers to select products that advance source reduction and recycling goals. Some states, such as Rhode Island and New York, have implemented labeling programs to identify and promote products that are reusable, recyclable, and/or made from secondary materials. In one "Model"

Table 3.1
Waste Generation Rates and Source Reduction Programs

Community	Type	Population	Per Capita Residential Waste Generation (lbs/day) (a)	Per Capita MSW Waste Generation (lbs/day)	Household Residential Waste Generation (lbs/day) (a)	Source Reduction Program (b)
Austin, TX	U	465,622	3.0	NA	7.0	Sa/R (c)
Berkeley, CA	U	102,724	NA	5.5	NA	B,P,Sa/R,V (d)
Berlin Township, NJ	S	5,620	5.9	7.7	18.4	None
Boulder, CO	S	88,000	1.8	3.9	4.6	E,P
Bowdoinham, ME	R	2,189	1.5	1.5	3.8	Sa/R,V
Columbia, MO	S	69,101	2.4	NA	6.6	None
Dakota County, MN	S/R	274,016	2.3	4.6	6.2	V
Fennimore, WI	R	2,378	1.5	2.9	3.7	BY (e)
King County, WA	S/R	991,060	4.4	7.6	11.5	BY,V
La Crescent, MN	R	4,306	1.4	2.3	3.9	Sa/R,V
Lafayette, LA	S	90,000	2.1	4.5	6.4	None
Lincoln, NE	U	191,972	3.9	7.1	10.0	E
Lincoln Park, NJ	S	10,978	3.9	6.3	9.4	None
Mecklenburg Co, NC	U/R	511,433	3.1	7.7	7.4	None
Monroe, WI	R	10,220	2.2	6.8	5.3	E,BY
Naperville, IL	S	85,351	3.2	NA	8.7	BY
Newark, NJ	U	275,221	NA	NA	NA	B,E,P,Sa/R
Perkasie, PA	S	7,878	2.4	NA	4.9	V
Peterborough, NH	R	5,239	2.1	5.2	6.1	None
Philadelphia, PA	U	1,633,826	3.7	6.9	8.9	Sa/R (f)
Portland, OR	U	440,000	NA	7.6	NA	B,V
Providence, RI	U	160,728	3.0	5.3 (g)	7.8	E
San Francisco, CA	U	723,959	2.3	5.4	5.1	E,P,V
Seattle, WA	U	516,259	3.2	7.8	6.7	BY,E,Sa/R,V
Sonoma County, CA	R	388,222	1.8	6.6	4.3	B,E,Sa/R,V
Takoma Park, MD	S	16,900	3.8	NA	9.2	None
Upper Township, NJ	R	10,861	NA	NA	NA	None
Wapakoneta, OH	R	9,214	NA	5.5	NA	V
West Linn, OR	S	16,557	2.1	2.6	5.7	BY,V
West Palm Beach, FL	S	62,530	6.1	10.6	15.6	None

Key:

B = Material/Product Ban
NA = Not Available
Sa/R = Salvage/Reuse Programs
V = Volume-based Refuse Rates
BY = Backyard Composting
P = Precycling or Environmental Shopping
S = Suburban or Small City
-- Not Applicable
E = Extensive Source Reduction Education
R = Rural
U = Urban

Notes:

(a) Per capita and per household waste generation figures were calculated for that portion of the population for which waste generation data were available. In the communities of Naperville, IL; Perkasie, PA; Philadelphia, PA; Providence, RI; and Takoma Park, MD, per capita waste generation was calculated based on the tons of waste generated in the refuse collection district divided by the estimated number of residents in the same district. Per capita and per household residential waste rates may underrepresent actual generation levels in some instances. For example, in some cases such as San Francisco and West Linn they exclude self-haul and bottle bill tonnages. In King County and Seattle, per capita and per household waste generation figures include residential self-haul tonnages. For some cities ILSR calculated the average number of people per household to arrive at a per capita figure. See Appendix C for community-specific descriptions of residential waste calculations. Tonnages composted in residents' backyards are excluded for all cities except San Francisco. Tonnages collected through salvage/reuse operations are included in above figures where available.

(b) While a number of cities provide source reduction educational materials in schools and/or to residents, only cities with extensive programs are listed. Only comprehensive salvage reuse operations are listed; thrift shops and second-hand stores, common in most communities, are excluded.

(c) In 1992 Austin will implement variable-based refuse rates.

(d) In 1991 Berkeley instituted a backyard composting program.

(e) Fennimore requires residents to purchase refuse bags for $0.07 per bag, however because this fee is so low, we do not consider it a volume-based refuse rate.

(f) In 1991 Philadelphia funded a master backyard composting program.

(g) Since the residential waste generated by households in buildings with more than six units is untracked, this per capita MSW waste generation figure is estimated by adding commercial/institutional waste generated per capita to the 3 lbs. per capita generated by residents in buildings with six or fewer units.

Supermarket established by the Central States Education Center (CSEC), a nonprofit organization located in Champaign, Illinois, hot pink labels on designated shelves identify products with the least packaging, products that are packaged in recyclable containers, and products that contain no toxic properties ("safer earth").[4]

Research from Europe, where national environmental labeling programs are well-established, indicates that residents are aware of the presence of environmental labels and that these labels have increased up to 40 percent the sale of identified products. Manufacturers are extremely interested in being awarded such labels.[5]

While there is some evidence that environmental shopping and labeling programs have increased consumers' awareness about waste reduction issues, and that manufacturers are responding to consumer demand, there is as yet no proof that, such programs have changed communities' waste generation rates. Berkeley, for example, has not tracked its waste generation rates or waste composition since 1989, and thus cannot accurately determine how its precycling program has changed the composition or volume of the waste stream.

There is evidence, however, that source reduction programs have changed waste generation rates at the institutional or business level. In the CSEC's Model Schools, for instance, students are encouraged to minimize the amount of packaging in their lunch boxes. One Illinois school reports that average lunchroom garbage decreased by one-third, from 60 to 40 pounds per day. Many children now bring their lunch in reusable rather than disposable containers.[6]

Monroe, Wisconsin is actively encouraging local businesses and institutions to reduce waste generation. Through educational outreach alone, the Monroe Area Recycling Committee convinced area schools to switch from disposable to reusable trays. One elementary school estimates that this switch has reduced by 75 percent the volume of trash generated on an average day. (See side bar, "Waste Reduction at Institutions and Businesses.")

Backyard or Home Composting

At least one-quarter of municipal solid waste consists of yard debris and food scraps,[7] much of which is generated by individual households and can be successfully and inexpensively recovered at the point of generation. Through backyard or home composting programs, residents can convert organic waste into a high-quality soil amendment suitable for house plants, seedling transplants, and general garden use. At-home recovery of organic materials reduces communities' waste collection and composting costs. Seattle, for example, estimates that it saves $20 in avoided yard debris collecting and tipping fees for each ton of material composted in residents' backyards.

A number of the communities have implemented backyard composting programs. (See Table 3.1.) The most noteworthy include Seattle and King County, Washington; San Francisco, California; Naperville, Illinois; and West Linn, Oregon. Other communities, such as Monroe and Fennimore, Wisconsin, also encourage their residents to compost organic materials in their yards and/or leave grass clippings on the lawn. At-home composting programs can be grouped into three categories: "grasscycling" programs, backyard composting programs, and vermicomposting (worm bin composting).

"Grasscycling" Programs

Home waste reduction systems may be as simple as leaving grass clippings on a mowed lawn. A thin layer of grass clippings and leaves will improve the moisture retention ability of soil and act as a natural fertilizer, reducing the need for commercial fertilizers. In order to encourage participation in backyard composting and "grasscycling" or "Don't Bag It" programs, Naperville began charging residents $1.50 per bag of yard waste set out at curbside for collection. Other communities promoting grasscycling programs include Austin, Texas and Montgomery County, Maryland.

Backyard Composting Programs

A number of communities promote backyard composting of organic materials by providing residents with composting bins at no charge or at subsidized rates.

The Environmental Consumer Movement

The U.S. is experiencing what has been termed an environmental or green consumer movement. In the last few years, American citizens have become increasingly aware of and concerned about environmental problems, and are expressing their willingness to change behavior—such as purchasing practices—to mitigate environmental problems. For example, a recent Gallup report indicated that 76 percent of consumers consider themselves "environmentalists." What's more, a 1990 CBS/New York Times poll reported that 74 percent of those surveyed said that the environment must be protected regardless of cost—up from 45 percent in 1981.

Manufacturers and retailers are responding to citizens' environmental concerns. The number of new products introduced with environmental claims jumped from 24 in 1985 to 160 in 1988, and then to 262 in 1989—a growth of 64 percent in one year. Procter and Gamble, for instance, has developed a 21.5-ounce milk carton-type container to hold concentrated fabric softener, replacing the 64-ounce rigid plastic bottle formerly used. Its label boasts that the new container is "better for the environment ... less packaging to throw away." Another product change in response to consumers' concerns about solid waste generation is the recent decision by the Recording Industry Association of America (representing 95 percent of the recorded music sold in the U.S.) to replace the long cardboard or plastic display boxes in which it sells compact disks with packaging no bigger than the small plastic container that holds the disk.

Sources: U.S. Environmental Protection Agency, *Assessing the Environmental Consumer Market*, Office of Policy, Planning, and Evaluation, Washington, DC, April 1991; "Greenwave," *The Boston Globe*, October 9, 1990, p. 41; and Shelia Rule, "Smaller CD Boxes Promised Amid Clamor About Waste," *The New York Times*, February 28, 1992.

Backyard composting is an integral part of King County's 1989 comprehensive Solid Waste Management Plan.[8] Since June 1989, the County has provided residents with bins at a subsidized rate ($8.75), and with technical assistance through the Master Recycler/Composter Program, the Nursery Composting Demonstration Program, and a recycling and composting information telephone line. Through a written survey, the County determined that residents receiving bins were composting at least 50 percent of their yard debris. Two-thirds of all participants reported composting at least 75 percent of their yard waste. Assuming that each household generates an average of 800 pounds of yard waste per year, the County recovered an estimated 4,220 tons of yard materials through backyard composting in the first year of the program (with 16,000 participants), and approximately 9,000 tons in its second year (with a total of 35,000 participants).[9]

In the second year of the program's operation, King County purchased and distributed 19,017 bins. The bins cost the County $20 each, about half of which was reimbursed by participating households. Assuming that the County spends no additional funds per composter after the first year, and that these 19,017 households compost yard debris for 7 years (the estimated lifespan of the bin), the County will incur a cost of only $14 per ton of yard debris composted in backyards.[10]

Vermicomposting Programs

While some communities instruct residents to compost food scraps out-of-doors, others, such as San Francisco and Seattle, also encourage residents to use worm bins. Vermicomposting can be successfully implemented indoors even in an apartment unit. This process involves the use of special worms, *Eisenia fetida* or *Lumbricus rubellus* (redworms), which thrive on food scraps. Worms can digest food quickly and produce a top-quality fertilizer, "vermicompost," in 4 months. Redworms need a dark, cool, well-aerated container, and thrive on moist bedding made from sources such as peat moss, shredded cardboard, or newspaper. If the bins are properly maintained, odor problems will not occur.[11]

The San Francisco Recycling Programs (SFRP) developed a home composting program in 1988 with the San Francisco League of Urban Gardeners (SLUG). During the summer of 1990, SLUG began vermicomposting workshops. Participants pay $35 for instruction, a worm bin, and worms. SFRP also offers multilingual workshops in backyard composting. In 1990 the City estimated that residents were composting 4,414 tons of food scraps (7 percent of residential food scraps generated that year), and 2,164 tons of yard debris at home. (While the potential for food scrap recovery is great, very little is being done. Where communities, such as San Francisco, have encouraged food waste recovery, the impact has been very slight.)

Volume-based refuse rates can encourage backyard composting. For example, communities with successful backyard composting programs, such as West Linn, Oregon also have variable refuse rates (see Table 3.1). Even Seattle and King County can partially attribute their success with backyard composting to their yard waste collection fee structure.

King County, Washington recovered an estimated 4,220 tons of yard debris through backyard composting in the first year of its program (with 16,000 participants), and approximately 9,000 tons in its second year (with a total of 35,000 participants).

Salvage and Reuse

Reusing materials in-house at the residential or commercial level prevents these discards from entering the municipal waste stream and therefore costs a community no money for collection or processing. Community-scale reuse operations generally cost very little for collection (since most materials are dropped off) and little for processing. Operations that salvage materials before they enter the refuse collection and disposal system not only save a community collection and processing costs, but also raise revenue in some cases. Private repair and reuse operations can net considerable profit as well as provide jobs for the local community. Communities can actively promote private salvage/reuse operations through written listings and other types of publicity.

Waste Reduction at Institutions and Businesses

Disposable beverage containers and dinnerware represent a significant portion of the waste stream, especially at institutions with large food service operations. The Associated Students of UCLA, for example, operate several on-campus dining programs that encourage the washing and reuse of durable utensils and mugs. At the University of Illinois-Urbana/Champaign, and at Rutgers University in New Jersey, most meals are served on reusable tableware. Bowling Green State University in Ohio offers 5 and 10 cent rebates, respectively, for the purchase of 10- and 16-ounce beverages in reusable rather than disposable containers. Serving a campus population of 20,000, the University documented a net annual savings of more than $33,000 after accounting for the avoided disposal costs, and the cost of purchasing new glasses and washing them.

The Boston Park Plaza Hotel has implemented an "ecological travel alternative." The hotel established a 25-member employee "green team" to address solid waste reduction, water conservation, educational awareness, and reduction of hazardous waste. As a result, the hotel now has a recycling program, buys 100 percent postconsumer recycled-content paper, and has eliminated single-use tableware in its food service area. Future plans include replacing individual containers for soap, shampoo, and other toiletries with refillable dispensers.

Sources: Resource Integration Systems, Ltd., *53 Simple Things Universities and Colleges Can Do to Reduce Waste*, May 1991; and *Recycling Today*, November 1991, p. 26.

Although local solid waste managers have given considerable attention to startup of curbside recycling programs, they have given little attention to salvage and reuse as a serious waste reduction strategy. Several communities run salvage operations at public disposal sites where recyclables are either dropped off already sorted or attendants must sort through the refuse. However, most of these operations are recovering minimal amounts of the waste stream. A few programs stand out as models. These include Garbage Reincarnation in Sonoma County, California and Urban Ore in Berkeley, California.

In Sonoma County, California, Garbage Reincarnation, a local nonprofit organization, operates two "recycling/reuse/resale" depots at the landfill and transfer station, under contract with the County. Residents or businesses self-hauling refuse to these facilities may stop at the depots and drop off any salvageable items, including appliances, bicycle parts, books, tires, wine bottles, batteries, and building materials. Many items are either repaired or set out "as is" in the yard. Repair shops regularly buy appliances, television sets, lawn mowers, and bicycles. Flea market vendors buy bulky items to repair for resale. Homeowners and contractors purchase used building materials. A mattress refurbishing company buys used mattresses, which it sterilizes and recovers. Recovered paint is given away free to residents. According to Garbage Reincarnation, start-up costs for a salvage/reuse business are minimal, and on-site sales start the first day. In 1990 Sonoma County salvaged 1,483 tons of residential items, equivalent to 8 percent of all residential materials recycled and 1 percent of all residential waste generated that year.

Urban Ore is a materials salvage business, which operates two drop-off sites in Berkeley. Nearly 90 percent of the materials Urban Ore recovers and resells are dropped off by residents and local businesses; the remainder are recovered from the City's transfer station. The City of Berkeley supports this recovery operation by publicizing it and leasing Urban Ore land and buildings.

In 1990 Urban Ore recovered an estimated 5,390 tons of materials.[12] Of these, 1,123 tons were household goods, including electronics equipment, clothing, and kitchen appliances. The other 4,267 tons were building materials, including cabinets, furniture, doors, windows, and white goods. Urban Ore recovered 68 percent, or 674 tons, of the 991 tons of white goods estimated to be generated in Berkeley in 1990. It recovered approximately 25 percent, or 3,369 tons, of the 12,325 tons of wood waste generated, and approximately 50 percent, or 1,123 tons, of the reusable items discarded in Berkeley that year.

Urban Ore's 1990 gross operating and maintenance costs totaled $702,242 ($130 per ton), and its revenue totaled $729,996 ($135 per ton). It earned $27,754 in profit, employed 16 people, and paid local residents and businesses $95,000 for reusable goods. Urban Ore's capital costs total approximately $211,900 (1990 dollars), less than $15,000 per ton-per-day (TPD) recovered, far below those of many intermediate processing centers (IPC's). (See Table 8.17)

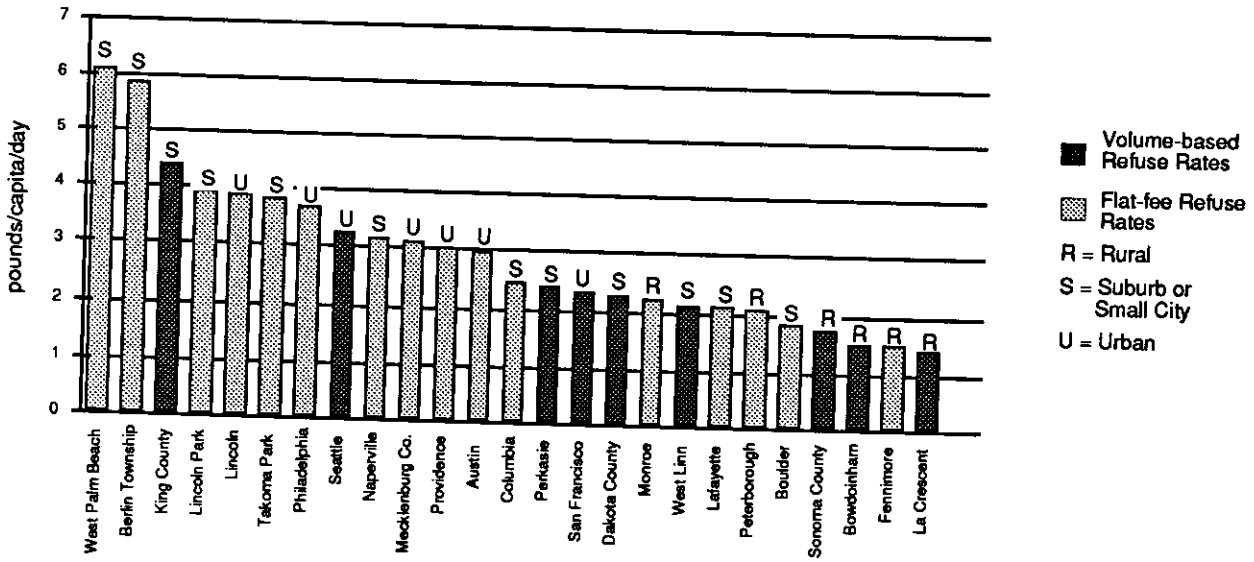
Variable Refuse Rates

Twelve of the 30 communities utilize variable refuse collection rates, charging residents higher fees for greater volumes of refuse set out. Most cities either charge residents a flat fee for refuse disposal or incorporate such costs into the municipal tax base. In contrast, variable rate (volume- or weight-based) systems charge residents on the basis of the amount of waste they generate, providing an immediate incentive to reduce the amount of waste set out for disposal. Chart 3.1 displays per capita *residential* waste generation levels for cities with and without volume-based rates. Communities with volume-based refuse rates, such as La Crescent, Minnesota; San Francisco, California; West Linn, Oregon; and Perkasie, Pennsylvania, are among those with the lowest per capita waste generation levels. As discussed in Chapter 2, demographic factors also affect waste generation rates.

Volume-based refuse collection systems were first introduced in Washington State: in Olympia in 1954, in Tacoma in the 1970's, and in Seattle in 1981.[13] Since then, variable refuse rates have been implemented in 200 cities around the nation, including rural communities (such as Bowdoinham, Maine and La Crescent, Minnesota), suburbs (such as Perkasie, Pennsylvania and West Linn, Oregon), and urban areas (such as Portland, Oregon and San Francisco).[14]

Chart 3.1

Per Capita Residential Waste Generation in Communities with Volume-based and Flat Refuse Rates



There are two basic types of volume-based refuse systems. In one, residents are charged a per-bag fee and must purchase special bags or tags to place on bags. In the second, residents choose among refuse containers with varying capacities, and pay substantially more for set-out of the larger containers. See Table 3.2 for a list of volume-based programs utilized by the communities studied, including the rates charged. West Linn, with one of the steepest fee structures, has a low per capita waste generation level.

Some evidence exists that volume-based rates encourage recycling and backyard composting, and may also reduce overall per capita residential waste generation.[15] In direct contrast to the national trend of increasing generation levels, some of the study communities with volume-based refuse rates experience reductions in or stabilization of per capita waste generation.

Perkasie has a successful variable rate system. In 1988 the Borough implemented a volume-based refuse collection system, requiring residents to place refuse in special 20- or 40-pound bags sold by the Borough for $0.80 and $1.50 respectively. (In 1991 bag prices increased to $1.00 and $1.75.) This per-bag fee program replaced a flat annual fee of $120 per residence for refuse collection and disposal. In 1988 residential waste generated by the sector the Borough serves dropped 26 percent, down to 1,868 tons from an average of 2,522 tons per year between 1985 and 1987. The Borough attributes this reduction to increased public awareness of waste generation and disposal habits, resulting in improved purchasing habits; commercial customers switching to private haulers due to the bag program;[16] waste burning in backyards, fireplaces, and wood stoves;[17] and exporting of waste from the Borough or depositing

Table 3.2
Communities with Volume-based Refuse Rates

Community	System	Program Initiation	Price Paid by Residents	Administrator	Service Provider	Apartments Served
Austin, TX (a)	per can	Pilot 1991/ Citywide 1992	$6/month/30-gallon container $12/month for 90-gallon container	public	public	no
Berkeley, CA	per can	1984	$4.60/month/13-gallon container $12/month/32-gallon container $24/month/64-gallon container $36/month/96-gallon container	public	public	yes
Bowdoinham, ME	per bag	1989	$1/30-gallon bag	public	private	not applicable (b)
Dakota County, MN	per bag/ per can	NA	Varied fees for 33-gallon bags and 30-, 60-, and 90-gallon containers	private	private	yes
King County, WA	per can	NA	Monthly refuse/recycling rates in unincorporated areas $5.60-$8.05/20-gallon container $7.47-$11.65/32-gallon container $9.73-$17.20/two 32-gallon cans or one 60-gallon can	public	private	yes
La Crescent, MN	per bag	1989	$1.35/30-gallon bag	public	private	yes
Perkasie, PA	per bag	1988	$0.80/20-pound bag $1.50/40-pound bag (c)	public	public	yes
Portland, OR (d)	per can	NA	$12/month for one 32-gallon can $22 for set-out of two cans	private	private	yes
San Francisco, CA	per can	NA	$8.03/month/20-gallon mini-can $9.35/month/32-gallon can + $4.24 for each additional can $7.19/month for residents 65 years old or older	public	private	yes
Seattle, WA	per can	1981	$10.70/month/19-gallon mini-can $13.75/month/32-gallon can $22.75/month/60-gallon can $31.75/month/90-gallon can	public	private	yes
Sonoma County, CA	per can	NA	$4.05 to $10 per 30- or 32-gallon can	public	private	yes
Wapakoneta, OH	per bag	1990	Beyond the $6/household monthly fee residents pay $0.70/30-gallon bag	public	public	not applicable
West Linn, OR	per can	NA	$11.55/month/one 20-gallon mini-can $13.70/month/one 32-gallon container $27.40/month/two 32-gallon containers	public	private	yes

Notes:
Administrator = Type of organization that initiated the program, collects the funds, and in most cases, sets the volume-based refuse rates.
Although Fennimore, Wisconsin requires residents to purchase special refuse bags, because this fee is so low (at $0.07 per bag), we do not term their program volume-based.
(a) Austin tested volume-based refuse rates in a small portion of the City in summer 1991. It plans to implement citywide volume-based rates in 1992.
(b) Residents in the Town's single multi-unit building haul their refuse to the landfill.
(c) In 1991 the Borough increased bag fees to $1/20-pound bag and $1.75/40-pound bag.
(d) Listed rate structure represents activities in 1990. The City has since restructured its volume-based system, and under the new program, the City will regulate the rate structure and require haulers to offer a "mini-can" at a substantially reduced rate.

of residential materials in commercial dumpsters (only four such instances were reported in 1988). The success of Perkasie's per-bag fee program is evident by comparing growth of households to growth of waste. While the number of households served by the Borough has increased 35 percent from 1987 to 1990, residential waste generated has increased by only 13 percent.

Illegal dumping or burning of refuse is a possible adverse effect of variable refuse rates. This has rarely presented an ongoing problem, however, since communities have found a variety of ways to stop illegal dumping. After experiencing increased illegal dumping during a period of rapidly rising user fee rates, Seattle in 1987 introduced a pre-paid sticker to handle additional waste generation, and hired inspectors to monitor complaints from customers and contractors.[18] In Perkasie, where there were four reports of illegal dumping in 1988, the offenders' names were reported in the local newspaper. Illegal dumping was not a problem in 1989.[19] Houston County, Minnesota, in which La Crescent is located, charges offenders $0.68 per pound of illegally dumped materials.

(See Chapter 5, "Improving Residential Recycling Rates," for discussion of how variable rates encourage recycling.)

Regulating Packaging and Other Materials

Some communities, such as Berkeley, California; Newark, New Jersey; and Portland, Oregon have passed local ordinances to ban use and/or sale of certain types of materials. In some cases, product bans lead to the substitution of one disposable material for another, and thus do not decrease the overall volume or weight of the waste stream. In other cases, however, nonrecyclable products are replaced with recyclable or reusable materials. For example, the City of Newark has worked with local retailers and cafeterias to switch from disposable to reusable utensils, plates, cups, and carry-out containers. Through product or material bans and taxes, communities can encourage manufacturers to redesign products so as to facilitate recycling and source reduction.

Conclusion

There are a variety of techniques available to control the ever-burgeoning tonnage of waste. Public education, reuse operations, and economic incentives have been implemented on a local level to encourage residents, institutions, and businesses to generate less waste. Backyard composting helps prevent organic materials from entering the waste stream, and salvage/reuse operations may indirectly help avoid waste generation. Cities are also supporting independent community-based source reduction efforts. Communites would benefit by developing ways to measure the success of source reduction programs.

Notes

[1]U.S. Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1992 Update*, Office of Solid Waste, EPA/530-R-92-019, July 1992, 2-2, 4-15, 5-2.

[2]Ibid, 2-29.

[3]The City of Berkeley, which has implemented a number of source reduction programs and has set a source reduction goal of 13 percent, has not conducted a waste generation study since 1989. Berkeley measures the amount of waste diverted from disposal by quantifying such things as the number of tons per week of disposable diapers not landfilled as a result of resident use of cloth diaper services. King County, Washington has estimated, through a survey, the number of tons of yard waste diverted from disposal through backyard composting.

[4]Joe Schwartz, "Shopping for a Model Community," *Garbage Magazine*, May/June, 1990, pp. 35-38.

[5]Naomi Friedman, *Certified Green: An Examination of Product Labeling and its Application to Environmental Protection* (Tufts University, February 1991), 101-103.

[6]Becky Stanfiel, "Towards a Model Community," *Model Community Update*, Central States Education Center, Champaign, Illinois, September 1991.

[7]Yard debris comprises on average 18 percent of the nation's municipal waste stream, while food waste comprises an additional 8 percent. (U.S. Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1990 Update*, Office of Solid Waste, June 1990.)

[8]While the City of Seattle is located in King County, all King County data and programs listed in this report exclude the City of Seattle.

[9]These estimates credit the County with all tonnages composted in the backyards of program participants, even if such individuals had previously composted. The County determined through a survey that 62 percent of first-year participants had composted previous to the distribution of backyard composting bins. However, once the program expanded into the cities in the second year of operation, the percentage of individuals who had composted previously may have dropped. Composting rates for King County reported in this report exclude these estimated tonnages recovered through backyard composting.

[10]King County spent $682,239 on capital and operating expenses for its backyard composting program in the second year of the program's operation (April 1990 to March 1991). Most of the costs associated with backyard composting are one-time implementation expenditures, such as bin purchase and distribution, and technical assistance. The County spent $380,334 to purchase 19,017 bins (approximately $20 each) and was reimbursed $195,460 by participating households. Thus the County's net outlay for compost bins came to $184,874 in 1990-91. Program operating expenses totaled $301,905. Of this, $114,304 was spent on program operations, $91,491 on marketing, $66,625 on bin distribution, $22,370 on program administration, $4,464 on monitoring and surveys, and $2,651 on a bin brochure.

[11]Robert Kourik, "As the Worm Turns," *Garbage*, January/February 1992. See also Mary Appelhof, *Worms Eat My Garbage* (Kalamazoo, Michigan; Flower Press, 1982).

[12]This tonnage actually covers the period July 1990 to June 1991.

[13]Lisa Skumatz, "Garbage By the Pound: The Potential of Weight-based Rates," *Resource Recycling*, July 1991. Seattle, Washington and Farmington, Minnesota have tested or plan to test residential weight-based refuse collection rates.

[14]Lisa Skumatz (Synergic Resources Corporation, Seattle, Washington), personal communication, March 1992.

[15]It is difficult to determine the effect of variable refuse rates in many instances, since communities do not always track tonnages generated before and after the implementation of these rates. Also, while per capita generation rates may continue to rise after the implementation of variable rates, such rises may be less than would have otherwise occurred.

[16]Attrition of commercial customers is responsible for at least a 3.1 percent reduction in waste collected. Perkasie's residential waste includes some material collected from a small number of businesses.

[17]In 1988 the Borough did not enforce an ordinance banning backyard burning, but there were no complaints of smoke or odor.

[18]Lisa Skumatz, et al., *Variable Rates in Solid Waste: Handbook for Solid Waste Officials, Volume II* (Washington, DC: NTIS Document No. EPA 910/9-90-012b, June 1990).

[19]Approximately five incidences of illegal dumping, mostly involving placement of refuse in private dumpsters, were reported in 1990.

Chapter Four

Comprehensive Source-Separation Composting Programs[1]

Overview

Our case-study communities with comprehensive source-separation composting programs are diverting significant amounts of organic materials from disposal facilities. Most of the communities recovering more than 30 percent of their municipal solid waste (MSW) are composting at least 11 percent of their waste. While 28 of the 30 communities studied have some type of composting program, some are more comprehensive than others. Communities with composting rates greater than 11 percent typically provide frequent and convenient collection, target a wide range of organic materials, serve a high percentage of households, and offer incentives to encourage composting. Set-out and collection methods, composting techniques, and marketing strategies vary widely among communities. By comparing the operating experience of these communities, this chapter discusses program features that help to maximize recovery of organic materials, one of the largest components of the municipal waste stream. The first section of this chapter details collection, processing, and marketing strategies. The second describes policies implemented on a local level to increase composting levels. (See Table 2.1 for each community's municipal solid waste composting recovery rate.[2])

Collection, Processing, and Marketing Strategies

Yard trimmings are a fairly homogeneous component of the waste stream that can be composted in residents' backyards, at community-scale composting sites, or in regional facilities. Food discards, another significant portion of the waste stream, can also be composted in residents' backyards or composted on a community level. Finished compost serves as a soil amendment or mulch, improving the physical, chemical, and biological properties of soil. In the case-study communities with source-separation composting programs, the supply of and demand for compost are usually well-balanced. In some cases, demand exceeds supply.[3]

Communities with composting rates greater than 11 percent typically provide frequent and convenient collection, target a wide range of organic materials, serve a high percentage of households, and offer incentives to encourage composting.

Collection

Tables 4.1 and 4.2 describe yard trimming collection program characteristics during the base year of study, including program initiation year, curbside versus drop-off service, types of materials collected, and set-out and collection methods. During the base year two communities, Providence, Rhode Island and Peterborough, New Hampshire, did not have composting programs.

As indicated in Table 4.1, many communities are encouraging backyard composting and "don't bag it" programs to reduce yard waste collection and processing costs. Many of the listed communities report that a substantial number of residents are employing such techniques. For example, the City of West Linn, Oregon estimates that 15 to 20 percent of all yard debris generated in 1990 was composted in residents' yards. (See Chapter 3 for a discussion of backyard composting programs.)

Table 4.1
Yard Debris Collection Characteristics

Community	Year Data Applicable	Curbside Initiation Year	Yard Waste Mandate	Compost Program Initiation	Collection Strategies	Private/ Public Collection (a)	Materials Coll. at Curbside for Composting	Materials Coll. at Drop-off for Composting	Households Served w/ Curbside Collection	Percent of Total Households Served w/ Curbside Collection (b)	Percent of Households Served in Refuse District (c)	Pounds/ Household/ Month Recovered at Curbside (d)
Austin, TX	FY89	1988	None	1988	CS,DO,BY	Public/Pvt.	[L]	[L,GC, CT]	110,000	55	100	2.1
Berkeley, CA	FY91	1976	None	1989 (e)	CS,DO	Public	[L,GC,BR,CT]	[L,GC,BR,CT]	2,600	6	6	96.2
Berlin Township, NJ	1990	1976	SS, LB	1976	CS,DO	Public	L,GC,BR,WW,CT	L,GC,BR,WW,CT	1,800	100	100	216.6
Boulder, CO	1990	1989	None	1989	DO,BY	Public	[BR]	[CT]	NA	NA	--	NA
Bowdoinham, ME	FY90	--	None	1990	DO	--	--	[L,GC]	--	--	--	--
Columbia, MO	FY90	1988	None	pre-1965	CS,DO	Public	[CT]	[L,GC,CT]	18,500	72	100	NA
Dakota County, MN	1990	1989	LB, HR	1989	CS,DO,BY	Private	[L,GC,BR,CT]	[L,GC,BR,CT]	70,000	70	--	33.6
Fennimore, WI	1990	1989	SS, LB	1989	CS,DO,BY	Public	L	L,GC,FW	970	100	100	NA
King Co., WA	1990	Varies	None	NA	CS,DO,BY	Varies	[L,GC,BR,CT]	[L,GC,BR,WW,CT]	NA	NA	--	NA
La Crescent, MN	1990	1989	LB	1989	DO	Public	--	[L,GC,BR]	--	NA	--	--
Lafayette, LA	FY90	1990	None	1990	CS,DO	Contract	[L,GC,BR,CT]	[L,GC,BR,CT]	27,500	93	100	32.2 (f)
Lincoln, NE	1990	1988 (P)	None	1988	CS,DO	Contract	[L,GC,BR]	[L,GC,BR,CT]	2,000	3	4	31.0
Lincoln Park, NJ	1990	1976	SS (g)	1976	CS,DO	Public	L,GC,BR,CT	L,GC,BR ,CT	2,772	65	65	85.6
Mecklenburg Co., NC	1990 (h)	--	None	1983 (h)	DO	Public	--	[L,GC,BR,WW]	--	--	--	--
Monroe, WI	1989	1981	SS	1981	CS,BY	Public	L,GC,BR,[CT]	--	3,900	91	0	22.9
Naperville, IL	1990	1975	LB	1975	CS,BY	Public	L,GC,BR,CT	--	24,500	79	NA	33.3
Newark, NJ	1989	1986	SS, LB	1986	CS	Contract (i)	L,GC,BR,[CT]	--	NA (i)	NA	NA	NA
Perkasie, PA	1990	1989	None	1989	CS	Public	[L,BR,CT]	--	3,500	90	100	31.1
Peterborough, NH	1990	--	None	1991 (j)	--	--	--	--	--	--	--	--
Philadelphia, PA	FY90	1978	SS	1978	CS,BY	Public	L, [CT]	--	45,000	7	28	NA
Portland, OR	1990	1973 (k)	None	1973	CS,DO,BY	Private	[L,GC,BR,CT,FW] (l)	[L,GC,BR,CT,FW]	NA	NA	0	NA
Providence, RI	1990	--	None	None	--	--	--	--	--	--	--	--
San Francisco, CA	1990	--	None	1988	DO,BY	--	--	[CT]	--	--	--	--
Seattle, WA	1990	1989	SS	1989	CS,DO,BY	Contract	L,GC,BR,WW	L,GC,BR,WW	94,805	38	--	NA
Sonoma Co., CA	1990	1990 (P)	None	1990	CS,DO	Private	[L,GC,BR,CT]	[CT]	1,200	1	NA	64.7
Takoma Park, MD	1990	1980	SS	1980	CS,BY	Public	L,GC, [CT]	--	4,100	58	100	11.5
Upper Township, NJ	1990	1972	SS, LB	1972	CS	Public	L, [GC,BR,WW,CT]	L, [GC,BR,WW,CT]	3,860	100	100	49.0
Wapakoneta, OH	9/89-8/90	>1970	LB	1971	CS,DO	Public	[L]	[BR,GC]	3,548	100	100	38.2
West Linn, OR	1990	1985	HR	1985	CS,DO,BY	Private	[L,BR,CT]	[L,GC,BR,WW,CT]	5,300 (m)	86	86	NA
West Palm Beach, FL	4/90-3/91	1990	None	1990	CS	Public	[L,GC,BR,WW,CT]	--	18,306	75	100	0.1
												113.0

Key:

Materials enclosed in brackets [ ] are those for which set-out or drop-off is voluntary. Participation is mandatory for all other materials.

BR = Brush
BY = Backyard Composting
CS = Curbside
CT = Christmas Trees
FW = Food Waste
GC = Grass Clippings
L = Leaves
LB = Landfill Disposal Ban
P = Pilot programs represent cities serving less than 5 percent of their total residential households with curbside collection of yard debris.
SS = Residential Source-Separation
WW = Wood Waste

Coll. = Collection
DO = Drop-off
HR = Hauler Requirement
NA = Not Available
-- = Not Applicable

Notes:
(a) Public – City or County provides curbside or drop-off service; Private -- one or more private haulers provide service; Contract -- City or County contracts with one or more providers.
(b) Percentage of total households serviced with curbside collection of yard waste.
(c) Percentage of the households in jurisdiction's refuse collection district that are also served with yard waste collection.
(d) Based on the number of households receiving municipal yard waste collection.
(e) Berkeley began composting in 1976, however this program was discontinued and no composting occurred between September 1988 and August 1989. Composting was re-instituted in mid-1989; an estimated 3,000 tons of yard waste were composted in 1990.
(f) Pounds recovered reflect tons collected over 5 months only, as Lafayette's program did not begin until May 1990.
(g) The City banned the landfilling of yard waste in 1991, effective October 1992.
(h) Because of the unrepresentative high volume of materials generated from Hurricane Hugo, yard waste tonnages used to calculate the composting rate are based on FY1989 data. Program characteristics are 1990 data. Charlotte, located in Mecklenburg County, initiated a weekly yard waste curbside collection program in January 1991.
(i) Newark's Office of Sanitation contracts with three private haulers to collect leaves from the residential sector. All households are served, as needed.
(j) Prior to 1991, the Town burned all brush and wood waste brought to its drop-off center. It is now composting yard and wood waste delivered to the center.
(k) Yard waste collection did not begin until 1987.
(l) Sunflower Recycling, Inc., picks up food waste in 5-gallon buckets it provided to its 105 customers. Sunflower composts the food waste with sawdust.
(m) Only an estimated 4 tons of the 1,552 tons composted in 1990 were collected at curbside by West Linn Disposal. While curbside service is offered to 5,300 households, it is rarely used. West Linn Disposal offers year-round, on-call collection of source-separated yard debris for a nominal charge: $3.50 for each bag of leaves and $7.50 for each bundle of brush. This is less than the charge for refuse collection, but more expensive than self-hauling yard waste to the composting site. As a result, most residents self-haul materials.

There are two ways to collect source-separated yard waste for composting at community-scale or regional sites: curbside or drop-off.

Curbside Collection

Twenty-four of the 30 communities studied have curbside collection programs. However, some of these service only a limited number of households and/or provide only fall leaf or seasonal Christmas tree collection. To collect yard debris and trimmings, communities often utilize existing public works equipment such as front-end loaders, refuse packers, and dump trucks. Packer trucks have the advantage of compacting material, reducing the frequency of unloading. Some communities purchase new equipment such as vacuum leaf loaders. The loaders can either be hooked up to existing packer or dump trucks, or can be purchased as a self-contained truck and vacuum loader unit. Leaf loaders, used in conjunction with existing vehicles cost approximately $10,000 to $20,000 each; self-contained vacuum loaders cost approximately $100,000. (See Chapter 8 for a discussion of how using existing equipment can reduce capital costs.)

Collection methods vary depending on the type and amount of yard materials collected. During the fall months of heavy leaf generation many communities collect leaves loose, using front-end loaders or vacuum attachments, to relieve residents of the task of bagging leaves. In northern cities, temporary crews are often hired or shifted from other departments to collect fall leaves. In Takoma Park, Maryland, for example, four five-person crews collect leaves in November and December; 10 crew members are temporary employees and 10 are assigned from the Streets and Parks Department. One worker drives the collection vehicle, one prepares leaves for vacuuming, one operates the vacuum, and two rake the leaves into the vacuum. Leaves are blown into a leaf collection box located behind the vacuum loader. In Monroe, Wisconsin, the Streets Department picks up fall leaves utilizing a retrofitted jeep with a push broom attached to the front. Drivers push leaves to street corners and a front-end loader scoops the material into a packer truck. Berlin Township switched from vacuum collection to front-end loader collection after designing a scoop—a 2-cubic-yard

Table 4.2
Curbside Set-out and Collection Method for Yard Debris

Community	Pick-up Frequency	Same Day Collection (a)	Collection Period	Set-out Method for Leaves	Set-out Method for Grass Clippings Brush, Wood Waste	Collection Vehicles	Number of Crew Members per Truck
Austin, TX	Weekly	Yes	Nov-Dec/Feb-Apr	Bagged (b)	--	Packer	3
Berkeley, CA	Semi-weekly	NA	Year-round	Bags or Carts	32-gal. Bags/64-gal. Carts	Packer	1
Berlin Township, NJ	Weekly	NA	Year-round	Loose	Cans or Bagged	Loader/Dump Truck	1-3
Boulder, CO	Once/year	NA	3 Weeks in Spring	--	Loose	Loader/Dump Trucks	NA
Bowdoinham, ME	--	--	--	--	--	--	--
Columbia, MO	Once/year	Yes	2 Weeks in January	--	--	--	--
Dakota County, MN	Weekly	Varies	Apr-Nov	Bagged or Loose	Bagged or Loose	Packer	--
Fennimore, WI	Varies (c)	NA	Varies (c)	Loose	Loose	Street Sweeper	2
King Co., WA	Varies (d)	--	Year-round	Cans or Toters	Cans, Toters, or Paper Bags	Packer	Varies
La Crescent, MN	--	--	--	--	--	--	--
Lafayette, LA	Weekly	Yes	Year-round	Bagged or Bundled	Bagged or Bundled	Packer	3
Lincoln, NE	Weekly	No	July-Nov	90-gallon Toter	90-gallon Toter	Packer	1
Lincoln Park, NJ	Semi-weekly	Varies	Apr-May, Oct-Nov	Bagged or Loose	Bagged or Loose	Vacuum/Dump Truck/Packer	2
Mecklenburg Co., NC	--	--	--	--	--	--	--
Monroe, WI	Weekly	Varies (e)	Seasonal (e)	Loose	Bagged	Broom/Loader/Packer	1
Naperville, IL	Weekly	NA	Apr-Nov	Loose	30-gallon Paper Bags	Vacuum/Leaf Loader	NA
Newark, NJ	Weekly	No	Oct-Jan	Bagged or Loose	Bagged or Loose	Loader/Packer/DumpTrucks	NA
Parkesie, PA	Weekly	NA	Oct-Nov	Loose	Bundled	Vacuum/Dump Truck	3-5
Peterborough, NH	--	--	--	--	--	--	--
Philadelphia, PA	Once/year	No	Nov-Dec	Loose	--	Leaf-loader/Vacuum/Trailer	Varies
Portland, OR	Weekly	NA	Nov-Apr	Bagged or Loose	Bagged or Loose	Packer	NA
Providence, RI	--	--	--	--	--	--	--
San Francisco, CA	--	--	--	--	--	--	--
Seattle, WA	Varies (f)	Yes	Year-round	Cans or Bagged	Cans, Bagged, or Bundled	Packer	1
Sonoma Co., CA	Weekly	No	Year-round	90-gallon Cans	90-gallon Containers	Packer	1-2
Takoma Park, MD	Weekly	No	Year-round	Loose	Cans or Bagged	Packer or Vacuum w/ box	3 or 5
Upper Township, NJ	Weekly	NA	Year-round/Seas.	Bagged & Loose (g)	Cans, Bagged, or Bundled	Packer Truck/Dump Truck	2 or 3
Wapakoneta, OH	NA	NA	Nov-Dec	Loose	--	Vacuum/Dump Truck	NA
West Linn, OR	On-call	--	Year-round	Bagged	Bundled	Pick-up Truck	1
West Palm Beach, FL	Semi-weekly (h)	Yes	Year-round	Bagged or Loose	Bagged or Loose	Crane/Packer	3 (i)

Key:
NA = Not Available
Semi-weekly = Every other week
-- = Not Applicable

Notes:
(a) Same day as refuse collection
(b) In 1991 Austin began collecting leaves loose at curbside. Residents can also drop off leaves and grass clippings at Austin Community Gardens, a nonprofit horticultural organization.
(c) The City picks up leaves two to three times during the fall season. Brush and wood waste, picked up monthly, year-round, are burned.
(d) Yard waste collection frequency varies from weekly to monthly.
(e) Grass clippings are collected weekly, on the same day as refuse collection, from April until Nov. Leaves are collected weekly, October 15 until Thanksgiving Day, not on refuse days.
(f) In the North Section, leaves are collected weekly, year-round; in the South Section leaves are collected bi-weekly from March through October and monthly the rest of the year.
(g) Bagged grass clippings and leaves are collected year-round and loose leaves are collected in November and December.
(h) In 1991 the City purchased a one-person-operated crane and began to collect yard waste weekly.
(i) Two people operate a crane truck and a third driver follows in a compactor.

container with the end cut out—to attach to the rear of the refuse vehicle. The Recycling Coordinator claims this scoop enables the crew to collect 50 percent more leaves in a day than with the vacuum loader.

Case-study communities with year-round collection of yard trimmings usually request residents to place trimmings in cans or in plastic or paper bags. Crews generally collect bagged materials in packer trucks. Plastic bags are not accepted in Naperville, King County, and Takoma Park because of problems associated with debagging the yard materials. The City of Monroe recommends that yard debris be placed in transparent plastic bags to ensure that residents separate yard waste from refuse.

West Palm Beach, Florida collects yard debris year-round using an alternative method. Fine-toothed loaders shaped like clamshells are attached to cranes. The loaders pick up both bagged and loose yard trimmings at the curb and dump the material into compactor trucks.

How Berlin Township, New Jersey and Seattle, Washington Achieve High Composting Levels

Berlin Township, a suburban community with primarily single-family residences, is prohibited by State law from landfilling leaves. The Pinelands Commission, a State-run board with jurisdiction over a protected area that encompasses part of Berlin Township, bans the landfilling of grass clippings. While Berlin Township currently has approval to compost only leaves at this site, it is applying for a permit to compost additional materials there. These legislative measures have prompted the Township to implement a comprehensive yard trimmings collection program. Berlin Township provides weekly, year-round curbside collection for four types of yard waste: leaves, grass clippings, wood waste, and brush from all of its households. Additionally, it collects and chips Christmas trees. Residents and businesses may also drop off materials free of charge at the regional composting facility located in the Township. In addition to weekly residential pick-up, workers collect loose leaves at curbside twice per month on average during November and December with a retrofitted scoop, a front-end loader, and a compactor truck. Loose leaves are also collected in April. In 1990, the Township composted 39 percent of its residential waste.

Seattle has one of the best materials recovery programs in the country. In order to meet its 1998 goal of 60 percent municipal solid waste recovery, Seattle plans to compost 99 percent of its residential yard waste (excluding self-haul waste) and 93 percent of yard waste self-hauled by residents and businesses. By 1991 Seattle was composting 95 percent of the 42,726 tons of residential yard waste generated and 90 percent of self-haul yard waste. Since 1989 source separation of yard waste has been mandatory for City residents receiving curbside collection of refuse. In addition, the City's volume-based refuse rate provides a direct incentive to source separate yard waste. The City's contracted waste haulers collect leaves, grass clippings, and brush at curbside. The north section receives year-round collection; the south section receives twice monthly collection from March through October and monthly collection during the rest of the year. Residents without curbside refuse service self-haul yard waste (as they do refuse) to the City's two transfer stations. Residents are charged $4 per carload of yard waste and $5 per carload of mixed refuse. Yard waste is composted at the Cedar Groves Compost Facility, a 26-acre site located 30 miles southeast of Seattle. Material is shredded with a tub grinder and then formed into piles. Finished compost sells for $6 per cubic yard to wholesalers; retailers and wholesale outlets sell the compost in 1-cubic-foot bags for approximately $3 per bag. Since 1986 Seattle has also implemented a successful backyard composting program that has served as a model for communities around the country. In 1990 Seattle composted 14 percent of its residential waste.

A study conducted in Bristol, Connecticut found that collecting bagged leaves requires less time and is more cost-effective than collecting loose leaves using a front-end loader.[4] However, our data indicate that both methods are cost-effective when large amounts of material are recovered. Therefore, communities might consider utilizing a set-out and collection method that maximizes resident participation in the program. (Chapter 8 provides a full discussion of the costs of composting collection and processing.)

In communities that provide curbside refuse collection, curbside yard waste collection is needed to divert large-volume materials (such as fall leaves and spring and summer grass clippings), but drop-off programs can play a crucial role in capturing additional organic waste off-season.

Drop-off Collection

Drop-off collection of yard debris can be practical and cost-effective. In rural and smaller communities, particularly in those where residents self-haul refuse, drop-off programs have recovered significant amounts of yard waste. In communities that provide curbside refuse collection, curbside yard waste collection is needed to divert large-volume materials (such as fall leaves and spring and summer grass clippings), but drop-off programs can play a crucial role in capturing additional organic waste off-season. Mobile drop-off centers can serve several municipalities on a rotating basis. These sites may also provide the only opportunity for private businesses such as landscapers to divert their yard trimmings from disposal. Communities can provide residents and private haulers maximum incentive to deliver their yard debris to drop-off sites by locating these at disposal facilities and accepting source-separated yard waste free of charge or at a reduced tipping fee. Volume-based refuse rates can also encourage residents to use drop-off sites.

The rural community of Bowdoinham, Maine, for example, has a yard debris drop-off site at the landfill, where two-thirds of the residents self-haul refuse for disposal. Residents pay volume-based rates to drop off refuse and no fee to drop off yard trimmings. In fiscal year 1990, Bowdoinham diverted 11 percent of its MSW through composting leaves and grass clippings at this site.

Although residents in West Linn, Oregon can receive curbside yard waste collection, they pay a lower fee ($0.50 per bag of leaves and $3 per cubic yard of brush) to drop off yard waste at the drop-off center than to have it collected at curbside ($3.50 for each bag of leaves and $7.50 for each bundle of brush). The City composted 21 percent of its municipal waste in 1990. Only an estimated 4 of the 1,552 tons composted were collected at curbside.

Processing and Marketing Strategies

Communities compost yard debris using a variety of techniques some requiring little or no maintenance, others requiring more intensive intervention. Each system has its own advantages and disadvantages. Instead of composting yard trimmings, communities may choose to grind them for a mulch product or spread them directly on agricultural land. Table 4.3 compares some of these methods. The amount of residual material (including plastic and other noncompostable materials) rejected from composting or mulching sites utilized by our communities is generally low, from 0 to 2 percent by weight. West Palm Beach, Florida reported a very high reject rate of 26 percent in 1990, which it attributed to careless set-out and collection methods.[5] The City was not required to pay a tipping fee at the mulch site that year and did not actively remind residents to keep refuse out of yard materials.

Finished compost or mulch is given away to residents free of charge in 13 communities and sold in 12 communities. Through the sale of compost or mulch end products, communities can recoup some of the costs associated with yard debris collection and processing. Selling compost or mulch end products also emphasizes to residents and landscapers the value of such material. (Table 4.4 lists the compost and mulch end products and per ton revenues.)

Many of the rural communities that compost their yard debris use low-technology systems, which require less intervention, and are thus generally less expensive. However, materials take longer to compost in low-technology systems, and a lack of adequate oxygen in the compost pile can result in the generation of malodorous compounds. Turning a pile more frequently can reduce odor problems.[6] In addition, because yard debris and/or finished compost is often not screened or ground in low-technology systems, the finished product may not be as uniform as that produced with other methods. Low-technology composting systems are often used in communities that have secluded composting sites, much available land, limited available capital equipment and labor, and little or no intention of selling the finished product. All the communities studied that processed yard trimmings using low-technology methods, including Takoma Park, Bowdoinham, La Crescent, and Monroe, did not sell the finished compost but allowed residents to take it free of charge.

Through the sale of compost or mulch end products, communities can recoup some of the costs associated with yard waste collection and processing. West Linn, Oregon earned $16,000 in 1989 from the sale of compost products.

Of the communities studied, fifteen compost yard debris in windrows (elongated piles) using a medium level of technology. Contaminants (such as plastic and paper) are removed, and material may be screened or ground prior to forming into windrows. In medium-level systems, windrows are turned a minimum of four times per year to control oxygen levels and temperature, and to hasten decomposition. After the decomposition process, windrows are often formed into curing piles until the microbial activity slows down to the point at which the compost is deemed stable. An end product, suitable for landscaping and gardening purposes, is complete in less than 1 year, and often in 4 to 8 months. Five of the communities that utilized a medium processing technology sold their compost. For example, Cape May County, New Jersey sells its compost for $7 per cubic yard. West Linn, Oregon earned $16,000 in 1989 from the sale of compost products, which it sells to residents for $5 per cubic yard or $0.50 per 3-cubic-feet bag.

High-technology systems are utilized in three of the communities studied: Austin, Texas; Berkeley, California; and Naperville, Illinois. (Austin co-composts leaves and sewage sludge.) In higher-technology composting systems, windrows are turned frequently (e.g., once per week), internal windrow temperatures are monitored daily, and nutrients and/or water are added as needed to hasten decomposition. Higher-technology systems can handle more material per year than lower-technology systems on the same amount of land because the compost is complete in much less time. High- and medium-technology composting systems are often used in urban and suburban communities, where high volumes of yard debris combined with a shortage of space demand a time-efficient process. These systems offer an additional advantage for urban- and suburban-based composting sites, which are often located near populated areas; the more frequent turning aerates windrows and reduces odor problems.

Both medium- and high-technology composting systems can produce higher-quality mulch and compost end products that are more readily marketable. Two of the three cities with high-technology systems, Austin and Berkeley, sell their finished compost, while five of the communities with medium levels of technology give the finished product away for free. Austin sells its compost end product under the trade name "Dillo Dirt." The Wastewater Treatment Department received $12,000 in 1990 from the sale of compost products.

Finished compost can also be utilized by the municipality. A number of public works departments use mulch and finished compost in parks and recreation areas, and alongside highways. An estimated 80 percent of Newark, New Jersey's compost is distributed to 266 community gardens and 540 backyard gardens through Rutgers University's Urban Gardening Program. A small amount of Newark's compost is sold to private businesses for $2 per cubic yard.

Landfill cover represents a lower-value use for finished compost, as practiced in several communities. In 1991 Bowdoinham, Maine began to

Table 4.3
Compost Site Characteristics

Community	Public/ Private Compost Site	Mulching/ Composting Operation (a)	Technology (b)	Reject Rate (% by wt.) (c)	Regional or Local Site (d)	Compost Site Tipping Fee for Residential/ Public Sector ($/ton) (e)
Austin, TX	Public	Windrow	Hi/Co-composting	<2%	Local	$0
Berkeley, CA	Private	Windrow	High	<1%	Regional	$25
Berlin Township, NJ	Public	Windrow	Med.	0%	Regional	$0
Boulder, CO	Public	Mulched	Low	--	Local	--
Bowdoinham, ME	Public	Pile	Low	0%	Local	$0
Columbia, MO	Public	Mulched	Low	NA	Local	$0
Dakota County, MN	Public/Private (f)	Pile	Med.	<1%	Local	Varies
Fennimore, WI	Public	Windrow/Farms (g)	Med.	NA	Local	$0
King Co., WA	Private	Varies	Varies	NA	Regional	$25
La Crescent, MN	Public	Pile	Low	0%	Local	$0
Lafayette, LA	Public	Windrow	Med.	<2%	Local	$24
Lincoln, NE	Public	Mulched	Med.	NA	Local	$0
Lincoln Park, NJ	Public	Windrow	Med.	NA	Regional	$12.36/$26.64
Mecklenburg Co., NC	Public	Mulched	Med.	NA	Local	$0
Monroe, WI	Public	Pile	Low	NA	Local	$0
Naperville, IL	Public	Windrow	High	<1%	Local	$0
Newark, NJ	Public	Windrow	Med	NA	Local	$0
Perkasie, PA	Public/Pvt	Windrow	Med.	NA	Local	$0
Peterborough, NH	--	--	--	--	--	--
Philadelphia, PA	Public	Windrow	Med.	0%	Local	$0
Portland, OR	Private	Varies	Varies	0.5%	Regional	Varies
Providence, RI	--	--	--	--	--	--
San Francisco, CA	--	--	--	--	--	--
Seattle, WA	Private	Windrow	Med.	<1%	Regional	$5.47/$18 (h)
Sonoma Co., CA	Private	Windrow	High	0%	Local	$0
Takoma Park, MD	Public	Windrow/Pile	Med./Low	0%	Regional/Local	$0
Upper Township, NJ	Public	Windrow	Med.	5%	Regional/Local	$0
Wapakoneta, OH	Public	Farm	Low	--	Local	$0
West Linn, OR	Public	Windrow	Med.	2%	Local	Leaves-NA, BR-$12
West Palm Beach, FL (i)	Public	Mulched	--	26%	Regional	$0

Key:
BR = Brush Med = Medium NA = Not Available Pvt = Private wt. = weight -- = Not Applicable

Notes:
(a) Windrow -- Collected organic materials are placed in one or more rows for decomposition; Farm(s) -- Organic materials are tilled into or spread over fields at one or more local farms; Mulched -- Materials are ground and distributed without further processing; Pile -- Organic materials are placed into one or more large piles. Materials take at least 1 year to compost.
(b) Low technology -- Materials are placed in piles or windrows (either screened or not) and turned up to four times per year. Windrows or piles are turned Medium technology -- Materials are often ground or shredded and sometimes watered before forming into windrows or piles. approximately four times per year, and compost is ready in 4 to 8 months.
High technology -- Material is screened and/or watered before forming into windrows or piles. Additional nutrients can be added to speed the compost process. Temperature is measured frequently, and windrows or piles are turned with machines approximately once per week. The final product is screened and ready in 1 to 4 months.
(c) The percentage of composted yard waste consisting of contaminants that require disposal.
(d) Local sites service the municipality; regional sites service a number of jurisdictions.
(e) Commercial businesses in Berlin Township, Bowdoinham, Fennimore, La Crescent, Mecklenburg County, Sonoma County, and Upper Township can use the composting sites free of charge. Commercial businesses in Berkeley pay $25 per ton, in West Linn businesses pay $12 per ton for brush, and businesses in Dakota County pay fees ranging from $3.50 per cubic yard for loose yard waste to $5.50 per cubic yard for bagged yard debris.
(f) Dakota County owns two compost sites that are privately operated. Three additional sites are privately owned and operated.
(g) Yard waste brought by residents to the drop-off site is windrowed; leaves collected at curbside are spread on local farms.
(h) Seattle's contract fee at the Cedar Groves Compost Facility covered the first 24,000 tons only; the City was charged an $18 per ton tipping fee for tons delivered above 24,000. The contract was renegotiated in 1992.
(i) Palm Beach County's Solid Waste Authority (SWA) charges the City of West Palm Beach a tipping fee of $37 per ton for yard waste dropped off at its sludge co-composting facility, which began operations in October 1991. The data given above are for the SWA's 5-acre mulch site at the North County Landfill.

compost food scraps, mixed waste paper, and other organic scraps. The finished compost is used as landfill cover, saving the Town between $8 and $10 per cubic yard for new cover material. When its landfill closes in 1992 the compost will be used as a final cover. Lincoln, Nebraska also uses its compost as a fill to help close the old landfill.

Some communities, such as West Palm Beach, Florida, Mecklenburg County, North Carolina, and Columbia, Missouri, mulch yard materials, particularly wood waste and brush, in lieu of more time- and land-intensive composting. Mulch can be used for landscaping purposes, to retain moisture in soil, and to control the growth of weeds. Mecklenburg County sells mulch produced from leaves, grass clippings, and small brush to the general public for $6 per cubic yard, and compost for $10 per cubic yard. Cape May County, New Jersey sells a mulch product for $10 per cubic yard. Some mulch is also used as a landfill cover. Palm Beach County uses mulch for landfill management including erosion control and landscaping.

Yard debris materials can also be used without being composted, mulched, or shredded. Cape May County dug an 8-foot "Hibernaculum" trench for large brush and stumps to be used as a wildlife habitat. The process will be repeated in an estimated 7 to 10 years, when these materials have decomposed. Boulder, Colorado and Columbia, Missouri sank Christmas trees in lakes to improve fish habitat. In Lafayette, Louisiana, trees were used as wave barriers and sediment traps to prevent coastal erosion.

How Do Communities Increase Composting Levels?

Charts 4.1 and 4.2 show the importance of composting in reaching a high level of materials recovery. The four communities recovering at least 50 percent of their municipal waste—Lincoln Park, Berlin Township, Bowdoinham, and West Linn—are composting between 11 and 30 percent of their municipal waste.[7] Since yard debris is often a larger component of the residential waste stream than of the commercial and institutional waste streams, yard debris composting has an even more pronounced effect on residential recovery levels. For example, Fennimore, Wisconsin composted 13 percent of its municipal waste stream but 26

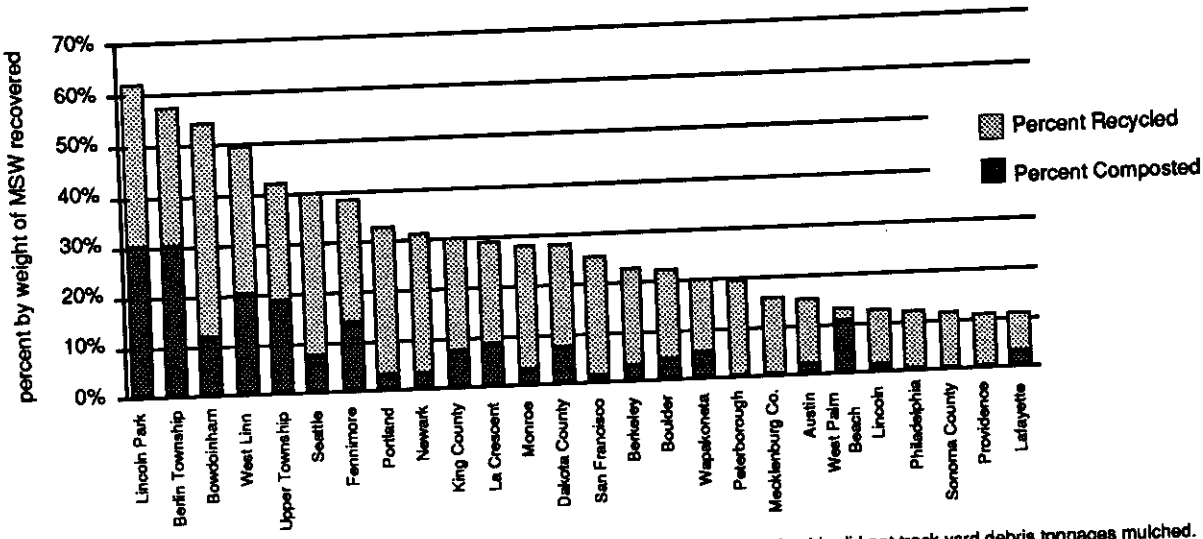
Table 4.4
Compost/Mulch End Products

Community	Compost or Mulch End Product	Compost or Mulch End User	Sale Price ($)
Austin, TX	Compost	Landscapers, Retailers	Marketed through garden shops as "Dillo Dirt"
Berkeley, CA	Compost, Mulch	Wholesalers, Nurseries, Businesses, Residents	$7 - $15/cy
Berlin Township, NJ	Compost	Residents	$0
Boulder, CO	Mulch	Residents, Public Facilities	$0
Bowdoinham, ME	Compost	Residents	$0
Columbia, MO	Mulch, Wildlife Habitat	Residents, Landscapers	$0
Dakota County, MN	Compost, Mulch	Residents, Landscapers	$0
Fennimore, WI	Compost, Farm Application	Farmers	$0 to $8/cy
King Co., WA	Compost, Mulch	Privately marketed	Not sold, used in City
La Crescent, MN	Compost	Residents	NA
Lafayette, LA	Compost for Public Facilities	Public Facilities	$0
Lincoln, NE	Compost for Landfill, Mulch	Landfill, Landscapers	Not sold
Lincoln Park, NJ	Compost, Mulch	NA	Mulch $3-$8 /cy
Mecklenburg Co., NC	Compost, Mulch	Residents, Landscapers	NA
Monroe, WI	Compost	Residents, Public Facilities	Compost $10/cy, Mulch $4-$6/cy
Naperville, IL	Compost, Mulch	NA	$0
Newark, NJ	Compost, Mulch	Rutgers U. Urban Gardening, Businesses	$0 for Mulch
Perkasie, PA	Farm Application, Mulch	Landscapers, Farm	Compost: $0 for residents, $2/cy for businesses
Peterborough, NH	--	--	$0
Philadelphia, PA	Compost, Mulch	Residents, Landscapers, Community Gardens	--
Portland, OR	Compost, Mulch	Residents, Landscapers, Nurseries	$0
Providence, RI	--	--	Varies; $10/cy for food waste compost
San Francisco, CA	Compost, Mulch	Retail and Residents	--
Seattle, WA	Compost	Retail and Wholesale Outlets	Compost "Zoo Doo" NA, Mulch $0
Sonoma Co., CA	Compost	Landscapers, Farmers, Residents	$6/cy (wholesale), $3/cubic-foot bag (retail)
Takoma Park, MD	Compost, Mulch	Residents, Garden Shops	$15-$25/cy
Upper Township, NJ	Compost, Mulch, Wildlife Habita	County, Residents	$0
Wapakoneta, OH	Farm Application	Residents, Farmers	Compost $7/cy, Mulch $10/cy
West Linn, OR	Compost, Mulch	Residents, Public Facilities	$0
West Palm Beach, FL	Mulch	Residents (Mulch), Landscaping at Landfill	$5/cy or $3/3 cubic-feet
			$0

Key:
cy = cubic yard NA = Not Available -- = not applicable

Chart 4.1

Percent of Municipal Solid Waste Recovered



Notes: Total waste recovery level is utilized for Austin, Newark, and Upper Township. In 1990 Columbia did not track yard debris tonnages mulched. MSW recovery rates are not available for Naperville, Perkasie, and Takoma Park.

percent of its residential waste stream in 1990. Communities with extensive landscaping, mature deciduous trees, and spacious yards generally have the potential to reach higher composting levels than other communities.

The following activities have proven successful in enabling communities to divert large portions of their waste through composting:

- provide frequent curbside collection of yard debris for composting;
- target all residential buildings for yard debris collection;
- promote and encourage backyard composting and "don't bag it" programs;
- offer collection of a variety of yard debris materials;
- start pilot programs collecting food discards for composting;
- increase residential, commercial, and institutional participation (strategies include mandates and economic incentives); and
- encourage landscapers and businesses to compost.

Frequent and Convenient Collection

The frequency of yard debris pick-up affects the level of participation and consequently the level of composting. Setting out yard trimmings for composting needs to be as convenient for residents as setting out their refuse. Weekly year-round curbside collection of organic waste for composting has proven effective in reaching high recovery levels in Berlin Township, Takoma Park, West Palm Beach, and Lafayette. Until June 1990, Takoma Park collected leaves during the fall months only. When it added year-round collection of leaves and grass clippings to its seasonal fall leaf collection program, the percentage of residential waste composted increased from 18 percent in 1990 to 24 percent in 1991.

Communities recovering large amounts of yard debris have collection programs that mirror yard debris generation patterns. In Southern cities, such as West Palm Beach and Lafayette, year-round collection is essential to reach high composting levels. Lafayette implemented a year-round, weekly collection program in May 1990 for leaves, grass clippings, branches, and brush. The program

was so effective that during the first year of its operation, the City composted 18 percent of its residential waste.[8] West Palm Beach recovered 18 percent of its residential waste from April 1990 to March 1991 through year-round, twice monthly yard debris collection. In fiscal year 1989, Mecklenburg County collected an estimated 1,176 tons of yard debris at its drop-off site. Charlotte, which has 80 percent of the County's population, implemented a weekly, year-round curbside program in January 1991. With the addition of this program, the County recovered 15,881 tons of yard debris during the first 6 months of 1991—almost 14 times the amount collected in 1989.

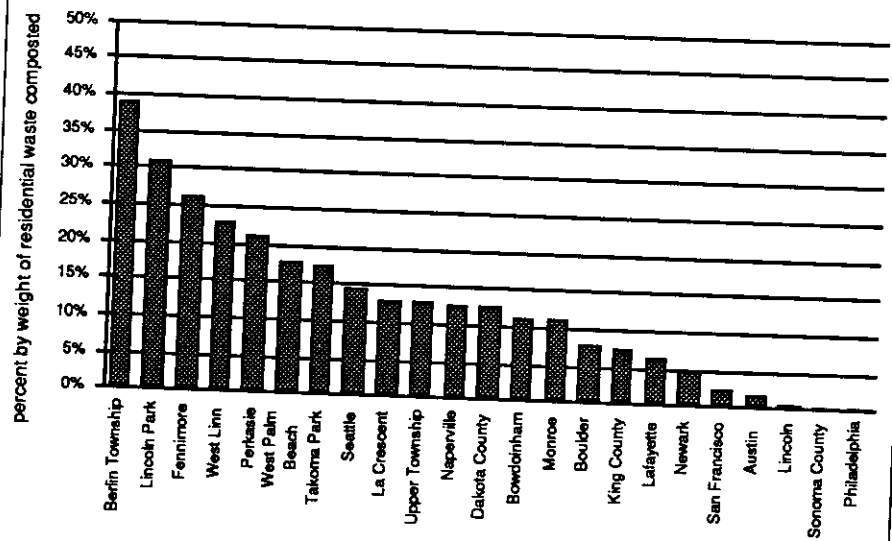
In northern climates, frequent seasonal collection can be an effective alternative to year-round collection. Naperville, Illinois composted 13 percent of its residential waste in 1990 through weekly collection of grass clippings and garden trimmings 8 months of the year. The City collected leaves and brush during three seasons, an average of three times each season. Lincoln Park composted 30 percent of its municipal waste in 1990 through mandatory curbside collection of leaves, brush, and grass clippings, at least twice per month, in the spring and fall. The Borough augments seasonal collection with a drop-off site at the recycling center that accepts yard materials year-round. Sixty percent of all residential material composted in 1990 was collected at curbside; the remainder was accepted at the drop-off site. In contrast, the City of Philadelphia, which collects leaves only once per year in the neighborhoods considered to have the highest tree density, composted less than 1 percent of its residential waste in fiscal year 1990.

Target All Residential Buildings for Yard Materials Collection

The three communities collecting yard debris at curbside from 100 percent of their households—Fennimore, Upper Township, and Berlin Township—composted between 13 and 39 percent of their residential waste.[9] The four municipalities targeting the lowest percentage of their total households with curbside pick-up, Berkeley (6 percent served), Philadelphia (7 percent served), Sonoma County (1 percent served), and Lincoln (3 percent served), are among the communities with the lowest composting rates. Santa Rosa is the sole city providing curbside yard debris collection in Sonoma County. However, the pilot curbside program provides service to only 1 percent of Santa Rosa's population. The City collected 50 tons of leaves and 33 tons of wood waste in 1990, less than 1 percent of residential materials recovered.

Chart 4.2

Percent of Residential Waste Composted



Notes: Bowdoinham's composting level is based on its municipal solid waste, which is largely residential. Lafayette's 6% composting level is based on the program's first 5 months of operation. After the first 11 months the City composted 18% of its residential waste. For Upper Township, Newark, and Philadelphia, composting levels represent that portion of the waste handled by the public sector. For these communities, compost tonnage thus may include some commercial waste, and exclude residential waste handled by the private sector.

Target a Wide Range of Materials for Collection

Communities collecting more types of organic waste for recovery generally have higher composting levels. The seven communities composting at least 15 percent of their residential waste stream composted at least three different types of organic materials. Of the 12 communities composting more than 10 percent of their residential waste stream, 9 collect grass clippings at curbside. Berlin Township composted 30 percent of its municipal waste in 1990 and collected five types of organic materials—leaves, grass clippings, brush, wood waste, and christmas trees—year-round at curbside. Austin, which collected only one type of organic waste at curbside, composted only 2 percent of its residential waste. Table 4.1 specifies the types of organic materials collected.

Berlin Township composted 30 percent of its municipal waste in 1990 and collected five types of organic waste—leaves, grass clippings, brush, wood waste, and Christmas trees—year-round at curbside.

Problems can arise as communities expand the number of materials targeted. For example, in response to a statewide yard debris ban, Naperville, Illinois began to collect and compost grass clippings, leaves, and brush. However, the City received some complaints from residents near the compost site about odor problems, which had developed due to composting an unbalanced ratio of grass clippings, leaves, and brush. Because grass clippings are high in nitrogen, they decompose at a faster rate than other yard trimmings. Odor can be avoided by providing an adequate supply of oxygen and a higher percentage of leaves, which are high in carbon. (Leaves collected in high-volume months, can be reserved to compost with grass clippings generated primarily in spring and summer.) In addition, "grasscycling" and backyard composting programs can obviate the need for large-scale composting of grass clippings. (See Chapter 3 for more information on these programs.)

Communities without accessible markets for mixed paper can compost these materials. Bowdoinham residents separate mixed paper such as junk mail, high-grade paper, paperboard, and paper towels from other recyclables. These materials are composted along with food discards at the landfill; the compost will be used as a landfill cover when the landfill closes in June 1992.

Composting Food Discards

Food discards constitute approximately 8 percent of municipal solid waste generated nationwide, and a larger percentage of residential waste. Some cities generate higher amounts. An estimated 31 percent of residential waste and 19 percent of commercial waste generated in San Francisco is food waste.

Recovery of food discards through composting can elevate waste diversion rates. Communities both within our sample and outside have diverted large amounts of food discards from disposal through composting programs. In addition, communities that encourage backyard composting of food scraps (excluding meat scraps and bones) or vermicomposting (the use of worms to digest and convert food waste into a fertilizer product), can reduce their waste collection and disposal costs and can increase recovery rates by reducing the amount of solid waste generated. Residents can be instructed in backyard or home composting techniques to ensure optimal compost processing and to avoid odor and vermin problems.

Backyard composting of food discards is practiced in rural, suburban, and urban communities. While cities such as Newark, New Jersey encourage backyard composting of food scraps, other cities such as San Francisco encourage vermicomposting. In 1990 San Francisco estimated that residents were composting 4,414 tons of food discards and 2,164 tons of yard materials at home, an amount equivalent to 6 percent of all material recovered from the residential sector that year. (See Chapter 3 for a discussion of backyard composting programs.)

Food discards can also be collected at curbside. Private New Jersey hog farmers collect food scraps from residents in Philadelphia and Kodiac Recycling collects food scraps from residents in

Peterborough for recovery as animal feed. In 1990 Sunflower Recycling Inc., a private hauler in Portland, Oregon, collected and composted food scraps from 105 City households. Sunflower provided residents with used 5-gallon paint or soap buckets free of charge, and charged residents an additional $2 for collecting the food scraps. Food scraps, including bones and fat, were collected in a separate side bin on a refuse hauling packer truck. To process the material, Sunflower mixed food scraps with sawdust (in a ratio of 2:1) in two 7-cubic-yard retrofitted cement mixers. The food waste could be finished in 2 to 3 weeks; however workers tended not to turn the material frequently, so the composting process took 2 months on average. The finished compost was sold at $10 per cubic yard. Sunflower collected an estimated 5 tons of food scraps per month in 1990.

Food waste can also be collected at curbside. Private New Jersey hog farmers collect food waste from residents in Philadelphia and Kodiac Recycling collects food waste from residents in Peterborough for recovery as animal feed.

The Town of Bowdoinham composted food scraps collected from a local college cafeteria with either mixed waste paper or leaves from the Town, in order to compare the resulting finished composts. Although the Town no longer composts food scraps from the college, Bowdoinham composts food scraps dropped off by residents each Saturday at the Town's Recycling Barn.

King County, Washington, including Seattle, is actively pursuing new ways to recover food discards. In FY 1992 the County allocated $800,000 to research the potential for food scrap composting. King County collected and composted food scraps generated during its 1990 County Fair in order to determine whether a consistent compost could be produced and whether it was feasible to compost food scraps on a large scale.

See side bars "New York's Park Slope Neighborhood Intensive Recycling Project" and "Lessons from Abroad" for additional discussion of food waste recovery programs.

Legislative Mandates and Economic Incentives

Communities have implemented economic and legislative incentives to encourage residents and businesses to source-separate organic materials, and to encourage haulers to collect them for recovery. Of the eleven communities with composting rates of at least 7 percent, three (Berlin Township, Lincoln Park, and Fennimore) require residents to participate in source-separation programs, six (West Linn, Bowdoinham, La Crescent, Dakota County, Perkasie, and King County) charge volume-based refuse rates, and Seattle has both variable refuse rates and requires the source-separation of yard debris. West Linn and Dakota County require haulers to collect source-separated yard debris from their refuse customers. (See side bar on Dakota County's User Fee Schedule.) West Palm Beach alone among the top eleven has a voluntary program without volume-based rates. West Palm Beach can attribute its high composting rate to twice monthly, year-round curbside collection of yard trimmings from 75 percent of its residents.

Volume-based refuse rates are at the heart of West Linn's successful composting program. In cooperation with the City, the private refuse and recycling hauler charges less for the collection of source-separated leaves and brush than for the collection of refuse. In order to avoid the fee for curbside collection of refuse and yard debris, many residents choose instead to compost yard debris in their yards (an estimated 15 to 20 percent of all yard debris was composted in yards in 1990) or to deliver materials to the composting site. Leaves, grass clippings, brush, and wood waste are accepted at the drop-off site for a lower fee than that charged by the private hauler for curbside pick-up. In 1990 West Linn composted 20 percent of its municipal waste (excluding backyard composted tonnages), primarily through drop-off collection.

King County, Washington has developed several types of drop-off collection programs for areas not serviced with curbside collection of yard materials. The County's experience with its mobile

Lessons from Abroad

Information generated from a number of European communities provide well-tested models for U.S. food scrap composting programs. Due to problems marketing finished MSW compost, many European cities are now targeting collection and composting of segregated "biowaste" (yard debris and food discards and sometimes soiled waste paper). In 1988 at least 71 source-separation projects were operating in West Germany. Approximately 430,000 households, which composted an estimated 200 pounds per person per year, were served by these projects. The largest program, in Heidelburg, serviced over 100,000 residents.

Residents of single- and multi-family households in some cities in the Netherlands keep food and yard materials segregated from refuse by placing these organic materials in bins ranging in size from 10 to 140 liters. Two workers operate automated collection compactor vehicles, which empty two containers simultaneously into the trucks. The average loading time for the two containers is 24 seconds. Refuse is either co-collected with food and yard materials in compartmentalized vehicles or collected on alternating days. A "bio bin" system developed in Germany recovers organic yard and food materials only, using an automated two-bin collection system for organic wastes and refuse. Most residents take recyclables to local drop-off sites.

Following the lead of Europe, cities in Canada are beginning to initiate extensive organic material recovery programs. The metropolitan Toronto area located in Ontario, Canada, initiated a 12-month wet waste pilot project in November 1991. Approximately 1,500 households in Toronto receive separate collection for recyclables, food and yard materials, and refuse. Separation of the wet waste is expected to reduce household waste 30 percent by weight in addition to the 15 percent being diverted through the recycling program.

Guelph, Ontario implemented a pilot wet and dry recovery program. Residents place all wet material (including food scraps, yard debris, soiled paper, and disposable diapers) in one container and dry recyclables and waste in a second. Wet materials are composted, while dry recyclables are sorted and marketed. Participation rates have been extremely high (99 percent), and these systems have recovered between 83 and 96 percent by weight of all organic materials. Guelph has expanded its wet and dry program, and will service all City households by the end of 1993. (See Chapter 5 and Appendix E for further information on wet and dry recovery systems and their costs.)

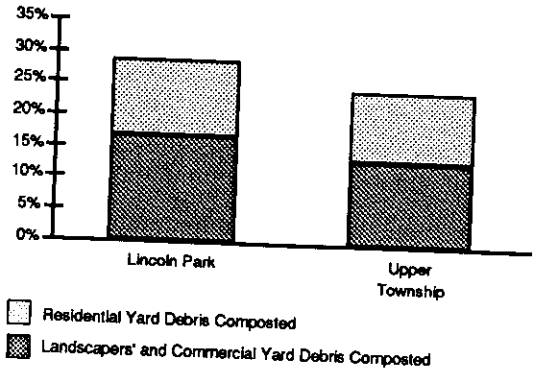
Sources: Office of Technology Assessment, *Facing America's Trash: What's Next for Municipal Solid Waste* (Washington, D.C.: U.S. Government Printing Office, October 1989), 188-189; Anne Scheinberg et al., "European Food Waste Collection and Composting Programs," *Resource Recycling*, December 1990; and "Wet Waste Collection Pilot Launched by Metro," *BioCycle*, December 1990.

drop-off depots, which rotate to different sites, emphasizes the importance of convenience and financial incentives for maximizing residents' participation in such programs. Drop-boxes—located at refuse disposal sites—serve rural areas, while a mobile yard debris collection program serves certain suburban and urban locations. In 1989, the first year of the program, residents could deliver yard debris for free one week per month at one of five mobile drop-off depots. Over a 6-month period that year, King County recovered a total of 2,801 tons of material at five mobile units (an average of 560 tons per unit). In 1990 the County instituted a $5.25 per cubic yard tipping fee (estimated at $42 per ton[10])—almost as much as the refuse tipping fee of $47 per ton—reduced service at its mobile units from one week to one weekend per month, and cut back from five mobile units to four. During a 6-month period in 1990, the County recovered only 683 tons (an average of 171 tons per mobile drop-off unit), almost 76 percent less than in the 6-month period the previous year.[11]

Yard debris disposal bans can lead to high composting recovery rates. By February 1992, 15 states, plus the District of Columbia, had enacted yard waste bans. (Connecticut, New Jersey and

Chart 4.3

The Effect of Composting Landscapers' Yard Debris on Composting Levels



Notes: For Upper Township, percentages are based on total waste generated. For Lincoln Park, percentages are based on MSW generated. Landscapers' waste consists of stumps and logs collected by tree trimming companies in Lincoln Park. Residential yard waste contains some commercial waste delivered to the drop-off site.

Pennsylvania ban leaves only.)[12] These bans have proven extremely effective in spurring the implementation of yard debris collection and composting programs.

In April 1990, for example, Naperville implemented weekly collection of garden trimmings and grass clippings in response to Illinois' yard debris landfill ban, which became effective in June of that year. In 1992, in order to encourage residents to compost at home and thus reduce collection and processing fees, Naperville began charging residents $1.50 per bag of yard debris set out.

Encouraging Businesses and Landscapers to Compost

In some communities, yard materials generated by business establishments and professional landscapers constitutes a substantial portion of total yard debris generated. By allowing private haulers to deliver their yard materials to drop-off sites for free or at reduced tipping fees, communities can attract haulers to composting sites and greatly increase composting levels. Chart 4.3 indicates the contribution of landscapers' waste to overall composting levels in Upper Township and Lincoln Park, New Jersey. Cape May County, in which Upper Township is located, allows businesses and residents to drop off leaves and grass clippings free of charge at the County-owned and -operated composting site. Lincoln Park recovered 1,876 tons of stumps and logs—equivalent to 12 percent of the MSW generated by the Borough—from tree trimming companies in 1990. These companies could drop off materials free of charge. Seattle's two transfer stations accept yard debris, including leaves and brush up to 12 inches in length, from residents and businesses at reduced tipping fees. Through this program, Seattle composted 15 percent of all waste self-hauled to disposal sites.[13]

In Dakota County, Minnesota, residents, landscapers, and haulers can drop off leaves, grass clippings, garden trimmings, and prunings up to 6 inches in diameter at one of the five compost sites in the County year-round. They pay a lower tipping fee at the composting site than at the landfill. In 1990 residents and landscapers dropped off 2,489 tons of yard materials at County sites,

User Fee Schedule Helps Dakota County, Minnesota Receive Loose Yard Debris

In order to encourage private haulers, landscapers, and residents to deliver loose rather than bagged yard debris to its three composting sites (to reduce compost processing labor and operating costs), Dakota County has implemented a sliding-scale tip fee, which it calls its User Fee Schedule:

User	Loose Yard Debris	Bagged Yard Debris
Haulers	$3.50/cubic yard	$5.50/cubic yard
Landscapers	$3.75/cubic yard	$5.50/cubic yard
	$3.00/cubic yard of brush	
Residents	$3.75/cubic yard	$0.15/bag
	$2.00/cubic yard of brush	

In 1990 Dakota County composted 16,602 tons of yard debris, equivalent to 58 percent of the yard debris generated.

New York City's Intensive Recycling Project

New York City is currently conducting an intensive recycling pilot project in which a wide range of materials, including food scraps, is collected for recovery from 3,500 households in Park Slope, Brooklyn. Residents participating in the Park Slope recycling project are instructed to place all food waste in cellophane-lined paper bags distributed by the City. Each multi-unit building is provided with a sealed plastic bucket in which residents place bags of food scraps at their convenience. (One- to three-unit buildings are provided with 8-gallon buckets; buildings with more than three units are provided 20-gallon buckets.) The City collects materials weekly in a 25-cubic-yard rear-end packer and composts the food and paper bags on 1 acre of land, located on a 40-acre composting site at the Fresh Kills Landfill. Leaves and wood chips are added as bulking agents. Materials were initially combined in a ratio of 3 parts leaves to 1 part food, but to reduce odors, the ratio was changed to 5 to 1.

By March 1992, 5 months into the food waste pilot, the City was collecting an average of 4.1 tons of food scraps per week from the 3,500 households. Food waste collection has been proceeding smoothly, with no complaints from residents about odor or vermin problems. (The City will continue to monitor this situation over the summer months.) Food waste comprises 13 percent of the waste generated in the pilot area; of this, the City estimates that it is capturing 41 percent. (The overall waste recovery rate in the intensive recyling district is estimated at 35 percent.) The material delivered to the site is relatively uncontaminated, probably due to the size of food waste bags (they are too small to hold other refuse) and the prominent instructions that appear in both English and Spanish on the side of the bags. Community volunteers encourage participation through the distribution of leaflets and in-person education. However, in some instances residents have run out of bags at a faster pace than anticipated, and some buildings have found their central containers to have inadequate capacity.

Source: Tom Outerbridge (Recycling Programs and Planning Division, The City of New York Department of Sanitation), personal communication, January to April 1992.

representing 4 percent of MSW recovered and 15 percent of the total materials composted in the County that year.

Since October 1990, Lincoln, Nebraska has allowed residents and landscapers to drop off brush and other yard materials at its transfer station for $4 per pick-up load. Although the City only composted 1 percent of its MSW in 1990, 80 percent of this amount was yard debris self-hauled to the transfer station.

In some communities, nonprofit organizations and community groups operate composting sites that accept commercially generated materials. In Austin, Texas, residents and landscapers can bring leaves and grass clippings year-round to a 6-acre compost site operated by Austin Community Gardens, a nonprofit horticultural organization. Residents drop off material free of charge, while landscapers pay a $35 annual fee. In 1989 landscapers contributed an estimated one-half of the materials composted that year. The compost is applied to the 23 public gardens operated by Austin Community Gardens. In 1989 this organization composted 5,628 tons of yard debris—67 percent of total yard debris recovered in Austin.

Conclusion

By integrating the best features of the best composting programs listed above, communities can divert a significant percentage of their waste from disposal while producing a valuable and marketable

soil amendment. Because yard and food materials constitute a significant portion of the municipal waste stream, communities need to target these organic fractions of both the residential and commercial waste streams in order to maximize recovery.

Notes

[1]This report examines source separation of yard debris and food scrap composting only. It does not provide an overview or an assessment of mixed MSW or sludge composting.

[2]In many cases, communities do not weigh yard materials, but rather convert volume to weight using local, regional, or national conversion factors. See Appendix C for sample conversion factors.

[3]In contrast, Portland, Oregon, which opened its *mixed* municipal solid waste (MSW) composting facility in April 1991, has yet to produce a marketable end product. At the end of January 1992, Portland's composting facility, the nation's largest operating MSW composting system, stopped accepting garbage due to persistent odor problems. Tests have shown lead content in the end product exceeding the acceptable standard of 250 parts per million.

[4]Lori Segall and Ron Smith, "Raking Versus Bagging," *BioCycle*, September 1989, 44-45.

[5]West Palm Beach's 18 percent residential composting level excludes the 4,299 tons of contaminated yard debris, which were disposed.

[6]In Portland Oregon, for example, yard trimmings were composted in a pile measuring over 100 feet in height at a private compost site, MacFarlene Bark. When the Oregon State Department of Environmental Quality received complaints about odor emanating from the pile, MacFarlene Bark resolved the problems by turning the pile more frequently. In 1991, the Town of Bowdoinham, Maine, began to compost fish waste from a local cannery along with other organic waste. Although fish waste gives off a strong odor, this reportedly does not create a problem since the compost site is located 6 miles from the Town.

[7]Except for San Francisco, composted tonnages do not include tonnages recovered through backyard composting or "grasscycling" programs.

[8]The City composted 5,760 tons over the 11-month period from May 1990 to April 1991, or 523 tons per month. If monthly residential waste generation remained unchanged from 1990 to 1991, Lafayette composted 18 percent of its residential waste. The 6 percent residential composting figure for Lafayette in Charts 4.1 and 4.2 is based on tonnage figures from November 1989 through October 1990.

[9]While Wapakoneta collects leaves from all its households, it does not track residential recovery rates and, up until June 1990, it burned a significant portion of its yard debris.

[10]The tipping fee for mixed yard debris was converted from volume to weight using a conversion factor of 250 lbs. per cubic yard. (*Regional Yard Debris Recycling Plan*, Portland, Oregon, December 1990.)

[11]From May to October 1989, the County recovered 2,801 tons of yard debris at its five mobile units; from June to November 1990, after program tipping fees were instituted and service reduced, the County recovered only 683 tons of yard debris through four drop-off units. The County has implemented curbside collection in some unincorporated areas and has consequently discontinued its mobile service.

[12]George Brabec, "The First Statewide Yard Waste Ban: Meeting the Challenge," *Resource Recycling*, February 1992, 69-74.

[13]The self-haul waste stream includes recyclable materials and waste brought to the City's transfer station by residents and businesses.

Chapter Five

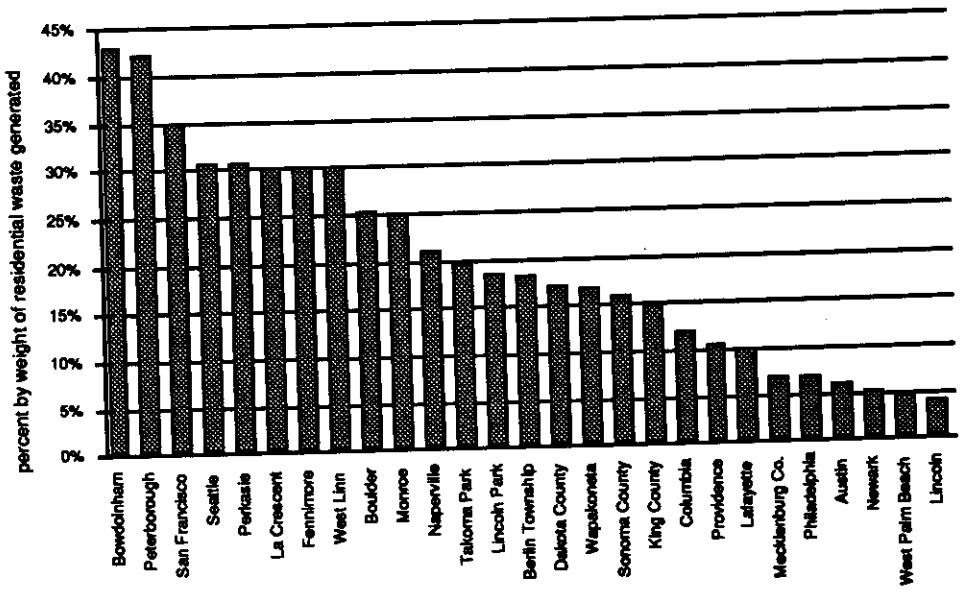
Improving Residential Recycling Levels

Overview

The nation has experienced tremendous growth in residential recycling opportunities in the last few years. In 1988 there were a little over 1,000 curbside recycling programs (full-scale and pilot) operating; by 1991 there were nearly 4,000—a growth of more than 250 percent in 3 years.[1] Drawing on the experience of the 30 communities studied, as well as model initiatives both in the United States and abroad, this chapter describes how municipalities are achieving high residential *recycling* levels. (Composting programs, which are also critical to reaching high levels of materials recovery in the residential sector, are discussed in Chapter 4.) This chapter discusses the range of design options (including set-out method, frequency of collection, containers, and materials targeted), and outlines the features that increase participation and the amount of material collected for recycling.

Tables 5.1 and 5.2 list residential recycling, composting, and recovery rates, and select program characteristics for the 30 communities studied. As indicated in these tables and Chart 5.1, communities are recycling up to 42 percent of their residential waste.[2]

Chart 5.1
Residential Recycling Levels



Notes: These rates exclude residential materials composted. For Philadelphia and Newark, residential material is publicly collected waste. Bowdoinham's tonnage includes waste generated from a small number of businesses. For Wapakoneta and West Linn, recycling rates represent MSW recycling rates. In Naperville and Takoma Park the recycling rate represents that for the city-service area (which includes less than 60% of households), not the whole city.

Table 5.1
Residential Materials Generated and Recovered

Community	Year Data Collected	Residential Waste Generated (TPY)	Residential Materials Recycled (TPY)	Residential Materials Composted (TPY)	Residential Materials Recovered (TPY)	% Residential Materials Recycled (By Wt.)	% Residential Materials Composted (By Wt.)	% Residential Materials Recovered (By Wt.)	Residential Materials Recycled (lbs/HH/yr.) (a)	Residential Materials Composted (lbs/HH/yr.) (a)	Residential Materials Recovered (lbs/HH/yr.) (a)
Austin, TX	FY89	254,464	13,387	4,186	17,573	5	2	7	135	42	177
Berkeley, CA	FY91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Berlin Township, NJ	1990	6,035	1,053	2,339	3,392	17	39	56	1,170	2,599	3,769
Boulder, CO	1990	29,204	7,265	2,300	9,565	25	8	33	415	131	547
Bowdoinham, ME	FY90	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Columbia, MO	FY90	30,857	3,242	NA	3,242	11	NA	11	252	NA	252
Dakota County, MN	1990	113,487	18,976	14,113	33,089	17	12	29	380	282	662
Fennimore, WI	1990	648	164	169	333	25	26	51	337	348	686
King County, WA	1990	646,109	77,328	48,058	125,386	12	7	19	408	254	662
La Crescent, MN	1990	1,109	309	144	453	28	13	41	394	184	578
Lafayette, LA	FY90	34,651	2,440	2,211	4,651	7	6	13	165	150	315
Lincoln, NE	1990	135,960	4,081	467	4,548	3	0	3	103	12	115
Lincoln Park, NJ	1990	7,750	1,409	2,387	3,796	18	31	49	662	1,121	1,782
Mecklenburg Co., NC	1990	292,897	20,171	0	20,171	7	NA	7	186	0	186
Monroe, WI	1989	3,802	804	417	1,221	21	11	32	376	195	572
Naperville, IL	1990	39,020	7,617	4,901	12,518	20	13	32	491	316	808
Newark, NJ (b)	1989	146,654	6,823	7,435	14,258	5	5	10	133	145	278
Perkasie, PA	1990	3,133	964	654	1,618	31	21	52	494	335	829
Peterborough, NH	1990	2,003	847	0	847	42	0	42	941	0	941
Philadelphia, PA (b)	FY90	928,054	56,284	1,571	57,855	6	0	6	167	5	172
Portland, OR	1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Providence, RI	1990	80,677	8,191	0	8,191	10	0	10	267	0	267
San Francisco, CA	1990	308,099	106,712	7,027	113,739	35	2	37	650	43	693
Seattle, WA	1990	256,219	78,911	36,780	115,691	31	14	45	634	295	929
Sonoma County, CA	1990	124,845	18,571	402	18,973	15	0	15	232	5	237
Takoma Park, MD	1990	6,889	1,269	1,206	2,475	18	18	36	361	343	703
Upper Township, NJ (b)	1990	6,879	2,527	884	3,411	37	13	50	1,309	458	1,767
Wapakoneta, OH	9/89-8/90	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Linn, OR	1990	NA	1,507	1,474	2,981	NA	NA	NA	489	478	967
West Palm Beach, FL	4/90-3/91	69,713	2,809	12,434	15,243	4	18	22	230	1,017	1,247

Key:

FY = Fiscal Year HH = Household NA = Not Available TPY = Tons Per Year Wt. = Weight

Notes:

Residential tonnages above may exclude some waste generated by the residential sector, such as waste generated by apartment buildings (e.g. in Takoma Park, Philadelphia, Providence and Newark), and self-haul waste (e.g. Seattle and Austin). For community-specific explanation of waste generation see Appendix C.

(a) Based on total households in the community.

(b) All tonnage figures and recycling, composting, and recovery rates represent materials handled by the public sector. Because public sector material in Upper Township includes recyclables collected from 222 businesses, which is over 5% of households served, figures for Upper Township are excluded from all graphs in this chapter. See Appendix A for definition of public sector waste.

Table 5.2
Select Residential Recycling Program Characteristics

Community	Year Data Collected	Residential Recycling Rate (% by wt.) (a)	MSW Recycling Rate (% by wt.) (a)	Mandatory Program (b)	Volume-based Refuse Collection Rates	Type of Recycling Program	Container Deposit Legislation	# of Public DO Sites	# of Private DO Sites/ Scrap Yards (c)
Austin, TX	FY89	5	NA	No	No	CS,DO,BB,Sa/R	No	0	33
Berkeley, CA	FY91	NA	20	No	Yes	CS,DO,BB,Sa/R	Yes	1	5
Berlin Township, NJ	1990	17	28	Yes	No	CS,DO	No	1	--
Boulder, CO	1990	25	18	No	No	CS,DO,BB	No	0	22 (d)
Bowdoinham, ME	FY90	NA	43	No	Yes	CS,DO,Sa/R	Yes	2 (e)	0
Columbia, MO	FY90	11	NA	No	No	CS,DO,BB	Yes	0	7
Dakota County, MN	1990	17	20	No	Yes	CS,DO,BB,Sa/R	No	1	Numerous
Fennimore, WI	1990	25	25	Yes	No	CS,DO	No	1	0
King County, WA	1990	12	22	No	Yes	CS,DO	No	7	49
La Crescent, MN	1990	28	21	No	Yes	CS,DO,Sa/R	No	2	0
Lafayette, LA	FY90	7	8	No	No	CS,DO,BB	No	0	5
Lincoln Park, NJ	1990	3	11	Yes	No	CS,DO	No	1	0
Lincoln, NE	1990	18	32	No	No	CS,DO,BB	No	16	--
Mecklenburg Co, NC	1990	7	16	No	No	CS,DO,BB,Sa/R	No	16	21
Monroe, WI	1989	21	25	Yes	No	CS,DO,BB	No	1	1
Naperville, IL	1990	20	NA	No	No	CS,DO	No	0	1
Newark, NJ	1989	5 (f)	NA	Yes	No	CS,DO,BB,Sa/R	No	1	50+
Perkasie, PA	1990	31	NA	Yes	Yes	CS,DO	No	1	0
Peterborough, NH	1990	42	19	Yes (g)	No	DO (h)	No	1	0
Philadelphia, PA	FY90	6 (f)	12	Yes	No	CS,DO,BB,Sa/R	No	2	30
Portland, OR	1990	NA	29	No	Yes	CS,DO,BB	Yes	0	147
Providence, RI	1990	10	NA	Yes	No	CS,DO (g)	No	1 (i)	--
San Francisco, CA	1990	35	25	No	Yes	CS,DO,BB	Yes	0	30+
Seattle, WA	1990	31	33	No	Yes	CS,DO,BB,Sa/R	No	2	100+
Sonoma County, CA	1990	15	11	No	Yes	CS,DO,BB,Sa/R	Yes	5	10
Takoma Park, MD	1990	18	NA	Yes	No	CS,DO	No	1	0
Upper Township, NJ	1990	37 (f)	NA	Yes	No	CS,DO	No	1	0
Wapakoneta, OH	9/89-8/90	NA	15	No	Yes	DO	No	1	0
West Linn, OR	1990	NA	30	No	Yes	CS,DO	Yes	1	0
West Palm Beach, FL	4/90-3/91	4	2	No	No	CS,DO,BB,Sa/R	No	4	4

Key:
BB = Buy-back center(s)
NA = Not available
CS = Curbside collection
Sa/R = Salvage/reuse operation(s)
DO = Drop-off site(s)
wt. = weight
FY = Fiscal Year
-- = Not applicable

Notes:
(a) Recycling rates exclude material composted. MSW recycling rates only are available in the cities of Berkeley, Bowdoinham, Portland, Wapakoneta, and West Linn.
(b) Residents must source-separate certain materials. Haulers in Dakota County, Portland, and West Linn are required to collect recyclables but set out by residents is voluntary.
Residents in Peterborough utilizing the Town dump must segregate recyclables; however some residents choose not to self-haul refuse to the Town dump.
(c) The number of private drop-off centers may exclude numerous deposit container depots.
(d) An additional 225 sites are located on the University of Colorado campus.
(e) In 1991 Bowdoinham closed one of the drop-off sites.
(f) Represents recycling level of only publicly collected waste (see Data Definitions in Appendix A).
(g) Source separation of recyclables is mandatory for residents utilizing the town refuse/recycling center. Approximately 70% of residents utilize the center.
(h) Two private haulers offer curbside collection to 100 to 200 households.
(i) This site accepts only motor oil.

Table 5.3
Residential Curbside Recycling Program

Community	Curbside Initiation Year (a)	Total House-holds	House-holds Served (b)	% Total House-holds Served	Number of Households In Refuse Jurisdiction (c)	% In Juris-diction Served (d)	Maximum Size of Multi-unit Bld. Served (# units) (e)	Manda-tory (f)	Economic Incent-ives (g)	Partici-pation Rate (%) (h)	Private Collection (i)	Public/ Private (Type)	Amount Recovered at Curbside (lbs/hh/wk)
Austin, TX	1982	198,464	110,000	55	110,000	100	2 (j)	No	A	40	Public	--	2.6
Berkeley, CA	1973	43,534	40,000	92	43,543	92	11 (k)	No	V	66	Contract	NP	5.8
Berlin Township, NJ	1980	1,800	1,700	94	1,700 (l)	100	1	Yes	F	97	Public	--	20.9
Boulder, CO	1976 (m)	35,000	26,500	73	NA	NA	7	No	None	60	Contract	FP	7.0
Bowdoinham, ME (n)	1989	880	290	33	290	100	1	No	V	95	Private	FP	NA
Columbia, MO	1985	25,742	7,050 (o)	27	18,500	38	1	No	None	62	Public	--	5.7
Dakota County, MN	1989	100,000	80,000	80	NA	NA	NA	No	A,V	75	Private (p)	FP	NA
Fennimore, WI	1989	970	970	100	970	100	All	Yes	F	100	Public	--	6.4
King County, WA	1989	379,090	NA	NA	NA	NA	4	No	V	80	Contr/Priv	FP	NA
La Crescent, MN	1989	1,568	1,568	100	1,568	100	All	Yes	V	74	Contract	FP	5.7
Lafayette, LA	1988	29,500	28,000	95	28,500	98	1	No	None	62	Contract	NP	3.4
Lincoln, NE	1989	79,079	622	1	NA	NA	1	No	None	51	Contract	FP	1.9
Lincoln Park, NJ	1987	4,260	4,260	100	2,772	100	All	Yes	F	95	Public	--	4.6
Mecklenburg Co, NC	1987	216,416	110,000	51	NA	NA	3	No	None	85	Public/Private	FP	6.1
Monroe, WI	1986	4,271	3,900	91	3,900	100	2	Yes	F	85	Public	--	5.3
Naperville, IL	1986	31,000	24,500	79	24,500	100	4	No	None (q)	75	Contract	NP	12.0
Newark, NJ	1988	102,473	90,000	88	NA	NA	NA	Yes	F	16	Contr/Public	NP,FP	2.2
Perkasie, PA	1988	3,900	3,500	90	3,500	100	1	Yes	V,F	100	Public	--	9.5 (r)
Philadelphia, PA	1987	673,880	159,245	24	572,798	28	6	Yes	None	80	Public	--	5.9
Portland, OR	1987	201,900	131,000	65	131,000	100	4	No	V	33	Private	FP,NP	4.4
Providence, RI	1989	61,454	56,423	92	56,423	100	6	Yes	F	74	Contract	FP	5.6
San Francisco, CA	1989	328,471	119,000	36	NA	NA	5 (s)	No	V	80	Private	FP	6.9
Seattle, WA (t)	1988	249,032	148,500	60	NA	NA	4	No	V	83	Contract	FP	14.5
Sonoma County, CA	1978	160,000	60,000	38	NA	NA	NA	No	V	54 (u)	Private	FP	NA
Takoma Park, MD	1989	7,036	4,100	58	4,100	100	12	Yes	F	88	Public	--	11.9
Upper Township, NJ	1984	3,860	3,860	100	3,860	100	All	Yes	F	95	Public	--	NA
West Linn, OR	1983	6,165	6,165	100	6,165	100	All	No	V	86	Private (v)	FP	7.7
West Palm Beach, FL	1990	24,442	18,306	75	24,442	75	3 (w)	No	None	79	Public	--	5.3

Key:

A = Awards
Bld. = Building
F = Fines
FP = For-profit company
FY = Fiscal Year
hh = Households served
NA = Not Available
NP = Nonprofit company
V = Volume-based refuse rates
wk = week
-- = Not Applicable

Notes:

This chart excludes the communities of Peterborough, NH and Wapakoneta, OH, which operate drop-off programs. Two private haulers offer curbside recycling collection to a limited number of Peterborough residents. Lincoln Park, NJ offers residents curbside collection of newspaper only.

(a) Berkeley began curbside collection of newspaper in 1973. Other materials were first collected at curbside in 1978. Ten of King County's 29 municipalities initiated curbside programs in 1989. Lincoln, NE has initiated only a pilot-scale recycling program. In Naperville, IL, one-quarter of the City received curbside service in 1986; citywide service began in 1989. In San Francisco, CA, 1 percent of the City's households received curbside service from 1981 to 1986. In Columbia, MO, a pilot program servicing 3,700 households was initiated in 1985. The program went citywide in 1986. In Newark, NJ, a pilot program for newspaper recycling began in December 1987.

(b) Households served by municipal or County curbside program.

(c) Number of households receiving municipal or public service refuse collection.

Notes (cont'd):

(d) Percent of households in refuse collection district that also receive municipal curbside recycling collection.
(e) Largest multi-unit building (number of units) served with municipal recycling collection.
(f) Mandatory for residents to source-separate recyclable materials. In Dakota County, MN, and in Portland and West Linn, OR, haulers are required to collect recyclables, but set-out of recyclables by residents is voluntary. In King County participation by residents is voluntary; however, cities must ensure the delivery of recycling services to residents.
(g) Economic incentives provided to residents to set out recyclables.
(h) See "In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results," ILSR, 1992, for information on the basis of participation rates.
(i) Public = City provides service; Contract = Municipality contracts with one or more providers; Private = One or more private haulers provide service independent of contract.
(j) In addition to servicing all one- and two-unit buildings, Austin services some three- and four-unit buildings.
(k) Berkeley's contractor services a few buildings with more than 12 units. In 1988, the City's Refuse Division began to service 15 multi-unit buildings with greater than 12 units.
(l) The number of households served with curbside collection of recyclables does not include two small apartment buildings.
(m) Curbside recycling was initiated by a nonprofit group in 1976, the municipal curbside program began in 1988.
(n) The majority of Bowdoinham's residents self-haul refuse to the landfill. One-third, or 290 households, pay for private refuse and recycling collection.
(o) The total number of households in Columbia and the total number served with recycling collection include 200 households served outside of the City limits.
(p) Recycling collection is public, or public under contract in three Dakota County cities.
(q) While no direct incentive is offered to residents for recycling, the City received a waste diversion credit from its refuse hauler of $35 for every ton of materials recycled in 1990.
(r) Includes some drop-off tonnage.
(s) By November 1990, 1,000 multi-unit buildings (with more than five units each) received municipal curbside service. San Francisco's two private haulers collect recyclables under contract with the City, but do not receive payment from the City for providing this service.
(t) Seattle has two different recycling programs, one in the north and one in the south section of the City. Each section is serviced by a different private hauler. In 1990, the participation rate in the north was 89.6 percent, and 15.82 lbs. per household per week were recovered. In the south, the participation rate was 77.3 percent and 13.15 lbs. per household per week were recovered. See Table 5.5 for more information.
(u) Participation rate for Sonoma County, CA is a 1989 figure based on data from the City of Santa Rosa. In June 1991, participation rate averaged 85 to 90 percent.
(v) West Linn Disposal is the sole hauler entitled to collect recyclables in West Linn.
(w) In March 1991, 888 four-plex apartments were added to the collection route in West Palm Beach.

While communities employ a variety of techniques to recover residential recyclables, those recycling large portions of their residential waste typically employ the following strategies:

- providing convenient collection services to all types of households;
- targeting a wide range of materials for recovery, particularly those that comprise a significant percentage of the waste stream;
- securing high levels of participation in recycling programs (such as mandating residents recycle, implementing strong economic incentives, and conducting a comprehensive educational and promotional program); and
- identifying outlets for collected materials.

Providing Convenient Collection Service

Communities utilize a variety of methods to collect residential recyclables and prepare them for market. Collection strategies fall into two general categories: curbside and drop-off. Residents are most likely to participate in a recycling program if doing so is as convenient as disposing of their refuse. To make participation in recycling programs as convenient as possible, and thus maximize the amount of material collected, communities are:

- providing weekly curbside collection of recyclables if weekly curbside collection of refuse is provided;
- offering service to all households;
- utilizing set-out and collection methods that encourage resident participation as well as yield high-quality, readily marketable materials;
- providing adequate containers for storage and set-out of residential recyclables; and
- establishing recycling depots or drop-off sites at disposal facilities if residents self-haul refuse.

Curbside Collection

Tables 5.3 and 5.4 describe curbside recycling programs, including program initiation year, number and type of households served, and service provider. Of the 30 communities documented, only

Table 5.4
Curbside Collection Methods for Recyclables

Community	Pick-up Frequency for Recyclables	Pick-up Frequency for Refuse	Same Day Collection (a)	Containers Provided (Gallons) (b)	Container Type	Comming. Set-out (c)	Segregations Required (d)	Sort En-Route (e)	Truck (Design/Capacity)	Crew Members per Vehicle
Austin, TX	Weekly	Semiweekly (g)	Yes	No (f)	Bucket	Yes	2	No	Eager Beaver 15-cy Recycler 6 Trailers	2
Berkeley, CA	Weekly	Weekly	Yes	Yes	Waxed Cardboard Bin	No	3	Yes	13-cy, 15-cy Lodal Trucks	1-2 (g)
Berlin Township, NJ	Weekly	Weekly	Yes	20	Bin	Yes	3	Yes	15- or 23-cy Eager Beaver Truck and a 10-ton Dump Truck	NA (h)
Boulder, CO	Weekly	Weekly	Varies	14	Bin	No	3	Yes	Retrofitted Compacter Truck	2
Bowdoinham, ME	Weekly	Weekly	Yes	No	--	Yes	5	No	1-ton 15-cy Dump Trucks	1
Columbia, MO	Monthly	Weekly	No	Few (i)	Bin	No	6	Yes	16-foot Trailer attached to Truck	2
Dakota County, MN	Weekly	NA	Varies	21	Bin	No	4	Yes	Varies	Varies
Fennimore, WI	Biweekly	Weekly	No	45	3 Stackable Bins, Bin	Yes	5	Yes	Used Beer/Pop Truck	2
King County, WA	Varies	Varies	Yes	33, 42, 90 (j)	3 Stackable Bins	Yes	Varies	No	Varies	1
La Crescent, MN	Weekly	Weekly	Yes	20	Bin	No	4	Yes	Retrofitted Vehicle	3
Lafayette, LA	Weekly	Semiweekly	Yes	34	3 Stackable Bins	No	3	Yes	15-cy Eager Beaver Trailers	3
Lincoln, NE	Weekly	Semiweekly	No	No	--	Yes (k)	2	No	Retrofitted Packer, Trailer	1
Lincoln Park, NJ	Monthly	Semiweekly	No	No	--	--	--	--	Dump Truck	3
Mecklenburg Co, NC	Weekly	NA	Yes	14	Bin	Yes	2	No	28-cy Lodal Trucks	1
Monroe, WI	Weekly	Weekly	Yes	12	Bin	Yes	3	No	Modified Dump Truck	1
Naperville, IL	Weekly	Weekly	Yes	No	--	No	8 (l)	Yes	Compartmentalized Trailer pulled by a 1-ton Truck	3
Newark, NJ	Biweekly (m)	Varies	Yes	8	Bucket	Yes	2	No	23-cy Eager Beaver Trucks and Eager Beaver Trailer	3
Perkasie, PA	Varies (n)	Weekly	No (n)	No	--	Varies	Varies	Yes	Trailer	4
Philadelphia, PA	Weekly	Weekly	No	6	Bucket	Yes	2	No	23-cy and 32-cy Lodal Trucks	3
Portland, OR	Wkly/Monthly	Varies	Varies	(o)	--	No	7	Yes	Varies	2
Providence, RI	Weekly	Weekly	Yes	14	Bin	Yes	2	No	31-cy Labrie Trucks	1
San Francisco, CA	Weekly	Weekly	Yes	12	Bin	Yes	2	No	31 cy Lodal Trucks	1
Seattle, WA (north)	Weekly	(p)	No	36	3 Stackable Bins	Yes	4	Yes	18- and 31-cy Trucks	1
Seattle, WA (south)	Monthly	(p)	No	60	Toters	Yes	1	No	Packers	1
Sonoma County, CA	Weekly	Semiweekly	Yes	Varies (q)	3 Stackable Bins (q)	Yes	3	Varies	44- and 50-cy Loaders with 3 Compartments	1
Takoma Park, MD	Weekly	Semiweekly (r)	Yes	5 (r)	Bucket	Yes	3	No	20-cy Kann Curb Sorter Truck	3
Upper Township, NJ	Weekly	Weekly	Yes	No	--	Yes	3	No	Two 20-cy Packer Trucks	3
West Linn, OR	Weekly	Weekly	Yes	14	Bin	No	5	Yes	3-cy and 16-cy Packer Trucks	3
W. Palm Beach, FL	Weekly	Semiweekly	Yes	18	Bin	Yes	2	No	30-cy Labrie Truck	1

Key:

Biweekly = every other week cy = cubic yard NA = Not available Semiweekly = twice per week -- = Not applicable

Notes:

(a) Recyclables are collected on the same day as refuse collection.
(b) Total capacity.
(c) "Commingled set-out" means that at a minimum, glass and metal food and beverage containers are set out in one recycling container.
(d) The number of segregations citizens must make when setting out recyclables at the curb, excluding the set-out of appliances, white goods, tires, car batteries, and motor oil. Often plastic containers are placed in the same container.
(e) Haulers place commingled or separated recyclables into more than two material-specific compartments on recycling vehicle.
(f) A limited number of households received recycling containers in 1990. In 1991, Austin began to distribute 14-gallon containers; 22 percent of eligible households received containers in that year. In 1992 Austin will collect refuse once per w
(g) Two-thirds of all routes are serviced by two crew members, one-third is serviced by one crew member.
(h) A total of eight workers collect refuse, recyclables, and yard waste.
(i) Residents are charged a fee for 14-gallon recycling bins; 200 residents, 3 percent of households receiving curbside service, had purchased bins by the end of 1990.
(j) In King County bin size varies from city to city. Generally one crew member operates each collection vehicle.
(k) Once ferrous cans and glass were added to the list of recyclables in 1991, residents were required to segregate (rather than commingle) recyclables.
(l) Naperville switched recycling contractors in 1991, and required commingled set-out of recyclables in 3 segregations.
(m) Commingled bottles and cans are collected one week, newspaper and magazines are collected the following week.
(n) Glass and aluminium are collected weekly. Newspaper, magazines, advertising mail, and corrugated cardboard are collected once per month. Recycling containers are available through the Borough.
(o) Some haulers offer 14-gallon containers for free.
(p) The majority of residents receive same day refuse collection.
(q) Recyclable materials are set out commingled in most cities. In Santa Rosa, Petaluma, Healdsburg, and Rohnert Park, residents set out recyclables in 3 stackable bins. In other cities, residents receive two 5-gallon buckets.
(r) Takoma Park began once per week collection of refuse in 1991 and began to distribute 14-gallon recycling bins.

Table 5.5
Seattle's Curbside Recycling Program By Section

Material	North Section (Tons, 1990)	South Section (Tons, 1990)	Total (Tons, 1990)
Newspaper	9,057.2	8,315.8	17,373.0
Mixed Paper	9,687.8	7,514.0	17,201.8
Glass	4,874.2	4,222.7	9,096.9
Aluminum	358.5	236.6	595.1
Tin	745.3	561.4	1,306.7
PET	64.0	99.0	163.0
Total	24,787.0	20,949.5	45,736.5
Frequency of Collection	Weekly	Monthly	—
Recycling Containers	Three 12-gallon stacking containers	One 60- or 90-gallon toter	—
Material Set-out	Commingled glass, aluminum, and ferrous cans, and PET containers in one bin; mixed waste paper in a second bin; newspaper in a third bin; corrugated cardboard on side.	All glass, PET containers, aluminum and tin cans, newspaper, and mixed waste paper in one container.	—
Collection Vehicle(s)	Compartmentalized Recycling Trucks	Rear-loading Packers	—
Avg. No. of HH Served (a)	60,256	61,290	121,546
Participation Rate (b)	89.6%	77.3%	83%
Avg. Pounds per HH per Year	822.7	683.6	752.6
Avg. Pounds per HH per Week	15.8	13.1	14.5

Notes:
Seattle believes that socioeconomic factors (in addition to collection frequency) may contribute to the difference in participation. The north end of Seattle is considered the University section, and, in general, is a higher income area than the south end.

(a) Seattle records the number of households signed up for the curbside program on a monthly basis. The average number of households served is the average of these numbers over 12 months of the year.

(b) Participation rate is defined as the sign-up rate—the ratio of the number of households registered for the program to the number of households eligible. As of June 1991, the participation rate increased to 92.3 percent in the north and 80.4 percent in the south section. In 1989, 89.3 percent of households in the north section and 67.3 of the households in the south section were registered.

Wapakoneta does not provide the option of receiving curbside recycling service.[3]

Collection Frequency

The majority of communities in this study with curbside recycling programs have weekly collection (see Table 5.4).[4]

In fact, most of the programs with high participation and recovery rates have weekly collection of recyclables. In communities with both weekly and monthly collection of recyclables, neighborhoods with weekly collection have higher participation rates. Participation in Portland's monthly collection programs averages 23 percent, while participation in its weekly programs averages 57 percent. In 1990 the north end of Seattle achieved a 90 percent participation rate in its weekly program, while the south side experienced only a 77 percent participation rate in its monthly program. (Table 5.5 compares participation rates, tonnage data, and program characteristics for Seattle's two curbside program).[5] Similarly, in communities that have switched from monthly to weekly collection, participation rates have increased. When Naperville switched from

biweekly to weekly collection in May 1990, overall monthly program participation increased from 54 percent in 1989, to 75 to 80 percent in 1990.

When participation increases, the amount of materials collected tends to increase. The tonnage of recyclables collected in Naperville after its switch from biweekly to weekly collection increased from an average of 436 tons per month (for the first 4 months of 1990) to an average of 750 tons per month (for the subsequent 5 months)—an increase of 72 percent. The same number of households were serviced and the same types of recyclables were collected. When Berkeley, California switched from monthly to weekly curbside collection during 1988 and 1989, curbside tonnages jumped significantly, from 2,044 total tons collected at curbside in FY 88 to 5,984 tons in FY 90. The same materials and households were targeted both years. Newark switched from biweekly to weekly collection of recyclables in October 1991; 20 percent more material was recovered in November 1991 than in November 1990.

More frequent collection can also increase the set-out rate and reduce the amount of material set out per household per collection day. This requires a collection vehicle to make more stops before filling up, thus decreasing collection efficiency. With the switch from biweekly to weekly service in Naperville, for example, the number of set-outs per collection day increased by 152 percent, while the weight of each set-out decreased by an average of 25 percent. (The total amount of material recovered from each household grew from 61 pounds per month to 71 pounds per month.) Additionally, the amount of certain materials recovered, including corrugated cardboard and HDPE plastic containers, increased disproportionately. The Naperville Area Recycling Center (NARC) explains that the bulkiness of these materials makes them inconvenient to store. When recycling collection became more frequent, storage was no longer a problem and setting out such materials for recycling collection became as convenient as setting them out for refuse collection.[6] Weekly collection of recyclables appears to be especially important in communities with weekly or twice weekly collection of refuse, since residents may be inclined to dispose of recyclable materials with refuse, particularly if storage is a problem.

Collection Day

Collecting recyclables on the same day as refuse does not necessarily increase participation rates or residential recycling rates. Establishing a consistent recycling collection day, and conducting an effective promotional program that instructs residents to set out recyclables on the designated day, appears to be more important than collecting recyclables on the same day as refuse. The cities of Perkasie, Seattle, and Fennimore, which collect recyclables on a different day from refuse, all record high participation and recycling rates. The City of Portland has concluded that its low participation rates result from confusion regarding the collection day as much as from infrequent (monthly) collection of recyclables in some parts of the City. While the fact that recyclables are not collected on the refuse collection day in parts of the City contributes to this confusion, a more substantial cause is the lack of a routine collection day within neighborhoods. Households on the same block may have different haulers and therefore different recycling collection schedules. Thus, setting out recyclables on collection day is not reinforced by the observed behavior of one's neighbors.

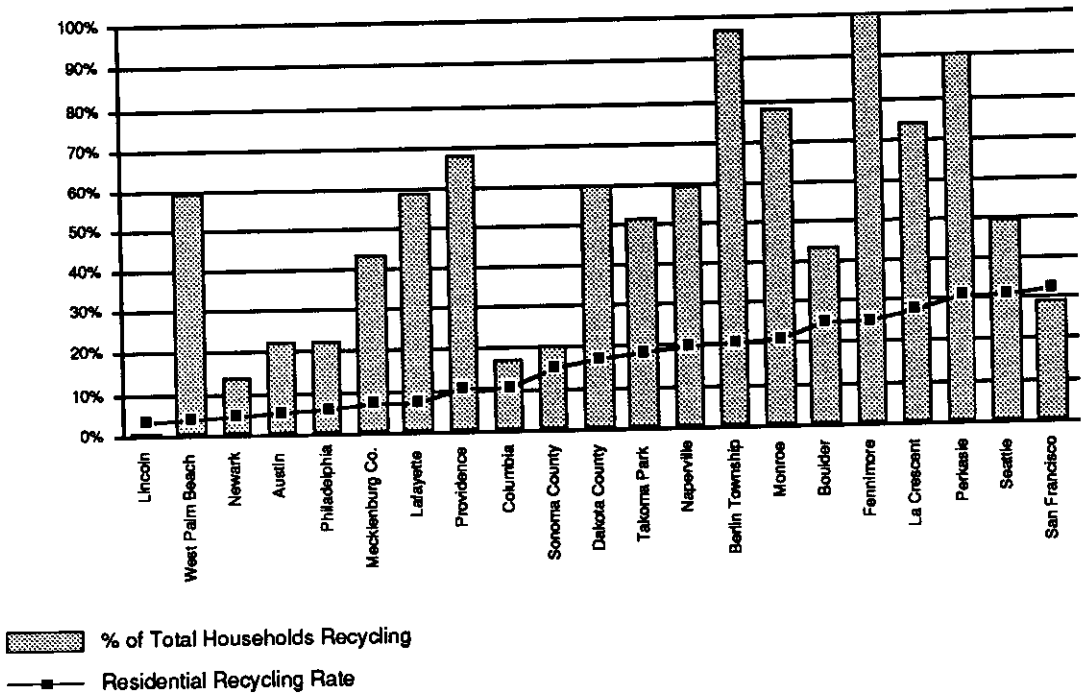
Offer Service to All Households

The more households that receive curbside collection of recyclables, the more residential materials a community will recover. Many of these communities with the highest residential recycling levels, such as Berlin Township, New Jersey; Fennimore and Monroe, Wisconsin; La Crescent, Minnesota; Perkasie, Pennsylvania; and West Linn, Oregon, collect recyclables from at least 90 percent of their households. (See Table 5.3.) Many of the communities with lower residential recycling rates collect recyclables from a limited number of households. In 1990 Philadelphia serviced only 28 percent of households in its public service area, and recycled only 6 percent of its publicly collected waste.

Communities wishing to raise recycling levels not only target all households with recycling collection, but also secure the participation of serviced households. Chart 5.2 compares net participation rates (the percent of total households serviced multiplied by the participation of serviced households) with residential recycling rates. Austin serviced only 55 percent of households with recycling collection in FY 1989; of these, only 40

Chart 5.2

Net Household Participation and Residential Recycling Rate



Notes: Net household participation represents the percent of total households receiving curbside recycling collection multiplied by the participation rate. For Providence, Philadelphia, Takoma Park, Naperville, and Perkasie recycling rate represents that in the City refuse collection jurisdiction only, in which 100% of households are serviced. For Philadelphia, the net participation rate represents that in City refuse collection area only. See Tables 5.2 and 5.3.

percent participated. This resulted in a 22 percent net participation rate, which explains Austin's residential recycling rate of 5 percent. The communities of Berlin Township, New Jersey and Fennimore, Wisconsin have high participation rates of 97 and 100 percent, respectively, and are recovering (recycling and composting) more than half of their residential waste stream. Participation in these communities' programs is required by law.

Providence is servicing 94 percent of its households (100 percent of the City's refuse collection district), but has achieved a moderate participation rate of 74 percent. (In addition, during the base year of study, Providence collected fewer types of materials for recovery than many of the communities with higher recovery rates.) In 1990 Providence recycled only 10 percent of its residential waste. Providence is working to increase program participation through education and publicity materials.

On the other hand, the cities of San Francisco, Seattle, and Boulder are recycling at least one-quarter of their residential waste streams despite the fact that their curbside programs serviced only 36, 60, and 73 percent of households, respectively. In these communities residential recyclables are also collected through many private drop-off and buy-back sites.[7] Seattle's 31 percent residential recycling rate is also attributed to the large amount of material collected at curbside per serviced household (14.5 pounds per household per week), primarily due to the collection of many grades of mixed waste paper.

Some cities already have plans to expand their curbside programs. Austin, for example, began collecting recyclables from an additional 1,500 households in 1991.

Recycling in Multi-Unit Buildings

In many communities, particularly urban areas, a large percentage of residents live in multi-unit buildings. Because refuse collection from these buildings is largely left to the private sector, many cities overlook large multi-unit buildings in setting up their residential recycling programs. (See Table 5.3.) However, cities with a large proportion of residents living in multi-unit buildings will have difficulty reaching high materials recovery levels without targeting multi-unit households for recyclables collection. The City of Austin, for example, recycled 5 percent of its residential waste in FY 89 by collecting recyclables from one- and two-family households; nearly 40 percent of residents did not receive collection, since they lived in buildings with three units or more.

Recovering recyclable and compostable materials from multi-unit buildings is typically more challenging than collecting recyclables from single-family units. Variables such as space and layout, waste hauling contracts, length of resident tenancy, and janitorial work agreements differ from building to building. Cities also often hesitate to intervene in apartment buildings' private waste-hauling arrangements. Yet programs currently

Model Rural, Suburban, and Urban Residential Recycling Programs

Bowdoinham, Maine, Perkasie, Pennsylvania, and **Seattle, Washington** represent rural, suburban, and urban communities, respectively, that have successfully matched recycling strategies to their individual needs and existing solid waste systems.

The rural Town of **Bowdoinham** (pop. 2,189) relies primarily on drop-off refuse collection. After experiencing little success with a voluntary drop-off recycling program instituted in 1985, the Town established a landfill user fee in 1989, which charges residents $1 per 30-gallon bag of refuse disposed of at the landfill but no fee to drop off recyclable materials. The Town's two private refuse haulers, which service approximately one-third of the community, offer their refuse customers co-collection of source-separated recyclable materials at no charge. These economic incentives have proved extremely effective; in 1990 Bowdoinham recycled 43 percent and composted 11 percent of its municipal solid waste.

The Borough of **Perkasie** (pop. 7,878) began its curbside recycling program in January 1988. By the end of 1989, it was recycling 30 percent and composting 14 percent of its residential waste. Perkasie collects a wide range of recyclable materials from all single-family households, including newspaper, magazines, third class mail, corrugated cardboard, glass, and aluminum cans. Participation in this suburban community's recycling program is mandatory, and is further encouraged by the Borough's volume-based refuse collection system. In 1990 Perkasie recycled 31 percent and composted 21 percent of its residential waste. Furthermore, residential waste generation levels have been stabilized.

The City of **Seattle** (pop. 515,259) has established a goal of 60 percent municipal solid waste recovery by 1998. Using an econometric forecast model, the City determined that it could meet this goal through implementation of a comprehensive program that included curbside recycling and yard waste collection, apartment building recycling, transfer station drop-off sites, commercial sector paper diversion, and backyard composting. The City is well on its way to meeting this ambitious goal. In 1990 the City recovered 40 percent of its MSW, recycling 31 percent and composting 14 percent of its residential waste. Seattle believes that convenient collection service, strong economic incentives, and an extensive recycling education program are responsible for the success of its program. The City is currently working to expand recycling activities in multi-unit households and to recover food waste.

operating indicate that multi-unit buildings can achieve high levels of materials recovery. Local government can play an important role in facilitating these recycling efforts. Our case study communities' efforts to promote multi-unit recycling include the following:

- establishing provisions that multi-unit buildings comply with residential recycling requirements and recover designated materials;
- providing collection service or requiring private haulers to provide this service;
- offering haulers economic incentives to collect recyclables;
- providing buildings with recycling containers and other equipment;
- offering buildings technical assistance, including waste audits;
- encouraging building owners and managers to take an active role in planning and promoting the program; and
- encouraging buildings to establish recycling systems that closely parallel existing refuse collection systems.

Portland, Oregon is currently working to expand the delivery of recycling collection services to multi-unit households. Refuse haulers in the City are required to collect recyclables from only one- to four-unit buildings. As a result, approximately one-quarter of all households in the City receive no recycling collection. (In addition, 15 percent of one- to four-unit households do not receive collection.) The City has contracted with Portland State University (PSU) to set up recycling collection systems in selected multi-unit buildings. As of June 1991, 330 buildings had been supplied with recycling systems. The City provides technical assistance and supplies recycling containers (such as 90-gallon carts), which PSU delivers to the site. The hauler selected by the building collects and markets the materials. (Buildings are not charged an additional fee for the collection of recyclables.) Many buildings have set up central recycling depots in parking lots, while others instruct residents to bring individual bins to the curbside. The City budgeted $162,000, equivalent to $27 per multi-unit household, to set up recycling systems at 170 buildings containing a total of approximately 6,000 apartment units in 1992.

Portland State University conducted a 3-year research and demonstration project on multi-unit recycling. By closely studying 20 representative multi-unit recycling systems, PSU reached the following conclusions:

- Both depot and individual collection systems operate well, but the recycling systems are generally most effective when they parallel refuse collection systems. For example, in one building where newspaper recycling depots were conveniently located on each floor near garbage chutes, but other recyclables were collected in the basement parking garage, one-half of those who recycled reported that they recycled only newspapers.
- Participation and diversion levels vary with the program's user friendliness, the location of the recycling depot within a building/complex, and the degree to which the manager promotes the recycling program.

Over 80 percent of randomly surveyed tenants reported participating in their buildings' recycling program. Actual measurements of recycled materials at representative sites indicated that over 30 percent of waste by weight was diverted. (This excluded deposit containers and other material taken to drop-off or buy-back sites.)

(See side bar, "New York City's Intensive Recycling Project" in Chapter 4 for a description of a comprehensive multi-material apartment building recycling program.)

Curbside Set-out and Collection Methods

When implementing a recycling program, an important first step is to determine which materials to target for collection and how such materials will be collected and prepared for market. These steps are interrelated. Available markets and processing capabilities will determine which materials to collect. Targeted materials and market specifications will influence how recyclables should be collected and processed.

A variety of curbside collection systems are available for recyclable materials. Each collection and processing system has advantages and disadvantages. Sorting materials in the household or on the collection route minimizes the amount of sorting that must be performed at a processing

Table 5.6
Recyclables Set-out and Collection Method

Community	Set-out Method
Austin, TX	Two segregations: 1) OCC, ONP bundled/bagged; 2) A,F,G commingled in a separate container
Berkeley, CA	Three segregations: 1) ONP bundled or bagged; 2) A, F in waxed OCC box; 3) G in another OCC box (a)
Berlin Township, NJ	Four segregations: 1) A,F,G,P in a 20-gallon bin; 2) OCC, PB crushed and bundled together; 3) ONP bundled; 4)MP bundled
Boulder, CO	Three segregations: 1) A,F; 2) G; 3) ONP; all materials bagged separately in a bin
Bowdoinham, ME	Five segregations, all bagged: 1) ONP, 2) OCC, 3) glossy paper, 4) mixed paper, 5) A,F,G,P,SM,X bagged
Columbia, MO	Six segregations: 1) ONP bagged/bundled; 2) OCC bagged or bundled; 3-5) three sorts of glass; 6) A bagged
Dakota County, MN	Three segregations: 1) ONP bagged; 2) A,F,P bagged; 3) G bagged in bin
Fennimore, WI	Five segregations: 1) ONP in bin; 2) P in bin; 3) A,F,G in bin; 4) MP bagged; 5) OCC set beside bins
King County, WA	Either one bin for commingled recyclables or 3 segregations: 1) ONP; 2) MP; and 3) A,G,P
La Crescent, MN	Six segregations: 1) G bagged; 2) A,F bagged; 3) P bagged; 4) HP, ONP bundled/bagged; 5) MP bundled; 6) OCC bundled
Lafayette, LA	Three segregations: 1) G,P in bin; 2) A,F in bin; 3) ONP in bin
Lincoln, NE	Two segregations: 1) ONP bagged, 2) A bagged
Lincoln Park, NJ	ONP bundled
Mecklenburg Co, NC	Two segregations: 1) commingled A,F,G,P in bin; 2) ONP bagged
Monroe, WI	Four segregations: 1) MP,ONP bundled; 2) OCC bundled; 3) HP boxed/bagged; 4) A,F,G,P,SM commingled in bin
Naperville, IL	Nine segregations: 1) ONP bagged; 2) OCC bundled; 3-5) G color-sorted; 6) A; 7) F; 8) P; 9) HP bagged
Newark, NJ	Two segregations: 1) A,F,G bagged; 2) ONP bagged/bundled
Perkasie, PA	Seven segregations: 1) ONP bundled/bagged; 2) A; 3) MP; 4) OCC; 5-7) color-sorted G
Philadelphia, PA	Two segregations: 1) A,F,G,P in bucket; 2) ONP bundled/bagged
Portland, OR	Seven segregations: 1-3) color-sorted G; 4) F bagged; 5) A bagged; 6) P bagged; 7) ONP bundled
Providence, RI	Two segregations: 1) A,F,G,P commingled in bin; 2) ONP bundled
San Francisco, CA	Two segregations: 1) HP,OCC,ONP bagged; 2) A,G,P in a bin
Seattle, WA	Commingled or Segregated in 3 bins: 1) A,F,G,P; 2) MP; and 3) ONP
Sonoma County, CA	Three segregations: 1) ONP in bin, 2) G in bin, 3) A,F,P in bin
Takoma Park, MD	Three segregations: 1) A,F,G in one bucket; 2) ONP bundled/bagged; 3) OCC bundled
Upper Township, NJ	Three segregations: 1) A,F,G,P in container; 2) MP bundled/bagged; 3) OCC bundled/bagged
West Linn, OR	Six segregations: 1) ONP bagged; 2) OCC bundled; 3-5) color-sorted G bagged; 6) A,F bagged
West Palm Beach, FL	A,G,ONP,P in one bin

Key:

A = Aluminum CS = Curbside F = Ferrous cans G = Glass HP = High-grade Paper MP = Mixed Paper
OCC = Corrugated Cardboard ONP = Newspaper P = Plastics PB = Paperboard SM = Scrap Metal
X = Other materials including textiles

Note:

(a) MP and OCC are collected from approximately 2,000 City households. They are set out in bags or bundled, and placed in a separate compartment in the recycling vehicle.

Table 5.6
Recyclables Set-out and Collection Method (continued)

Community	Collection Method
Austin, TX	Two sorts: 1) OCC,ONP; 2) A,F,G in compartmentalized Eager Beaver Trailer.
Berkeley, CA	Three sorts: 1) ONP; 2) A, F; 3) G in a compartmentalized Lodal truck.
Berlin Township, NJ	A,F,G,P commingled in Eager Beaver truck; OCC, PB in dump truck, second dump truck for ONP, MP
Boulder, CO	Three sorts: 1) ONP in rear; 2) G on side; 3) A,F on other side, of a compartmentalized packer truck
Bowdoinham, ME	All segregated materials are placed in front or rear portion of a dump truck
Columbia, MO	Materials placed segregated in compartmentalized trailer, OCC in a packer truck
Dakota County, MN	Compartmentalized vehicles vary by hauler
Fennimore, WI	Eight sorts: 1) A,F; 2-4) color-sorted G; 5) MP; 6) ONP; 7) P; 8) OCC in a used beer/pop truck
King County, WA	Varies
La Crescent, MN	Eight sorts: 1-3) color-sorted G; 4) A,F; 5) P; 6) OCC; 7) MP; 8) MP,ONP
Lafayette, LA	Three sorts: 1) G,P; 2) A,F; 3) ONP in compartmentalized trailer
Lincoln, NE	Two sorts for A and ONP, placed in bins retrofitted on to refuse vehicles
Lincoln Park, NJ	ONP placed in a dump truck
Mecklenburg Co, NC	Three sorts: 1) A,F,G in one compartment, 2) ONP in a second, 3) P in cage on Lodal truck
Monroe, WI	Four sorts: recyclables are separated in different areas on a dump truck
Naperville, IL	Nine sorts: 6 for A,HP,OCC,ONP,P,PB, and 3 sorts of G on a compartmentalized trailer
Newark, NJ	One sort: A,F,G collected commingled one week, ONP the following in Eager Beaver trucks
Perkasie, PA	Four sorts in compartmentalized vehicle: 1) 3 color-sorted G; 4) A,MP,ONP in a packer; OCC in second packer
Philadelphia, PA	Two sorts: 1) A,F,G,P in one compartment; 2) ONP in another on a Lodal or Eager Beaver vehicle
Portland, OR	Varied compartmentalized vehicles
Providence, RI	Two sorts: 1) ONP placed on one side; 2) A,F,G,P on other side of a dual side-loading vehicle
San Francisco, CA	Two sorts: 1) HG,MP,ONP in one compartment; 2) A,G,P in second on compartmentalized Lodal truck
Seattle, WA	Compartmentalized vehicles for segregated recyclables, packers for commingled materials
Sonoma County, CA	Three sorts in varied compartmentalized vehicles (three compartments)
Takoma Park, MD	Two sorts: 1) OCC and ONP in rear compartment; 2) A,F,G in front compartment of Kann Curbsorter truck
Upper Township, NJ	Two sorts: 1) MP,ONP in packer truck; 2) A,F,G,P in second packer
West Linn, OR	Six sorts: 1) ONP; 2-5) Color-sorted G; 6) A,F separated in modified garbage truck or Kann Curbsorter
West Palm Beach, FL	Two sorts: 1) ONP; 2) A,G,P in Labrie recycling truck

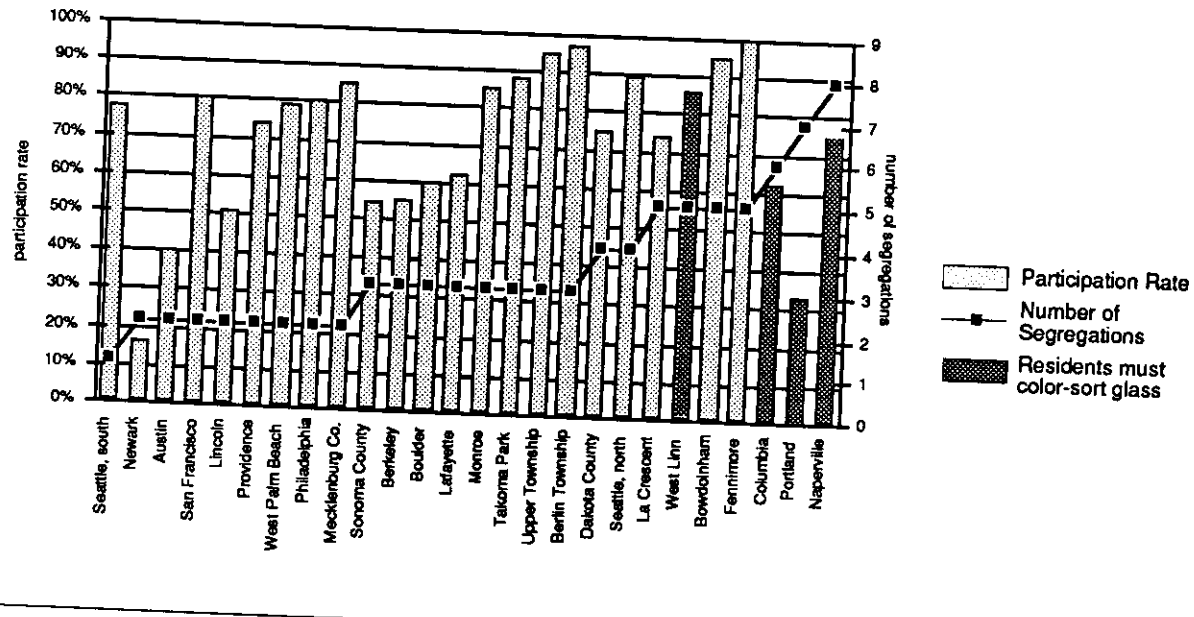
Key:
A = Aluminum CS = Curbside F = Ferrous cans G = Glass HP = High-grade Paper MP = Mixed Paper
OCC = Corrugated Cardboard ONP = Newspaper P = Plastics PB = Paperboard SM = Scrap Metal
X = Other materials including textiles

center, and frequently results in lower overall breakage and reject rates, increasing the net amount of material marketed. Sorting materials at a processing center may increase program participation and speed up collection, but often requires construction of a more capital-intensive facility, which may be difficult for a community to finance.

Table 5.6 details the set-out and collection methods utilized by the 30 communities studied. These represent a wide range of strategies, from an entirely commingled set-out and collection procedure used on the south side of Seattle, to an eight-sort set-out system utilized by Naperville, Illinois, in 1990. Eight of the communities studied require minimal separation on the household level; that is, segregation into only two fractions: paper in one container, and commingled food and beverage containers in a second container. (In this report, we have called collection programs "commingled" when residents are required to set out food and beverage containers in a single container.) Four communities require complete segregation of materials, including color separation of glass.

Set-out requirements may affect program participation. Chart 5.3 indicates that while both programs with simplified set-out arrangements and those with more complicated requirements achieve participation rates of 80 percent or higher, all three of the cities that require more than five segregations (including color-sorting of glass) have secured the participation of 75 percent or fewer households.[8] These lower participation rates may also be attributed to factors such as voluntary participation (all three programs are voluntary) and collection schedules. The fourth city requiring color-sorting of glass, West Linn, has an 86 percent participation rate. Its steep volume-based rates may be more of a recycling incentive than the color-sorting is a deterrent. In fact, this may be the case with programs requiring four and five sorts. Five out of six of these have volume-based refuse rates. Many of the cities with the lowest participation rates are actually those that require commingled set-out with only two segregations. This can be explained by the fact that many of these are large cities with diverse populations, where securing resident participation can be a challenging task.

Chart 5.3
Curbside Set-out Requirement and Participation Rate



Set-out and collection systems affect the overall recovery of materials. Within the 30 communities studied, processing facilities that accept segregated materials report low residue rates of 0 to 4 percent by weight, while those that accept commingled materials often rely on mechanized sorting and report higher residue rates of 0.5 to 16 percent by weight, largely due to glass breakage.[9] If, for example, the amount of recyclable material disposed of as residue from Rhode Island 's processing facility (which has a residue rate of 14 percent) is subtracted from Providence's collected tonnage and added to their tonnage disposed, the City's recycling rate would drop from 10 percent to 9 percent. To increase the value of recyclables collected, Seattle is requiring its recycling hauler who services the south end of the City (which previously utilized a fully commingled system) to color-sort glass en route; paper contaminated with broken glass was becoming increasingly difficult to market. Sorting materials at the household level or on the truck can increase the net tonnage of material marketed. (See Chapter 8 and Table 8.17).

In the effort to increase materials recovery rates, a few communities in Europe, Canada, and the United States are pilot testing and/or implementing "wet/dry" collection systems. These programs typically target more materials for recovery in order to achieve higher overall recovery rates. However, due to the commingled collection system utilized, a larger proportion of collected recyclables and organics may be contaminated than is the case with more traditional recycling systems. (See side bar, "Wet/Dry Collection Systems.")

Provision of Recycling Containers

Providing suitable containers to households for storage and set-out of recyclable materials may increase participation and recycling levels. The majority of the 30 communities studied distribute recycling containers to households. Table 5.4 lists container type and size. Storage containers serve several purposes: (1) they publicize a recycling program and remind individuals to source-separate material, thereby increasing program participation; (2) they assist drivers' identification of recyclable materials and loading of materials onto vehicles; and (3) they may increase the amount of material residents set out per collection day by providing a convenient and attractive place to store materials.[10]

All the communities with the highest participation rates (over 80 percent), except Upper Township and Bowdoinham, distribute recycling containers to residents. In Upper Township, residents are required by law to source-separate materials, and set-out is made convenient (only three segregations are required). In Bowdoinham, the per-bag refuse fee provides residents an economic incentive to participate in the recycling program. Many of the communities with low participation rates (including Newark, Austin, and Lincoln) did not distribute containers to residents. Newark, with the lowest participation (estimated at 16 percent in 1989), had distributed recycling containers to only 15,000 households.[11]

Within the 30 communities studied, processing facilities that accept segregated materials report low residue rates of 0 to 4 percent by weight, while those that accept commingled materials often rely on mechanized sorting and report higher residue rates of 0.5 to 16 percent by weight, largely due to glass breakage.

Container size may influence recycling rates. Small containers may limit the amount of material recovered. A container must not only be large enough to accommodate current levels of material, but must also accommodate substantial program growth. Communities have found 5-gallon bins suitable during the early stages of a recycling program, but inadequate once new materials are added to a collection program. Berlin Township's experience with different containers provides a striking example of the importance of container size. When the Township replaced its 5-gallon buckets with 20-gallon buckets to accommodate recycling of plastic containers, the amount of commingled recyclables collected, excluding plastics, increased 49 percent by weight with the distribution of the larger buckets.

Wet/Dry Collection Systems

In parts of Europe and Canada, communities have implemented a new type of materials recovery system known as "wet/dry" collection. These systems collect all refuse, recyclable, and compostable components in two or three fractions. In the two-stream method, residents place all wet wastes, including food scraps, yard waste, and soiled paper, in one container, and all dry waste, including recyclable components, in a second container. Wet and dry fractions are collected in one dual-compartmentalized vehicle. Recyclables are separated from the dry fraction at a processing center; inorganics are screened out of the wet fraction at a composting facility; and the remaining material is composted. Residual materials from the wet and dry fractions, which came to less than 40 percent of total materials in the pilot studies conducted in Guelph, Ontario and Kokomo, Indiana, are landfilled. In the three-stream system, residents separate organic yard and food waste into one bin, dry recyclables into a second, and residual materials into a third. Materials are collected in two separate vehicles; generally, organic waste and refuse are co-collected in one vehicle, and commingled recyclables are collected in a second vehicle. Wet waste is composted; recyclables are removed from the dry waste; and the refuse is landfilled. In some European countries, residents bring recyclables, such as glass, paper, and batteries, to igloos or other depot sites.

Wet/dry collection systems typically achieve high materials recovery rates of over 60 percent. A 10-week wet/dry pilot study conducted in Kokomo, Indiana, for example, recovered 82 percent of all waste generated. Residents in the 70 participating households were extremely surprised to discover the small quantity of material needing to be disposed in the refuse bag destined for the landfill.

Appendix E outlines the results of the wet/dry collection study conducted in Guelph, Ontario, a city of nearly 90,000.

Source: Michael Gibson (Waste Management Technician, City of Guelph, Ontario), personal communication, February 1991; (City of Guelph Wet/Dry Pilot Project, Summary of Preliminary Findings), April 1991; Anne Scheinberg et al., "European Food Waste Collection and Composting Programs," Biocycle, December 1990, 76-80; Tom Watson, "The Latest European Import: Wet/Dry Collection Systems," *Resource Recycling*, April 1991,19-23; Dan Hoornweg et al., "Wet/Dry Household Waste Collection," *BioCycle*, June 1991, 52-54; and Thomas High, *Kokomo's Recycling Demonstration Program.*, Kokomo Municipal Sanitation Utility, Kokomo, Indiana, n.d.

Small containers may increase the frequency with which residents set out recyclables, but decrease the amount of materials per set-out, thus decreasing overall collection efficiency. A study of 2,200 households in a southern California neighborhood found that households utilizing the largest of the four container systems tested—a set of three stackable recycling bins—had the lowest set-out rate (while still achieving high participation) and the greatest amount of material per set-out. Collection efficiency was highest with the stacking containers, averaging a collection time of 20 seconds per stop. Blue boxes, on the other hand, had an average loading time of 28 seconds per stop. While participation among households using blue boxes was quite high, residents reported that the rectangular boxes had inadequate capacity for their materials.[12]

Inadequately sized containers appear to be hampering the success of New York City's pilot project to collect a wide range of recyclable and compostable materials from 7,000 multi-unit households in Park Slope, Brooklyn. The City has supplied one- to three-unit buildings with a single 17-gallon container for waste paper; a 20-gallon container for commingled plastic, metal, and glass; and an 8-gallon bucket for food and yard waste. Although the amount of recyclables recovered increased after the distribution of recycling containers, one-quarter of the inquiry calls received

from residents have been complaints regarding small containers.[13]

In most instances, cities provide bins free of charge. To cover the cost of purchasing bins, cities sometimes charge residents for these items. However, requiring residents to pick up and purchase bins, particularly in voluntary programs, can decrease program participation. The City of Columbia, for instance, charges residents $5 for bins. At the end of 1990, 5 years into its voluntary curbside program, the City had distributed recycling bins to only 200 households (representing 3 percent of enrolled households) and had secured the participation of only 62 percent of enrolled households.

Drop-off Collection

As indicated in Table 5.2, most of our study communities utilize some form of drop-off collection. While curbside collection is generally a more effective way to maximize the amount of recyclable materials collected, drop-off collection can augment curbside and serve as the primary method of recyclables collection in communities in which residents self-haul refuse. Convenient placement of sites, and economic incentives (such as payment for recyclables, or variable refuse rates) increase residents' participation in drop-off programs.

There is great variation in the type of drop-off opportunities offered. Some sites collect a wide range of materials, while others collect only bottle bill containers or scrap metal. Some sites operate unstaffed, while others are staffed. Some pay individuals for materials, while others accept materials at no charge. Table 5.7 lists the materials collected at public and private drop-off sites.

Drop-off sites are a particularly viable and cost-effective alternative to curbside collection in rural or suburban communities in which residents self-haul refuse to disposal sites. Communities such as Peterborough, New Hampshire; Bowdoinham, Maine; Seattle, Washington; and Sonoma County, California operate successful drop-off sites at transfer stations and landfills. Peterborough, for instance, recovered 42 percent of its residential waste through drop-off collection alone.[14] All residents and private haulers utilizing the Town refuse and recycling center must source-separate a wide range of recyclable items, including many grades of paper, glass, metal, reusable items, and food waste, and deposit all material generated or collected, not just nonrecyclable (refuse) items or materials with a low market value. The rural community of Bowdoinham successfully recycled 43 percent of its municipal waste (which is largely material from the residential sector), primarily through two publicly run drop-off sites, one of which was located at the Town landfill.[15] Bowdoinham's volume-based refuse rates provide residents the incentive to self-haul recyclables to the Center.

Sonoma County and San Francisco, California and Seattle and King County, Washington utilize drop-off collection for those households not serviced by curbside collection, or for those self-hauling refuse to the landfill. Seattle, for example, recovers recyclable and compostable materials through hundreds of private drop-off sites (in addition to its curbside program) and two public drop-off centers, one each at the City's two transfer stations. The City's volume-based refuse fees provide residents ample incentive to source-separate and deliver recyclable materials to drop-off sites. Philadelphia has implemented a "block corner" recycling program to service those households not provided with curbside collection. (See side bar, "Philadelphia's Block Corner Recycling Program.")

Seven of the 30 communities studied are located in jurisdictions with container deposit legislation. Beer and soft drink containers constitute on average 4.1 percent of the municipal solid waste stream. States with container deposit legislation realize return rates of 72 to 98 percent for such material,[18] enabling communities to recycle between 2.9 and 4.1 percent of their waste without spending any municipal funds. In 1977 Columbia enacted the nation's first and only local bottle bill. An estimated 85 percent of all glass, aluminum, and PET plastic deposit containers are returned through this legislation. While Columbia has a limited recycling program (only 27 percent of households received curbside collection service in 1990, and 33 percent received such service in 1991), the City recycled 13 percent of its total waste in FY 1990. Twelve percent of recycled material consisted of deposit containers.

Targeting a Wide Range of Materials for Recovery

Table 5.7 lists materials collected through drop-off sites. Table 5.8 lists residential recyclable and compostable materials collected at curbside. Communities with the highest recycling levels are generally those that target a large number of materials for recovery, particularly those materials that constitute a significant percentage of the waste stream. The six communities recycling 28 to 42 percent of their residential waste target between 5 and 15 types of recyclable materials for citywide collection. The three communities recycling 35 percent or more of their residential waste—Bowdoinham, Peterborough, and San Francisco—are each collecting between 9 and 14 materials.[17] On the other hand, Newark, with a residential recycling rate of 5 percent, was collecting only four recyclable materials at curbside in the base year. Lincoln, Nebraska has the lowest residential recycling rate—3 percent—and targets only two materials, newspaper and aluminum cans, for curbside collection.

Philadelphia's Block Corner Recycling Program

Philadelphia utilizes a "block corner" collection program for areas of the City not yet serviced with curbside collection. The program, initiated by a neighborhood group in 1985, is a cross between curbside and drop-off service and costs about a third of curbside collection. Residents from 30 to 150 households in each block corner zone bring newspaper, glass, and aluminum cans to designated street corners for weekly or biweeky collection. Over a 3-hour period, City crews pick up material from 25 street corners. Materials are fully segregated at the curb, including glass separated by color, and require no further sorting. Neighborhood groups play a very active role in initiating and maintaining the program, but depend on the City for pick-up. Revenue from the sale of material is returned to the neighborhood to fund community projects. City costs for running this program were $58 per ton in 1990.

Charts 5.4 and 5.5 provide a breakdown of residential materials recycled, as a percentage of residential waste generated and in pounds per household. While the breakdowns in Chart 5.4 are affected by the relative weight of the other components of the residential waste steam, the per household breakdowns in Chart 5.5 are not.

Waste Paper

Paper, the largest single component of the waste stream, also accounts for the largest portion of residential recyclables. Paper comprises between 50 and 80 percent by weight of all residential materials recycled in the majority of these communities.

While newspaper comprises the bulk of this waste paper, other grades of paper, such as high-grade paper, mixed waste paper (including advertising mail, magazines, and paperboard packaging), and corrugated cardboard, can comprise a substantial percentage. The cities with the highest waste paper recycling levels, San Francisco and Seattle, are recovering 29 percent and 24 percent of their residential waste streams, respectively, through waste paper recycling alone. Both recover a wide range of paper grades, including newspaper, magazines, advertising mail, and corrugated cardboard.

As indicated on Chart 5.4, the recovery of mixed waste paper, which composes approximately 13 percent by weight of MSW nationally, plays an important role in reaching high recycling rates. All of the six communities recycling between 28 and 42 percent of their residential waste target mixed waste paper for collection. None of the eight communities with the lowest residential recycling rates are recovering mixed paper from the residential sector.

The City of Seattle has determined that mixed household waste paper comprises 19 percent of its residential waste. (Approximately half of which is not targeted for collection as it is coated or contaminated.) Of this mixed paper, it recovered nearly 30 percent in 1990. The City collects magazines, advertising mail, coupons, fliers, wrapping paper, used envelopes, cereal boxes, phone books, tube board, paper egg cartons, and brochures, in addition to corrugated cardboard and newspaper. The only paper that it does not collect

Table 5.7
Materials Recovered from Public and Private Drop-off Sites

	ONP	OCC	HP	MP	PHONE BKS	ALUM	FR CAN	SM	GLASS	PET	HDPE	OTHR PLAS	WG	OIL	FOOD	BATT	TIRES	OTHR	FOOD	GRS	LVS	WW	BRUSH	CT	LNDSCPRS' WASTE	MATS RECY (a)	MATS COMP (a)	TOT MATS (a)
Austin, TX	V		V	V		V	V	V	V	V	V		V			V				V	V			V	V	11	3	14
Berkeley, CA (b)	V	V	V	V		V	V	V	V				V					V		V	V	V	V		V	10	4	14
Berlin Township, NJ	M	M	V	M		M	M	M	M	M	M			M						M	M	M	M	M	V	11	5	16
Boulder, CO	V	V	V	V	V	V	V		V	V	V					V								V		11	1	12
Bowdoinham, ME (c)	V	V	V	V		V	V	V	V	V	V					V										16	2	18
Columbia, MO	V		V	V		V	V	V	V	V	V	V	V	V		V	V	V		V	V			V	V	11	3	14
Dakota Co., MN (d)	V	V	V	V		V	V	V	V	V	V	V	V	V		V	V	V		V	V		V	V	V	16	4	20
Fennimore, WI	M	M	M	M		M	M		M	M	M					V				M	M	M	M			9	4	13
King Co., WA	V	V	V	V		V	V	V	V	V	V					V				V	V		V	V	V	11	5	16
La Crescent, MN (e)	M	M	V	V		M	M	V	M	M	M					V				V	V				V	18	2	18
Lafayette, LA	V	V	V	V		V	V	V	V	V	V		V	V		V	V	V		V	V		V	V		13	4	17
Lincoln, NE	V	V	V			V	V	V	V	V	V		V	V				V		V	V		V	V		12	4	16
Lincoln Park, NJ (f)	M	M	M	M		M	M	M	M	M	M					M	M			M	M	M	M	M		15	5	20
Mecklenburg Co., NC (g)	V	V	V	V	V	V	V	V	V	V	V	V	V	V		V	V			V	V		V			16	3	19
Monroe, WI	M	M	M	M		M	M	M	M	M	M			V		M										13	0	13
Naperville, IL (h)	V	V	V	V		V	V	V	V	V	V	V	V	M		M										13	0	13
Newark, NJ	M	M	M	V		M	M	V	M					V		V	V									11	0	11
Parkside, PA	M	M				M	V		M	V	V				V											7	0	7
Peterborough, NH (i)	M	M	M	M		M	M		M	M	M	M	M	M	M	M		M	M							16	0	16
Philadelphia, PA (j)	M	M	V	V		M	M	V	M					V		V	V	V		M	M		M			12	3	15
Portland, OR (k)	V	V	V	V		V	V	V	V		V	V	V	V						V	V	V	V		V	11	4	15
Providence, RI														V												1	0	1
San Francisco, CA (l)	V	V	V			V	V		V	V	V		V	V		V		V						V		13	1	14
Seattle, WA	V	V	V	V		V	V	V	V				V	V	V	V	V	V		M	M		M	M		14	4	18
Sonoma Co., CA (m)	V	V	V	V		V	V	V	V					V	V	V	V	V		M	M		M			14	4	18
Takoma Park, MD				V						V	V									V	M			V	V	9	0	9
Upper Township, NJ	M	M	M	M		M	M		M	M	M									M	M		M			9	3	12
Wapakoneta, OH (n)	V	V	V	V		V	V	V	V	V	V	V	V			V								V	V	11	3	14
West Linn, OR (o)	V	V	V	V		V	V		V		V			V						M	M	M	M	V	V	10	5	15
West Palm Beach, FL	V	V	V		V	V	V	V	V	V	V		V			V				V	V	V	V	V		12	0	12

Key:

ALUM = Aluminum
Batt = Batteries
CT = Christmas Trees
FR CANS = Ferrous Cans
GRS = Grass Clippings
HDPE = High-density Polyethylene
HP = High-grade Paper
L = Leaves
LDPE = Low Density Polyethylene
LNDSCPRS' WASTE = Landscapers' Waste
MATS COMP = Materials Composted
MATS RECY = Materials Recycled
MP = Mixed Paper
OCC = Corrugated Cardboard
ONP = Newspaper
OTHR PLAS = Other Plastics
OTHR = Other, including textiles, furniture, small household goods
PET = Polyethylene Terephthalate
SM = Scrap Metal
TOT MATS = Total Materials
WG = White Goods
WW = Wood Waste

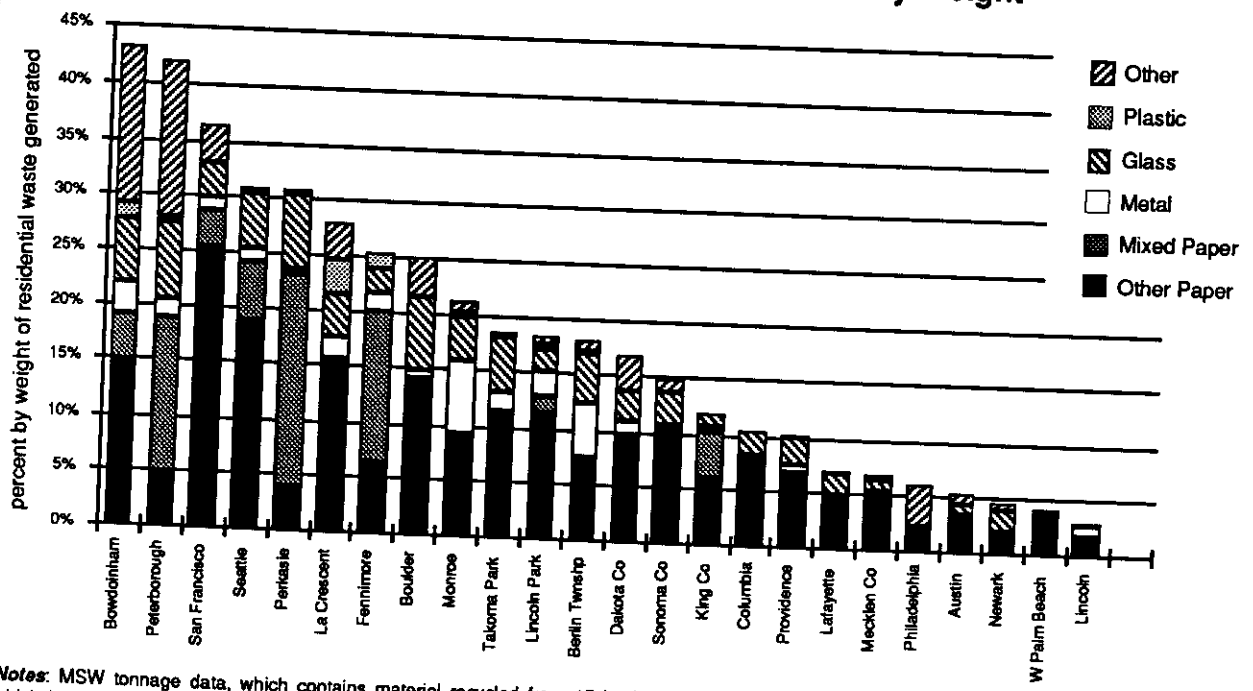
V = Source-separation of material by residents is voluntary.
M = Source-separation of material by residents is mandatory.

Notes:

Total materials recycled and recovered may be underestimated in some cases as mixed paper can incude several grades of paper. Landscapers' waste and phone books are not included in the number of materials composted or recovered.

(a) Materials recycled and materials composted represent the number of types of materials recycled and composted, respectively. Total materials recovered is the sum of the number of materials recycled and composted.
(b) Other includes household items such as furniture.
(c) Other materials collected are clothing, furniture, and rags.
(d) Other materials collected are household items including toys, clothing and books.
(e) Other materials includes furniture.
(f) Other is all plastic that held liquid.
(g) Other plastics include polypropylene, polyvinyl chloride, and scrap plastics.
(h) Recycles all types of plastic.
(i) Other materials include salvaged items and textiles.
(j) Collection of corrugated cardboard is mandatory for businesses and voluntary for residents.
(k) Other plastics are polystyrene packaging peanuts.
(l) Other materials collected are clothing, small appliances, and paint.
(m) The food waste collected is grease.
(n) Other plastics are polystyrene trays.
(o) Other plastic collected includes LDPE film and polystyrene.

Chart 5.4
Residential Materials Recycled, Percent by Weight



Notes: MSW tonnage data, which contains material recycled from 15 businesses, is utilized in lieu of Bowdoinham's residential tonnage data—which is unavailable. For Newark and Philadelphia, residential waste represents publicly collected material. "Other" includes white goods, tires, food waste, and reusable items. Deposit containers for Bowdoinham are included under "other." Deposit containers for Sonoma County and San Francisco are included under material type. Mixed paper collected in Berlin Township is included under "other paper."

from the residential sector is food-contaminated paper or paper coated with wax, plastic, or metal. On the other hand, Dakota County, which estimates that mixed waste paper comprises 10 percent of its residential waste, recovered none of its mixed paper in 1990. While Seattle recycled 31 percent of its residential waste in 1990, Dakota County recycled only 17 percent.

A number of communities have found that adding mixed paper to materials collected at curbside increases curbside tonnages. In 1990 Naperville, Illinois collected high-grade paper, box board (such as cereal boxes and tissue boxes), and magazines in addition to corrugated cardboard and newspaper. In 1991 its new hauler also began to collect advertising mail and all types of paperboard. The addition of these materials is partially responsible for the substantial increase in average monthly tonnages collected.[18] When Monroe, Wisconsin added telephone books, catalogues, paperboard packaging, and glossy inserts (in addition to PVC and PS plastics) to its curbside program in 1990, its curbside tonnages jumped from 537 tons in 1989 (the year of study) to 650 tons in 1990 and an estimated 748 tons in 1991.

Other Materials

As Chart 5.4 indicates, tires, white goods, glass, and metals can comprise a substantial percentage of residential recyclables. Targeting all these materials for collection helps raise recovery levels. For instance, 16 percent of the materials Peterborough recycled through its Town drop-off center in 1990 consisted of glass. To achieve its 31 percent residential recycling rate, Seattle recycled 59 percent of all residential glass waste generated in 1990, and 43 percent of all metal waste.

A number of communities target plastics for collection. See Tables 5.7 and 5.8. These include Berlin Township, Bowdoinham, Monroe,

Naperville, San Francisco, West Palm Beach, and Providence. While PET soda bottles and HDPE milk containers are the most common plastics recovered, some communities collect PVC, polystyrene, and LDPE film as well. Naperville, Illinois, with a residential recycling rate of 20 percent, collects all types of HDPE and PET containers, clean polystyrene containers, and LDPE six-pack rings. While plastics are light weight and thus add little to the weight of recovered materials, recovering such materials can reduce the volume of solid waste, as well as provide a feedstock for industry.

Food waste recovery has untapped potential. While food waste comprises a significant percentage of residential waste, few U.S. communities are recovering it. Food waste can be used as livestock feed, composted into a high-quality soil amendment, or manufactured into such products as perfumes and soaps. (See Chapter 4 for information on food waste composting in the U.S. and abroad.)

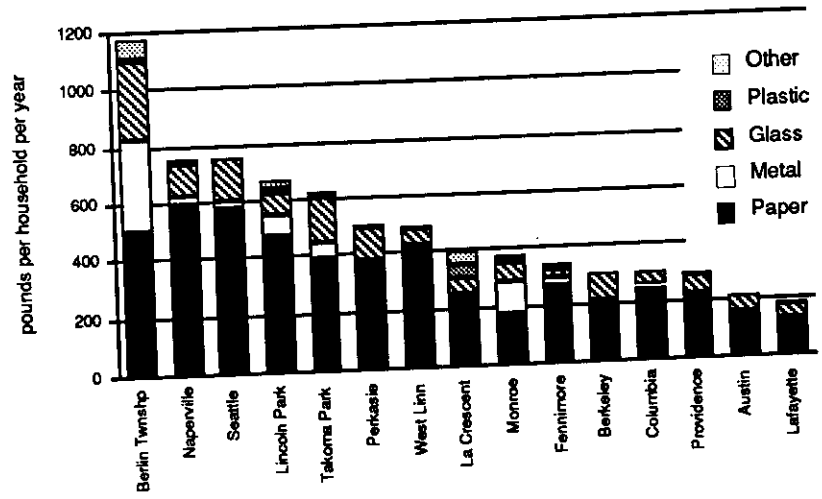
Hog farmers in New Jersey have provided Philadelphia residents the opportunity to recycle their food waste for over 80 years. In fiscal year 1990, hog farmers collected an estimated 30,000 tons of food waste from Philadelphia residents, equivalent to 3 percent of the residential waste generated and 53 percent of municipally sponsored materials recovered. (See side bar, "Urban and Rural Communities Collect Food Waste for Use as Animal Feed.")

Most communities have overlooked the recovery of reusable items. Reusable goods may compose up to 5 percent of the total waste stream.[19] Among the communities studied, Berkeley and Sonoma County, California have most effectively targeted this component of the waste stream for recovery. Berkeley, for example, recovered an estimated 68 percent of the white goods disposed of in the city through a private salvage/reuse operation. Please see Chapter 3 for further discussion of salvage and reuse.

Securing High Levels of Participation

Many of the programs with high participation levels are mandatory. In fact, most of the communities recovering 40 percent or more of their waste have mandatory programs. Chart 5.6 examines participation rates for 38 mandatory and voluntary programs, including 10 communities from *Beyond 40 Percent: Record-Setting Recycling and Composting Programs* (ILSR, 1990).[20] Chart 5.7 shows that of the nine communities in our study recovering over 40 percent of their residential waste, four mandate participation, three have volume-based refuse rates

Chart 5.5
Residential Materials Recycled, Pounds per Household



Notes: Communities for which the number of households generating recycled tonnage is unknown are excluded from this chart. For Austin, Berkeley, Columbia, Naperville, Providence, and Seattle, tonnages are those collected at curbside only. For West Linn, deposit containers are excluded from residential material. "Other" includes white goods, tires, and food waste.

Table 5.8
Materials Recovered at Curbside from the Residential Sector for Recycling and Composting

	YEAR DATA COLLECTED	ONP	OCC	HP	MP	PHONE BOOKS	ALUM	FR CAN	SM	GLASS	PET	HDPE	OTHR PLAS	WG	OIL	FOOD	BATT	TIRE	OTHR	GRS	LVS	WW	BRUSH	CT	NO. MATS RECYCLED	NO. MATS COMPOSTED	NO. MATS COLLECTED
Austin, TX	FY89	V	V				V	V		V																	
Berkeley, CA (a)	FY91	V					V	V		V											V				5	1	6
Berlin Township, NJ	1990	M	M		M		M	M	M	M	M	M		V	M		M	M		M	M	M	M	M	4	4	8
Boulder, CO (b)	1990	V					V	V		V															13	5	18
Bowdoinham, ME (c)	FY90	V	V	V	V		V	V	V	V	V	V	V							V	V	V			4	1	5
Columbia, MO	FY90	V	V		V		V			V				V	V										11	3	14
Dakota Co., MN	1990	V	V				V	V		V	V	V	V	V										V	7	1	8
Fennimore, WI	1990	M	M	M	M		M	M		M	M	M		V						V	V		V	V	9	4	13
King Co., WA (d)	1990	V	V	V	V		V	V		V	V	V									M	M			10	2	12
La Crescent, MN (e)	1990	M	M	V	V		M	M		M	M	M	V							V	V		V	V	9	4	13
Lafayette, LA	FY90	V					V	V		V	V	V													10	0	10
Lincoln, NE	1990	V					V													V	V		V	V	6	4	10
Lincoln Park, NJ	1990	M																		V	V		V		2	3	5
Mecklenburg Co., NC	1990	V					V	V		V	V			V						M	M		M	M	1	4	5
Monroe, WI	1989	M	M	M	M		M	M	M	M	M	M		M	M		M	M		M	M		M	V	14	4	18
Naperville, IL (f)	1990	V	V	V	V		V	V	V	V	V	V	V	V						M	M		M	M	12	4	16
Newark, NJ	1989	M					M	M		M										M	M		V	V	4	4	8
Perkasie, PA (g)	1990	M	M		V		M			M										M	V		V	V	5	3	8
Peterborough, NH (h)	1990	V	V	V	V		V	V		V	V	V	V	V	V	V	V				M				14	0	14
Philadelphia, PA	FY90	M					M	M		M	M	M		V		V		V					V	V	9	2	11
Portland, OR (i)	1990	V	V		V		V	V	V	V		V			V	V				V	V		V	V	9	5	14
Providence, RI	1990	M					M	M		M	M	M													6	0	6
San Francisco, CA (j)	1990	V	V	V	V	V	V	V	V	V	V									V	V		V	V	9	5	14
Seattle, WA	1990	V	V		V	V	V	V		V	V														10	1	11
Sonoma Co., CA (k)	1990	V					V	V		V	V	V								M	M		M		8	3	11
Takoma Park, MD	1990	M	V				M	V		M				V										V	5	1	7
Upper Township, NJ	1990	M	M	M	M		M	M	V	M	M	M		V	V		V	V		V	V			V	6	3	9
Wapakoneta, OH	9/89-8/90																								14	5	19
West Linn, OR	1990	V	V				V	V		V				V											0	0	0
West Palm Beach, FL	4/90-3/91	V				V	V			V	V	V	V								V	V	V	V	6	3	9
																				V	V	V	V	V	7	5	12

Key:

ALUM = Aluminum
Batt = Batteries
CT = Christmas Trees
FR CANS = Ferrous Cans
HDPE = High-density Polyethylene
HP = High-grade Paper
L = Leaves
LDPE = Low Density Polyethylene
MP = Mixed Paper
OCC = Corrugated Cardboard
OTHR = Other, including textiles, furniture, small household goods
OTHR PLAS = Other Plastics
PET = Polyethylene Terephthalate
SM = Scrap Metal
WW = Wood Waste

V = Set-out of material by residents is voluntary.

M = Set-out of material by residents is mandatory.

Notes:

Total materials collected may be underestimated in some cases as mixed paper can include several grades of paper.

(a) Only 2,600 of the 40,000 households, or 7%, receive yard waste collection.
(b) The Public Works Department collects brush over a 3-week period during spring cleanup.
(c) Bowdoinham collects high-grade and mixed paper for composting. Glossy paper (e.g. magazines) is recycled. Other plastic includes polystyrene and all other plastic resins.
(d) Six of thirteen cities have curbside collection of PET and HDPE plastic containers; nine received yard waste collection in 1990.
(e) Other plastic includes polyvinylchloride, polypropylene and all other plastic.
(f) Other plastic includes polystyrene, LDPE and six-pack rings
(g) It is not mandatory for residents to recycle junk mail.
(h) In 1990, 100 households received curbside recycling service. Other plastic collected is polystyrene.
(i) Some haulers collect HDPE milk jugs or mixed waste paper; food waste was collected for composting from an estimated 105 households in 1990.
(j) A small sector of the City receives curbside collection of Christmas trees.
(k) The County began a pilot curbside program in 1990 to collect leaves, grass, and yard waste from 1,200 homes; some areas have curbside Christmas tree collection.

Urban and Rural Communities Collect Food Waste for Use as Animal Feed

New Jersey hog farmers have collected food waste from Philadelphia residents for over 80 years. The City has reimbursed hog farmers for this service for 25 years. Currently farmers are paid a fee equivalent to the landfill tipping charge, which was $67 per ton in fiscal year 1990. Because the City avoids the cost of collection, this program is cost-effective.

Residents in over three-fourths of the City are eligible for food waste collection. Food scraps are set out at curbside in tightly covered 5- or 10-gallon containers, twice a week. Farmers unload the food waste into their sealed rear-loading vehicles. The City reports no fly or odor problems. The U.S. Department of Agriculture requires that food waste be heat-sterilized, or cooked for 30 minutes at a core temperature of 212 degrees Fahrenheit, before use as an animal feed. Some of the farmers' vehicles heat the food waste en route. Farmers also collect large quantities of food waste from businesses such as bakeries and groceries.

The rural community of Peterborough, New Hampshire has recovered food waste through the Town Recycling Center since 1987. In 1990 approximately 4 percent of materials collected at the drop-off site (32.84 tons) consisted of food waste. Residents store food scraps, including meat and fat, in plastic bags, which they deposit in 55-gallon drums at the Center. According to the Town Administrator, nearly all residents who use the Center—an estimated 64 percent of the Town's residents—drop off food waste. A local pig farmer collects the food scraps twice a week in the summer and once a week in the winter.

One local hauler in Peterborough, Kodiac Recycling, collects food waste from 100 households in a customized recycling vehicle. All residents who receive refuse/recycling collection from Kodiac must separate food waste from refuse. Food waste is placed in a lined compartment of the vehicle. The hauler recommends storing the materials in close-fitting containers or bags, which are collected and brought to the Town Recycling Center.

(which provide a strong economic incentive to recycle), and the other two do both.

Recycling mandates, however, may be weak without proper enforcement.[21] In Newark, New Jersey, enforcement of the 1987 mandatory source-separation ordinance has noticeably increased recovery rates. Beginning in January 1991, three municipal enforcement officers have performed spot checks for recyclables in residential refuse. As of July 1991, 863 warnings had been issued. After two warnings, residents are subject to a fine of $25 per violation. The Office of Recycling credits this new enforcement policy with the 20 percent increase in recyclables collected in the first quarter of 1991 (over 1990 rates).

Establishing Economic Incentives

Communities in our study are using economic incentives such as high tipping fees at disposal sites, low or no tipping fees at recycling or composting facilities, volume-based refuse collection rates, and contest awards to increase participation in recycling programs and reduce overall waste generation rates. (See Chart 5.7 and Table 5.3.)

Twelve of our 30 communities utilize volume-based refuse collection rates through which residents are charged higher fees for greater volumes of refuse set-out. In most instances, residents are not charged for set-out of recyclable or compostable materials, or are charged a reduced fee. Such rates, also known as variable rates, provide a direct economic incentive to generate as little waste as possible and recycle as much as possible.

There is some evidence that volume-based rates encourage recycling and waste reduction. Many of the communities with the highest recycling rates in the nation have volume-based refuse rates (see Chart 5.7). In 1985, 3 years before the start-up of Seattle's curbside recycling program, the City recycled 22 percent of its waste through small-scale, independent recycling centers. This recycling level is attributed to the City's variable can rate. Since the implementation of Seattle's variable can system the weighted average number of cans subscribed to by a single-family household decreased from 3.5 in 1981 to 1.4 in 1988. A significant increase in Seattle's refuse collection rates between 1985 and 1989, and the start-up of the City's curbside

recycling program in 1988, has led to an even more significant reduction in waste disposed than during the program's earliest years. Seattle recovered 40 percent of its municipal solid waste in 1990.

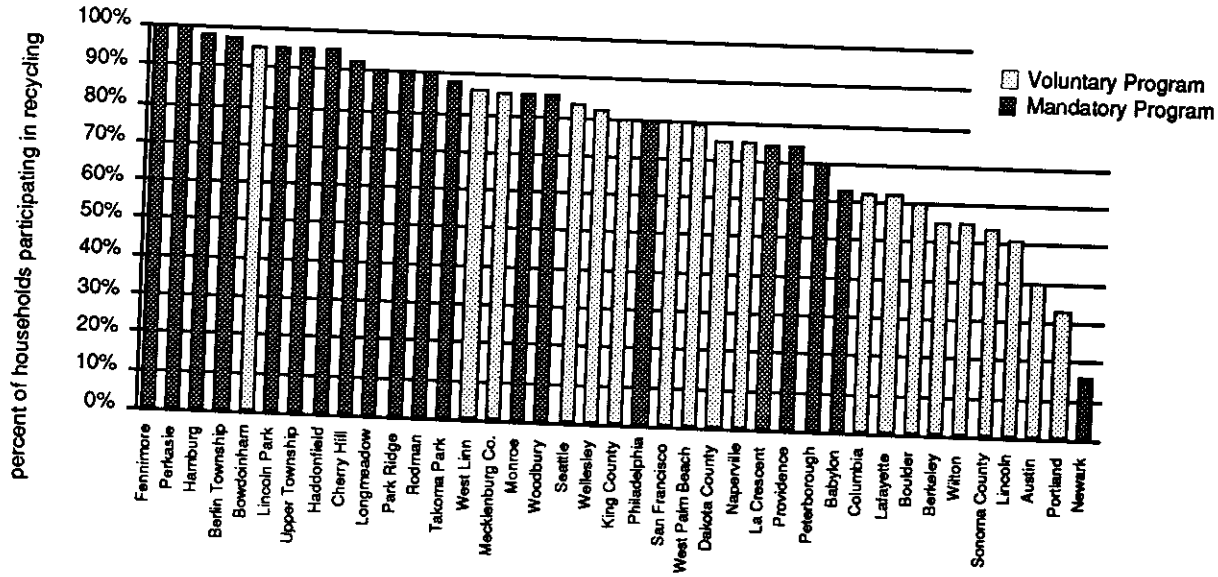
Since June 1990, Wapakoneta, Ohio has charged households $0.70 per bag of refuse in addition to a $6 per month flat trash collection fee. During the first year of the program's implementation, the City reported a decrease in the volume of waste disposed from 20 to 30 percent. Municipal pick-up of refuse has been reduced from 5 days to 4 days per week. Wapakoneta attributes this decline to increased recycling activities, backyard composting, and compaction of waste by residents. Attrition of approximately 20 commercial customers from municipal refuse collection may also contribute to this decrease. (See Chapter 3 for further discussion of variable refuse rates.)

Comprehensive Educational and Promotional Programs

In order to motivate residents to participate in source-separation programs and instruct them how to comply with collection requirements, many communities undertake comprehensive educational and promotional programs. Educational outreach appears to be most critical for obtaining high participation rates in urban areas.

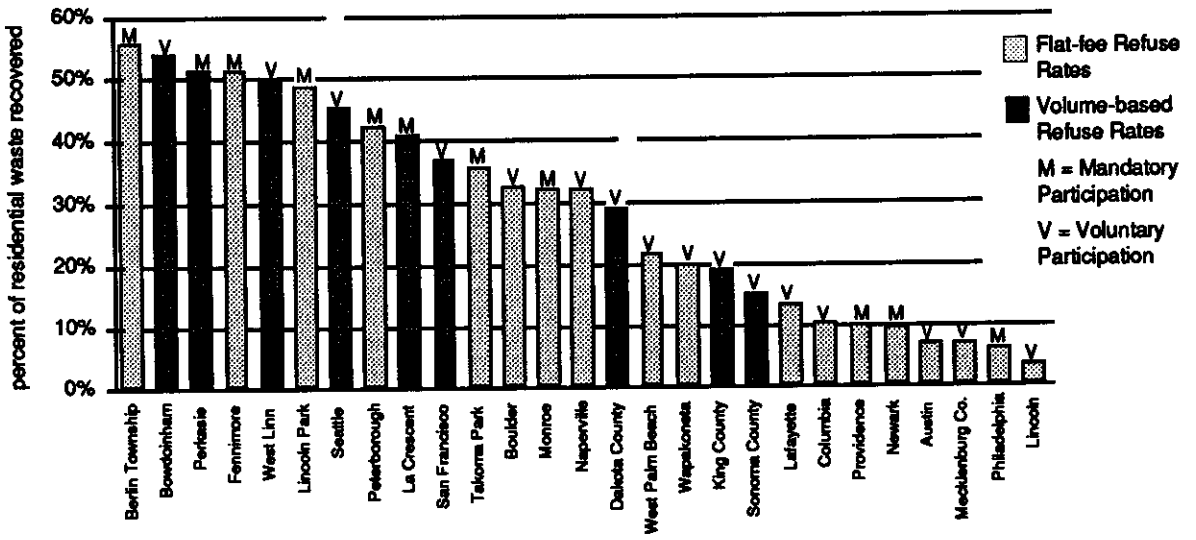
Virtually all 30 communities studied promote recycling. To target as wide an audience as possible, communities utilize techniques such as recycling information sheets, newsletters, posters, and utility bill inserts. Many communities take advantage of print and broadcast media, with their potential for reaching the broadest segment of the population. Monroe, Wisconsin reports the success

Chart 5.6
Household Participation Rates in Voluntary and Mandatory Programs



Note: Communities documented in ILSR's report *Beyond 40 Percent: Record-Setting Recycling and Composting Programs* are included in this chart. Two communities are excluded, Wapakoneta—for which a participation rate is not available, and Peterborough—for which an exact participation rate is unavailable and participation cannot easily be classified as mandatory or voluntary (64% of residents self-hauling refuse to Town dump and an additional 6% of residents utilizing select private refuse haulers must source-separate recyclables. Other residents are not required to.)

Chart 5.7
Volume-based Refuse Rates and Residential Recovery Levels



Notes: Recovery rates include recycled and composted material. MSW recovery rates are utilized in Bowdoinham, Wapakoneta, and West Linn, as residential breakdowns are not available and MSW is largely residential. Wapakoneta instituted volume-based refuse rates in June 1990 but because tonnage data were collected from Sept. 1989 to August 1990, it is listed as a flat-fee program.

of local recycling efforts in a local newspaper column. Local cable stations in Takoma Park, Maryland; Monroe, Wisconsin; Wapakoneta, Ohio; and Naperville, Illinois run programs highlighting solid waste management issues. Some communities promote recycling and composting through in-person education, which can be particularly effective. In-person includes door-to-door visits, staffed recycling booths at city or county fairs, or block leader programs.

Block leader or block captain programs actively promote recycling through neighbor-to-neighbor communication. Boulder, Colorado successfully initiated a block leader program in 1980. Designed by a psychology professor at the University of Colorado, Boulder's block leader program is currently run by Eco-Cycle, a community-based recycling company. During the first year of the program, a study revealed that participation rates in the neighborhoods with block leaders were over two times those without such programs. Boulder currently spends $30,000 per year on materials and labor to coordinate its block leader program. Communities as widespread and diverse as Minneapolis, Minnesota; Seattle Washington, and Austin, Texas have replicated the block leader program.

Similar in design are the Master Recycler/ Composter programs, through which volunteers are trained to educate friends, neighbors, and co-workers about home composting, source reduction, and recycling. King County, Washington conducts three 2-month training sessions each year; participants agree to contribute 40 hours each to community outreach initiatives. Capital expenditures for the program included $10,000 for training manuals and curricula, $6,000 for outreach tools, and $10,000 for the construction of two demonstration sites. The County spends $15,000 on training and equipment for each training session.

Education programs directed at school-age children play a vital role in the long-term success of a recycling program. Many communities utilize formal or informal recycling curricula to teach recycling concepts. The Ecology Center in Berkeley,

California developed "the Recyclones," lovable cartoon characters that reinforce recycling concepts. Newark, New Jersey created the Recycling Rangers to encourage students to spread the word about recycling to their parents. To generate enthusiasm for recycling, several communities conduct recycling poster contests, which use either a recycling theme or recycled materials.

Demographic factors play an important role in determining the amount of money a community must spend on recycling educational programs, and the types of programs implemented. Cities with transient populations and diverse ethnic groups face the greatest challenges in securing broad participation, and must typically spend more money on recycling education. Smaller communities, on the other hand, can rely on volunteer efforts, and word-of-mouth to ensure participation in recycling programs. Peterborough and Monroe, for example, report spending no money on education, yet both enjoy high residential recovery levels at 42 percent and 32 percent, respectively.

Educational outreach has played an important role in elevating recycling rates in large cities. Providence, Rhode Island, for example, increased participation in its curbside recycling program in the south side of the City (which has a large multilingual population) from 30 percent at the startup of the program to 60 percent one year later, using foreign-language brochures and other materials. Newark, New Jersey hired a local minority public relations firm to initiate a promotional campaign. Newark translates most mailings and bulletins into Spanish and Portuguese to reach its minority communities. Jersey City, New Jersey distributes recycling information pamphlets in Arabic, Hindi, Spanish, and Korean. San Francisco informs its Latino residents about its recycling program via Spanish-language radio and television stations. San Francisco also offers backyard composting workshops in Spanish and Cantonese.

By enlisting the help of community volunteers and school teachers, communities are implementing very successful educational programs without spending large sums of money.

Identifying Outlets for Collected Materials

Collecting materials for recycling is a challenging task, but perhaps one of the most difficult yet fundamentally important tasks is finding an outlet for the collected material. Identifying markets, securing agreements with materials brokers and end users, and meeting buyer specifications are all part of this task. Recycling collection programs can only be as successful as a recycling marketing program. Consequently market analysis will be both a planning and ongoing activity.

Identifying outlets for collected recyclables is an important component of all of the 30 recycling programs evaluated as part of this project. Many of these communities rely on private processors to find end users. Others undertake this legwork themselves. Municipal recycling coordinators and private processors are finding different end uses for the same material and using a variety of strategies to keep materials moving to those who can manufacture new products from them.

Wapakoneta, Ohio, sells its newspaper directly to a local manufacturer of insulation, whereas in Bowdoinham, Maine, a local farmer shreds the Town's old newspaper at no charge for animal bedding. In Sonoma County, California, some old newspaper is shipped to the Far East for deinking and reprocessing. The private processor of the County facility that Upper Township uses, sells some of its glass to manufacturers of new glass containers, and the rest is delivered to a manufacturer of glassphalt. Often communities sell their collected materials to brokers who resell the materials to manufacturers. Wapakoneta, for example, sells its baled PET to a broker in Minster, Ohio, who resells the containers to a firm in Cleveland for manufacturing into plastic lumber.

In Monroe, Wisconsin, the Monroe Area Recycling Committee (MARC) has secured a number of in-state brokers and end users for the City's recyclables. Much of the materials collected through the curbside program is sold locally to the Green County Salvage Yard, which resells it to various end users. MARC is considering selling more of the City's recyclables directly to end users, such as paper mills. MARC seeks additional markets when the supply of recyclables exceeds the

capacities of existing markets. For example, when traditional paper outlets are filled, Green County, in which Monroe is located, shreds and bales its paper for sale as animal bedding.

Peterborough, New Hampshire, is very active in the New Hampshire Resource Recovery Association (NHRRA). Begun in Peterborough in 1979, NHRRA helps to develop new markets for recyclable materials. Peterborough collectively markets some materials, such as glass, corrugated cardboard, newspaper, and plastic containers, through the NHRRA. Member communities are charged a fee of $0.03 per capita for this service plus a fee for brokering specific material; in return they receive revenue from the sale of certain materials. The NHRRA markets about 50 percent of all recyclables collected in the State of New Hampshire.

In addition to seeking markets for recyclables, a number of our case-study communities have implemented policies such as recycled-content product procurement to encourage further market development. See Appendix D for a list of these communities.

Notes

[1]Jim Glenn, "The State of Garbage in America." *BioCycle*, April 1992.

[2]For the communities of Philadelphia and Newark, residential material is publicly collected waste. Bowdoinham, West Linn, and Wapakoneta's MSW recycling rates are utilized in Chart 5.1 as their MSW is largely residential. The Cities of Berkeley and Portland have been excluded from Chart 5.1 as residential rates are not available. Upper Township has also been excluded as its publicly collected waste contain recyclables (although not refuse) from 222 businesses. Residential recycling rates are based on data provided by municipal officials and the private sector. Recycling rates are based on marketed tonnages in the few communities where such information was available; in most cases, however, recycling rates are based on collected tonnages. See Appendix A for methodology and data definitions, and Appendix C for waste calculations.

[3]Wapakoneta recycled 16 percent of its municipal solid waste in fiscal year 1990. While residents in the rural community of Wapakoneta receive curbside collection of refuse, they must drive to the privately run recycling drop-off site to participate in the City's voluntary recycling program. The Wapakoneta Recycling Center is operated by 19 Girl and Boy Scout troops and 1 volunteer recycling coordinator. In order to increase its recycling rate, Wapakoneta will institute weekly curbside collection of recyclable materials in spring 1992, based on a plan designed by the City's volunteer Waste Minimization Committee. In Lincoln Park, New Jersey, newspaper is the only material collected at curbside; all other recyclables are collected at the Borough's drop-off yard. Drop-off is the primary method of recyclable and refuse collection in the rural communities of Bowdoinham, Maine and Peterborough, New Hampshire. However, private haulers in both cities offer limited curbside recycling opportunities. In Bowdoinham one-third of the City receives curbside service.

[4]There are some exceptions. Columbia, Missouri; Lincoln Park, New Jersey; the south side of Seattle; parts of Portland, Oregon; and King County, Washington have monthly collection. Perkasie has weekly collection of glass and aluminum, and monthly collection of newspaper, junk mail, and corrugated cardboard. During the base year of study, Newark collected commingled recyclables and newspaper on alternate weeks. Residents of Lincoln Park receive monthly collection of newspaper only; all other recyclables in Lincoln Park are collected through drop-off. Residents of Fennimore receive collection of recyclables every other week.

[5]Communities measure program participation differently. In most cases, the participation rate is the number of households setting out recyclable materials at least one time per month divided by the total number of households served. In Seattle, participation is the sign-up rate—the ratio of the number of households registered for the program to the number of households eligible. See *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results* (Washington, DC: ILSR, 1992) for information on how communities determine participation rates.

[6]NARC also discovered that biweekly collection saw a greater variation (plus or minus 40 percent) in the size of daily collection. With weekly collection, variation in tonnage decreased (to plus or minus 18 percent), which made scheduling easier and reduced the need for workers to put in overtime hours. Miriam Foshay and Anne Aitchison, "Factors Affecting Yield and Participation in Curbside Recycling Program," *Resource Recycling*, March 1991.

[7]In the base year of study (1990), only 20 percent of San Francisco's residential recyclables were collected at curbside. With the curbside program fully phased in, the City estimates that it is recovering 55,000 tons per year at curbside, two and one-half times the amount recovered at curbside in 1990. In Boulder, the University, which comprises approximately 25 percent of the City's population, has 225 drop-off sites for recyclables on campus.

[8]Generally a household is considered a participant in a recycling program even if it sets out only one or two materials. Thus, participation rates do not indicate if all materials are set out.

[9]Glass breakage occurs on the collection vehicle as well as in the processing center. For example, the operators of the facility that processes Providence's commingled recycables report that approximately 20 percent of glass entering the plant arrives broken.

[10]Before Monroe implemented its citywide curbside program in 1986, it conducted a study to gauge residents' participation rates and the suitability of recycling containers. The City observed that the type of collection container used had a direct effect on the amount of recyclables collected. During the pilot study, households that received a reusable plastic recycling bin set out an average of 4.94 pounds of recyclables each week. Households that received a plastic bag set out an average of 2.18 pounds per week.

[11]In order to increase participation rates, Newark distributed an additional 5,000 8-gallon bins in 1990, and budgeted for 12,000 bins to be distributed in 1991. The City is requiring its new recycling contractor, who services one-third of the City, to supply residents with recycling bins.

[12]Jennifer S. Gitlitz, "Curbside Collection Containers: A Comparative Evaluation," *Resource Recycling*, January/February 1989.

[13]Tom Outerbridge (Recycling Programs and Planning Division, New York DEP), personal communication, February 1992. Alicia Culver (Center for the Biology of Natural Systems, Queens College), personal communication, March 1992.

[14]Two private haulers in Peterborough collect recyclables and refuse at curbside from 100 to 200 households requesting this service, and bring materials to the Town drop-off center.

[15]In 1991 Bowdoinham closed the landfill drop-off site in order to avoid transporting materials the 6 miles from the landfill to the processing center. The City now collects most of the Town's recyclables at the processing center.

[16]General Accounting Office, "Solid Waste: Trade-offs Involved in Beverage Container Deposit Legislation," November 1990, 34.

[17]The number of materials targeted for collection may under represent the actual number of material types collected. Mixed paper, for example, contains several types of materials. Perkasie, for example, collected two types of mixed paper—magazines and advertising mail. Recycling rate excludes tonnages recovered through composting activities. Including composting, 11 communities are recovering 35 percent of their residential waste, and 9 of these are recovering more than 40 percent.

[18]Other factors responsible for the jump in curbside tonnages collected in Naperville, from an average of 750 tons per month from April to August 1990, to an average of 940 tons per month from April to August 1991, were the increased publicity for recycling as a result of the City's securing a new recycling hauler, and the change in set-out requirements, from eight sorts under the old system to three sorts under the new contract.

[19]Urban Ore, Inc. (Salvage/reuse business), Berkeley, California, personal communication, June 1991.

[20]The Institute for Local Self-Reliance's 1990 publication, *Beyond 40 Percent: Record-Setting Recycling and Composting Programs*, documents 17 materials recovery programs recovering between 32 and 57 percent of their solid waste.

[21]Cities may choose to give residents a grace period before beginning enforcement measures, to allow residents time to adjust to recycling requirements.

Chapter Six

Improving Commercial and Institutional Recovery Levels

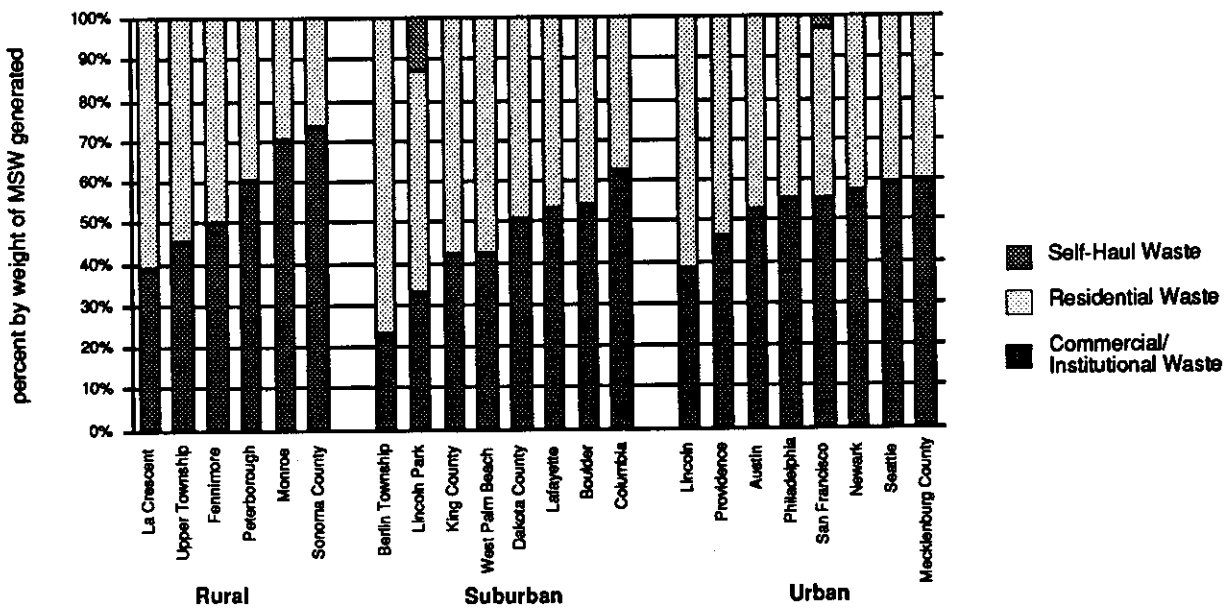
Overview

Commercial and institutional waste is often a significant portion of municipal waste, even in small cities and suburbs.[1] (See Chart 6.1.) For our sample, commercial waste generated ranged from 23 percent of municipal solid waste (MSW) in the suburban community of Berlin Township, New Jersey to over 50 percent of MSW in cities such as Philadelphia, San Francisco, and Seattle. Unlike most residential waste, however, commercial material is usually collected by the private sector, and municipalities have been slower to target this waste stream for recovery. Many communities now realize that commercial and institutional recycling and composting efforts play an important role in meeting high waste recovery goals.

Table 6.1 lists figures for commercial and institutional waste generated and recovered in the

Chart 6.1

The Contribution of Commercial and Institutional Waste to MSW Generated



Notes: Residential and commercial breakdowns in the cities of Wapakoneta, West Linn, Bowdoinham, Berkeley, and Portland were not available. Total recovery rates were used in Austin, Columbia, Newark and Upper Township as C&D waste is not tracked separately from MSW. Commercial waste in Newark and Upper Township is privately collected material and residential waste is publicly collected material. Naperville, Perkasie, and Takoma Park are excluded as commercial waste generation data were not available. Self-haul waste includes materials generated by the residential and commercial sectors; a breakdown between these sectors is not available in these cities.

Table 6.1
Commercial and Institutional Waste Generated and Recovered

Community	Year Data Collected	Com/Inst Waste Generated (Tons)	Com/Inst Materials Recycled (Tons)	Com/Inst Materials Composted (Tons)	Com/Inst Materials Recovered (Tons)	% Com/Inst Materials Recycled (By Wt.)	% Com/Inst Materials Composted (By Wt.)	% Com/Inst Materials Recovered (By Wt.)
Austin, TX	FY89	NA	13,312	0	13,312	NA	NA	NA
Berkeley, CA	FY91	NA	NA	NA	NA	NA	NA	NA
Berlin Township, NJ	1990	1,853	1,124	0	1,124	61	0	61
Boulder, CO	1990	33,605	4,137	25	4,162	12	0	12
Bowdoinham, ME	FY90	NA	NA	NA	NA	NA	NA	NA
Columbia, MO	FY90	51,971	6,671	NA	6,671	13	NA	13
Dakota County, MN	1990	114,010	27,748	0	27,748	24	0	24
Fennimore, WI	1990	631	158	0	158	25	0	25
King County, WA	1990	541,116	159,439	34,528	193,967	29	6	36
La Crescent, MN	1990	683	59	0	59	9	0	9
Lafayette, LA	FY90	39,005	3,125	0	3,125	8	0	8
Lincoln, NE	1990	82,989	21,027	0	21,027	25	0	25
Lincoln Park, NJ	1990	4,608	3,193	20	3,213	69	0	70
Mecklenburg Co., NC	1990	425,678	92,520	0	92,520	22	NA	22
Monroe, WI	1989	8,858	2,359	0	2,359	27	0	27
Naperville, IL	1990	NA	NA	NA	NA	NA	NA	NA
Newark, NJ (a)	1989	195,556	87,350	2,172	89,522	45	1	46
Perkasie, PA	1990	NA	NA	NA	NA	NA	NA	NA
Peterborough, NH	1990	2,998	120	0	120	4	0	4
Philadelphia, PA (a)	FY90	1,132,079	181,959	0	181,959	16	0	16
Portland, OR	1990	NA	NA	NA	NA	NA	NA	NA
Providence, RI	1990	67,000	NA	NA	8,700	NA	NA	13
San Francisco, CA	1990	392,764	68,971	1,858	70,829	18	0	18
Seattle, WA	1990	397,315	154,199	3,444	157,643	39	1	40
Sonoma County, CA	1990	340,297	32,319	1,570	33,889	9	0	10
Takoma Park, MD	1990	NA	4	0	4	NA	NA	NA
Upper Township, NJ (a)(b)	1990	5,733	547	1,409	1,957	10	25	34
Wapakoneta, OH	9/89-8/90	NA	NA	0	NA	NA	NA	NA
West Linn, OR	1990	NA	340	78	417	NA	NA	NA (c)
West Palm Beach, FL	4/90-3/91	51,004	174	0	174	0	0	0

Key:

Com = Commercial Inst = Institutional NA = Not Available Wt. = weight

Notes:

In larger cities such as Philadelphia and Providence some private sector recycling activities were not tracked during the base year and thus listed data may not reflect all private sector recovery activities. See Appendix C for a detailed explanation of what may or may not be included in above commercial/institutional figures, and, if applicable, how tonnage figures were calculated. Yard waste composted by landscapers and any beverage containers recovered under bottle bills are excluded as this tonnage cannot be broken into residential and commercial/institutional. Self-hauled materials are similarly excluded.

(a) Figures represent tonnage handled by private sector, which may include some residential waste.

(b) The commercial/institutional recovery activities undertaken by the public sector are not reflected in these figures.

(c) Figures for commercial/institutional waste disposed are not available, thus a commercial/institutional recovery rate cannot be calculated. According to estimates of waste disposed provided by the City's Recycling Coordinator, West Linn recovered approximately 45% of its commercial waste.

Table 6.2
Commercial/Institutional Recovery Activities

Community	Total Businesses/ Institutions	Businesses/ Institutions Served w/CS (a)	Institutions/ Businesses Privately Served	Mandatory (b)	Materials Mandated for Separation	Economic Incentives to Haulers (c)	Economic Incentives to Bus/Instit. (d)	Technical Assistance to Businesses (e)	Number of Private Haulers
Austin, TX	NA	0	350	No	None	None	None	None	2
Berkeley, CA	3,318	250	NA	No	None	None	RC	None	NA
Berlin Township, NJ	280	200	80	Yes	ONP,OCC,A,F,S,G,P (f)	None	NF,RC	None	NA
Boulder, CO	6,000	0	150 (g)	No	None	None	None	None (h)	3
Bowdoinham, ME	15	0 (i)	4	No	None	None	NF,RC	None	2
Columbia, MO	3,032	0	300	No	None	None	RF,RC	None	1
Dakota County, MN	44,227	0	NA	No	None	RS	NA	None	NA
Fennimore, WI	105	100	0	Yes	ONP,OCC,HP,MP,A,F,G,P,WG	None	RC,NF	PR	0
King County, WA	49,000	NA	NA	No	None	None	None	PR,T,WR	<5
La Crescent, MN	205	0	10	No	None	None	NF,RS,RC (j)	PR	1
Lafayette, LA	7,654	0	25	No	None	NF	NF	None (k)	1
Lincoln, NE	7,574	0	350	No	None	None	None	PR,T	2
Lincoln Park, NJ	195	195	--	Yes	ONP,OCC,HP,A,G	None	None	None	NA
Mecklenburg Co, NC	17,303	7	10	No	None	NF	NF	PR, T	1
Monroe, WI	437	0	NA	No (j)	None	None	NF,RC	None	2
Naperville, IL	3,113	0	NA	No	None	None	NF	None	5+
Newark, NJ	4,642	70	NA	Yes	ONP,OCC,HP,A,F,G	None	RC,NF	None	88+
Perkasie, PA	76	15	--	No	None	None	NF,RC	None	NA
Peterborough, NH	267	0	15	No	None	None	None	None	1
Philadelphia, PA	26,579	NA (m)	NA	Yes	OCC,HP,A,L	None	NA	PR,T,WR	76
Portland, OR	NA	NA	NA	No	None	None	RS,RF	PR	NA
Providence, RI	1,066	0	NA	Yes	ONP,OCC,HP,A,F,G,P (n)	RF	FN	PR	10+
San Francisco, CA	62,135	0	NA	No	None	GR	RS,RC	T	33
Seattle, WA	30,000	0	NA	No	None	TX	RC, RF	T	NA
Sonoma County, CA	15,000	0	NA	No	None	RS,RF	RC	PR	NA
Takoma Park, MD	245	0	NA	No	None	None	None	None	NA
Upper Township, NJ	261	222	38	Yes	ONP,OCC,HP,MP,A,F,G,P,O	RF (o)	None	PR	5
Wapakoneta, OH	456	--	--	No	None	None	NF	None	0
West Linn, OR	379	0	50	No	None	None	RF	PR,T	1
West Palm Beach, FL	2,778	30	8	No	None	None	RC (p)	PR,T	1

Key:

A = Aluminum
Bus = Businesses
S = Scrap Metal
TX=Tax Incentive
F = Ferrous Cans
G = Glass
CS = Curbside Collection Service
SS = Shared Savings or Diversion Credits (haulers receive a share of money saved through recycling)
Instit. = Institutions
GR=Grant
HP = High-grade Paper
T = Technical Assistance such as waste audits and consultations
MP = Mixed Paper
IPC = Intermediate Processing Center
L = Leaves
W = White Goods
O = Oil
NA = Not Available
NF = No Tipping Fees
WR = Workshops and Seminars
P = Plastic
OCC = Old Corrugated Cardboard
ONP = Newspaper
-- = Not Applicable
RS = Revenue Sharing
PR = Printed materials such as brochures
RF = Reduced Tipping Fees

Notes:

(a) Businesses/institutions served with municipal curbside/alley collection of recyclables.
(b) Businesses are required to recycle designated materials. In Portland and West Linn haulers are required to collect recyclables, but businesses are not required to participate.
(c) Community offers haulers economic incentives to collect recyclables. For example, Seattle, WA, does not charge the Occupation Tax to haulers that collect commercial recyclables.
(d) Public or private sector offers businesses economic incentives to recycle, such as no tipping fee at drop-off sites.
(e) Community offers businesses technical assistance to recycle, such as waste audits, consultations, workshops, and printed material.
(f) Businesses must chose one of the listed materials for recycling.
(g) Eco-Cyle serves about 150 businesses; the number of businesses the other two haulers serve is unknown.
(h) In 1991 the City held recycling seminars for businesses and began to develop written recycling material.
(i) Most businesses deliver recyclables to the drop-off site.
(j) In 1990 businesses did not receive revenue.
(k)In 1991 the Chamber of Commerce distributed literature on source reduction in the workplace.
(l) Commercial recycling became mandatory as of 1990. Tonnage data used for this study are for 1989.
(m) The Department of Sanitation collects refuse and recyclables from small businesses. It does not know how many.
(n) These are materials mandated for recycling in 1990. This list has subsequently been revised to include wood waste, used lubricating oil, vehicle batteries, telephone directories, leaves and yard waste (after 1/193).
(o) Cape May County offers reduced tipping fees to haulers from Upper Township.
(p) Businesses were not charged a collection fee for recyclables during the pilot study.

30 communities studied, and Table 6.2 describes these communities' commercial/institutional waste recovery programs. Chart 6.2 shows the importance of commercial/institutional waste recovery in reaching high MSW recovery rates. Communities that achieved MSW recovery rates greater than 30 percent, recovered between 25 and 70 percent of their commercial waste streams.

How Communities Increase Commercial/Institutional Recovery Levels

The number and type of commercial recycling opportunities vary greatly among the communities studied. As Tables 6.1 and 6.2 and Charts 6.3 and 6.4 indicate, some communities, such as Lincoln

Communities Employ Multiple Strategies to Encourage Commercial Sector Recycling

Lincoln Park and **Newark, New Jersey** and **Seattle, Washington** have achieved high commercial/industrial recovery rates using a variety of the techniques described in this chapter.

Seattle successfully recovered an estimated 40 percent of its commercial and institutional waste in 1990. Without commercial/institutional waste recovery activities, Seattle's MSW recovery rate would have been 18 percent rather than 40 percent. Two private franchised haulers collect all commercial refuse in the City. Both offer their customers curbside collection of source-separated recyclables at rates 25 to 40 percent lower than those for refuse collection. A number of other for-profit and nonprofit recycling companies also collect recyclables from a large number of commercial establishments. To encourage recycling collection, Seattle exempts recycling revenues from the City Business and Occupation Tax that haulers pay on garbage collection revenues. Haulers are able to pass on these savings, as well as the savings from avoided tipping fees, to their customers.

Hundreds of private drop-off and buy-back centers throughout Seattle, as well as the two public drop-off sites operated by the Solid Waste Utility, accept commercial recyclables free of charge. The Solid Waste Utility has published the Commercial Waste Audit Manual to aid businesses in evaluating their waste streams and their current recycling programs, and to help them develop waste reduction and recycling programs.

Lincoln Park requires commercial establishments to recycle glass, aluminum, high-grade paper, newspaper, and corrugated cardboard. It encourages businesses to use the public recycling depot by allowing them to deliver materials there free of charge. Most of the Borough's 195 businesses and institutions utilize the drop-off site, and thus avoid the $118.80 per ton refuse tipping fee. Larger businesses contract with private haulers to collect recyclables or sell materials directly to market. In 1990 Lincoln Park recovered 70 percent of all waste generated by the commercial and institutional sector.

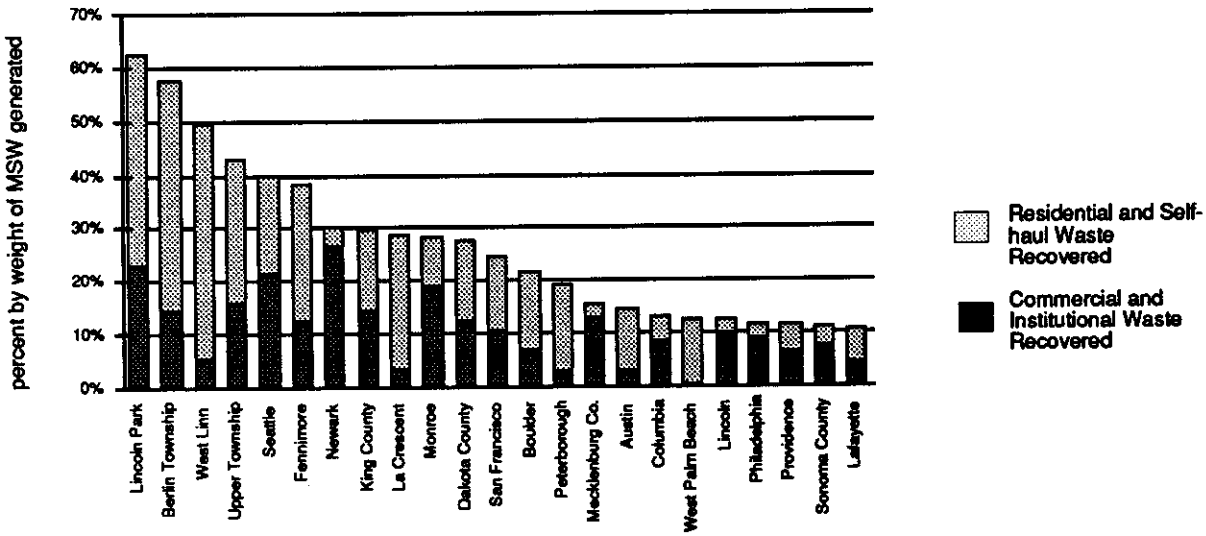
In 1989 **Newark** recovered 46 percent of its private sector waste (which consists primarily of material generated by commercial and institutional establishments), equivalent to 86 percent of the total waste recovered that year. The City requires businesses to recycle newspaper, corrugated cardboard, glass food and beverage containers, and aluminum and bimetal cans. The City will issue $25 fines to businesses that do not comply with the mandate. While private haulers collect corrugated cardboard and other recyclables from high-volume generators, Newark offers collection of corrugated cardboard to smaller businesses (for whom contracting with a private hauler may be prohibitively expensive). In addition, over 50 drop-off centers and scrap yards accept or purchase commercially generated recyclables. Since refuse tipping fees range from $97 to $102 per ton, businesses can easily realize economic benefits through recycling. To further encourage recycling, the City offers recycling workshops for businesses, notifies businesses of local marketing opportunities, and recognizes exemplary businesses at an annual awards ceremony.

Park, Newark, and Seattle, are successfully encouraging businesses to recycle, while many others are not. (See side bar, "Communities Employ Multiple Strategies to Encourage Commercial Sector Recycling.") In many instances, expanded commercial and institutional recycling efforts have been hampered by a lack of knowledge about the components of the commercial waste stream that are recyclable and compostable; few incentives for businesses to arrange separate collection for recyclable materials; and a lack of private sector recycling collection services. The following State and local government initiatives have been used to spur the development of private sector recycling programs in these and other communities:

- instituting economic incentives targeted at businesses and private haulers, such as high tipping fees at refuse disposal sites, reduced or no tipping fees at recycling drop-off sites and materials processing centers, recycling start-up funds, and rebates and tax relief for haulers who recycle commercial wastes;
- targeting a wide range of materials for recovery;
- mandating that businesses and institutions recover a wide range of recyclable and compostable materials (or prohibiting disposal of specific materials such as yard waste);
- requiring businesses to write and submit recycling plans;
- providing technical assistance, such as waste audits and listings of drop-off sites and private recycling services;
- assisting businesses and haulers with marketing of recovered materials by informing them of different marketing options, allowing them to bring materials to public processing

Chart 6.2

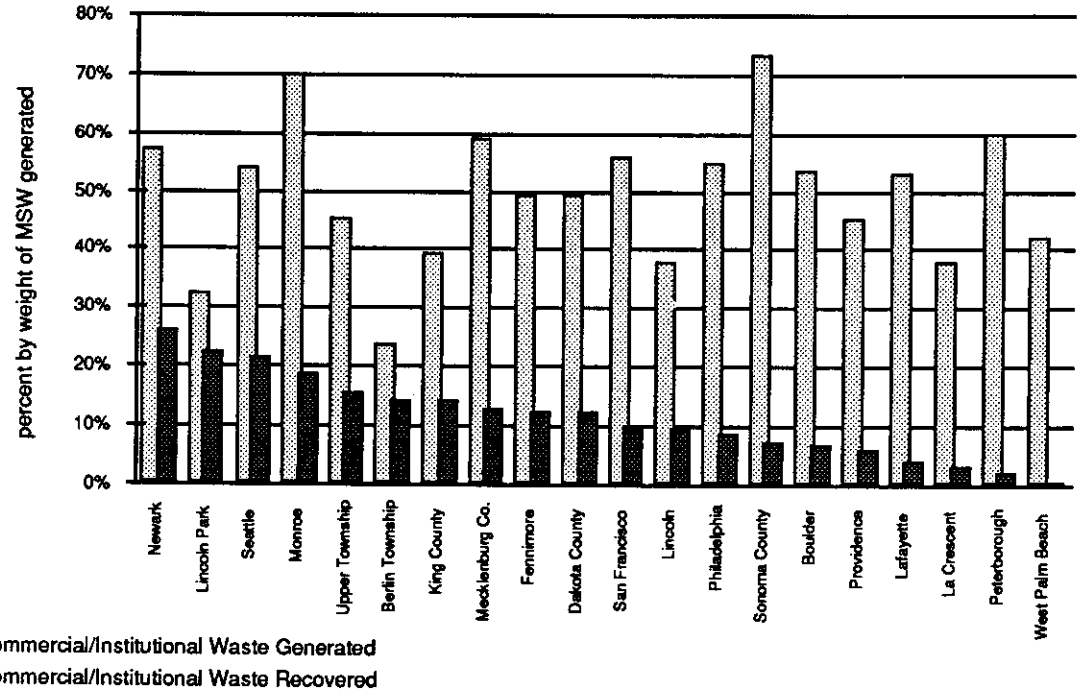
The Contribution of Commercial and Institutional Waste Recovered to MSW Recovery



Notes: A breakdown for residential and commercial materials recovered were not available in Berkeley, Bowdoinham, Portland, and Wapakoneta. Naperville, Perkasie, and Takoma Park were excluded as only residential waste recovery data was available in 1990. Self-haul waste in Austin and San Francisco includes materials generated by the residential and commercial sectors; a breakdown is not available, and these materials are included under residential materials. Commercial/institutional waste recovered from self-haul sites in King County and Seattle is included in commercial waste recovered. Commercial/institutional recovery figures for Upper Township, Newark, Columbia, and Austin are a percent of total solid waste (including C&D) as MSW figures are not available. In Upper Township and Newark commercial tonnages represent privately-collected waste only (see Appendix C for information on what this waste includes).

Chart 6.3

The Contribution of the Commercial/Institutional Sector to Waste Generated and Recovered



centers, and sharing losses if materials revenues fall below a designated threshold; and

- providing municipal pick-up of commercial/institutional recyclables and/or convenient drop-off depots that accept materials generated by the commercial and institutional sector.

Economic Incentives

Economic incentives, such as high refuse disposal costs, reduced tipping fees for delivering recyclable and compostable materials to drop-off sites, rebates, revenue from the sale of recyclables, and tax incentives, encourage businesses to recycle and haulers to offer collection of recyclable materials.

Avoided Costs and Cost Savings

In cities with moderate to high tipping fees, recycling can be extremely cost-effective for businesses. Recycling reduces the size of refuse containers businesses may need and/or the frequency of refuse collection, thereby saving businesses money in disposal costs. Alerting businesses to the potential cost savings is one way communities are assisting commercial recycling efforts. Some communities with lower tipping fees are making the economic climate for recycling more favorable by further reducing tipping fees for the delivery of source-separated recyclable and compostable materials. (See Table 6.3 for a list of tipping fees.)

West Palm Beach recovered less than 1 percent of its commercial waste during the base year April 1990 to March 1991. In 1990 refuse tipping fees increased drastically to $84 per ton from $47 per ton in 1989. To alert businesses to the potential cost savings through recycling, and to encourage sustained recycling efforts in the commercial sector, the Palm Beach County Solid Waste Authority (SWA) implemented a 1-year pilot bar and restaurant recycling program in 1990. At the end

of the pilot study, the SWA provided each participating business a cost analysis showing how it could reduce refuse disposal fees through recycling. By recycling corrugated cardboard and glass, some businesses were able to reduce waste volume 24 percent, and switch from an 8-cubic-yard trash dumpster costing $1,088 per month to a 6-cubic-yard dumpster that cost $816 per month. Taking into account the costs of renting three 95-gallon containers for glass at $17 each per month, and one 8-cubic-yard dumpster for cardboard at $55 per month, these businesses have been able to save $165 per month, or $1,980 per year.

Many communities now realize that commercial and institutional recycling and composting efforts play an important role in meeting high waste recovery goals.

Private haulers in Providence, Rhode Island pay a $49 per ton tipping fee at the State's central landfill for commercial refuse. Businesses in the State are required to recycle. Two-thirds of Rhode Island's large businesses that have completed mandatory recycling reports have either saved money or maintained their previous costs as a result of recycling. Businesses have reported net savings of up to $108,000 per year, while net costs reported for recycling programs ranged from $200 to $5,175 per year. Many of these costs include one-time implementation expenses. The grocery store chain "Stop and Shop," which reported the $108,000 cost savings, reduced its waste stream by 41 percent through corrugated cardboard and office paper recovery. The Brown & Sharpe Manufacturing Company, which manufactures precision metrology products, recovers high-grade paper, newspapers, magazines, wood waste, polystyrene peanuts, and coolant. During the first year of program implementation, the company diverted almost 53 percent by weight of its waste from landfill disposal and reduced its disposal costs 51 percent from $66,000 to $33,820.[2]

A number of communities, including Lincoln Park and Cape May County, New Jersey (in which Upper Township is located), and Bowdoinham, Maine allow private haulers and/or businesses to drop off source-separated recyclable and compostable materials at waste handling sites free

Table 6.3
Tipping Fees for Commercial Refuse

Community	% Com/Inst Materials Recovered (By Wt.) (a)	Commercial Tipping Fee ($/ton)
Lincoln, NE	25%	$8
Columbia, MO	13%	$10
Boulder, CO	12%	$11
Monroe, WI	27%	$15
Sonoma County, CA	10%	$17
Lafayette, LA	8%	$20
Mecklenburg Co., NC	22%	$26
San Francisco, CA	18%	$45
Fennimore, WI	25%	Free/$32.00 (b)
Seattle, WA	40%	$31.50 to $62 (c)
King County, WA	36%	$47
La Crescent, MN	9%	$48
Providence, RI	13%	$49
Dakota County, MN	24%	$55
Berlin Township, NJ	61%	$65
Philadelphia, PA	16%(d)	$70
West Palm Beach, FL	0%	$84 (e)
Peterborough, NH	4%	$85
Upper Township, NJ (a)(b)	34% (d)	$89
Newark, NJ	46% (d)	$109
Lincoln Park, NJ	70%	$119

Notes:

(a) Percentage of commercial/institutional waste generated.

(b) From January to March 1990, refuse was tipped for free at the City-owned landfill, after March waste was incinerated for $32/ton.

(c) Seattle's 1990 tipping fee at the landfill was $32/ton; haulers paid $62/ton at City transfer stations, and $58/ton at private transfer stations.

(d) Figures are based on the tonnage handled by the private sector, which may include some residential waste. The commercial/institutional recovery activities by the public sector are not reflected in these figures.

(e) West Palm Beach's tipping fee increased from $47/ton in 1989 to $89/ton in 1991.

of charge. Mecklenburg County, North Carolina encourages businesses to recycle at the County landfill by allowing private haulers to dispose of refuse free of charge provided they separate out at least one-half of their loads for recycling. Private haulers can also avoid the $26 per ton tipping fee at County disposal sites by dropping off recyclables at publicly run drop-off sites. Such measures have proven very successful. In 1990 Lincoln Park recovered 70 percent of its commercial waste; Upper Township recovered 34 percent of its privately collected waste; and Bowdoinham recovered 54 percent of its MSW. (Commercial figures for Bowdoinham are unavailable.) Mecklenburg County recovered only 22 percent of its commercial waste in 1990; however, commercial waste comprised 81 percent of all waste recovered in the County that year.

While businesses may be able to save money in the long run through waste reduction and recycling practices, savings are not always realized immediately. This is particularly the case when a business contracts separately for refuse and recycling collection, and refuse contracts have established, nonvariable rates. In Boulder, Colorado, for example, many refuse accounts are based on 3-year contracts; cost savings cannot be achieved until the contract is renegotiated. At that time, a business can reduce the size of its refuse container or the frequency of collection.

Shared Savings and Rebates

Some refuse haulers pass on a portion of the savings from avoided tipping fees, and of the revenues earned from material sales, to those of their customers that recycle. This provides businesses an immediate incentive to recycle. Modern Clean-up Services of La Crescent, Minnesota will pay businesses for corrugated cardboard when its price reaches a certain level. In 1990 the hauler collected 52 tons of cardboard from 10 businesses. Although none of the businesses received revenues from the sale of the cardboard in 1990 or 1991, the hauler provided cardboard dumpsters free of charge and charged businesses only $5 per month for weekly cardboard collection. Modern Clean-up Services' tipping and hauling fees for refuse typically range between $53 and $60 per ton.

The City of San Francisco provided local haulers Golden Gate Disposal and Sunset Scavenger a matching grant to initiate a bar and restaurant recycling program. In 1990 approximately 300 bars, restaurants, and hotels separated glass bottles and aluminum cans in a variety of containers (including 60- and 90-gallon plastic wheeled bins, and 1-cubic-yard and 1.5-cubic-yard metal containers) loaned by Golden Gate at no charge. Haulers collect these materials up to four times per week. Until September 1991, high-volume generators received rebates from their hauling fees for separating glass from refuse. The rebate ($36.50 per ton in mid-1990) proved a very effective recycling incentive. In 1990 the two haulers collected an estimated 3,500 tons of glass and cans and paid over $100,000 in rebates to bars and restaurants.[3] The haulers discontinued the rebates in September 1991 due to a decline in the market price for glass containers. The rebate may be reinstated when market conditions improve.

Shared savings and material rebates offered by private haulers are highly variable and directly depend on the tipping fees and materials revenues in that region of the country.

Tax Incentives

Communities are providing tax incentives to haulers to collect commercial recyclables, and to businesses to purchase recycling equipment. Seattle, for example, charges garbage haulers a tax on collection revenues, but excludes the collection of commercial recyclables from this tax. The City's two primary refuse haulers offer recycling services to all customers. Fees for the collection of source-separated corrugated cardboard, office paper, computer paper, magazines, aluminum and ferrous cans, and plastic and glass containers are 25 to 45 percent less than the fees for refuse collection. The haulers pass on this savings, plus the savings from avoided tipping fees, to their customers.

Targeting a Wide Range of Materials for Recovery

While there is great similarity in the composition of the residential waste stream from residence to residence, the commercial waste stream

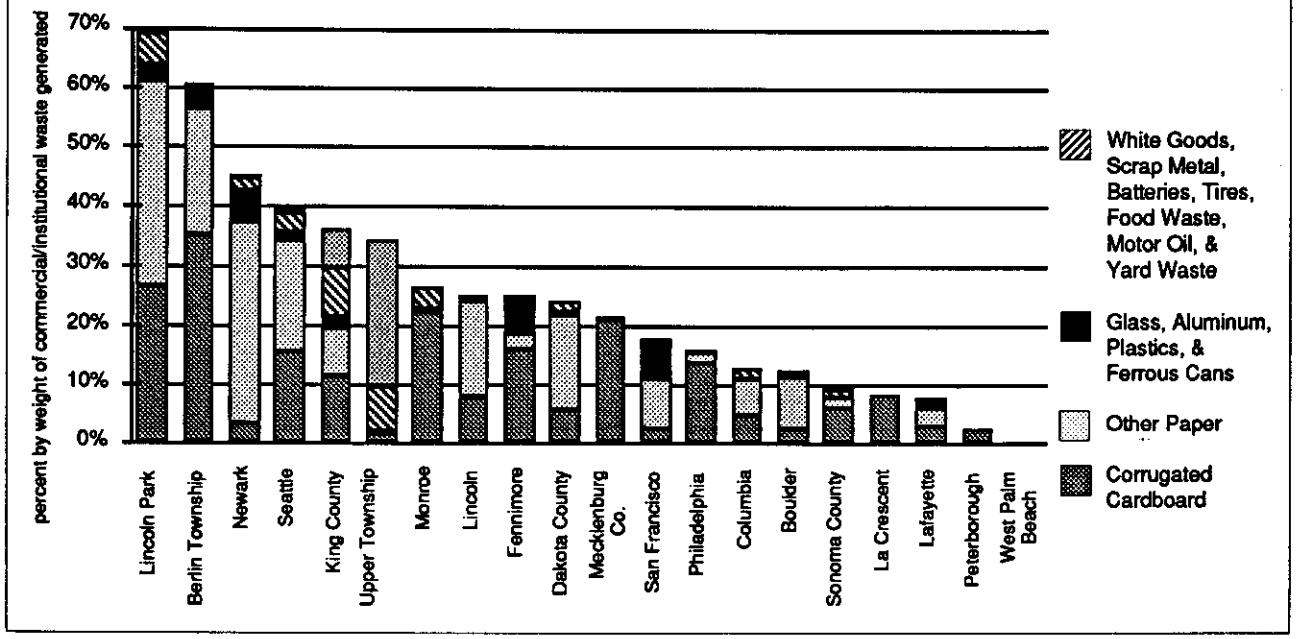
can vary significantly with the type of business. Yet within a single business establishment, the waste stream is often homogeneous. Office waste is composed mostly of paper; restaurant waste contains a large percentage of food scraps; and shopping malls generate large volumes of corrugated cardboard. In order for communities to reach high commercial recovery rates, businesses need to identify the recoverable components of their waste streams and find markets for these materials. As described in this chapter, legislative mandates, technical assistance, and planning requirements are spurring businesses to identify and recover recyclable and compostable materials. (See Tables 6.4 and 6.5 for a listing of publicly and privately collected commercial/institutional materials, and Table 5.6 for a listing of materials recovered from public and private drop-off sites.)

Paper is the largest single component of most communities' commercial and institutional waste streams, and is generally the largest component recovered (see Chart 6.4). Cities with high commercial/institutional recovery levels typically have strong paper recovery programs. Lincoln Park recycled 61 percent of its commercial waste stream in 1990 through paper recycling alone. The Borough not only required commercial recycling of high-grade paper, newspaper, and corrugated cardboard, but also accepted mixed paper at its drop-off site. Seattle, which recovered an estimated 40 percent of its commercial waste in 1990, has a successful paper recovery program. Approximately 68 percent, or 266,600 tons, of Seattle's commercial/institutional waste stream consists of paper. Of this amount, the City recovered an estimated 136,554 tons (51 percent) in 1990. In contrast, neither San Francisco nor Dakota County, Minnesota is recovering as large a volume of commercial waste paper; consequently, these communities have lower overall commercial recovery levels. Paper comprised 49 percent of San Francisco's commercial waste[4] and 57 percent of Dakota County's commercial waste, in 1990. Yet San Francisco recovered 23 percent, and Dakota County 39 percent (25,147 of an estimated 64,885 tons),[5] of commercial waste paper generated.

In 1990 Mecklenburg County recovered 22 percent of its commercial waste stream; nearly all of this material consisted of corrugated cardboard, collected by the private sector. The County hopes

Chart 6.4

Commercial/Institutional Materials Recovered



to substantially increase its commercial recovery rate by targeting other paper types in 1993, when a new processing facility, designed to process primarily waste paper from the commercial/institutional sector, will come on line. (Businesses will be charged a tipping fee to drop off materials at this facility.)

Communities are elevating commercial recovery levels by encouraging businesses to recover a wide range of materials, including glass, aluminum, ferrous metal, and food scraps. For example, 45 percent of the commercial materials recovered in King County in 1990 consisted of glass, plastics, metals, tires, motor oil, batteries, textiles, yard and wood waste, and food waste. (See side bar, "Commercial Food Waste Recovery Programs.")

Mandating Participation in the Commercial/Institutional Sector

By mandating businesses and institutions to recycle, communities encourage the establishment of a private sector recycling infrastructure.

Six of the 30 communities in our sample require businesses to recycle a designated list of materials. These include many of the communities with the highest commercial/institutional recovery rates, such as Lincoln Park (with a 70 percent commercial/institutional recovery rate), Newark (with a 46 percent private sector recovery rate), and Upper Township (with a 34 percent private sector recovery rate).[6]

Essex County, in which Newark is located, has mandated that municipalities provide, at a minimum, drop-off sites for corrugated cardboard and high-grade paper. In addition to these materials, Newark requires businesses to recycle newspaper, glass food and beverage containers, and aluminum and bimetal cans.

Monroe, Wisconsin has required businesses to recycle a wide range of materials (including newspaper, corrugated cardboard, glass containers, aluminum and ferrous cans and scrap, lead-acid batteries, tires, motor oil, and grass clippings) since July 1990. The City's two primary refuse haulers offer their refuse customers curbside/alley collection of recyclable materials. One of the haulers conducts waste audits for its commercial businesses before initiating recycling collection. Because refuse fees are based on per-container charges, some businesses save money through recycling.

According to State law, haulers in West Linn and Portland, Oregon are required to pick up recyclable materials from businesses, and may not charge businesses more for refuse and recycling collection than they charge for refuse collection alone. (Many haulers in Portland, however, have not informed their customers of this option.)

Comprehensive Prison Recovery Program

Spurred by rapidly escalating labor costs, the New York Department of Corrections (DOC) currently recycles several materials at 64 of its 68 facilities and composts food waste at 32 facilities. As a result of all waste recovery activities, the DOC is saving a total of $55,000 to $75,000 per month in avoided tipping and hauling fees.

Inmates ("recycling porters") source-separate recyclable corrugated cardboard, high-grade paper, newspaper, ferrous cans, plastic containers, and polystyrene. Food waste is collected daily from the kitchens and delivered to a compost pad. The food is mixed with wood chips and leaves, using a front-end loader, and formed into windrows. Operators monitor windrow temperatures and turn the windrows as needed.

At two facilities, Shawangunk and Wyoming, with 547 and 1,389 inmates respectively, corrugated cardboard, office paper, newspaper, bimetal cans, and plastic are recycled, and food waste is composted. In 1991 Shawangunk recovered 30 percent of its waste through recycling and 11 percent through composting, yielding a total recovery rate of 41 percent. Wyoming recovered 20 percent through recycling and 18.5 percent through composting.

Source: "Integrated Recycling Pays off at Prison Facilities," *BioCycle*, May 1991; and Jim Marion (Resource Management Director, Fallsburg, NY) personal communication, February 1992.

Enforcing Recycling Mandates

Many communities have established enforcement measures to ensure program participation. Enforcement measures for mandatory programs include warnings, penalties, fines, and refusal to collect refuse containing recyclables. The manager at Monroe County's landfill, for instance, periodically inspects refuse. If recyclables are found, the manager photographs the material and reports the offense to the Department of Public Works, which advises the offender how to comply with the recycling regulations. As of fall 1991, three businesses had been found to be in noncompliance with Monroe's recycling regulations, which went into effect in July 1990.

Newark may issue fines of $25 for noncompliance with commercial recycling requirements. However, no enforcement fines had been levied as of mid-1991.

In large cities, it may not always be practical for public works officials to examine refuse for compliance with recycling regulations. City officials use other mechanisms such as requiring each business to fill out a recycling planning report detailing the operation of its recovery program.

Planning and Reporting Requirements

Through waste audits and planning efforts, communities are setting in motion and tracking commercial recycling.

While businesses in Providence are responsible for arranging their own collection and recovery programs, the State provides technical assistance and tracks waste generation and recovery through mandated waste reduction and recycling plans. Businesses with more than 50 employees must submit annual recycling reports and waste reduction plans to the State according to a specific timetable. In 1990 each of these businesses was required to complete a waste audit and submit a plan to the State Department of Environmental

Table 6.4
Materials Collected from Commercial/Institutional Establishments at Curbside/Alley by the Public Sector

	ONP	OCC	HP	MP	ALUM	FR CAN	SM	GLASS	PET	HDPE	WG	OIL	BATT	TIRES	Total Materials Collected
Berkeley, CA	V	V	V	V	V	V		V							7
Berlin Township, NJ	M	M			M	M	M	M	M	M					8
Fennimore, WI	M	M	M	M	M	M		M	M	M					9
Newark, NJ		M													1
Perkasie, PA	V	V		V	V			V							5
Upper Township, NJ	M	M	M	M	M	M	V	V	V	V	V	V	V	V	14
Wapakoneta, OH		V													1
West Palm Beach, FL		V						V	V	V					4

Key:
ALUM = Aluminum
BATT = Batteries
FR CAN = Ferrous Cans
HDPE = High-density Polyethylene
HP = High-grade Paper
MP = Mixed Paper
OCC = Corrugated Cardboard
ONP = Newspaper
PET = Polyethylene Terephthalate
SM = Scrap metal
WG = White Goods

V = Set-out of material by business or institutional establishment is voluntary.
M = Set-out of material by business or institutional establishment is mandatory.

Notes:
Communities listed represent only those cities offering municipal curbside collection of commercial materials. Total materials collected may be underestimated in some cases as mixed paper can include several grades of paper. The City of Redman, located in King County, Washington, collects high-volume, low-value material such as mixed waste paper.

Management detailing the amount of material currently disposed, the amount and type of material currently recycled, a waste composition breakdown, and a proposed plan for reducing and/or recycling each component comprising over 5 percent of the waste stream, including how materials would be separated, collected, and transported to market.[7] Once recycling plans have been approved by the DEM, businesses must file annual reports on their recycling activities. As of 1991, all businesses with over 100 employees that were required to submit recycling plans to the DEM, had done so. While the DEM did not enforce implementation of such plans until mid-1991, it believes that the majority of large businesses are currently recycling. (By 1991 neither the State nor the City of Providence had determined how much commercial waste was being recycled in Providence; tonnages utilized for this study were estimated and may under-represent actual recovery levels.)

Berlin Township, with a commercial/institutional recovery rate of 61 percent, reviews all business recycling plans prior to issuing or renewing a mercantile license.

Technical Assistance

Municipalities also encourage commercial recycling through technical assistance. Eleven of the communities studied, primarily the larger communities and the counties, provide the commercial/institutional sector with some form of technical assistance. Such assistance may include:

- on-site assistance, including waste audits;
- business-specific informational exchanges and round-table discussions; and
- listings of markets, haulers, and other commercial sector publications.

While Lincoln, Nebraska recovered only 3 percent of its residential waste in 1990, it recovered 25 percent of it commercial/institutional materials. (Seventy-seven percent of the MSW recovered in Lincoln in 1990 consisted of commercially generated materials.) The City Recycling Office and the University of Nebraska Civil Engineering Department have helped encourage such recovery efforts through a waste assessment project. Ten different types of businesses, including a hospital, an office building, and a manufacturer, participated in this voluntary program. An assessment team conducted a waste audit for each business and followed with a technical and economic feasibility analysis for reducing each business's waste stream. Participating businesses estimate that 30 to 65 percent by weight of their waste stream has been diverted as a result of recycling.

The Philadelphia Recycling Office (PRO) has published a pamphlet, entitled *Commercial Recycling Quick Reference* to assist businesses in locating recycling vendors. Another PRO publication, *Recycling at Work: Profiles of Commercial Recycling*, highlights innovative business recycling programs, and offers instructions on how to conduct waste audits and start up a recycling program. PRO has also organized a number of business-specific information exchanges to promote recycling.

Awards

Prestigious awards can spur businesses and institutions to recycle. Awards provide businesses with free advertising and can be a valuable public relations tool. A number of cities including Newark and Lincoln, where businesses pay refuse tipping fees ranging from $8 to $102 per ton, distribute awards annually to businesses.

Assisting Businesses and Haulers with Marketing Recyclables

Some municipalities are helping local haulers and businesses locate markets for commercial recyclables, and in some cases, accepting privately generated material at public facilities. Mecklenburg County, for example, plans to open a recycling facility to process commercially generated waste paper. The County will charge businesses a tipping fee to drop off this material.

Private haulers in Providence have reported some difficulty marketing commercially generated recyclables. The State of Rhode Island allows private haulers to use the State processing facility as a market of last resort, however, it charges the private sector a tipping fee equivalent to the tipping fee at the State landfill.

Table 6.5
Materials Privately Collected at Curbside/Alley from Commercial/Institutional Establishments

	Year Data Collected	ONP	OCC	HP	MP	ALUM	FR CAN	SM	GLASS	PET	HDPE	OTHR PLAS	WG	OIL	FOOD	BATT	TIRES	TEX	Total Materials Collected
Austin, TX	FY89	V	V	V	V	V	V		V										7
Berkeley, CA (a)	FY91																		NA
Berlin Township, NJ	1990		M	M	M														3
Boulder, CO	1990	V	V	V		V			V										5
Bowdoinham, ME	FY90	V	V	V	V	V	V	V	V	V	V	V						V	12
Columbia, MO	FY90	V	V	V		V			V	V									6
Dakota Co., MN (b)	1990	V	V	V	V	V	V		V	V	V	V							10
Fennimore, WI	1990																		0
King Co., WA	1990		V	V	V	V	V	V											6
La Crescent, MN	1990		V																1
Lafayette, LA	FY90	V	V	V	V	V	V		V	V	V								9
Lincoln, NE	1990			V	V	V													3
Lincoln Park, NJ	1990	M	M	M		M			M										5
Mecklenburg Co.,NC	1990		V																1
Monroe, WI	1989		V																1
Naperville, IL (c)	1990	V	V	V		V	V		V	V	V	V							9
Newark, NJ	1989	M	M	M	V	M	M	V	M					V	V	V	V		12
Perkasie, PA	1990																		0
Peterborough, NH	1990		V																1
Philadelphia, PA	FY90		M	M	V	M	V			V	V				V		V		9
Portland, OR	1990	V	V	V	V		V	V	V	V	V								9
Providence, RI	1990	M	M	M		M	M	V	M	M	M	V	V	V	V	V		V	15
San Francisco, CA	1990	V	V			V			V										4
Seattle, WA	1990		V	V	V	V	V		V	V	V	V							9
Sonoma Co., CA	1990	V	V	V		V			V										5
Takoma Park, MD	1990																		0
Upper Township, NJ	1990	M	M	M	M	M	M		M	M	M			M	V				11
Wapakoneta, OH	9/89-8/90																		0
West Linn, OR	1990	V	V		V		V		V	V	V			V					8
West Palm Beach, FL (d)	4/90-3/91		V																1

Key:

ALUM = Aluminum
BATT = Batteries
FR CAN = Ferrous Cans
HDPE = High-density Polyethylene
HP = High-grade Paper
MP = Mixed Paper
OCC = Corrugated Cardboard
ONP = Newspaper
OTHR PLAS = Other Plastics
PET = Polyethylene Terephthalate
SM = Scrap metal
TEX = Textiles
WG = White Goods

V = Set-out of material by business or institutional establishments is voluntary.
M = Set-out of material by business or institutional establishment is mandatory.

NA= Not Available

Notes:

The number of total materials collected may be underestimated in some cases as "mixed paper" and "other plastics" can include several types.

(a) Private haulers offer curbside collection of certain recyclables to their refuse customers. Specific information is not available.
(b) All plastics with a neck are accepted.
(c) Other plastic is polystyrene, 6-pack rings and clear polystyrene.
(d) Corrugated cardboard was collected during the last 3 months of the year documented.

A cooperative program in New Hampshire, run by the Governor's office, the State Food Waste Recycling Association, the University of New Hampshire, and the State Veterinarian's Office, helps local food producers locate food waste users, such as pig farmers.[8]

Municipal Collection

In some communities, private haulers do not offer businesses collection of recyclables. In such cases, and in order to reach high recovery rates, some municipalities become the primary hauler of commercial recyclables. Municipalities either provide businesses collection services, contract with private haulers to provide such service, or establish drop-off sites that accept recyclables generated by commercial and institutional establishments.

In Berlin Township businesses are required to recycle. The Department of Public Works collects refuse from 20 of the 280 businesses located in the Township but offers recycling service to 200. It collects source-separated aluminum and tin cans, glass, corrugated cardboard, HDPE and PET plastic containers, newspaper, and scrap metal on a weekly basis, for no charge from these 200 businesses. Upon request, the Township provides bars and restaurants with 20- and 55-gallon drums for glass storage, and with 20-gallon drums for storage of aluminum, tin cans, and plastic containers. In 1990 Berlin Township recovered 61 percent of its commercial/institutional waste stream.

The City of Wapakoneta, Ohio collects commercial and institutional refuse; since 1990 it has also collected corrugated cardboard for recycling. The City is restructuring its refuse fees to provide businesses maximum incentive to source-separate cardboard. It will charge businesses $10, $12, or $14 per pick-up of mixed

Commercial Food Waste Recovery Programs

For more than 10,000 years, people have kept swine and fed them food wastes. This practice continues today in many communities. In New Jersey, food scraps from 12 food waste classes are fed to swine. These include bakery waste, seafood residues, and residential food scraps, as well as waste from restaurants, institutions, dairies, processing plants, supermarkets, and camps. In Philadelphia, hog farmers collect an untracked amount of food waste from bakeries, hospitals, prisons, and supermarkets for use as a feed.

Due to geographical and other factors, recovering food waste for animal feed is not always feasible. Animal rendering operations are another means of food waste recovery. Renderers collect meat scraps from butchers and supermarkets for the manufacture of soap, cosmetics, perfume, and animal feed. Standard Tallow, a company located in Newark, provides customers with barrels for food scraps, which it collects up to two times per week. Approximately 2 percent by weight of the materials collected through commercial (and other private sector) recovery efforts in 1989 consisted of food scraps.

The large amount of food waste generated in institutions such as prisons and schools can also be composted. Brown University in Providence, Rhode Island recovers food waste from dining halls. The hog farmer picks up the food waste (estimated at 1,500 pounds a day) every morning, 7 days a week. Beginning in 1989 with a pilot project at two facilities, the New York Department of Corrections (DOC) currently composts a good portion of the food waste produced at 32 of its 68 facilities. (See side bar, "Comprehensive Prison Recovery Program.")

Businesses can donate unused food to shelters. City Harvest in New York City delivers 10,000 pounds of food that restaurants, corporations, and cafeterias would otherwise dispose of, to homeless shelters, day care centers, and other social service facilities.

Source: Jeffrey Suhr et al., *Feasibility of Food Waste Recycling in New Jersey*—Fourth Quarterly Draft Report to the New Jersey Office of Recycling, Rutgers University, New Brunswick, NJ, 1984; and *Inform Reports*, Inform, Inc., New York City, Summer/Fall 1991.

Hospital Recycling and Source Reduction Initiatives

Large institutions, such as hospitals, generate significant amounts of solid waste. In some communities, hospitals are beginning to target their waste for recycling and to substitute reusable products for disposable ones. For example, twenty of the twenty-three hospitals in the Seattle metropolitan area are now using cloth diapers. Emerson Hospital in Boston reported savings of approximately $1,000 annually by using a cloth diaper service.

In Philadelphia, the Hospital of the University of Pennsylvania established a recycling program in 1988. Thirty-five departments, including the nursery, pharmacy, and many laboratories, collect corrugated cardboard, high-grade paper, clear glass, and aluminum cans for recycling under the supervision of an area coordinator. Collection of corrugated cardboard alone has decreased the volume of waste disposed by an estimated 20 percent, saving the hospital an estimated $25,000 to $30,000 per year. The hospital plans to add polystyrene and PET and HDPE plastics to the program in July 1992. The recycling program has not required hiring any additional staff.

Hospitals in Monroe, Wisconsin are required by City law to recycle a range of materials, including glass, many grades of paper, and ferrous and aluminum cans. In order to meet these requirements, St. Clare Hospital purchased a baler to bale corrugated cardboard on the premises. Hospital departments separate newsprint, high-grade paper, mixed paper (including magazines), glass, metal, four types of plastic, and batteries. Materials are placed in separate bins in a "recycling room" located near the loading dock. Hospital personnel then haul these recyclables to the City recycling center. In summer 1991, the hospital intends to switch from disposable to cloth diapers, and from paper to cloth drapes in surgery rooms.

The Butterworth Hospital in Grand Rapids, Michigan conducted waste audits in all its departments to identify opportunities for reducing and recycling the waste stream. The hospital switched from disposable to autoclavable bed pans, saving an estimated $15,000 per year in product expenditures and $877 in disposal fees. Butterworth has also been recycling corrugated cardboard for over 10 years, and most of its departments collect mixed office paper for recycling. An estimated 70 tons of corrugated cardboard and 40 tons of mixed paper are recycled per year at this 529-bed facility.

Sources: Prall Culviner, "Disposable Diapers - Do They Have a Future?" *Waste Age*, May 1991; Charles DiPietro Robbe, "Michigan hospital creates 'Recyclicare' program," *BioCycle*, May 1991.

refuse, depending on container size, but only $8 per pick-up of segregated cardboard.

Businesses in Berkeley receive municipal refuse collection service. Refuse rates are based on container size as well as on frequency of collection service. Businesses may receive municipal curbside/alley collection of recyclables for no additional fee. (The City's cost for the separate collection of recyclables is covered by the refuse fees it charges businesses.) In 1990 the City collected recyclable materials from 250 businesses. By 1992, 600 businesses had signed up for recycling collection service.

Sometimes private haulers charge moderate fees for collection of recyclables from large-volume generators, but relatively high collection fees for smaller generators. In some cases, municipalities provide collection service to smaller businesses. In Newark, for example, private haulers collect most commercial wastes, but the City provides smaller businesses with free collection of corrugated cardboard in all major business corridors. This service costs the City $58 per ton. Newark has expanded the number of corrugated cardboard customers from 70 in 1989 to 247 in 1991.

In some communities, private haulers will not pick up high-volume, low-value recyclable materials. Communities can encourage private haulers to offer collection of such materials. For example, in Redmond, Washington (located in King County), the City contracts with a private recycler on a per ton basis to pick up mixed paper and other low-grade paper from small and

large businesses. The fee paid to this hauler is obtained from a waste surcharge that the City has levied on all businesses. All businesses are, in effect, paying for this service.

Many businesses, particularly smaller ones, utilize drop-off and buy-back sites for recyclables. Cities can encourage commercial recycling efforts by allowing businesses to drop off materials at publicly run or contracted drop-off sites. Lincoln Park, for example, encourages businesses to use the public drop-off site. The Borough spends an average of $54 per ton of material collected and processed through the drop-off site. Businesses primarily deliver corrugated cardboard, which the Borough was able to sell for $12 to $15 per ton in 1990.

The Community Conservation Centers Inc. (CCC), a nonprofit company in Berkeley, operates two drop-offs and one buy-back site. Businesses can deliver newspaper, mixed paper, glass containers, aluminum and tin cans, refillable wine bottles, and corrugated cardboard to all three sites. They are paid for materials brought to the Berkeley Buy-Back Center, which is operated under contract with the City. For the $25,000 the City paid CCC to operate the buy-back in FY 1991, it recovered a total of 2,386 tons of material (from both the commercial and the residential sectors) at a cost to the City of approximately $10 per ton.

Recycling in a Resort Community

Upper Township, a resort community in Cape May County, New Jersey, requires commercial and residential recycling. To assist commercial recycling efforts, the Township collects recyclable materials from 222 of its 260 businesses. The County has provided real estate agents with recycling bins for motels and rental apartments, and with stickers in each unit instructing vacationers how to recycle. Upper Township supplies marinas, campgrounds, bars, and restaurants with 20-gallon containers for commercial recyclables. The program has been so successful that in the summer of 1990 the Township had to hire an additional crew to collect materials twice a week. In 1990 Upper Township recovered 43 percent of its total solid waste.

Conclusion

Cities are stimulating businesses and institutions to recover a wide range of recyclable materials. Commercial and institutional waste recovery helps communities meet high recycling goals. Communities, particularly large cities, can encourage commercial recycling through legislative mandates, technical assistance, and recycling planning requirements, and by allowing private haulers to deliver materials to public processing centers. Communities that collect refuse from the commercial and institutional sector may find it cost-effective to collect source-separated recyclable and compostable materials from this sector as well. Communities with such incentives and programs in place are already recovering 40 to 70 percent of their commercial and institutional waste streams and continue to strive for still higher recovery levels.

Notes

[1]The large percentage of commercial waste generated in certain rural communities is attributed to the relatively low per capita generation of residential waste. Due to backyard composting, waste burning, and other factors, per capita residential waste generation is quite low in many rural communities, ranging between 1 to 2 pounds per person per day in many instances.

[2]John McCabe, "Commercial waste recycling: the experience in one state," *Resource Recycling*, November 1991.

[3]Although the haulers would like to continue the service, Golden Gate's Recycling Manager estimates that 30 percent by weight of the commingled material was lost to theft in the beginning of 1990. In addition, the Company incurred several thousand dollars in damages to toters and bins due to scavenging of materials. The Recycling Manager attributes these problems to the increase in California's redemption value from 1.5 to 2.5 cents in January 1990. Customers have since been asked to secure bins to prevent further scavenging. An estimated 15 percent of customers no longer receive the service due to their inability to secure containers. The haulers have also enlisted the help of the local police to enforce the City's anti-scavenging ordinance. As of mid-1990, seven arrests had been made.

[4]This estimate was calculated by the Institute for Local Self-Reliance based on data from Brown, Vence, and Associates. This consulting company estimates that San Francisco generated 191,375 tons of waste paper in 1990. A total of 392,764 tons of commercial waste were generated that same year, minus animal manure and inerts. (Brown, Vence and Associates, personal communication, November 1991.)

[5]The tonnage of commercial waste paper generated was obtained from Franklin Associates, Ltd., *Dakota County Generation and Characterization Study*, February 1991.

[6]New Jersey businesses are required by State law to recycle.

[7]In June 1992 the provisions of the mandated recycling plan were altered and streamlined.

[8]*Resource Recycling*, November 1991, 22.

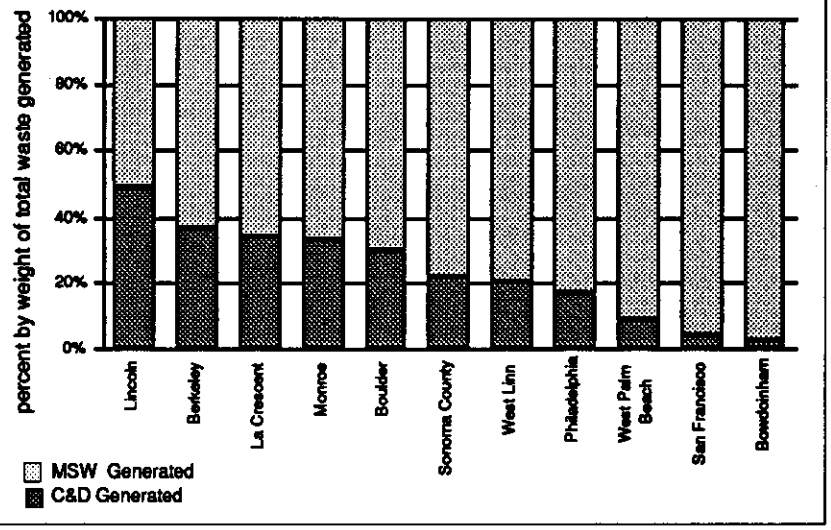
Chapter Seven
Targeting Construction and Demolition Debris for Recovery

Construction and demolition (C&D) debris is waste generated as a result of building activities, including road repair projects. This waste includes tree stumps and other treated and untreated wood waste, bricks, concrete, asphalt, metal, roofing shingles, dry wall, and other building materials. The amount of C&D debris any given community generates may fluctuate widely from year to year as land clearing, construction, and demolition activities vary over time. C&D often comprises a significant portion of the total solid waste generated by many communities. While this waste often burdens local collection and disposal systems, much of it is handled by the private sector; as a consequence, tonnages generated are often untracked and therefore unknown.[1]

Chart 7.1, which compares the amount of C&D waste generated to the amount of municipal solid waste generated for select communities, illustrates how much C&D debris generation can vary among communities. (C&D waste is neither household nor commercial/institutional waste. Thus the tonnages of MSW generated and recovered in this report do not include C&D waste. C&D waste is, however, included in total solid waste tonnages. See Table 2.2.) In the rural community of Bowdoinham, Maine, C&D debris made up 2 percent of the local waste stream in fiscal year 1990, or 0.01 tons per capita. In comparison, C&D totaled 1.07 tons per capita in the City of Lincoln, Nebraska in 1990—nearly 50 percent of the total waste stream. As a result of major street repair work in 1989, the rural city of Monroe, Wisconsin, also generated a large amount of C&D waste, equivalent to 0.60 tons per person.

Table 7.1 provides C&D waste generation and recovery data for 13 communities (all those in our study for which such information was available), including which materials are reclaimed. Chart 7.2 shows the significant contribution recovery of C&D materials makes to the total solid waste recovery rate in Monroe, Wisconsin; Lincoln, Nebraska; La Crescent, Minnesota; and Berkeley, California. In our base year of study, the annual tonnage of C&D materials recovered in these communities exceeded that of MSW recovered. (See Tables 2.1 and 7.1.) In fact, if the tonnage of C&D recovered is excluded from total waste recovered and disposed, recovery rates would drop from 38 percent to 22 percent in Berkeley, from 41 percent to 29 percent in La

Chart 7.1
Contribution of Construction and Demolition Debris to Total Solid Waste Generated



Crescent, from 52 percent to 12 percent in Lincoln, and from 50 percent to 28 percent in Monroe.

Asphalt and concrete are currently the most popular C&D materials being recovered. Some communities recycle and/or compost wood waste, and a few are recovering other C&D materials through public or private operations. This chapter describes C&D recovery strategies employed in these communities. These include:

- salvaging bricks, wood waste, and other discarded building materials for reuse,
- grinding asphalt, concrete, and bricks for use as an aggregate, primarily in new roadbed construction, or as landfill cover,
- recovering asphalt roofing waste for recycling into a road repair asphalt material,
- recovering scrap metal for remanufacturing,
- grinding wood waste into a mulch product, and
- using C&D for fill or landfill cover.

Reuse Operations

In a few communities, public and private operations recover a wide range of materials from construction and demolition projects, including windows, doors, wood waste, and shingles, for reuse by professional contractors and "do-it-yourselfers." Of the nearly 40,000 tons of C&D debris recovered in Berkeley, California from July 1990 through June 1991 (66 percent of C&D waste generated), an estimated 3,590 tons were salvaged by Urban Ore, a Berkeley-based company. That year, the company salvaged 27 percent of the 12,325 tons of wood waste generated in Berkeley. Urban Ore recovers used building materials, such as windows and doors, at its Building Materials Exchange for resale to local homeowners and builders. In its 1991 fiscal year, Urban Ore grossed $724,364 ($134 per ton recovered) from the salvage and resale of C&D debris and other household materials, earning a net profit of $27,754.

The Loading Dock, a nonprofit building supply recycler located in Baltimore, Maryland, redirects bulky material such as lumber, drywall, floor covering, doors, paints, and windows from disposal to end uses. Donated materials must be reusable. The Loading Dock distributes these materials to organizations that use them to build low-income housing. The operation currently recycles 12,000 to 14,000 tons of materials per year.

The Town of Peterborough, New Hampshire recovers an untracked amount of bulky items, such as lumber, windows, and wire, at its Recycling Center, and gives these away to residents. According to the Town Administrator, the Recycling Center has gained a reputation as a place to find hard-to-obtain items. (See Chapter 3 for further discussion of reuse operations.)

Chart 7.2

Construction & Demolition Debris and MSW Recovery

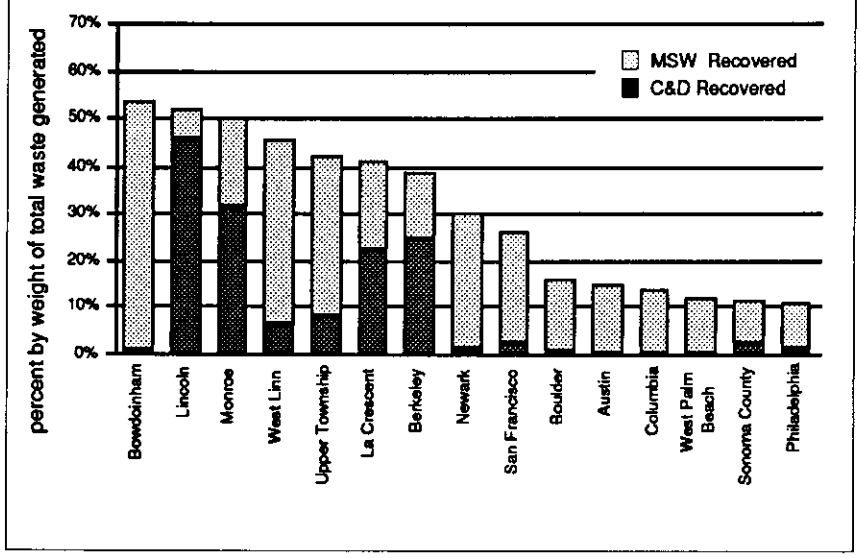


Table 7.1
Construction & Demolition Debris Recovery (a)

Community	Population	Year Data Applicable	C&D Generated (Tons)	Per Capita Generation (Tons/Year)	C&D Recycled (Tons)	C&D Composted (Tons)	C&D Recovered (Tons)	% C&D Recovered (By Wt.)	C&D Materials Recovered	C&D End Use
Berkeley, CA	102,724	FY91	59,626	0.58	39,593	0	39,593	66%	ASP, BLD, C&D	RB,BLD
Boulder, CO	88,000	1990	26,766	0.30	342	0	342	1%	SM, X	NA
Bowdoinham, ME	2,189	FY1990	12	0.01	(b)	0	(b)	(b)	C&D	BLD
La Crescent, MN	4,305	1990	919	0.21	600	0	600	65%	ASP	RB
Lincoln, NE	191,972	1990	206,146	1.07	193,167 (c)	0	193,167	94%	ASP, CON	LC,RB
Lincoln Park, NJ	11,000	1990	NA	NA	522	83	604	NA	ASP, WW	NA
Monroe, WI	10,220	1989	6,142	0.60	5,875	0	5,875	96%	ASP	RB
Newark, NJ	275,221	1989	NA	NA	1,873	1,726	3,599	NA (d)	ASP, WW	NA
Philadelphia, PA	1,633,826	FY1990	431,684	0.26	19,088	4,500	23,588	5%	ASP, CON, C&D, WW	RB,LS
San Francisco, CA	723,959	1990	27,504	0.04	12,428	0	12,428	45%	ASP, CON	RB
Sonoma County, CA	388,222	1990	131,501	0.34	14,089	515	14,604	11%	ASP, CON, WW	NA
Upper Township, NJ	10,861	1990	NA	NA	0	766	766	NA (d)	WW	RB
West Linn, OR	1,977	1990	1,977	0.12	593	0	593	30%	C&D	NA
West Palm Beach, FL	62,530	4/90-3/91	132,684	2.12	0	0	0	0%	None	(e)

Key:

ASP = Asphalt
BLD = Building Materials
C&D = Undifferentiated C&D (including cinder blocks and brick)
CON = Concrete
LC = Landfill Cover
LS = Landscaping Material
NA = Not Available
RB = Roadbase
SM = Scrap Metal
WW = Wood Waste
X = Carpet Pads

Notes:

(a) Most communities do not track tonnages of C&D generated and recovered. We obtained most of our tonnage data from the private sector and disposal facilities. Our figures may exclude some C&D waste privately disposed or recovered. Other cities that recover C&D but do not track C&D tons generated include Berlin Township, Dakota County, Naperville, Peterborough, and Seattle. Although C&D tonnages in Naperville were not available, ILSR estimated, using a County figure, that the City generated 35,626 tons of C&D in 1990. In 1990 the City asphalt paving recycling program recycled an estimated 10,247 tons of asphalt.

(b) Bowdoinham recycled less than 1 percent (less than 1 ton) of its C&D debris.

(c) 133,167 tons, 69 percent of C&D waste recovered, were used as a landfill cover.

(d) The percentage of C&D waste recovered cannot be calculated, as C&D waste disposed is not available.

(e) Although no C&D was recovered in West Palm Beach during 1990, the County Solid Waste Authority recovers some C&D waste such as large cement pipes which are used to form artificial reefs.

Asphalt and Concrete Recovery

Rubble such as concrete, bricks, dirt, and asphalt is a common component of C&D waste. A number of municipalities reprocess and reuse asphalt and concrete from city street and sidewalk repair projects. Using reclaimed materials avoids disposal fees, and reduces the expense of producing and buying paving materials. New asphalt sells for approximately $30 per ton (in 1991 dollars) in the Northeast, whereas recycled asphalt sells for $5 to $10 per ton.[2]

Asphalt used for paving roads actually contains 95 percent aggregate and only 5 percent pure asphalt. When roads are built, gravel is first laid and then covered with roadbase material. The roadbase, termed "cold mix," typically includes a mixture of crushed asphalt, aggregate, and stone. This layer is then covered with a protective coating, or "hot mix." Most waste asphalt is generated when existing paved areas are prepared for repaving; this involves removing the top layer of the old asphalt before replacing it with new asphalt. Some of the old asphalt can be mixed with new asphalt before being applied to the road surface. However, recycled asphalt is more often used as a roadbase or for shoulders on roads. With the improvement of technologies and the strengthening of secondary asphalt materials, the use of recycled asphalt in the top layer could increase in the future.[3]

Concrete waste, another component of C&D rubble, is a byproduct of sidewalk construction and repair, foundation pouring, and bridge building and repair. "Concrete" is actually a combination of concrete and an aggregate that contains crushed stone, sometimes mixed with sand and grit. Crushed concrete is primarily used as an aggregate for roadbase material. It can also be used for many other purposes, such as foundations or the concrete layer used below the cold and hot mixes on highway bridges. Reclaimed asphalt and concrete can be reprocessed at the construction site where they are generated or at a separate facility.[4]

La Crescent, Minnesota; Monroe, Wisconsin; Lincoln, Nebraska; Naperville, Illinois; Berkeley, California; and Philadelphia, Pennsylvania reclaim asphalt and concrete materials. In 1990 La Crescent recovered 600 tons of asphalt (65 percent of C&D generated that year), which was ground and relaid. Monroe repaired its street beds in 1989, and a local company reprocessed the resulting 5,875 tons of asphalt for use in relaying the road bed. MSW recovery activities diverted 19 percent of Monroe's solid waste in 1989; C&D recovery increased this diversion level to 50 percent. The City of Berkeley recovered about 60 percent of the approximately 40,000 tons of C&D debris generated between July 1990 to June 1991 through two private C&D recovery operations.

Wood Waste Recovery

Wood waste often comprises a significant portion of the total C&D debris recovered by a community. Often such wood waste is burned as a fuel. While this may be an appropriate end use for untreated wood, it is not considered recycling. Wood waste from land clearing and other construction and demolition activities can be chipped or ground for use as a mulch product. In 1990 Lincoln Park recovered 1,876 tons of wood stumps and logs, which were delivered to The Ox Stump Factory in Ledgewood, New Jersey, for composting/mulching. This tonnage represents 43 percent of the organic materials recovered in Lincoln Park that year. (Tonnages of C&D disposed are not available; thus, a C&D recovery rate cannot be calculated for Lincoln Park.) The Factory, which opened in 1989, accepts yard waste, brush, and tree stumps for a fee of $8 per cubic yard. Another 83 tons of wood waste from the demolition of two houses were recovered and composted in Lincoln Park by the private sector. Berlin Township chips brush, tree stumps, and clean lumber on a small area of its public works yard with a Chipmore chipper. In 1990 the Township recovered 640 tons (almost 22 percent of the materials it composted or chipped) this way.

Lower Value Uses

While new construction projects may represent the highest value use for asphalt and concrete, some communities are diverting these and other materials to other kinds of projects. Palm Beach County uses clean concrete such as cement pipes to form artificial reefs. Of the 193,167 tons of construction and demolition debris recovered in Lincoln, Nebraska in 1990, 133,167 tons were put

to a low-value use as fill material to close the landfill. (The other 60,000 tons of concrete and asphalt were recovered by private haulers and used for road resurfacing or to make new asphalt.)

Economic Incentives and Legislative Initiatives

Some of the communities in our study use financial incentives in the form of reduced tipping fees to encourage haulers and businesses to separate C&D materials for recovery. If haulers can deliver the waste they collect to a private or public recovery facility at a lower cost than a disposal facility would charge, they will tend to do so. In April 1990, Cape May County, New Jersey, opened the Bulky Waste Sorting and Recycling Facility at its landfill site to separate out scrap metal, tires, commercial cardboard, bulky waste, and wood waste. The County normally charges a landfill tipping fee of $83.50 per ton, which can be reduced to $60 per ton if private haulers separate out clean wood waste. If more than 5 percent of the private hauler's load contains unsorted recyclable materials (that is, recyclables mixed with trash), the County charges $200 in addition to the tipping fee.

The City of Lincoln encourages private haulers to deposit construction and demolition materials at the City's old landfill by not charging them a tipping fee. In 1990 a total of 193,167 tons of C&D (94 percent of C&D generated) were recovered at this facility. Much of this material was used to close the landfill.

Dakota County has a few private C&D recovery operations. One such operation, SKB (a subsidiary of Carl Bolander & Sons), a C&D demolition landfill, charges $4.50 per cubic yard for clean and mixed loads of C&D debris—eight times less than the charge to haulers at the local municipal solid waste landfills. SKB recovers stumps, pallets, and clean wood from demolition and construction sites, processes these materials into a mulch, and sells them to landscapers and residents. In 1990 the facility produced an estimated 20,000 tons of mulch. SKB also crushes concrete, brick, and stone on site into materials to be used as a road base. Reinforcing rods removed at the processing plant are sold as scrap metal.

Communities also use legislative initiatives to help spur C&D recovery. When Cherry Hill, New Jersey contracts with private companies to repair the roads, the contract stipulates that torn asphalt be pulverized and used as a bottom layer on the same street. This process, called Pulverization Stabilization Layover, resulted in the recycling of 19,413 tons of asphalt in 1989.[5] In order to encourage reclamation of C&D materials—estimated to constitute 17 percent of its solid waste stream—McHenry County, Illinois has proposed requiring developers to submit a construction material recovery plan as a condition for receiving a building permit ordinance. After construction is completed, the builder would have to document what materials and what tonnages were recovered before occupancy approval was issued.[6]

Notes

[1]Most communities do not track the tonnage of C&D generated and recovered. We obtained most of our tonnage data from the private sector and disposal facilities. Our figures may exclude some C&D waste privately disposed or recovered.

[2]Christine T. Donovan, "Construction and Demolition Waste Processing: New Solutions for an Old Problem," *Resource Recycling*, August 1991.

[3]Ibid.

[4]Ibid.

[5]Brenda Platt et al., *Beyond 40 Percent: Record-Setting Recycling and Composting Programs*, (Washington, D.C.: Institute for Local Self-Reliance, 1990).

[6]"C&D Targeted for Recovery," *BioCycle*, October 1991, p. 10.

Chapter Eight
The Costs of Recycling and Composting

Overview

This chapter evaluates the costs of 30 diverse recycling and composting programs. The first section presents capital and operating and maintenance cost data. The second section examines the effect of program design on costs, and in the third section, we draw upon the experience of these 30 communities to offer suggestions on how communities can reduce the costs of materials recovery. The final section briefly compares communities' materials recovery operating costs to the costs they incur for refuse collection and disposal.[1]

Capital and Operating and Maintenance Costs

Communities incur two types of costs when implementing a materials recovery program: capital costs and operating and maintenance (O&M) costs.

Capital costs are one-time expenditures including equipment (e.g., vehicles, household storage containers, conveyors, crushers, and balers), land, and building construction and improvements. Capital costs can be accounted for as one-time expenses or amortized over the lifetime of the equipment.

Table 8.1 lists the total capital investment in recycling and composting made by each jurisdiction. Capital costs that were picked up by public agencies outside the jurisdiction, or by the private sector, are not included in this study. Also excluded is any equipment donated or owned before the initiation of recycling and/or composting programs. While we recognize that previously owned equipment is an asset, which can be sold for cash, used for its original purpose, or used for recycling, the difficult and somewhat arbitrary task of placing an accurate dollar value on older equipment was beyond the scope of this report. In addition, by excluding the value of previously owned equipment, capital costs figures reflect the benefit communities reap when they avoid purchasing new equipment to start recycling programs. By using previously owned equipment, communities can recover materials without the cash outlay to purchase this equipment new. Communities doing this are benefitting from reduced cash requirements as compared to communities choosing to purchase new or additional equipment. (See Integrating Materials Recovery Into Solid Waste Systems, page 140.) All the capital cost figures in Table 8.1 are expressed in 1990 dollars and represent the costs incurred only by the documented community. Table 8.2 lists capital costs on a ton-per-day recovered basis, which, in cases where complete costs are given, allows for comparison of capital investments both within our sample, and between our communities and communities employing other solid waste management options. Table 8.3 lists annualized capital costs per ton of materials recovered.[2] Tables 8.4 through 8.7 present capital cost data broken down into recycling collection and processing and into yard waste collection and composting, and indicate for each of these categories what these costs include and what, if any, other equipment is used for which the jurisdiction did not have a cash outlay. (Table 8.17, presented later in the chapter, lists the capital costs of intermediate processing facilities.)

Annual O&M costs are ongoing expenses that include such items as equipment leasing and maintenance, utilities, labor, administrative expenses, licenses, supplies, insurance, residue disposal, marketing fees, contract fees, and publicity programs. In this study, materials recovery O&M costs are broken down into four basic categories: collection, processing and marketing,

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Table 8.1
Communities' Capital Costs for Recycling and Composting, in Constant 1990 Dollars (a)

Community	Recycling Capital Costs			Composting Capital Costs			Total Capital Costs
	Collection (b)	Processing (c)	Subtotal	Collection (b)	Processing (d)	Subtotal	
Austin, TX	$503,735	$0	$503,735	NA	$288,455	NA	NA
Berkeley, CA	$702,006	$370,397	$1,072,403	$0	$0	$0	$1,072,403
Berlin Township, NJ	$93,705	$0	$93,705	$30,130	$13,239	$43,369	$137,073
Boulder, CO	$174,085	$0	$174,085	$114,000	$375	$114,375	$288,460
Bowdoinham, ME	$0	$16,354	$16,354	$0	$0	$0	$16,354
Columbia, MO	$19,332	$0	$19,332	$0	$0	$0	$19,332
Dakota County, MN	$7,750	$43,574	$51,324	$0	$0	$0	$51,324
Fennimore, WI	$34,608	$94,692	$129,301	$3,112	$0	$3,112	$132,413
King County, WA	$0	$0	$0	$0	$0	$0	$0
La Crescent, MN	$8,715	$0	$8,715	$0	$24,153	$24,153	$32,867
Lafayette, LA	$430,389	$0	$430,389	$0	$190,000	$190,000	$620,389
Lincoln, NE	$2,500	$0	$2,500	$3,700	$90,208	$93,908	$96,408
Lincoln Park, NJ	$70,440	$15,000	$85,440	$18,094	$19,488	$37,582	$123,022
Mecklenburg Co., NC	$459,446	$58,146	$517,591	$22,595	$1,416,787	$1,439,383	$1,956,974
Monroe, WI	$23,008	$16,606	$39,614	$8,790	$7,308	$16,098	$55,712
Naperville, IL	$0	$0	$0	$243,060	$223,680	$466,740	$466,740
Newark, NJ	$37,229	$0	$37,229	$0	$191,325	$191,325	$228,553
Perkasie, PA	$21,312	$51,682	$72,994	NA	NA	NA	NA
Peterborough, NH	$0	$33,144	$33,144	--	--	--	$33,144
Philadelphia, PA	$1,788,882	$154,121	$1,943,003	NA	NA	NA	NA
Portland, OR	$0	$0	$0	$0	$0	$0	$0
Providence, RI	$0	$0	$0	--	--	--	$0
San Francisco, CA	$0	$0	$0	$0	$0	$0	$0
Seattle, WA	NA (e)	$0	NA	$0	$0	$0	NA
Sonoma County, CA	$0	$0	$0	$0	$0	$0	$0
Takoma Park, MD	$83,530	$0	$83,530	$83,530	$9,000	$92,530	$176,060
Upper Township, NJ	$60,394	$0	$60,394	$84,053	$1,410	$85,463	$145,856
Wapakoneta, OH	$0	$4,800	$4,800	$19,480	$0	$19,480 (f)	$24,280
West Linn, OR	$15,794	$15,590	$31,384	$0	$70,595	$70,595	$101,979
West Palm Beach, FL	$78,185	$0	$78,185	NA	$0	NA	NA

Key:
NA = Not Available -- = Not Applicable

Notes:
These capital costs represent those which are incurred by the jurisdiction and not necessarily all the costs of the equipment utilized for the program(s). For example, in Lafayette a private nonprofit group, The Recycling Foundation, operates the curbside program under contract with the City. The only collection costs incurred by the City were the contract fees and the cost of the bins. For the four counties listed above, any equipment purchased by municipalities within these counties is excluded. Tables 8.4 to 8.7 provides detailed information on what costs cover.

(a) For detailed breakdowns of equipment purchased, dates of purchase, and costs, see "In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results," Vols. I, II, and III (Washington, D.C.: Institute for Local Self-Reliance, 1992). Each capital expenditure was converted to constant 1990 dollars using producer price indices. Tables 8.4 to 8.7 provide detailed information on what costs cover.

(b) The capital investment made for equipment used to collect materials for recycling or composting.

(c) The capital investment made for equipment used to process recyclable materials in preparation for marketing to end users. Processing typically includes sorting, contaminant removal, and crushing or baling.

(d) The capital investment made for equipment used to process -- compost, chip, or mulch -- organic materials. Processing or composting equipment typically includes shredders or chippers and front-end loaders.

(e) Private hauler under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off site at the transfer station; these costs are not available.

(f) A leaf loader was not used during the base year but has been included, as costs of equipment used in base year are unavailable.

Table 8.2
Capital Costs Per TPD Recovered, in Constant 1990 Dollars

Community	Collection	Recycling Processing	Subtotal	Collection	Composting Processing	Subtotal	Total Collection	Total Processing	Total Materials Recovery
Austin, TX	$16,987	$0	$16,987	NA	$54,664	NA	NA	$8,258	NA
Berkeley, CA	$16,324	$8,613	$24,937	$0	$0	$0	$14,393	$7,594	$21,988
Berlin Township, NJ	$14,425	$0	$14,425	$3,349	$1,472	$4,821	$7,993	$855	$8,848
Boulder, CO	$9,753	$0	$9,753	$13,173	$43	$13,217	$10,870	$14	$10,884
Bowdoinham, ME	$0	$19,327	$19,327	$0	$0	$0	$0	$19,327	$19,327
Columbia, MO	$4,778	$0	$4,778	$0	$0	$0	NA	$0	NA
Dakota County, MN	NA	$1,024	NA	$0	$0	$0	NA	$512	NA
Fennimore, WI	$27,945	$76,460	$104,404	$4,788	$0	$4,788	$19,974	$50,143	$70,117
King County, WA	$0	$0	$0	$0	$0	$0	$0	$0	$0
La Crescent, MN	$9,767	$0	$9,767	$0	$43,609	$43,609	$6,026	$16,701	$22,727
Lafayette, LA	$45,861	$0	$45,861	$0	$9,310	$9,310	$14,446	$6,377	$20,823
Lincoln, NE	$1,492	$0	$1,492	$418	$10,189	$10,606	$585	$8,510	$9,095
Lincoln Park, NJ	$12,459	$2,653	$15,112	$1,971	$2,123	$4,094	$5,968	$2,325	$8,293
Mecklenburg Co., NC	$31,419	NA	NA	NA	NA	NA	NA	NA	NA
Monroe, WI	$7,440	$5,370	$12,810	$5,481	$4,557	$10,037	$6,771	$5,092	$11,863
Naperville, IL	$0	$0	$0	$12,894	$11,866	$24,761	$5,048	$4,646	$9,694
Newark, NJ	$1,419	$0	$1,419	$0	$6,691	$6,691	$679	$3,489	$4,168
Perkasie, PA	$5,748	$13,939	$19,687	NA	NA	NA	NA	NA	NA
Peterborough, NH	$0	$7,736	$7,736	--	--	--	$0	$7,736	$7,736
Philadelphia, PA	$25,322	$2,182	$27,503	NA	NA	NA	NA	NA	NA
Portland, OR	$0	$0	$0	$0	$0	$0	$0	$0	$0
Providence, RI	$0	$0	$0	--	--	--	$0	$0	$0
San Francisco, CA	$0	$0	$0	$0	$0	$0	$0	$0	$0
Seattle, WA	NA (a)	$0	NA	$0	$0	$0	NA	$0	NA
Sonoma County, CA	$0	$0	$0	$0	$0	$0	$0	$0	$0
Takoma Park, MD	$17,101	$0	$17,101	$18,008	$1,940	$19,949	$17,543	$945	$18,488
Upper Township, NJ	$6,214	$0	$6,214	$24,721	$415	$25,136	$11,010	$107	$11,118
Wapakoneta, OH	$0	$1,358	$1,358	NA	NA	NA	NA	NA	NA
West Linn, OR	$2,956	$79,476	$82,433 (b)	$0	$11,826	$11,826	$1,396	$13,979	$15,375
West Palm Beach, FL	$8,048	$0	$8,048	NA	$0	NA	NA	$0	NA

Key:
NA = Not Available TPD = Tons Per Day -- = Not Applicable

Notes:
Capital cost per TPD is calculated based on 260 days of operation per year (with the exception of Lafayette's composting costs, which are based on 5 months of program operation). In actuality collection and processing schedules may vary from this. Some costs do not add up because the tonnage collected differs from the tonnage processed.

(a) Private haulers under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station; these costs are not available.

Table 8.3
Communities' Annualized Capital Costs for Materials Recovery, in Constant 1990 Dollars Per Ton (a)

Community	Recycling Collection	Recycling Processing	Recycling Subtotal	Composting Collection	Composting Processing	Composting Subtotal	Subtotal Collection	Subtotal Processing	Total Materials Recovery
Austin, TX	$12	$0	$12	NA	$21	NA	NA	$3	NA
Berkeley, CA	$9	$3	$12	$0	$0	$0	$8	$3	$11
Berlin Township, NJ	$8	$0	$8	$2	$1	$2	$4	$0	$5
Boulder, CO	$5	$0	$5	$7	$0	$7	$6	$0	$6
Bowdoinham, ME	$0	$7	$7	$0	$0	$0	$0	$7	$7
Columbia, MO	$2	$0	$2	$0	$0	$0	NA	NA	NA
Dakota County, MN	NA	$0	NA	$0	$0	$0	NA	$0	NA
Fennimore, WI	$15	$29	$45	$3	$0	$3	$11	$19	$30
King County, WA	$0	$0	$0	$0	$0	$0	$0	NA	$0
La Crescent, MN	$5	$0	$5	$0	$17	$17	$3	$6	$10
Lafayette, LA	$25	$0	$25	$0	$4	$4	$13	$2	$15
Lincoln, NE	$1	$0	$1	$0	$4	$4	$0	$4	$4
Lincoln Park, NJ	$18	$1	$19	$1	$1	$2	$7	$1	$8
Mecklenburg Co., NC	$17	NA	NA	NA	NA	NA	NA	NA	NA
Monroe, WI	$4	$2	$6	$3	$2	$5	$4	$4	$8
Naperville, IL	$0	$0	$0	$5	$5	$10	$3	$5	$7
Newark, NJ	$1	$0	$1	$0	$6	$6	$1	$2	$3
Perkasie, PA	$3	$5	$9	NA	NA	NA	NA	NA	NA
Peterborough, NH	$0	$3	$3	--	--	--	$0	$3	$3
Philadelphia, PA	$84	$1	$85	NA	NA	NA	NA	NA	NA
Portland, OR	$0	$0	$0	$0	$0	$0	NA	$0	$0
Providence, RI	$0	$0	$0	--	--	--	$0	$0	$0
San Francisco, CA	$0	$0	$0	NA	NA	NA	NA	NA	NA
Seattle, WA	NA	$0	NA	$0	$0	$0	NA	$0	NA
Sonoma County, CA	$0	$0	$0	$0	$0	$0	$0	$0	$0
Takoma Park, MD	$9	$0	$9	$10	$1	$11	$10	$1	$10
Upper Township, NJ	$3	$0	$3	$14	$0	$14	$6	$0	$6
Wapakoneta, OH	$0	$1	$1	$6	$0	$6	$2	$1	$3
West Linn, OR	$2	$31	$32 (b)	$0	$5	$5	$1	$35	$37
West Palm Beach, FL	$4	$0	$4	NA	$0	NA	NA	$0	NA

Key:
-- = Not Applicable NA = Not Available

Notes:
(a) Per ton annualized capital costs equals annualized capital costs divided by the annual tonnage recovered that the costs cover. Collection equipment was annualized over a 7-year period, while processing equipment was annualized over a 10-year period. No discount or financing rates were applied except in the cases of Austin, Philadelphia, Lincoln Park, and Newark where financing rates were incurred. For these communities, actual financing rates and payback periods were applied. In Austin, Eager Beaver truck and trailers were financed with a 5-year loan at an interest rate of 10.67%. All equipment in Philadelphia was amortized over 5 years at an 8.5% interest rate. The City of Newark floats bonds for the purchase of its equipment, which is amortized over a 5-year period. Lincoln Park issued bonds at a rate of 6% for a 5-year period for the puchase of one vehicle; all of its other equipment was paid in full at the time of purchase.
(b) This applies to drop-off equipment and tonnage only, which represents 1% of the total amount of recyclables collected and processed in the City in 1990.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables

Community	Annual Tonnage (a)	House-holds Served	Per Ton O&M Cost (b)	Capital Costs (1990 $)	Description
Austin, TX	7,710	110,000	$95	$503,735	Capital costs cover 13 trucks, 11 trailers, and 6,000 buckets, but exclude two trucks and 20,000 buckets purchased and used after the base year. O&M costs include one drop-off at the landfill run privately under contract with the City, and municipal curbside collection of five materials weekly with two-person crews.
Berkeley, CA	11,181	40,000	NA	$702,005	Capital costs include six recycling trucks, one commercial recycling vehicle, 70 curbside truck bins, six scales, and 50,000 waxed tote boxes. O&M costs in Table 8.9 cover one- to two-person nonprofit crews under contract with the City to collect four materials weekly; municipal commercial curbside collection; and one buy-back and two drop-offs under contract with the City. Collection and processing cost the City $63 per ton in O&M; collection costs alone are not available.
Berlin Township, NJ	1,689	2,000	$43	$93,705	Capital costs include seven trucks (shared between recycling, composting, and the DPW), one recycling trailer, and one loader. O&M costs include collection of 13 materials weekly by public crews; there is one public unstaffed drop-off site.
Boulder, CO	4,641	25,500	$51	$174,085	Capital costs include 31,500 recycling bins and exclude 4,000 bins purchased and used after the base year and 10 privately owned trucks. O&M costs cover contract fees paid for two-person crews to collect four materials weekly.
Bowdoinham, ME	288	290	$23	$0	No capital costs are incurred for collection. O&M costs cover one drop-off center open three days per week. (Drop-off center equipment is included under processing capital costs.)
Columbia, MO	1,052	7,060	$49	$19,332	Capital costs include one trailer and one pick-up truck. The cost incurred in 1992 for a packer truck used for recycling in 1990 is not included. O&M costs cover two-person public crews to collect seven materials monthly.
Dakota County, MN	NA	80,000	NA	$7,750	Capital costs cover a truck used for office paper collection. The County incurred $643,873 in O&M costs paid to municipalities to support recycling collection programs. The tonnage recovered as a result of these payments is not available.
Fennimore, WI	322	970	$39	$34,608	Capital and O&M costs cover collection of 10 materials every other week with a two-person public crew in a retrofitted truck, and one public drop-off center.
King County, WA	1,965	NA	NA	$0	Recyclables are primarily collected by the private sector. The County spent $102 a ton to collect and process 1,965 tons through its drop-off program; collection costs alone are not available.
La Crescent, MN	232	1,568	$111	$8,715	Capital costs cover 1,400 recycling bins and exclude equipment used by the contracted hauler. O&M costs cover contracted 3-person crews to collect 10 materials weekly. The County incurs the cost of collection at the City drop-off sites (77 tons in 1990).
Lafayette, LA	2,440	27,500	NA	$430,389	Capital costs cover 78,000 recycling bins and exclude four trucks, and four trailers owned by the private hauler, a local nonprofit group. O&M costs cover contract fees paid to this group to collect six materials weekly with three-person crews. The City incurred $39 a ton for collection and processing.
Lincoln, NE	454	622	$24	$2,500	Capital costs include 18,000 cornstarch bags and exclude 10 EWI Fivestar roll-off bins purchased by the private sector. The private sector incurs most of the capital costs for recyclables collection. O&M costs cover a one-person crew under contract with the City to pick up two materials weekly, and one drop-off collection contract with the City.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables (cont.)

Community	Annual Tonnage	House-holds Served	Per Ton O&M Cost	Capital Costs (1990 $)	Description
Lincoln Park, NJ	1,470	4,260	$49	$70,440	Capital costs include a dump truck (shared with composting), one roll-off truck, 11 roll-off containers, lumber and metal beams, one hydraulic tailgate, and three self-dumping hoppers, but exclude one donated packer truck. O&M costs cover a three-person public crew to collect newspapers monthly, and one public drop-off.
Mecklenburg Co., NC	3,802	110,000	NA (c)	$459,446	Capital costs include three front-end loaders, two Cube Vans, two roll-off trucks, one truck, one trailer, two forklifts, and 40 bins for the County's drop-off sites and its office building collection program. O&M costs, which cover 16 drop-off sites, are not available because collection costs cannot be separated from processing. (Charlotte incurs O&M costs of $96/ton for curbside collection and additional capital costs.)
Monroe, WI	804	3,900	$41	$23,008	Capital costs cover 4,500 recycling bins and exclude two dump trucks and barrels purchased before the onset of the program, as well as a Kann Curbsorter purchased and used after the base year. O&M costs cover a one-person public crew to collect 14 materials weekly, and one public drop-off.
Naperville, IL	7,617	24,500	$73	$0	Capital costs are incurred by private haulers under contract with the City. O&M costs cover contract fees for a nonprofit three-person crew to collect 12 materials weekly.
Newark, NJ	6,823	90,000	$109	$37,229	Capital costs cover one recycling vehicle used to pick up four different recyclable materials collected on alternative weeks, but exclude a packer truck used to collect commercial corrugated cardboard purchased prior to the onset of this program, as well as capital costs incurred by contracted haulers. O&M costs cover contract fees to two private haulers collecting 47 percent of public sector materials weekly; and the City's labor costs to run a drop-off site, and to collect commercial corrugated cardboard.
Perkasie, PA	964	3,500	$50	$21,312	Capital costs cover one trailer, modifications to a truck, a security fence, steel barrels, and recycling buckets. O&M costs cover two- to four-person public crews to collect glass and aluminum weekly and newspapers and mixed paper monthly, and one public drop-off center.
Peterborough, NH	1,114	1,800	NA	$0	The Town incurs no capital costs for collection. It incurs O&M costs of $45/ton for collection and processing (covers drop-off only); collection cost cannot be divided from processing.
Philadelphia, PA	48,368	159,245	$107	$1,788,882	Capital costs cover 21 Lodal trucks, 178,987 buckets, 13 Eager Beaver trucks, seven 15-cubic-yard trucks, a tractor trailer, and 60 igloos. O&M costs cover the collection of six materials weekly by three-person public crews at a cost of $173 per ton, and the private collection of 30,000 tons of food waste, which is subsidized by the City at a cost of $67 per ton.
Portland, OR	180,695	201,900	$0	$0	The private sector primarily incurs capital and O&M costs. Metro (serving a multi-county area) owns 2 drop-off sites.
Providence, RI	8,171	56,423	$105	$0	Providence does not directly incur capital costs. The private hauler purchased nine recycling trucks. Recycling bins are supplied by the State. O&M costs cover the collection of 10 materials weekly by a one-person crew under contract with the City.
San Francisco, CA	NA	169,000	$0	$0	Capital and O&M costs are incurred by the private sector.
Seattle, WA	53,775	121,546	NA	NA	Capital costs are incurred by the private haulers contracted for curbside collection. The City incurs O&M and some capital costs for materials collected at the transfer station. Collection O&M costs cannot be separated from processing costs; the City spent $47/ton for both. The City incurs contract fees to have one-person crews pick up nine materials weekly in half of Seattle and one-person crews pick up seven materials monthly in the other half of Seattle.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables (cont.)

Community	Annual Tonnage	House-holds Served	Per Ton O&M Cost	Capital Costs (1990 $)	Description
Sonoma County, CA	4,063	NA	NA	$0	No capital costs are incurred by the County because recycling collection is carried out by the private sector. The O&M costs cover the contract fees paid to operate the recycling centers located at the County landfill and the transfer stations. Collection costs cannot be separated from processing costs; the County incurred $12/ton for both.
Takoma Park, MD	1,270	4,100	$97	$83,530	Capital costs include 5,400 buckets and one Curb Sorter Truck, but exclude buckets and one recycling truck purchased and used after the base year, as well as three compactor trucks used 10 percent for recycling, which were owned prior to the City's recycling program. O&M costs cover three-person public crews that pick up six materials weekly.
Upper Township, NJ	2,527	4,082	$71	$60,394	Capital costs cover 500 bins and a compactor truck but exclude another compactor truck bought after the base year. O&M costs cover the collection of fourteen materials with a three-person public crew, and one unstaffed public drop-off center.
Wapakoneta, OH	919	3,548	NA	$0	Capital costs are not incurred by the Town. A packer truck bought prior to the program is used for commercial recycling and is not included in the capital cost. O&M costs are incurred by the private nonprofit drop-off but are unavailable because collection costs could not be separated from processing.
West Linn, OR	1,389	6,165	NA (d)	$15,749	Capital costs include 5,300 collection containers but exclude a recycling truck, a packer at 20 percent use, and a compactor owned by the private hauler as well as a Curbsorter truck purchased and used after the base year. O&M costs for curbside collection ($114/ton) are not incurred by the City. O&M cost for drop-off collection is incurred by the City but the costs for recycling cannot be separated from composting.
West Palm Beach, FL	2,526	19,194	$148	$78,185	Capital costs cover 18,306 recycling bins and 147 containers but exclude 100 containers and 6 trucks owned by the Solid Waste Authority. O&M costs cover one-person public crews picking up six materials weekly.

Notes:

(a) Tonnage given above represents the annual tonnage collected that the costs cover in the base year and do not necessarily represent the total amount of materials recycled in the community.
(b) Per ton O&M costs reflect average annual O&M costs incurred in the base year of study divided by the annual tonnage collected that these annual costs cover.
(c) The County incurred $626,636 to (1) collect and process 3,802 tons at its drop-off sites and through its office building collection program and (2) process another 17,356 tons collected by the City of Charlotte and Mint Hill.
(d) The City incurred $31 per ton in O&M costs to collect and process 51 tons of recyclables and 1,552 tons of yard waste at its drop-off site.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables

Community	Annual Tonnage (a)	Per Ton O&M Cost (b)	Capital Costs (1990 $)	Description
Austin, TX	7,710	$0	$0	Processing capital and O&M costs are incurred by the private sector.
Berkeley, CA	11,181	NA	$370,397	Capital costs cover a horizontal baler, four forklifts (including two paid for by private contractors), an aluminum separator, and a glass conveyor but exclude a 40-foot conveyor system (purchased and used after the base year) used at the medium-technology nonprofit facility. Collection and processing cost the City $63 per ton in O&M; processing costs alone are not available.
Berlin Township, NJ	1,689	$10	$0	The Township owns no processing equipment. Commingled materials are taken to the medium-technology County facility, where they are tipped for free. O&M costs cover the fee for marketing newspaper and mixed paper to waste paper brokers.
Boulder, CO	4,641	$5 (c)	$0	Capital costs are covered by the private sector. A baler, a truck scale, two forklifts, a front-end loader, a magnet-sorting conveyor, a semi-tractor trailer, a hopper, and two utility trucks are used at the medium-technology private facility. O&M costs cover the contract fee paid to a nonprofit group.
Bowdoinham, ME	220	$124	$15,835	Capital costs cover a dual-axle trailer, a baler, five storage bins, a loading ramp, two pallet trucks, a barrel jack, an electric hoist, and a chain hoist, but exclude a sorting conveyor, 81 pallet boxes, and a converted chicken barn (which are leased), and a fire truck purchased prior to the program's existence. O&M costs cover processing at the medium-technology municipal facility.
Columbia, MO	1,052	$0 (d)	$0	The private sector incurs capital and O&M costs. Three balers, a shredder, two conveyor systems, two front-end loaders, a trailer, three forklifts, four digital scales, and a truck scale are used at the medium-technology processing center.
Dakota County, MN	11,061	$81	$43,574	Capital costs cover only equipment that the County purchased for its privately operated medium technology facility — a baler, two shredders, and two conveyors used for animal bedding — and represent only 18% of the total cost of the processing facility. The contracted facility operator paid for the other 82%. O&M costs cover a contract fee paid to private processors.
Fennimore, WI	322	$83	$94,692	Capital costs cover a newsprint baler, a forklift, a skidloader, a cardboard baler, a paper shredder, a glass crusher, and remodeling of the building used at the medium-technology municipal facility. O&M costs cover municipal processing.
King County, WA	NA	NA	$0	Recyclables are processed primarily by the private sector; capital and O&M costs are thus not available. The County did incur $102 per ton in O&M costs for collecting and processing 1,965 tons through drop-off sites.
La Crescent, MN	309	$0 (e)	$0	Houston County processes recyclables free of charge for the municipality which, therefore, incurs no capital or O&M costs. An Alcon building (IPC), a bobcat, a pallet lifter, three balers, two shredders, a glass crusher, a magnetic separator, an aluminum blower and flattener, two self-dumping hoppers, five scales, and other equipment such as hard hats, tools, forklifts, and grinders are used at the medium-technology facility.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables (cont.)

Community	Annual Tonnage	Per Ton O&M Cost	Capital Costs (1990 $)	Description
Lafayette, LA	2,440	NA	$0	The City incurred no capital costs. O&M costs cover a contract fee paid to private processors, but the processing cost cannot be separated from the collection cost (the City incurred $39 a ton for both). A truck scale, a vertical baler, a glass crusher, a conveyor belt, a CP Manufacture 600 Densor, and a forklift are used at the private low-technology processing facility.
Lincoln, NE	30	$15	$0	Capital costs are incurred by the private sector. O&M costs cover the contract fee paid to the private processor.
Lincoln Park, NJ	1,470	$5	$15,000	Capital costs cover two used balers and a plastic compactor used at the drop-off. O&M costs cover minimal processing before materials are delivered directly to markets.
Mecklenburg Co., NC	18,610	$8	$58,146	Capital costs cover two vertical balers and a forklift(the tonnage these costs cover is not available). They exclude balers, hoppers, three conveyors, three skid steer loaders, and two forklifts, all of which are owned and used by the private contracted processor. O&M costs cover the tipping fee the County paid to the private medium-technology processor for materials collected at curbside and at the drop-offs (18,610 tons). The County's per ton O&M cost for processing another 2,545 tons of white goods and other recyclables collected at the landfill are not available.
Monroe, WI	804	$45	$16,606	Capital costs cover two balers and 10 dumping hoppers. O&M costs cover low-technology municipal processing.
Naperville, IL	7,617	$43	$0	Capital costs are not incurred by the City but by the medium-technology contracted processor. O&M costs cover a contract fee paid to this nonprofit group.
Newark, NJ	6,823	$0 (f)	$0	The private sector incurs all capital and O&M costs.
Perkasie, PA	964	$10	$51,682	Capital costs cover a conveyor, a can crusher, and a recycling building. O&M costs cover low-technology municipal processing.
Peterborough, NH	1,114	NA	$33,144	Capital costs cover two downstroke balers, a conveyor, a forklift/truck, a used plastic granulator, and a chop saw, but exclude a donated band saw. The Town incurred $45 per ton in O&M costs for collection and processing of materials delivered to the Town drop-off center. Processing costs alone are not available.
Philadelphia, PA	48,368	$8	$0	Private processors incur all Capital costs. O&M costs cover the contract fee paid to the medium-technology processors.
Portland, OR	180,695	$0	$0	The private sector primarily incurs all capital and O&M costs. Metro (serving a multi-county area) owns two drop-off sites in the City.
Providence, RI	8,171	$0 (g)	$0	The State incurs all processing costs at its high-technology processing system, which employs Bezner equipment.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables (cont.)

Community	Annual Tonnage	Per Ton O&M Cost		Capital Costs (1990 $)	Description
San Francisco, CA	NA	$0		$0	The private sector incurs all capital and O&M costs.
Seattle, WA	53,775	NA	(h)	$0	Two contracted companies incur capital costs. O&M costs cover the contract fees, which in turn cover both collection and processing. The City incurred $47/ton for curbside and transfer station programs.
Sonoma County, CA	4,063	NA		$0	The private sector incurs capital costs. A densifier, a forklift, two scales, and a baler are used by a contracted nonprofit group to process the material collected through the two County drop-off centers, a mobile drop-off/buy-back service, and two independent drop-off/buy-back centers. The County spent $12/ton to collect and process recyclables recovered at its drop-off sites; processing costs alone are not available.
Takoma Park, MD	1,270	$15		$0	The private sector incurs capital costs. O&M costs in the base year cover the fees paid to a private company for hauling plastic, glass, and cans to processors. The City now delivers its recyclables to a new high-technology County facility, which employs Bezner equipment.
Upper Township, NJ	2,527	$0	(i)	$0	The County incurs capital and O&M costs. The Township tips materials at the medium-technology County facility free of charge.
Wapakoneta, OH	1,369	NA		$4,800	Capital costs cover a can crusher and a glass crusher but exclude a baler, a used forklift truck, a scale, and a trailer, which were paid for by the County. The County incurs O&M costs.
West Linn, OR	51	NA	(j)	$15,590	Capital costs cover those for the drop-off site (a front-end loader (20 percent use) and two drop boxes), but exclude a donated drop box and sorting conveyor. The pre-sorted materials are generally delivered directly to market. The City's O&M costs cannot be separated from its composting costs.
West Palm Beach, FL	2,526	$0	(k)	$0	The County incurs the capital and O&M costs. A forklift, a sweeper attachment, two bobcats, a grapple attachment, a ramp master, three vertical balers, two pallet jacks, five glass breakers, interim IPC buildings, a scale, five conveyor belts, and two aluminum can crushers are used at the medium-technology facility.

Notes:

(a) Tonnage given above represents the annual tonnage processed that the costs cover in the base year, and do not necessarily represent the total amount of materials processed by either the community or the processing facility.

(b) Per ton O&M costs reflect average annual O&M costs incurred in the base year of study divided by the annual tonnage processed that these costs cover. Costs, including those reported in notes (c) through (k), represent gross costs and therefore exclude revenue from sale of materials.

(c) Eco-Cycle incurred $37 per ton.

(d) Civic Recycling incurs this cost, which is unavailable.

(e) Houston County incurs $104 per ton.

(f) REI Distributors incurred about $9 per ton for processing.

(g) The State incurs $32 per ton.

(h) The Recycle America Processing Center incurred approximately $30 per ton in 1989.

(i) Cape May County incurred $80 per ton for processing.

(j) The City incurred $31 a ton in O&M costs to collect and process recyclables and yard waste at its drop-off site.

(k) The Solid Waste Authority of Palm Beach County incurred $26 per ton in the base year of study and $21 a ton when its new facility opened in 1991.

Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste

Community	Annual Tonnage (a)	House-holds Served	Per Ton O&M Costs (b)	Capital Costs (1990 $)	Description
Austin, TX	1,372	110,000	$4	NA	Capital costs are not available because the City uses 1 to 40 compactor trucks (@ approx. $55,000 each) in a given week. O&M costs cover three-person public crews to collect bagged leaves weekly Nov.-Dec.
Berkeley, CA	1,500	2,600	$94	$0	A packer truck is used, but it was purchased prior to the initiation of the program, so the cost is not included. O&M costs cover one-person public crews to collect leaves, grass clippings, brush, and Christmas trees in bags or carts every other week.
Berlin Township, NJ	2,339	1,800	$7	$30,130	Capital costs cover four trucks (shared with recycling and the DPW) and two leaf loaders. O&M costs cover two-person public crews collecting grass clippings and other yard waste in cans or bags weekly year-round, and three-person crews collecting loose leaves in fall and spring with a special scoop.
Boulder, CO	2,250	35,000	$54 (c)	$114,000	Capital costs cover four front-end loaders and 20 trucks (both at six percent of the time) and five dump trucks whose cost and purchase dates are not available. In addition, the City paid contractors for the use of 10 tractor trailers (included in O&M). O&M costs cover City and contracted crews to collect brush during spring clean-up over a three-week period.
Bowdoinham, ME	7.5	880	$0	$0	In the base year of study, the Town composted only 7.5 tons, which residents dropped off at the Town landfill. The Town incurred no collection costs.
Columbia, MO	41	NA	$40	$0	The City incurred no capital costs. One packer is used when City crews collect Christmas trees.
Dakota County, MN	11,051	70,000	$0	$0	County does not incur capital or O&M costs. Private haulers collect yard waste bagged or loose in compactor trucks.
Fennimore, WI	169	970	$60	$3,112	Capital costs include a dump truck used 10 percent of the time. O&M costs cover two-person public crews to collect piled or loose leaves, brush, and wood waste. Brush and wood waste are collected monthly year-round, leaves are collected two to three times in the fall. Tonnages are for leaves only; brush and wood waste are burned.
King County, WA	2,023	NA	$71	$0	The County did not incur capital costs. O&M costs cover 1,323 tons of yard waste and 700 tons of Christmas trees collected through various drop-off programs serving certain areas of the County. Costs for yard waste collected at curbside from 200,000 households is incurred by the private sector.
La Crescent, MN	144	1,568	$0	$0	The City incurs no capital and O&M costs because yard waste is only collected at its drop-off site.
Lafayette, LA	2,211	27,500	$73 (d)	$0	Capital costs are not incurred by the City. The hauler owns three compactor trucks. O&M costs cover contracted three-person crews to collect leaves, grass clippings, brush, Christmas trees bagged, bundled, or in containers weekly, year-round.
Lincoln, NE	2,302	(e)	$14 (f)	$3,700	Capital costs cover 3,700 paper bags. O&M costs cover the collection of 372 tons of leaves, grass clippings, and brush at curbside by contracted one-person crews weekly July through Nov. 1,930 tons were collected at municipal drop-off sites.

Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste (cont.)

Community	Annual Tonnage	House-holds Served	Per Ton O&M Costs	Capital Costs (1990 $)	Description
Lincoln Park, NJ	2,387	(g)	$16	$18,094	Capital costs cover two vacuums and a dump truck used 30 percent of the time. O&M costs cover two-person City crews to collect bagged leaves and grass clippings at least two times per month in April, May, October, and November. Loose leaves are picked up as needed with a vacuum pulled by a dump truck. 40 percent of yard waste was collected at the public drop-off site.
Mecklenburg Co., NC	NA	NA	NA	$22,595	Capital costs cover 50 percent of the maintenance service truck, which is shared with the recycling program. The County operates a drop-off site for yard waste at the landfill, but O&M costs are not available.
Monroe, WI	417	3,900	$67	$8,790	Capital costs cover a jeep and a sweeper attachment but exclude a packer truck. O&M costs cover one-person public crews to collect bagged grass clippings and brush weekly April to November, and to collect leaves weekly from October 15 to Thanksgiving.
Naperville, IL	4,901	24,500	$77 (h)	$243,060	Capital costs cover a J.D. Loader, four brush chippers, and two leaf loaders, but exclude two vacuum sweepers at 20 percent use (purchasesd 1975) and any equipment used by the private contractors. O&M costs cover a public crew to collect loose leaves and brush three times per year, and Christmas trees. O&M costs also cover contract fees for collection of bagged grass clippings and other garden waste weekly April through December.
Newark, NJ	7,435	NA	$10	$0	The City incurs no capital costs. O&M costs cover contract fees with three private haulers to collect leaves, grass clippings, brush, and Christmas trees at curbside weekly from October through January. All households are served as needed.
Perkasie, PA	654	3,500	$36	NA	Capital costs are not available. O&M costs cover three to five public workers to collect leaves with vacuums and dump trucks weekly from late October through November, and brush monthly on an on-call basis.
Peterborough, NH	0	0	--	--	Peterborough has no composting program. Brush and wood are burned.
Philadelphia, PA	1,571	45,000	NA	NA	Capital costs are not available, but two vacuum leaf loaders, six tractor and trailers, two large loaders, 10 mechanical brooms, and a compactor truck are used for composting and various Streets Department activities. Three- to five-person public crews collect leaves once in four neighborhoods November through December and also collect Christmas trees. O&M costs are not available.
Portland, OR	411	NA	$0	$0	The private sector incurs capital and O&M costs. (Only some haulers offer yard waste collection service.)
Providence, RI	0	0	--	--	Providence has no composting program.
San Francisco, CA	172	NA	$35	$0	The City does not have curbside service for yard waste. $35 per ton figure covers the City's O&M cost to collect and chip Christmas trees in 1990.
Seattle, WA	36,781	94,805	$65 (i)	$0	The City incurs no capital costs. O&M costs cover contract fees. Two private contractors collect bagged, bundled, or containerized leaves, grass clippings, brush using one-person crews and rear-loading packer trucks. North section is serviced weekly year-round. South section is serviced biweekly March through October and monthly the rest of the year.

Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste (cont.)

Community	Annual Tonnage	House-holds Served	Per Ton O&M Costs	Capital Costs (1990 $)	Description
Sonoma County, CA	83	1,200	$0	$0	The County does not incur capital or O&M costs. The City of Santa Rosa began a pilot curbside yard waste collection program in Sept. 1990. It served 1,200 households and collected 83 tons of wood and yard waste in 1990. Almost 2,000 tons of yard waste was composted in the County in 1990.
Takoma Park, MD	1,206	4,100	$76	$83,530	Capital costs cover three compactor trucks at 10 percent use, five leaf vacuums, and four 15-cubic-yard leaf collection boxes. O&M costs cover three-person public crews to collect bagged leaves, grass clipppings, and Christmas trees weekly year-round (starting June 1990) and five-person crews to collect loose leaves in the fall.
Upper Township, NJ	884	3,860	$49	$84,053	Capital costs cover two leaf vacuums and a compactor truck. O&M costs cover two-person public crews to collect leaves weekly year-round and grass clippings, wood waste, brush, Christmas trees weekly spring to November. Loose leaves are collected in November and December. Two-person crews collect and chip large brush.
Wapakoneta, OH	455	3,548	$45	$19,480	Capital costs cover a leaf loader truck and a dump truck at 8 percent use. O&M costs cover this collection but also include some activities at the compost site. The City collects leaves at the curb during November and December.
West Linn, OR	4	5,300	$0	$0	The City incurs no capital and O&M costs for curbside collection; these are picked up by a private hauler. In total, 1,552 tons were collected in 1990 through curbside and drop-off (but only 4 tons through curbside).
West Palm Beach, FL	16,703	18,306	$37	NA	Capital costs are not available, but three compactor trucks, five cranes, and 10 Lightning Loader Trucks are used. O&M costs cover two-person public crews to collect leaves, grass clippings, brush, wood waste, and Christmas trees, two times per month, year-round.

Key:
-- = Not Applicable NA = Not Available

Notes:
(a) Tonnage given above represents the annual tonnage of yard waste collected covered by the listed costs, and do not necessarily represent the total amount of materials collected.
(b) Per ton O&M costs reflect average annual costs incurred in the base year of study divided by the annual tonnage collected that these annual costs cover.
(c) Includes cost of composting.
(d) Contract fee is based on a per household cost.
(e) 2,000 households were served by the pilot curbside program.
(f) Curbside yard waste collection cost the City $32 per ton ($11,966). Drop-off collection of yard waste and Christmas trees cost the City on average $11 per ton.
(g) 1,424 tons of yard waste were collected at curbside from 2,772 households; the other 963 tons were collected at the drop-off site.
(h) Leaf and brush collection costs the City $64/ton and $84/ton, respectively. The private hauler is paid the equivalent of $111 per ton for refuse and yard waste collection, and $120 per ton for Christmas tree collection.
(i) The City paid U.S. Disposal $84.29/ton to collect and compost yard waste in 1990, and General Disposal $56.36/ton for collection alone. U.S. Disposal collected 36,781 tons and General collected 10,845 tons.

Table 8.7
Communities' Capital and O&M Costs for Composting

Community	Annual Tonnage (a)	O&M Per Ton Costs (b)	Capital Costs (1990 $)	Description
Austin, TX	1,372	$58	$288,455	Capital costs cover a windrow turner, a front-end loader, a conveyor, and screens. O&M costs cover a municipal high-technology co-composting site, temperature testing, turning rows 2 times per week, and screening compost.
Berkeley, CA	1,500	$24.75 (c)	$0	Capital costs are not incurred by the City. One packer truck is used 50 percent of the time. O&M cost listed is the tipping fee paid to the private high-technology facility. Recycled Wood Products uses a tub grinder; material is watered, screened, windrowed, turned weekly, temperature monitored, and tested.
Berlin Township, NJ	2,339	$2	$13,239	Capital costs cover a chipper and exclude a windrow turner. O&M costs cover the medium-technology municipal site. Windrows are turned once per month.
Boulder, CO	2,250	NA	$375	Capital costs cover 15 backyard composting bins. Brush is chipped with a tub grinder owned by a private contractor. O&M costs for municipal brush chipping are not available because processing cost cannot be separated from collection.
Bowdoinham, ME	8	NA	$0	The Town had not incurred any capital costs through the base year, but has since purchased a shredder. A municipal drop-off is located at the landfill where the compost is piled (low-technology processing), but O&M costs are not available.
Columbia, MO	NA	NA	NA	Capital and O&M costs are not available. There is a municipal drop-off site for low-technology mulch production.
Dakota County, MN	11,051	$33	$0	Capital costs are not incurred by the County. Operator owns all equipment for the medium-technology processing facility, including three conveyors, a trommel screen, a clump breaker, a tub grinder, a Seppi tree/brush chopper, a skid-steer loader, a front-end loader, and a trackdozer. O&M costs are contract fees paid to the private company that operates the two County-owned yard waste composting sites. Workers empty bags, mix contents with soil, use clump breakers, pile, and repeat the process.
Fennimore, WI	169	$13	$0	The City incurred no capital costs, although it uses one 1975 front-end loader, purchased prior to the program. O&M costs cover medium-technology municipal processing. Dropped off yard waste is windrowed and turned each week. Leaves picked up at curbside are spread on a local farm.
King County, WA	2,023	$25 (c)	$0	The County incurs no capital costs. O&M costs cover the tipping fees paid to four private composting sites with varying processing technologies.
La Crescent, MN	144	$12 (d)	$24,153	Capital costs cover a front-end loader used 40 percent of the time. O&M costs cover low-technology processing (turning of the pile 3-4 times per year). Drop-off site is open from April through October.
Lafayette, LA	2,211	$17 (e)	$190,000	Capital costs cover a tub grinder and front-end loader. O&M costs cover City-owned and -operated medium-technology site. The yard waste is unloaded on an asphalt pad, ground with a tub grinder, windrowed, temperature monitored, and reformed.
Lincoln, NE	2,302	$14	$90,208	Capital costs cover a front-end loader (used 10 percent of the time) and a chipper. The medium-technology site is owned and operated by the City. O&M costs cover rental of a tub grinder and the grinding, windrowing, and weekly turning of yard waste.
Lincoln Park, NJ	2,387	$3	$19,488	Capital costs cover two chippers purchased in 1982 for brush, now used only for Christmas trees. O&M costs cover tipping fees for yard waste at the medium-technology County processing facility. The Borough brings leaves and grass clippings to two local composting facilities (one County facility at $3.71/cy and one municipal facility at no charge) and brush to three private chipping/composting sites. The Ox Stump Factory charges $8/cy.

Table 8.7
Communities' Capital and O&M Costs for Composting (Cont.)

Community	Annual Tonnage	O&M Per Ton Costs	Capital Costs (1990 $)	Description
Mecklenburg Co., NC	NA	NA	$1,416,787	Capital costs cover a pick-up truck, a tub grinder, a windrow turner, two tub grinders, a steer loader, a tractor loader, a shredder, four dump trucks, and two wheel loaders but excludes two conveyors, a tractor loader, and a trommel screen purchased and used after the base year. The county purchased most of this equipment as a result of Hurricane Hugo. O&M costs are not available. The yard waste is windrowed, turned, and cured at the medium-technology County facility.
Monroe, WI	417	$18	$7,308	Capital costs cover a chipper. O&M costs cover a tub grinder rental fee at the City-owned and -operated low-technology site. Materials are mixed, ground, and formed into a large pile, which is turned 4 times per year. Christmas trees are chipped.
Naperville, IL	4,901	$27	$223,680	Capital costs include a dump truck, a windrow turner, and a tractor but exclude a spreader truck bought in 1977 (cost is not available). O&M costs cover windrowing, temperature monitoring, turning as needed (once per week in the summer), and watering as needed at the municipal high-technology site. Christmas trees are chipped.
Newark, NJ	7,435	$11	$191,325	Capital costs cover a chipper (6 percent use), a front-end loader, and a shredder-mixer. The medium-technology site is municipally owned and operated. O&M costs cover the rental of a screen-all and windrowing of leaves and grass clippings, watering once per month, and turning every 2 weeks. Finished compost is screened. Christmas trees are chipped with a borrowed chipper.
Perkasie, PA	654	$0	NA	Capital costs are not available. The Borough delivers leaves to a farm 2 miles away, where they are windrowed and turned with a back hoe (medium-technology processing). Some leaves are also delivered to a landscaping company. Brush chipped at curbside is simply deposited in piles at local parks.
Peterborough, NH	0	--	--	The Town had no composting program during the base year.
Philadelphia, PA	1,006	$89	NA	Capital costs are not available, but front-end loaders and a windrow composter are used. The medium-technology site is City-owned and -operated. O&M costs cover the salaries of three employees but exclude the costs of fuel and of windrowing and turning the leaves weekly, which are not available.
Portland, OR	19,054	$0	$0	The City incurs no costs. There are at least two private composting sites in the metro area that accept yard waste from residents and private businesses. Grimm's charges between $4 and $6.5/cy; MacFarland Bark charges $35 per ton.
Providence, RI	0	--	--	Providence has no composting program.
San Francisco, CA	6,578	$13	$0	The City incurs no capital costs. O&M costs cover a backyard composting program. In 1990 the City budgeted $83,000 for backyard composting. The tonnage composted is estimated.
Seattle, WA	38,900	$17	$0	Seattle incurs no capital costs. O&M costs cover the tipping fee ($5.47 to tip the first 24,000 tons and $18/ton for any tonnage above that) paid to a private medium-technology processor for yard waste collected by the contractor, General Disposal. U.S. Disposal (the other contracted service provider) delivers yard waste directly to the privately owned and operated medium-technology Cedar Groves Compost Facility.
Sonoma County, CA	1,972	NA	$0	Capital costs are not incurred by the County. Yard waste is composted at the Bennet Valley Farm , where it is screened and windrowed. The County also operates a Christmas tree chipping recovery program, but the per ton cost is not available.

Table 8.7
Communities' Capital and O&M Costs for Composting (Cont.)

Community	Annual Tonnage	O&M Per Ton Costs	Capital Costs (1990 $)	Description
Takoma Park, MD	1,206	$2	$9,000	Capital costs cover a backhoe (20 percent use) and exclude a wood chipper. O&M costs cover the low-technology composting of fall leaves. Bagged leaves and grass clippings are taken to a medium-technology County composting facility and tipped at no charge.
Upper Township, NJ	884	$12	$1,410	Capital costs cover a chipper (10 percent use) but exclude a front-end loader, screen-all, and tub grinder used at the medium-technology County composting site. O&M costs cover tipping fees charged by the County for brush and wood waste. Leaves and grass clippings are tipped for free. The municipality does not incur any costs. No composting was done in the base year.
Wapakoneta, OH	455	NA	$0	In the base year, the municipality rented a manure spreader to land-apply some the organic matter. This cost is included in its $45/ton O&M cost for collection and processing.
West Linn, OR	1,552	$31 (f)	$70,595	Capital costs cover composting equipment, land improvements, and a tub grinder/power unit. O&M costs cover grinding wood material and windrowing and turning yard waste every 6 weeks at the medium-technology municipal site.
West Palm Beach, FL	12,404	$0	$0	The City incurs no costs. Yard waste and Christmas trees are delivered to a County composting site free of charge. Composting costs the County about $20 per ton.

Key:
cy = cubic yard NA = Not Available – = Not Applicable

Notes:
(a) Tonnage given above represents the annual tonnage composted that the costs cover in the base year, and do not necessarily represent the total amount composted by either community or composting facility.
(b) Per ton O&M costs reflect average annual costs incurred in the base year of study.
(c) Represents tip fee paid.
(d) Administration costs ($9,187) added another $64 per ton.
(e) City charges WMI a $24 per ton tip fee.
(f) Includes collection and processing of 51 tons of recyclables at drop-off site.

Table 8.8
Communities' Materials Recovery Operating & Maintenance Costs (Recycling and Composting Combined)

Community	Collection	Processing	Subtotal Coll & Proc	Admin	Educ/Pub	Total Materials Recovery Costs
Austin, TX	$740,000	$80,000	$820,000	$75,300	$40,400	$935,700
Berkeley, CA	NA	NA	$878,000	$275,000	$25,000	$1,178,000
Berlin Township, NJ	$88,900	$22,304	$111,204	$3,000	$500	$114,704
Boulder, CO	NA	NA	$380,946	$45,000	$35,000	$460,946
Bowdoinham, ME	$6,754	$27,184	$33,938	$10,401	$500	$44,839
Columbia, MO	NA	$1,040	NA	$29,995	$8,650	NA
Dakota County, MN	$643,873	$1,256,210	$1,900,083	$330,000	$91,000	$2,758,904 (a)
Feasimore, WI	$22,650	$28,825	$51,475	$700	$500	$52,675
King County, WA	NA	NA	$394,925	$135,000	$1,414,951	$1,944,876
La Crescent, MN	$25,723	$1,715	$27,438	$1,876	$551	$29,865
Lafayette, LA	NA	NA	$294,075	$130,000	$60,000	$484,075
Lincoln, NE	$43,743	$32,710	$76,453	$54,000	$8,566	$139,019
Lincoln Park, NJ	$111,500	$14,585	$126,085	$17,000	$1,000	$144,085
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA
Monroe, WI	$61,436	$43,638	$105,074	$10,203	$0	$115,277
Naperville, IL	$931,013	$459,561	$1,390,574	$40,000	$9,500	$1,440,074
Newark, NJ	$815,159	$80,155	$895,314	$208,000	$90,000	$1,193,314
Perkasie, PA	$71,454	$10,073	$81,527	$5,470	$742	$87,739
Peterborough, NH	NA	NA	$50,000	$23,000	$0	$73,000
Philadelphia, PA	NA	$244,121	NA	$680,950	$108,000	NA
Portland, OR	$0	$0	$0	$612,250	$63,048	$675,298
Providence, RI	$857,343	$0	$857,343	$85,853	$1,950	$945,146
San Francisco, CA	$6,000	$83,000	$89,000	$521,000	$290,300	$900,300
Seattle, WA	NA	NA	$5,573,674	$600,000	$500,000	$6,673,674
Sonoma County, CA	NA	NA	$48,020	$38,142	$5,450	$91,612
Takoma Park, MD	$213,830	$21,130	$234,960	$49,800	$6,000	$290,760
Upper Township, NJ	$222,607	$10,200	$232,807	$59,600	$3,200	$295,607
Wapakoneta, OH	NA	NA	$28,600	NA	NA	$28,840
West Linn, OR	NA	NA	$49,464	$60,000	(b)	$109,464
West Palm Beach, FL	$997,732	$0	$997,732	$104,133	$0	$1,101,865

Key:
Admin = Administration
Coll = Collection
Educ = Education
NA = Not Available
O&M = Operating and Maintenance
Proc = Processing
Pub = Publicity
– = Not Applicable

Notes:
See Tables 8.4-8.7 for descriptions of what costs cover and what costs exclude. Figues in this table are based on those provided in Tables 8.9 and 8.10. For more detailed information on what costs cover see, "In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results" (Washington, DC: ILSR, 1992).
(a) Total materials recovery cost includes $437,821 paid to municipalities for recycling activities.
(b) Education and publicity cost are included in adminstration costs.

Table 8.9
Communities' Recycling Operating & Maintenance Costs

Community	Year Data Collected	Collection	Processing	Coll & Proc	Admin	Educ/Pub	Subtotal
Austin, TX	FY89	$735,000	$0	$735,000	$65,300	$30,400	$830,700
Berkeley, CA	FY91	NA	NA	$700,000	$275,000 (a)	$25,000 (a)	$1,000,000
Berlin Township, NJ	1990	$72,684	$17,500	$90,184	NA	NA	$90,184
Boulder, CO	1990	$235,000	$25,000	$260,000	$45,000	$35,000	$340,000
Bowdoinham, ME	FY90	$6,754	$27,184	$33,938	$10,401	$500	$44,839
Columbia, MO	FY90	$51,398	$0 (b)	$51,398	$28,291	$8,650	$88,339
Dakota County, MN	1990	$643,873	$895,428	$1,539,301	$280,000	$81,000	$2,338,122 (c)
Fennimore, WI	1990	$12,500	$26,625	$39,125	$700	$500	$40,325
King County, WA	1990	NA	NA	$200,000	NA	NA	NA
La Crescent, MN	1990	$25,723	$0 (d)	$25,723	$938	$551	$27,212
Lafayette, LA	FY90	NA	NA	$95,700	$97,500	$50,000	$243,200
Lincoln, NE	1990	$10,787	$450	$11,237	$39,000	$6,833	$57,070
Lincoln Park, NJ	1990	$72,725	$7,760	$80,485	$17,000	$1,000	$98,485
Mecklenburg Co., NC	1990	NA (e)	NA (f)	$626,636	$181,613	$87,000	$895,249
Monroe, WI	1989	$33,311	$36,138	$69,449	$8,328	$0	$77,777
Naperville, IL	1990	$554,333	$325,561	$879,894	$32,000	$7,000	$918,894
Newark, NJ	1989	$744,023	$0 (g)	$744,023	$188,000	$72,000	$1,004,023
Perkasie, PA	1990	$47,898	$10,073	$57,971	$3,847	$522	$62,340
Peterborough, NH	1990	NA	NA	$50,000	$23,000	$0	$73,000
Philadelphia, PA	FY90	$5,181,439	$154,121	$5,335,560	$670,950 (h)	$108,000	$6,114,510
Portland, OR	1990	$0	$0	$0	NA	NA	NA
Providence, RI	1990	$857,343	$0 (i)	$857,343	$85,853	$1,950	$945,146
San Francisco, CA	1990	$0 (j)	$0 (k)	$0	$434,500	$251,620	$686,120
Seattle, WA	1990	NA (l)	NA (l)	$2,537,652	$300,000	$200,000	$3,037,652
Sonoma County, CA	1990	NA	NA	$48,020	NA	NA	NA
Takoma Park, MD	1990	$122,130	$18,430	$140,560	$36,800	$5,000	$182,360
Upper Township, NJ	1990	$179,207	$0 (m)	$179,207	$58,700	$3,000	$240,907
Wapakoneta, OH	9/89-8/90	NA	NA	$8,200	$240	$0	$8,440
West Linn, OR	1990	NA (n)	NA (i)	NA	$45,000	(o)	NA
West Palm Beach, FL	4/90-3/91	$374,641	$0 (p)	$374,641	$34,133	$0	$408,774

Key:
NA = Not Available

Notes:
This table represents costs incurred by the local jurisdiction only. See Tables 8.4 and 8.5 for descriptions of what costs include and exclude.
(a) A small portion of these education/publicity and administration costs are spent on composting activities.
(b) The cost is incurred by Civic Recycling and is unavailable.
(c) Total materials recovery cost includes $437,821 paid to municipalities for recycling activities.
(d) The cost is incurred by Houston County and is $104/ton.
(e) The City of Charlotte incurred $1,533,311 ($96/ton) in addition to the County's costs.
(f) Mecklenburg County incurred a $7.50/ton tipping fee for processing.
(g) REI Distributers incurred between $490,000 and $690,000 (about $9/ton) for processing.
(h) These costs cover the curbside recycling program alone.
(i) The State incurres $32/ton.
(j) Golden Gate Disposal spent $7,512,305.
(k) The cost is incurred by the private sector and is unavailable.
(l) The City's costs include contract fees for collection and processing.
(m) Cape May County incurred gross costs of $80 per ton for processing.
(n) West Linn Disposal spent $153,109 to collect 1,338 tons of recyclables.
(o) Education and publicity costs are included with administrative costs.
(p) The Solid Waste Authority of Palm Beach Co. incurred $26 per ton in 1990; this decreased to $21 per ton when its new facility cam online in 1991.

Table 8.10
Communities' Composting Operating & Maintenance Costs

Community	Year Data Collected	Collection	Processing	Coll & Proc	Admin	Educ/Pub	Subtotal
Austin, TX	FY89	$5,000	$80,000	$85,000	$10,000	$10,000	$105,000
Berkeley, CA	FY91	NA	NA	$178,000	NA	NA	$178,000
Berlin Township, NJ	1990	$16,216	$4,804	$21,020	NA	NA	$21,020
Boulder, CO	1990	NA	NA	$120,946	$0	$0	$120,946
Bowdoinham, ME	FY90	NA	NA	NA	NA	NA	NA
Columbia, MO	FY90	NA	$1,040	NA	$1,704	$0	NA
Dakota County, MN	1990	$0	$360,782	$360,782	$50,000	$10,000	$420,782
Fennimore, WI	1990	$10,150	$2,200	$12,350	$0	$0	$12,350
King County, WA	1990	$144,350	$50,575	$194,925	NA	NA	NA
La Crescent, MN	1990	$0	$1,715	$1,715	$938	$0	$2,653
Lafayette, LA	FY90	$160,875	$37,500	$198,375	$32,500	$10,000	$240,875
Lincoln, NE	1990	$32,956	$32,260	$65,216	$15,000	$1,733	$81,949
Lincoln Park, NJ	1990	$38,775	$6,825	$45,600	$0	$0	$45,600
Mecklenburg Co., NC	1990	NA	NA	NA	NA	NA	NA
Monroe, WI	1989	$28,125	$7,500	$35,625	$1,875	$0	$37,500
Naperville, IL	1990	$376,680	$134,000	$510,680	$8,000	$2,500	$521,180
Newark, NJ	1989	$71,136	$80,155	$151,291	$20,000	$18,000	$189,291
Perkasie, PA	1990	$23,556	$0	$23,556	$1,623	$220	$25,399
Peterborough, NH	1990	--	--	--	--	--	--
Philadelphia, PA	FY90	NA	$90,000	NA	$10,000	$0	NA
Portland, OR	1990	$0	$0	$0	NA	NA	NA
Providence, RI	1990	--	--	--	--	--	--
San Francisco, CA	1990	$6,000	$83,000	$89,000	$86,500	$38,680	$214,180
Seattle, WA	1990	NA	NA	$3,036,022	$300,000	$300,000	$3,636,022
Sonoma County, CA	1990	NA	NA	NA	NA	NA	NA
Takoma Park, MD	1990	$91,700	$2,700	$94,400	$13,000	$1,000	$108,400
Upper Township, NJ	1990	$43,400	$10,200	$53,600	$900	$200	$54,700
Wapakoneta, OH	9/89-8/90	NA	NA	$20,400	NA	$0	$20,400
West Linn, OR	1990	NA	NA	NA	$15,000	(a)	NA
West Palm Beach, FL	4/90-3/91	$623,091	$0	$623,091	$70,000	$0	$693,091

Key:
Admin = Administration
NA = Not Available
Coll = Collection
Proc = Processing
Educ = Education
Pub = Publicity
-- = Not Applicable

Note:
See Tables 8.6 and 8.7 for descriptions of what costs include and exclude.

(a) Education and publicity costs are included under administrative costs.

Table 8.11
Communities' Combined Per Ton O&M Costs for Recycling and Composting

Community	Collection	Processing	Subtotal Coll & Proc	Admin	Educ/Pub	Total Materials Recovery Gross	Revenue (a)	Net
Austin, TX	$81	$9	$90	$8	$4	$103	$24	$79
Berkeley, CA	NA	NA	$69	$15	$1	$93	$0	$93
Berlin Township, NJ	$22	$6	$28	$1	$0	$28	$2	$26
Boulder, CO	NA	NA	$55	$7	$5	$67	$0	$67
Bowdoinham, ME	$23	$124	$118	$36	$2	$156	$10	$146
Columbia, MO	NA	NA	NA	$27	$8	NA	$7	NA
Dakota County, MN	NA	$57	NA	NA	NA	NA	$11	NA
Fennimore, WI	$46	$59	$105	$1	$1	$107	$15	$92
King County, WA	NA	NA	$99	NA	NA	NA	$0	NA
La Crescent, MN	$68	$5	$73	$5	$1	$79	$0	$79
Lafayette, LA	NA	NA	$63	$28	$13	$104	$0	$104
Lincoln, NE	$16	$12	$28	$20	$3	$50	$1	$49
Lincoln Park, NJ	$29	$4	$33	$4	$0	$37	$3	$35
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA	$13	NA
Monroe, WI	$50	$36	$86	$8	$0	$94	$23	$72
Naperville, IL	$74	$37	$111	$3	$1	$115	$0	$115
Newark, NJ	$57	$6	$63	$15	$6	$84	$4	$80
Perkasie, PA	$44	$6	$50	$3	$0	$54	$6	$48
Peterborough, NH	NA	NA	$45	$21	$0	$66	$18	$48
Philadelphia, PA	NA	$5	NA	$14	$2	NA	$1	NA
Portland, OR	$0	$0	$0	NA	NA	NA	$0	NA
Providence, RI	$105	$0	$105	$11	$0	$116	$0	$116
San Francisco, CA	NA	NA	NA	NA	NA	NA	$0	NA
Seattle, WA	NA	NA	$54	$6	$5	$64	$0	$64
Sonoma County, CA	NA	NA	$12	$9	$1	$22	$0	$22
Takoma Park, MD	$86	$9	$95	$20	$2	$117	$0	$117
Upper Township, NJ	$65	$3	$68	$17	$1	$87	$0	$87
Wapakoneta, OH	NA	NA	$21	NA	NA	$21	$0	$21
West Linn, OR	NA	NA	$31	$20 (b)	(b)	$51	$0	$51
West Palm Beach, FL	$52	$0	$52	$5	$0	$57	$0	$57

Key:
Admin = Administration
Coll = Collection
Educ = Education
NA = Not Available
O&M = Operating and Maintenance
Proc = Processing
Pub = Publicity
-- = Not Applicable

Notes:
Per ton costs reflect average annual operating costs in the base year of the study.
Some costs do not add up because tonnage collected, processed, and the tonnage adminstration and education/publicity costs cover may differ from the tonnage processed. For per ton costs for recycling collection and processing, see Tables 8.4 and 8.5.

(a) Represents revenue received by community from the sale of recyclable or compostable materials divided by the total tonnage of material recovered through publicly sponsored programs.
(b) The administration cost for West Linn includes education and publicity.

Table 8.12
Combined Per Ton Recycling and Composting Costs
(Annualized Capital and O&M)

Community	Recycling			Composting			Total Materials Recovery				
	Capital	O&M	Gross	Capital	O&M	Gross	Capital	O&M	Gross	Revenue	Net
Austin, TX	$12	$108	$120	NA	$77	NA	NA	$103	NA	$24	NA
Berkeley, CA	$12	$89	$102	$0	$119	$119	$11	$93	$104	$0	$104
Berlin Township, NJ	$8	$53	$61	$2	$9	$11	$5	$28	$33	$2	$31
Boulder, CO	$5	$73	$79	$7	$54	$61	$6	$67	$73	$0	$73
Bowdoinham, ME	$7	$156	$163	$0	NA	NA	$7	$156	$163	$10	$153
Columbia, MO	$2	$84	$86	$0	NA	NA	NA	NA	NA	$7	NA
Dakota County, MN	NA	NA	NA	$0	$38	$38	NA	NA	NA	$22	NA
Fennimore, WI	$45	$125	$170	$3	$73	$76	$30	$107	$138	$15	$122
King County, WA	$0	NA	NA	$0	NA	NA	$0	NA	NA	$0	NA
La Crescent, MN	$5	$117	$123	$17	$18	$35	$10	$79	$89	$0	$89
Lafayette, LA	$25	$100	$125	$4	$109	$113	$15	$104	$119	$0	$119
Lincoln, NE	$1	$126	$126	$4	$36	$40	$4	$50	$55	$1	$54
Lincoln Park, NJ	$19	$67	$86	$2	$19	$21	$8	$37	$46	$3	$43
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	$13	NA
Monroe, WI	$6	$97	$103	$5	$90	$95	$8	$94	$102	$23	$79
Naperville, IL	$0	$121	$121	$10	$106	$116	$7	$115	$122	$0	$122
Newark, NJ	$1	$147	$148	$6	$25	$32	$3	$84	$87	$4	$83
Perkasie, PA	$9	$65	$73	NA	$39	NA	NA	$54	NA	$6	NA
Peterborough, NH	$3	$66	$69	--	--	--	$3	$66	$69	$18	$51
Philadelphia, PA	$85	$158	$243	NA	NA	NA	NA	NA	NA	$1	NA
Portland, OR	$0	NA	NA	$0	NA	NA	$0	NA	NA	$0	NA
Providence, RI	$0	$116	$116	--	--	--	$0	$116	$116	$0	$116
San Francisco, CA	$0	NA	NA	NA	NA	NA	NA	NA	NA	$0	NA
Seattle, WA	NA	$56	$56	$0	$73	$73	NA	$64	$64	$0	$64
Sonoma County, CA	$0	NA	NA	$0	NA	NA	$0	$22	$22	$0	$22
Takoma Park, MD	$9	$144	$153	$11	$90	$101	$10	$117	$128	$0	$128
Upper Township, NJ	$3	$95	$99	$14	$62	$76	$6	$87	$93	$0	$93
Wapakoneta, OH	$1	$9	$10	$6	$45	NA	$3	$21	$24	$0	$24
West Linn, OR	$32	NA	NA	$5	NA	NA	$37	$51	$88	$0	$88
West Palm Beach, FL	$4	$162	$166	NA	$41	NA	NA	$57	NA	$0	NA

Key:
NA = Not Available O&M = Operating and Maintenance -- = Not Applicable

Note:
Per ton costs reflect average annual costs for the base year of study, which is typically 1990. See Table 1.1.
(a) Private haulers under contract with the City incur all capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station. Although these costs are unavailable, net costs are calculated because, according to City officials, these capital costs are accounted for in the City's O&M costs.

administration, and education/publicity. Most O&M costs vary with the amount of material recovered and labor hours spent. Some O&M costs, such as insurance fees, heating costs, and publicity costs, remain fixed despite the volume of material handled. Tables 8.8 through 8.10 present annual total gross O&M costs incurred by each jurisdiction for recycling, composting, and total materials recovery, including the costs for publicity and education programs and for program administration and overhead. These tables exclude expenditures by public agencies other than the community documented, as well as the value of any volunteer labor.[3] Tables 8.4, 8.5, 8.6, 8.7, and 8.11 list per ton gross O&M costs for recycling collection and processing and for yard waste collection and composting, and indicate for each of these categories what these costs include. Total gross and net O&M costs for recycling and composting are presented in Table 8.11.[4] (Recycling and composting costs include marketing costs, but they should also take into account revenues from the sale of materials. For comparative purposes we generally use gross costs and thus exclude the effect of higher sales prices, on average, for scrap materials on the coasts than in the Midwest. Net costs for these programs are often significantly lower when revenues are factored in.)

Table 8.12 lists total materials recovery costs (composting and recycling costs combined), including annualized capital costs and O&M. Capital costs typically comprise a small percentage of total costs. Traditionally, community recycling systems do not have large fixed investments, and, as a result, are able to respond to near-term changes in their operating environment (e.g., changes in the amount or composition of the waste stream, better processing technologies, more rigorous environmental standards). As indicated in Table 8.17, some recycling systems have recently become more capital-intensive.

We have made every effort to use a uniform methodology for documenting and assessing costs. Yet, due to the difficulty in gathering reliable and consistent cost information, the figures presented in this chapter do have some limitations. The observations made are not based on rigorous statistical data. In addition, the costs documented focus on the costs incurred by the local government or community studied. All the costs being incurred by all the parties involved in recycling and composting are not necessarily reflected in the figures presented here. (The notes at the end of each table help clarify what costs are excluded, as do Tables 8.4 through 8.7.) While costs incurred by the private sector are not documented in this report, Table 8.16 does list gross operating costs by all the public sector parties involved in curbside recycling activities. Private sector recovery enterprises operate as businesses and cover their costs through the fees they charge and the materials revenues they receive. (If private recycling processors or composters do not charge local, county, or state governments for handling materials, these operators' costs are typically being covered by materials revenues, not by the taxpayer.) Readers interested in undertaking their own cost analysis should review the raw cost data as reported in *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results.*

The Effect of Program Design on Costs

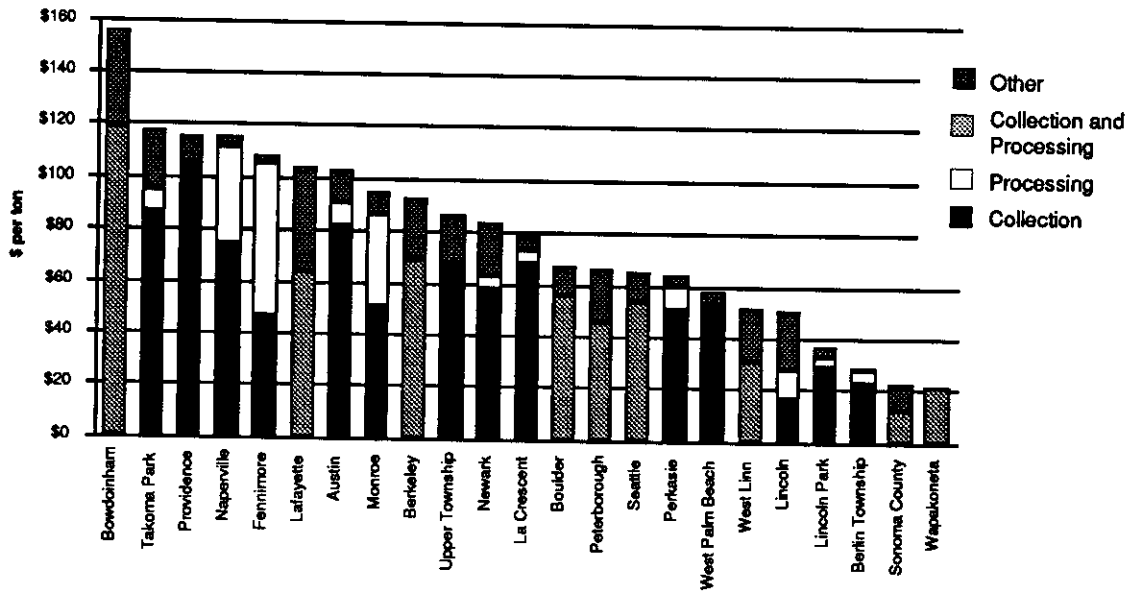
Tables 8.1 through 8.12 indicate that capital and O&M costs vary widely from community to community. O&M costs (excluding revenues) for recycling range from $9 per ton in Wapakoneta to $162 per ton in West Palm Beach. O&M costs for yard waste collection and composting range from $9 per ton in Berlin Township to $109 per ton in Lafayette. The capital investment made per ton-per-day recovered also varies widely. Newark has invested only $1,420 for every ton-per-day it recycles, while Fennimore has invested $104,400. Fennimore made the lowest investment in yard waste collection and composting equipment at $4,800 per ton-per-day composted, while Austin made the largest at $54,660.[5]

Why do reported materials recovery costs vary so much? How can communities avoid incurring high costs? By answering the former question, we can also address the latter.

Evaluating the economics of community materials recovery programs is a challenging task. Reliable and consistent data are often lacking. Publicly funded programs may underestimate their costs by including large volunteer efforts or excluding expenditures made by other public agencies, while private operations' data are often

Chart 8.1

Gross O&M Costs Per Ton Recovered



Notes: This chart does not include communities for which total costs were unavailable. "Other" includes administration, education, publicity, and costs that could not be broken down into the specific categories. In a few communities, costs cannot be broken down into collection and processing.

unavailable for public scrutiny. Collection and processing systems vary widely from one community to the next. Each system collects different types and amounts of materials, requires distinct set-out procedures, utilizes different vehicles and crew sizes, and employs different processing techniques. Moreover, programs differ as to service provider. Some use public crews to collect materials, others contract with private haulers for collection. While there is no simple formula for determining which system is more advantageous, this section will examine the relationships between different program types and costs.

Drop-off Versus Curbside Collection

As we discussed in Chapter 5, there are two basic strategies for collecting recyclable and compostable materials: drop-off and curbside collection. While curbside collection is critical to maximizing participation and therefore recovery levels, drop-off is cheaper. Chart 8.1 graphs gross O&M costs per ton of material recovered. Charts 8.2a and 8.2b graph gross O&M costs for collection and processing of recyclables and compostables, respectively. In comprehensive curbside programs, collection accounts for most of the total O&M costs. The six communities whose costs in Charts 8.1 and 8.2 largely represent drop-off programs—Sonoma County, Lincoln, Lincoln Park, Peterborough, Wapakoneta, and West Linn—are those with very low per ton collection costs.[6] While Bowdoinham is also largely a drop-off program, its expensive processing costs ($124 per ton) elevate the total cost of the program. The small throughput at its processing facility accounts for this high per ton processing cost.

Drop-off can work as a primary collection strategy in communities in which residents self-haul

Table 8.13
Communities' Total Recycling Costs
(Annualized Capital and O&M)

	Annualized Capital Cost ($/ton)	O&M Cost ($/ton)	Gross Cost ($/ton)	Revenue ($/ton)	Net ($/ton)	Collector	Set-out Collection Method
Seattle, WA (a)	NA	$56	$56	$1	$56	Contract	Commingled
Boulder, CO	$5	$73	$79	$0	$79	Contract	Segregated
La Crescent, MN	$5	$117	$123	$0	$123	Contract	Segregated
Berkeley, CA	$12	$89	$102	$0	$102	Contract	Segregated
Providence, RI	$0	$116	$116	$0	$116	Contract	Commingled
Naperville, IL	$0	$121	$121	$0	$121	Contract	Segregated
Lafayette, LA	$25	$100	$125	$0	$125	Contract	Segregated
Newark, NJ (b)	$1	$147	$148	$8	$141	Contract/Public	Commingled
Peterborough, NH (DO)	$3	$66	$69	$18	$51	Public	--
Berlin Township, NJ	$8	$53	$61	$5	$57	Public	Commingled
Perkasie, PA	$9	$65	$73	$12	$61	Public	Segregated/Comm
Monroe, WI	$6	$97	$103	$35	$68	Public	Commingled
Lincoln Park, NJ	$19	$67	$86	$7	$79	Public	--
Columbia, MO	$2	$84	$86	$7	$79	Public	Segregated
Austin, TX	$12	$108	$120	$29	$91	Public	Commingled
Upper Township, NJ	$3	$95	$99	$0	$99	Public	Commingled
Lincoln, NE	$1	$126	$126	$0	$126	Public/Contract	Commingled
Fennimore, WI	$45	$125	$170	$23	$147	Public	Segregated
Bowdoinham, ME	$7	$156	$163	$13	$150	Public	Commingled
Takoma Park, MD	$9	$144	$153	$0	$153	Public	Commingled
West Palm Beach, FL	$4	$162	$166	$0	$166	Public	Commingled
Philadelphia, PA	$85	$158	$243	$2	$241	Public	Commingled

Key: DO = Primarily drop-off program O&M = Operating & Maintenance -- = Not Applicable

Notes:

(a) Private haulers under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station. Although these latter costs are not available, net costs are calculated above because, according to City officials their costs are accounted for in the City's O&M costs.

(b) The publicly run component of Newark's curbside program was more expensive, on a per ton basis, than the contracted segment of the program.

refuse to disposal sites. In 1990 Peterborough, a small rural New England town, recycled 42 percent of its residential waste at its drop-off site, incurring an O&M cost of $45 per ton for collection and processing (see Tables 8.4, 8.5, and 8.11).

Drop-off collection supplements curbside collection in a number of communities. By enabling residents and/or business establishments to drop off their recyclable or compostable materials throughout the week, and by accepting materials not collected at curbside, drop-off collection not only reduces total per ton program costs but also can increase the overall tonnage of material collected. In West Linn, 36 percent of the materials recovered in 1990 were collected and marketed through the City's drop-off center at an O&M cost of $31 per ton (see Tables 8.4 and 8.11). In contrast to these costs, the City's private hauler reports incurring $114 per ton to collect recyclable material at curbside. Sonoma County contracts with nonprofit and for-profit recycling companies to operate drop-off sites at disposal facilities. In FY 1990 these contracts cost the County $12 for every ton recycled (see Tables 8.4 and 8.11).

Philadelphia's Block Corner Program is another effective and inexpensive recycling system. In 1990 recyclables were collected from 10 block corner neighborhoods at an estimated cost of $58 per ton—one-third the cost of the City's curbside program. Revenues from the material sales are returned to the community and used to fund neighborhood projects.

Service Provider: Public Versus Private

Either the public sector, the private sector, or some combination of the two can undertake collection and processing services for recyclables

Chart 8.2a

Recycling Collection and Processing O&M Costs

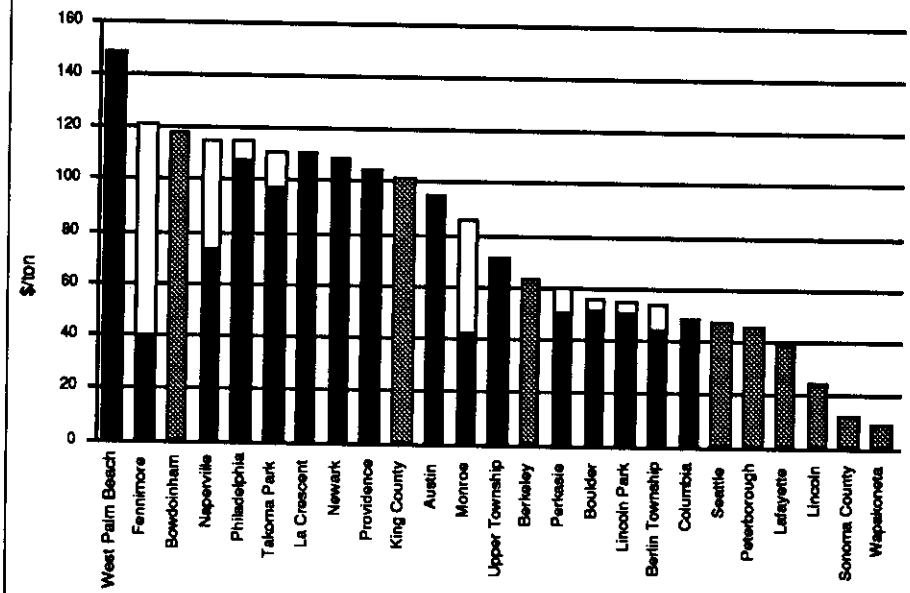
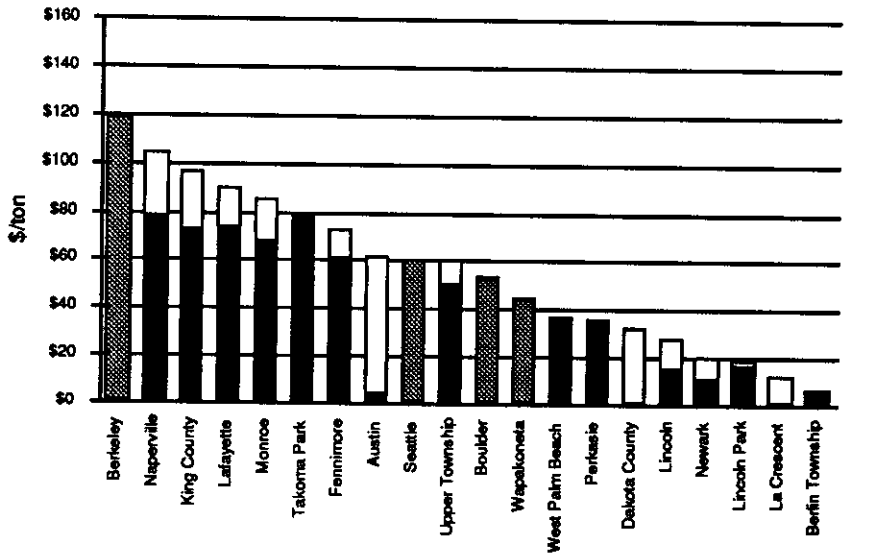


Chart 8.2b

Composting Collection and Processing O&M Costs



Note: In a few communities costs cannot be broken down into collection and processing.

and yard waste. A little over one-third of our 30 communities use public crews to collect recyclables; another third contract with private haulers to provide this service; and in the remainder private haulers provide this service independent of the public sector. Arrangements for yard waste collection service vary similarly. Table 8.13 lists communities' total capital and O&M costs for recycling organized by service provider.

As Table 8.13 indicates, costs vary widely for systems with both public and contracted haulers.[7] The net recycling costs (including collection, processing, administration, education, and annualized capital costs) of programs with contracted collection service range from $56 per ton in Seattle to $125 per ton in Lafayette.[8] The City of Newark, which relies primarily on contracted service, incurred a net cost of $141 per ton of material recycled. Communities using public collection crews incur net total costs ranging from $57 per ton in Berlin Township, New Jersey to $307 per ton in Philadelphia.[9] The two least expensive programs (Wapakoneta

and Peterborough) are publicly run drop-off programs. The least expensive curbside program is Seattle's, a contract system.[10] The next least expensive curbside program is Berlin Township's, a publicly run system.

There are financial advantages and disadvantages to each system. (See Table 8.14.) Communities with contracted recycling programs incur fewer capital outlays than do communities that provide service. By contracting out collection, communities also relieve themselves of the responsibility of coordinating the logistics of collection, which may lower their administrative and overhead costs. Yet contractors may pass on these costs and the cost of their equipment in the fees they charge. As listed in Table 8.11, many of the communities with the highest per ton administrative costs (over $14 per ton) are those with publicly run systems. However, communities contracting out service usually do not receive the revenue from material sales (which may be of greater concern when secondary material prices rise). As indicated in Table 8.13, revenue earned from the sale of materials can substantially lower the per ton costs of publicly run materials recovery programs.

There is some difference between public and private service providers in regard to crew size. Within our 30 communities, the average crew size per collection vehicle is 2.4 people for public collection programs and 1.8 people for private collection. In some cases larger crews increase costs, but in other cases they do not. Although labor costs do make up a large portion of O&M costs, total labor costs depend not on the number of crew members per vehicle but on total labor hours required. Larger crews may get the job done more quickly. For instance, the Naperville Area Recycling Center switched from two- to three-

Table 8.14
Advantages and Disadvantages of Public and Private Service Providers

	Public	Private/Contracted
Collection	Municipalities directly control the number and types of materials targeted.	Municipalities can control the number and types of materials targeted through contracts. However, if contracts are not up for renegotiation, municipalities may not have this flexibility. Municipalities do not need to oversee the logistics of collection, which will reduce administrative overhead.
Processing	Municipalities incur costs of processing and are responsible for finding markets, unless counties or state agencies provide this service.	Municipalities do not need to oversee the logistics of processing, which minimizes administrative overhead. Municipalities often pay no costs for delivering materials to private processing centers. They may have to pay a tipping fee or they may even be paid revenue.
Marketing	Municipalities retain direct control of the materials and how these are marketed. Municipalities retain control of the materials revenue.	Municipalities may have less control over the choice of end markets. (Contracts may stipulate market preferences.) Municipalities avoid the responsibility of securing markets thus avoiding the potential need to store materials until markets open up. Relying on private processors/contractors can ease the effect of market fluctuations on smaller communities' budget.
Efficiency	Municipal employees may not be as efficient due to lack of profit incentive. (Time incentives may alter this.)	Private sector may provide more efficient services due to profit incentive.
Labor	Public crews tend to be larger than private crews.	Private crews tend to be smaller than public crews.
Financing	Municipalities may have better access to more capital to purchase equipment.	Municipalities do not need to incur capital costs for equipment. However, contractors may pass these costs on in the fees they charge.
Other	Communities may have the opportunity and ability to more fully integrate recycling programs into their solid waste management system rather than having recycling as an add-on cost to the system.	Communities can negotiate flexibility into their contracts. Community-based recycling businesses provide benefits to the community beyond recycling collection and processing services.

person crews to speed curbside collection of materials and to minimize overtime pay. The City of Philadelphia, which has the highest reported per ton O&M curbside collection cost in our sample, utilizes three crew members per vehicle. The City asserts that reducing crew size would not increase route efficiency. (Due to the high population density of Philadelphia, the City claims that recyclables are loaded more rapidly when the driver remains on board and two additional crew members follow behind to load materials.) The City does agree that reducing crew size from three to two in less dense regions, which represent approximately 10 to 20 percent of the City, would lower costs. In addition, the City is working to increase the operating efficiency of its crews.

Whether collection is private or public, municipalities have the opportunity to restructure their overall solid waste management system by shifting crews or vehicles from refuse collection to materials recovery or by encouraging their contractors to do so. Flexible contracts that allow restructuring are more attractive than fixed contracts, which do not allow the community to shirt personnel and equipment to other tasks. Perkasie, Pennsylvania and Takoma Park, Maryland replaced their second weekly trash collection day with recycling collection, using the same municipal crews to collect trash and recyclables. In an effort to encourage integration of recycling and refuse collection, Newark has requested that its new contracted hauler, servicing one-third of the City, collect both refuse and recyclables.

Segregated Versus Commingled Collection and Processing

Curbside set-out and collection methods vary widely from community to community. (See Table 5.6 in Chapter 5.) Communities design their set-out and collection methods to fit existing or planned processing systems, which in turn are designed to meet the material specifications stipulated by end users. Overall O&M and capital costs depend on both collection and processing strategies. There are trade-offs between capital investments and operating costs, and between collection costs and processing costs. A community may have an expensive collection system but an inexpensive processing system, which may translate to an inexpensive recycling program overall, or vice versa. For example, a collection system in which materials are sorted en route may obviate the need for a processing facility or may only require one with minimal processing equipment. Expensive equipment may reduce labor requirements and thus operating costs. However, the higher the capital costs, the larger the debt a community generally has to assume.

The reject rate, which results primarily from excessive glass breakage, at high-technology facilities can have a direct effect on recovery rates and costs.

The number and types of materials targeted for collection, the type of processing system available, market specifications for sale of the material, and level of service desired (customer convenience), often dictate the nature of set-out and collection. Over one-third of the 27 communities with curbside collection programs utilize some form of segregated set-out, with the number of sorts varying from three to eight.[11] (In this report, segregated systems are defined as those in which residents are requested to separate their glass from their metal food and beverage containers.) In other programs, residents are allowed to commingle at least some materials, which are sorted either en route (partially or completely) or at processing facilities.

Co-collection systems, in which source-separated materials are collected at the same time and with the same vehicle as refuse, may offer communities the opportunity to reduce recycling collection costs by eliminating the need for separate recycling vehicles, crews, and routes. A number of communities have tried these systems with mixed results. (See side bar, p. 138.) A promising type of co-collection is the "wet/dry" system—which has demonstrated potential to achieve high diversion rates. In wet/dry systems, dry recyclables are segregated at set-out from wet organic and compostable materials; these are segregated from any remaining refuse, and all three are collected either in the same vehicle or in different vehicles. See Chapter 5 and Appendix E for further discussion on wet/dry collection.

Table 8.15
Advantages and Disadvantages Between Commingled and Segregated Set-Out and Collection Systems

	Commingled	Segregated
O&M Cost	The O&M cost to collect commingled recyclables may be less since there are usually only two different containers or bags to pick up, but processing costs may be higher. Collection costs will increase if processing center is located far away.	The O&M cost may be more due to the slower speed of collection since there can be many different containers or bags to pick up, but processing costs may be lower or avoided altogether.
Capital Cost	The capital cost for collection may be less because specialized recycling vehicles are not needed.	Capital cost for collection may be higher if specialized recycling vehicles or several different vehicles are used.
	Processing facilities may be more expensive to build since more sorting equipment may be needed.	Processing facilities will not need as much sorting equipment.
Reject Rate	Materials entering the processing facility are rejected (average 7 percent with a range of 0.5-16 percent).	Segregated materials entering the processing facility have a lower reject rate (average 1.2 percent with a range of 0-4 percent).
Revenue	Materials may be more contaminated resulting in a lower market value.	Materials may be higher quality and have a higher market value.
Labor	Less labor is required for collection.	More labor may be needed for processing.
	More time is needed for crew to load recyclables into collection vehicle.	Less labor may be needed for processing.

Of our 30 communities, two—Bowdoinham and Lincoln—have used co-collection. In the small rural town of Bowdoinham, a private hauler collects clear bags of recyclables and clear bags of refuse in a pick-up truck. In Lincoln two private haulers retrofitted their packer trucks with bins for collecting aluminum and newspapers. As the private sector operates both these programs, costs are not available.

The other 25 communities with curbside collection systems collect either commingled or segregated recyclables using dedicated recycling vehicles. Communities within our sample that utilize segregated collection systems are primarily suburban or rural. In Naperville, Columbia, Portland, and West Linn, residents set out their recyclables completely segregated, and even color-sort glass. In Fennimore and La Crescent, collection crews color-sort glass. The programs in Berkeley, Boulder, and Perkasie can also be considered segregated collection systems. The majority of the communities in this study, including many of the largest cities such as Providence, San Francisco, Charlotte (Mecklenburg County), Philadelphia, and Seattle, utilize commingled collection systems. The propensity of larger communities to select commingled systems may be attributed to the desire to speed collection; the desire to increase program participation through convenient set-out methods; the ability to support large, capital intensive processing centers to sort recyclables; and the ability to realize low operating costs as a result of the economies of scale of these centers.

There are advantages and disadvantages to both commingled and more segregated set-out and collection methods, as outlined in Table 8.15. Commingled systems allow crews to collect materials faster than segregated systems. Greater collection efficiency translates into lower collection costs. (It also might mean less capital cost investment in collection equipment because communities might be able to use existing collection vehicles and need fewer trucks.) Processing costs may be higher than those incurred by more segregated systems, and depend on scale of processing facility and equipment and labor requirements. If commingled materials are sorted at a central sorting facility, the community may benefit from low operating costs that economies of scale provide. Systems with highly segregated set-out and those that require workers to do additional sorting on the collection route can be expected to have higher collection costs due to the increased time needed to load the different materials. This higher collection cost may be offset by lower processing costs and lower materials reject rates, which lead to lower disposal costs. (The costs of collection in Fennimore and Columbia, however, indicate that segregated collection systems do not necessarily have high costs. Operating and maintenance costs for collection in these communities, where public crews color-sort glass en route, are $39 and $49 per ton, respectively.)

Table 8.16 lists per ton O&M collection and processing costs incurred by the public sector including the community itself, the County, and the State if applicable. (As mentioned earlier, previous tables list only communities' direct costs.) Costs vary widely. The gross operating costs of segregated curbside systems, including collection and processing, range from a low of $39 per ton in Lafayette to a high of $215 per ton in La Crescent. Of the communities with commingled systems, Berlin Township has the lowest O&M collection cost at $42 per ton ($58 per ton including processing). Philadelphia has the highest at $173 per ton ($181 per ton including processing), and West Palm Beach has the second highest at $148 per ton ($169 per ton including processing).

Because our sample of 30 communities consists of very different programs across the country, we cannot effectively compare costs among them to determine whether commingled or segregated systems are more cost-effective. Other variables—amount of materials collected per household, tons per day collected and processed, labor costs, and basis of contract fees—may have a more significant impact on operating costs than actual set-out, collection, and processing methods. For example, Philadelphia's and West Palm Beach's high collection costs may have something to do with the fact that both programs collect less than 6 pounds of recyclable material per serviced household per week. Berlin Township, on the other hand, which has a low collection cost, collects nearly 20 pounds per serviced household. Both Lafayette and La Crescent contract out recycling collection service, and thus these costs may not be representative of the actual operating expenses of the programs.[12] La Crescent's high program costs can be attributed to factors other than set-out and collection system. These include the long distances (up to 40 miles each way) that its contracted hauler must travel to unload materials at the County processing center, the relatively small amount of recyclables collected per household, and the fact that payment to the City's recycling hauler (which is also the City's refuse hauler) is tied to the number of refuse bags sold in the City, which may diminish the company's incentive to increase the amount of recyclables collected.

Nevertheless, by looking at some individual programs and processing facilities we can illustrate some of the strengths and weaknesses of commingled and more segregated systems.

Most of the facilities accepting segregated materials have lower capital costs than those accepting commingled materials (see Table 8.17). The high-technology 240 ton-per-day CRInc facility—which processes commingled recyclables—in Montgomery County, Maryland cost $8.5 million to construct. In contrast, the 72 ton-per-day medium-technology processing center, which is owned and operated by Eco-Cycle in Boulder and processes segregated recyclables, cost $687,500 (1990 dollars) to build and equip—one third the cost per ton-per-day of installed capacity. The two processing facilities in Seattle provide a striking comparison of the cost difference between high-technology systems and low- and medium-technology systems. The hauler serving Seattle's north section delivers semi-segregated recyclables to the 300 ton-per-day Recycle America Processing

Table 8.16
Public Sector Curbside Recycling Collection and Processing Gross O&M Costs

	Lbs. Per Serviced Household Per Week	Per Ton Collection Cost	Public/ Private Collection	Contract Arrangement (a)	Number of Crew Members	Per Ton Processing Cost	Public or Private Facility (b)	Per Ton Collection & Processing Cost	Per Household Collection & Processing Cost Per Year	Commingled Collection System
Austin, TX	2.6	$98	Public	--	2	$0 (c)	Private	$98	$7	Yes
Berkeley, CA	5.8	NA	Contract	flat fee	1-2	NA	Private	$67	$10	No
Berlin Township, NJ	20.9	$42	Public	--	1	$16 (d)	Pub/Pri	$58	$30	Yes
Boulder, CO	7.0	$51	Contract	flat fee, per HH (e)	2	$5 (f)	Private	$56	$10	No
Columbia, MO	5.7	$49	Public	--	2	$0 (c)	Private	$49	$7	No
Dakota County, MN	NA	NA	Private	--	Varies	$81	Pub/Pri	NA	NA	No
Fennimore, WI	6.4	$39 (g)	Public	--	2	$83	Public	$122	$20	No
La Crescent, MN	5.7	$111	Contract	per refuse bag sold	3	$104 (h)	Public	$215	$32	No
Lafayette, LA	3.4	NA	Contract	per HH	3	NA	Private	$39 (i)	$3	No
Lincoln, NE	1.9	$33	Contract	NA	1	$15	Private	$48	$2	Yes
Mecklenburg Co., NC	6.1	$96 (j)	Public	--	1	$8	Private	$104	$16	Yes
Monroe, WI	5.3	$41 (g)	Public	--	2	$45	Public	$86	$12	Yes
Naperville, IL	12.0	$73	Contract	flat fee	3	$43	Private	$116	$36	No
Newark, NJ	2.2	$140	Public/Contract (k)	--	3	$0 (c)	Private	$140	$8	Yes
Perkasie, PA	9.5 (l)	$50 (g)	Public	--	2-4	$10	Public	$60	$17	Varies
Philadelphia, PA	5.9	$173 (m)	Public	--	3	$8 (n)	Private	$181	$21	Yes
Providence, RI	5.6	$105	Contract	flat fee, per HH	1	$32 (o)	Pub/Pri	$137	$20	Yes
San Francisco, CA	6.9	$0	Private	--	1	$0	Private	$0	NA	Yes
Seattle (North), WA	15.8	NA	Contract	per ton	1	NA	Private	$52 (p)	$19	Yes
Seattle (South), WA	13.1	NA	Contract	per ton	1	NA	Private	$57 (p)	$15	Yes
Sonoma County, CA	8.8	$0	Private	--	1	$0	Private	$0	NA	Yes
Takoma Park, MD	11.9	$97	Public	--	3	$14 (q)	Private	$111	$34	Yes
Upper Township, NJ	NA (r)	$71 (g)	Public	--	3	$80 (s)	Pub/Pri	$151	NA	Yes
West Linn, OR	7.7	$0	Private	--	3	$0	Private	$0 (t)	$23	No
West Palm Beach, FL	5.3	$148	Public	--	1	$21 (u)	Pub/Pri	$169	$23	Yes

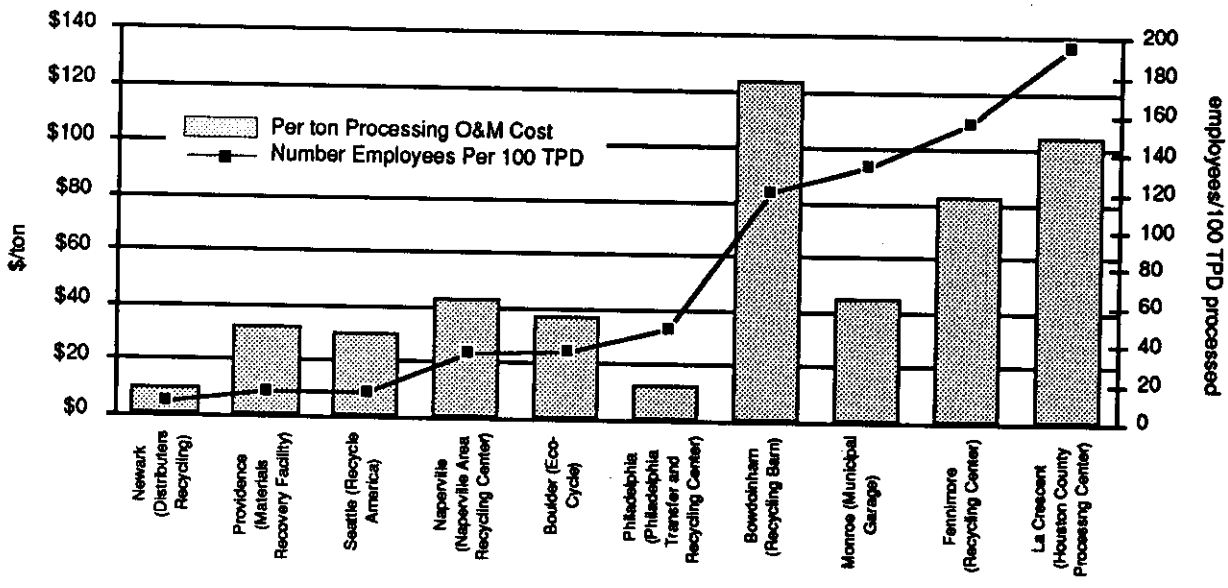
Key:
HH = Household NA = Not Available -- = Not Applicable

Notes:
Above costs are the per ton gross O&M curbside collection and processing costs incurred by the public sector, including the community itself, the County, or the State. These costs exclude any revenue received from sale of materials.
(a) Contract arrangement: "Flat fee" indicates that the contracted curbside hauler is paid a flat yearly fee for service. "Per ton" or "per household" indicates that the contracted service provider is paid on the specified basis only.
(b) Pub/Pri indicates publicly owned and privately operated facilities.
(c) Austin delivers recyclables to a private processing facility and no tipping fee is incurred. Columbia's and Newark's materials are privately processed and the City incurs no cost.
(d) Processing cost represents Township's cost to market its waste paper and the County's cost to process the Township's food and beverage containers. This latter cost was reported as $25 per ton in 1990 in "1992-93 Materials Recovery a
(e) Boulder paid Western Disposal a flat fee to service a certain number of households and a per household fee for the households above that number.
(f) The City pays Eco-Cycle $5 per ton processed. (Eco-Cycle's 1990 gross O&M cost was $37 per ton.)
(g) Cost includes some drop-off collection.
(h) Houston County incurred this cost.
(i) This cost represents contract fees the City paid to The Recycling Foundation in FY 1990. Contract fees increased in FY 1991.
(j) The City of Charlotte incurred this cost, which is based on 6-month cost data.
(k) The City collected materials from one-third of Newark for 6 months and contracted with two different groups to collect the remainder.
(l) Includes materials collected from 15 small businesses and the drop-off site.
(m) Cost excludes the compensation paid to farmers to collect food waste. If included, per ton collection cost would drop to $107.
(n) The City paid $30 per ton at the Philadelphia Transfer and Recycling Center and received $5 per ton at The Forge.
(o) The State incurs this cost.
(p) Seattle renegotiated its contract. In 1993 the City will pay one hauler $78 per ton and the other $84 per ton for both collecting and processing recyclables.
(q) Cost largely represents City's fees to private hauler to market materials collected at curbside and at drop-offs.
(r) The Township also collects recyclables from businesses; lbs./household is not available.
(s) Cape May County incurs this cost.
(t) West Linn Disposal, the City's private hauler, incurs $114 per ton for collecting and processing recyclables.
(u) The Solid Waste Authority of Palm Beach County incurs this cost, which represents processing costs at its new facility built after the base year of study.

Center, which cost an estimated $500,000. Since recyclables are partially separated by the generators and are collected in compartmentalized trucks, the facility is used primarily for baling and for sorting commingled bottles and cans. In contrast, the Rabanco Recycling Center, to which the hauler serving Seattle's south section brings fully commingled recyclables, is a 500 to 700 ton-per-day facility that cost between $6 million and $8 million. This facility uses a combination of conveyors, trommel, disc screens, magnetic separation, air classification, hand picking, and baling. The Rabanco Recycling Center cost almost seven times as much as the Recycle America Processing Center on a ton-per-day of installed capacity basis.

On the other hand, because of the low throughput of many of the facilities processing segregated recyclables, these systems often have higher capital costs per ton-per-day of installed capacity than the typically larger commingled facilities. Fennimore, for example, which has relatively low collection costs, has relatively high processing costs at $83 per ton. Two factors contribute to Fennimore's high per ton operating costs: only 1.62 tons per day are processed, and the City's crews must travel 42 miles to market glass and metals. In addition, processing facilities with small tonnage throughputs, such as those utilized by Bowdoinham, Fennimore, and Monroe, have much higher per ton O&M processing costs than larger facilities (such as those in Seattle, Providence, or Montgomery County). The amount of manual labor used at small facilities is one reason for their higher per ton cost. Bowdoinham employs two workers at its 2 ton-per-day facility (or 120 employees per 100 tons per day processed). Large facilities can process on the order of several hundred tons per day with high-technology equipment and relatively few employees. For example, the Montgomery County facility employs 9 workers per 100 tons per day processed; the Rhode Island facility utilizes 12.5 employees per 100 tons per day processed. Chart 8.3 shows the relationship between the number of employees per 100 tons per day processed and the O&M processing cost. As the number of employees per ton-per-day processed increases, so does the O&M cost.

Chart 8.3
Processing Facility O&M Costs and Labor Requirements



Note: Costs represent the actual operating and maintenance expenses of the listed facility and are not necessarily incurred by the documented communities. Some communities are excluded because either their O&M costs or the number of employees per 100 tons per day were not available.

Table 8.17

Costs and Characteristics of Intermediate Processing Facilities

Community	Facility Name	Distance to IPC (miles)	Regional Facility	Days Per Year in Operation	Design Capacity (TPD)	Through-put (TPD)	Daily Tonnage Delivered By Community	Capital Cost (1990$) (a)	Capital Cost ($/TPD of capacity) (b)
SEGREGATED									
Berkeley, CA	SWMC	L	No	NA	75	50	NA	$370,400	$4,900
Boulder, CO	Eco-Cycle	L	Yes	254	NA	72	25	$687,500	$9,500
Columbia, MO	Civic Recycling	5/L	No	260	100	75	5.8	NA	NA
Dakota County, MN	RCC	--	No	307	20	40	--	$238,100	$11,900
Fennimore, WI	Recycle Center	1/L	No	200	NA	1.6	1.6	$94,700	$58,800
La Crescent, MN	Houston County IPC	10-40	Yes	235	5	2.6	1.3	$269,700	$53,900
Lafayette, LA	Recycling Foundation IPC	0-15	No	305	30	20	8	NA	NA
Naperville, IL	NARC	10/L	Yes	NA	50	35-70	NA	$75,000	$1,500
Perkasie, PA	Public Works Yard	0-15/L	No	--	NA	3	--	$51,700	$16,200
Portland; West Linn, OR	K.B. Recycling	32,242	Yes	312	NA	167	NA	$1,500,000	$9,000
COMMINGLED									
Austin, TX	ACCO	L	Yes	280	400	200	25	NA	NA
Austin, TX	Ecology Action	L	Yes	250	21	11	NA	NA	NA
Berlin Township, NJ	CCRF	10	Yes	250	80	72	1.5	$781,400	$9,800
Bowdoinham, ME	Recycling Barn	1	No	156	NA	1.4	1.4	$16,400	$11,700
Mecklenburg Co, NC	FCR/Charlotte IPC	NA	Yes	255	200	80 (g)	73	$700,000	$3,500
Monroe, WI	Municipal Garage	1/L	No	NA	NA	3	NA	$16,600	NA
Newark, NJ	Distributers Recycling	1-20/L	Yes	NA	NA	240	NA	$1,250,000	$5,200
Philadelphia, PA	PTRC	1-10/L	Yes	260	100	75	40	NA	NA
Providence, RI	MRF	15	No	260	120	190-240	31	$6,000,000	$25,000
San Francisco, CA	West Coast Salvage	3-5/L	Yes	NA	NA	450	3,000	NA	NA
Seattle, WA	Recycle America PC	NA/L	No	260	300	<200	NA	$500,000	$1,700
Seattle, WA	Rabanco Recycling Ctr.	NA/L	No	NA	600	300	NA	$7,000,000	$11,700
Takoma Park, MD	Georgetown Paper Stock	10	Yes	281	500	350-400	1.2	NA	NA
Takoma Park, MD	Montgomery Co. Rec. Ctr.	13	Yes	260	240	NA	NA	$8,500,000	$35,400
Upper Township, NJ	CMCMUA IPF	1-15/L	Yes	256	225	50-90	10	$575,400	$2,600
West Palm Beach, FL (k)	SWA MRF	18-51	Yes	302	250	200	8.4	$6,300,000	$25,200

Key:

() Denotes revenue received.
A = Aluminum
ACCO = ACCO Waste Paper Processing Center
B = Batteries
CCRF = Camden County Recycling Facility
CMCMUA IPF = Cape May County Intermediate Processing Facility
F = Ferrous Cans
G = Glass
FCR = Fairfield County Recycling
HP = High-grade Paper
IPC = Intermediate Processing Center
L = Located within city limits
M = Scrap Metal
MP = Mixed Paper
MRF = Materials Recovery Facility

Notes:

"Segregated" designates IPCs that receive food and beverage containers pre-sorted into more than one stream.
"Commingled" designates IPCs that receive food and beverage containers unsorted in one stream.
Costs are not necessarily incurred by the listed jurisdiction.

(a) In Naperville, West Linn, Portland, Mecklenburg Co., Newark, Takoma Park (Montgomery Co.), Seattle (both), and Providence, capital costs of IPCs are estimates based on the year of construction and therefore are not converted into 1990 dollars.

(b) For Fennimore, Monroe, Newark, Perkasie, Portland, and West Linn capital costs $/TPD of capacity were calculated with the TPD throughput because the design capacity is not available. The capital costs for the improvements of Naperville's facility are not included. In Providence, the MRF currently operates over two shifts; thus 240 TPD was utilized.

Table 8.17 continued

Annual O&M Cost ($/ton)	Tip Fee ($/ton)	Revenue Per Ton	Revenue Recipients	Materials Processed	Reject Rate (% by weight) (c)	Total Number of Employees	Number of Employees Per 100 TPD Processed	Tech-nology Type (d)
NA	$0	$28	Operator	A,F,G,MP,ONP	1	14	28	Medium
$37	$0	$53	Operator	A,B,F,G,HP,MP,OCC,ONP	1	25	35	Medium
NA	RR (e)	NA	City/Operator	A,F,G,HP,MP,OCC,ONP,P	NA	20	27	Medium
$68	($33)	$35	Operator/County	A,F,G,OCC,ONP,P	1	NA	NA	Medium
$83	$0	$23	City	A,F,G,HP,MP,OCC,ONP,P	0	3	155	Medium
$104	$0	$51	County	A,B,F,G,HP,OCC,ONP,P,WG	1	5	195	Medium
NA	$0	$37	Operator	A,F,G,OCC,ONP,P	1	13	65	Low
$43	$0	NA	Operator/City	A,F,G,HP,MP,OCC,ONP,P	2-5	15-20	33	Medium
$12	$0	$11	Borough/Operator	A,G,MP,OCC,ONP	0	NA	NA	Low
NA	RR	NA	Operator	A,F,G,M,MP,O,OCC,ONP,P	2	20	12	Medium
NA	($20)	NA	City	A,F,G,OCC,ONP	10	22	11	Medium
NA	NA	NA	Operator	A,B,F,G,HP,MP,OCC,ONP,P	NA	4	36	Medium
$25 (f)	$0	NA	County/City	A,F,G,P	15.6*	20	28	Medium
$124	$0	$10	City	A,B,F,G,HP,M,MP,O,OCC,ONP,P,WG,X	5	2	120	Low
NA	$8	NA	Operator/County	A,F,G,ONP,P	7	26	33	Medium
$45	$8	$35	City	A,B,F,G,HP,M,MP,O,OCC,ONP,P,WG	<1	5	133 (h)	Low
$9	($12)	NA	Operator	A,F,G,M	5	15	6	Medium
$13	$30	NA	Operator	A,F,G,ONP,P	13	35	47	Medium
$32	$0	$29	Operator/State	A,F,G,ONP,P	14	27	13	High
NA	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P,X	NA	102	23	Medium
$30	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P	0.5	24.5	~13	Medium
NA	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P	2.7	16	5	High
NA	$20 (i)	NA	Operator	A,F,G,HP,MP,ONP	10	50	13	Medium
NA	NA (j)	NA	Operator/County	A,F,G,ONP,P	7-12	24	9 (h)	High
$80	$0	NA	Operator/County	A,F,G,HP,MP,OCC,ONP,P	2.38*	40-85	NA	Medium
$21	$0	NA	Operator/County	A,F,G,OCC,ONP,P	6	18	9	High

NA = Not Available
NARC = Naperville Area Recycling Center
O = Oil
OCC = Corrugated Cardboard
ONP = Newspaper
P = Plastics
PC = Processing Center
PTRC = Philadelphia Transfer and Recycling Center
RCC = Recyclables Collection Center
RR = Revenue Received
RRT = Resource Recycling Technologies
SWA MRF = Solid Waste Authority MRF
SWMC = Solid Waste Management Center
TPD = Tons Per Day
WG = White Goods, Appliances
WMI = Waste Management Inc.
X = Other, inc. salvaged items

(c) Municipalities noted with an asterisk weigh residue; the remaining municipalities do not.
(d) Low: minimal equipment, relies heavily on manual labor. Medium: some equipment and manual labor. High: extensive equipment (elaborate conveyor systems, etc.) to sort/process commingled recyclables.
(e) In Columbia revenue is received as part of the processing tipping fee arrangement for all materials but paper.
(f) Represents 1990 O&M costs as reported in "1992-93 Materials Recovery and Recycling Yearbook" (New York: Governmental Advisory Associates, Inc., 1992)
(g) Although FCR/Charlotte processes 80 tons per day operating one shift, the facility was designed to process 200 tons per day in two daily shifts.
(h) The number of employees per 100 TPD processed is based on design capacity rather than throughput.
(i) There is a $20 per ton processing fee arrangement for commingled recyclables.
(j) The County pays CRInc. a flat fee of $844,000 per year for processing recyclables.
(k) Characteristics listed above are for Palm Beach County's new processing facility, which became operational in April 1991 (after the base year of study).

One way to reduce materials recovery processing costs is to deliver materials directly to market without prior processing, and/or to perform a minimal level of processing, such as color-sorting glass, on the vehicle. In Berlin Township, Dakota County, Lincoln Park, Perkasie, and Portland, some materials are delivered directly to markets without being processed. Berlin Township brings newspaper and mixed paper directly to a paper mill. Perkasie does not have a real processing facility. Collection workers separate all glass and aluminum at curbside, put them into a compartmentalized trailer, and deliver them to the pubic works yard, where vendors collect them. Paper is collected separately and delivered directly to markets. Because materials are sorted at the curb or on the collection vehicle, material collected through segregated systems require minimal to no processing. In fact, a number of the communities employing segregated systems, such as Naperville, Boulder, and Perkasie, incur lower O&M processing costs than collection costs. Processing costs are $43 per ton in Naperville, $5 per ton in Boulder, and $10 in Perkasie.

Overall O&M and capital costs depend on both collection and processing strategies. There are trade-offs between capital investments and operating costs, and between collection costs and processing costs.

Another way to reduce processing costs is to take advantage of the economies of scale offered by centralized sorting facilities. Many of the communities utilizing commingled collection systems rely on large County- or State-run processing centers. (See Table 8.17.) Such facilities usually are capital-intensive, but have relatively low operating expenses. For example, Palm Beach County processes West Palm Beach's recyclables in its new $6.3 million processing facility, which opened in mid-1991 and is designed to process 220 tons per day. The County pays private operators $21 per ton to run the plant.

While large capital-intensive facilities benefit from economies of scale and thus can have lower operating costs, the extensive machinery utilized often results in high material breakage rates.

Providence, one of the largest cities in this study, provides a useful example of the advantages and disadvantages of commingled systems. Providence pays a private hauler $105 per ton to collect commingled recyclables, and the State spends $32 per ton to process the material at a high-technology processing facility operated by New England CRInc. The 200 ton-per-day facility cost $6 million. The facility receives an average of $29 per processed ton in materials revenue ($33 per marketed ton), half of which is for the sale of aluminum. However, over 40 percent of all glass entering the facility breaks. Broken glass is landfilled, as is other processing residue, which is estimated at 14 percent by weight of all material entering the facility. If we subtract the amount rejected at Rhode Island's processing center, Providence's per ton collection costs jump from $105 per (collected) ton to $119 per (marketed) ton. Operating costs for the processing facility are $37 per ton actually marketed ($32 per ton processed). The State of Rhode Island estimates that in 1990 it incurred $1.3 million in disposal costs and lost revenue collecting and processing glass containers that ended up in the landfill.[13]

In commingled systems, material can break or be otherwise rendered nonmarketable during collection and processing. For example, Rhode Island reports that approximately 20 percent of all glass collected breaks en route while another 20 percent breaks during processing at its high-technology facility. Seattle also reports problems with glass breakage en route and is currently storing a large pile of mixed glass cullet in the hope that market opportunities will open in the future. (In its new recycling contract, Seattle is requiring one of its haulers, who formerly collected all materials in one stream, to color-sort glass. This is predicted to reduce problems with glass breakage as well as increase the value of paper, which sometimes had been contaminated with broken glass slivers.) Fennimore and La Crescent, on the other hand, deliver color-sorted material to their processing centers and lose next to no material; nearly all collected tonnages are marketed.

Rhode Island is examining ways to retrofit collection vehicles (which are generally Labrie sideloading, dual-compartmentalized vehicles),

including installation of an interior net or baffling. Such methods have proven successful in shortening the fall of the glass containers and providing a plastic cushion for the glass.[14]

Some communities with medium- and high-technology processing facilities, such as Cape May County, New Jersey, have secured markets for broken glass. Approximately 50 percent of the glass delivered to Cape May County's IPC is broken by the time it reaches the facility. The County's arrangement with the IPC's private operators requires that they pay for the disposal of residue materials if these exceed 5.5 percent of commingled glass and cans. The operators market broken glass to a local glassphalt manufacturing company. In 1990 only 2.38 percent of all material entering the facility was landfilled as residue. Glassphalt, however, is not an optimum solution to the glass breakage problem. Whereas clear glass cullet was worth $42 per ton in 1991, a ton of mixed cullet for production of glassphalt brought in only $0 to $10.[15]

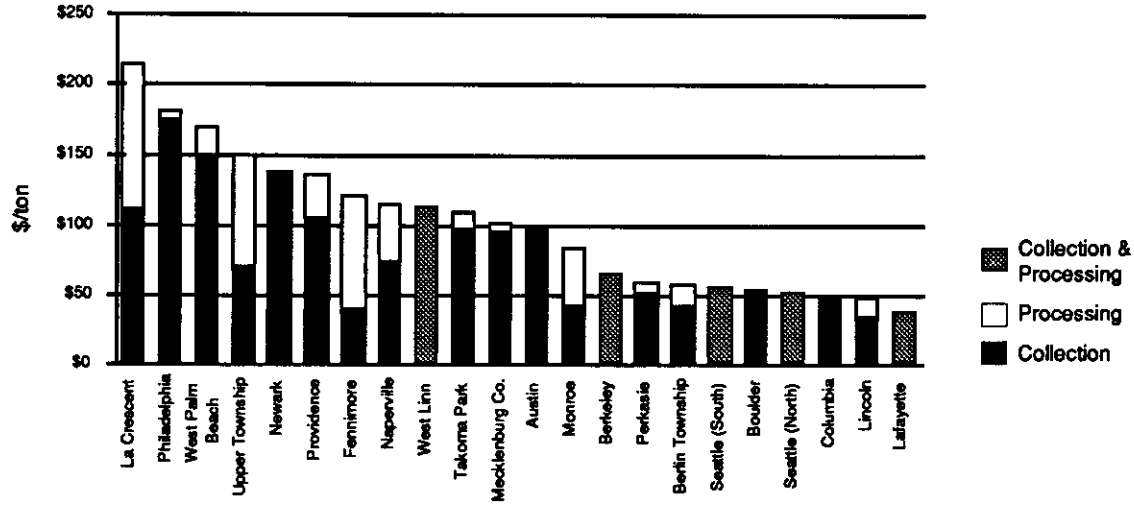
Collection and processing systems for segregated recyclables result in low breakage and reject rates. Reject rates at centers for segregated materials range from 0 to 4 percent by weight, with an average of a little above 1 percent. For commingled facilities the range is 0.5 percent to 16 percent by weight, with an average of 7 percent.

Many of the communities with segregated systems, such as Naperville, Berkeley, and Boulder, have gained a reputation of having especially high-quality materials. In some instances, end users have approached these cities to purchase materials.

The Effect of Labor on Cost

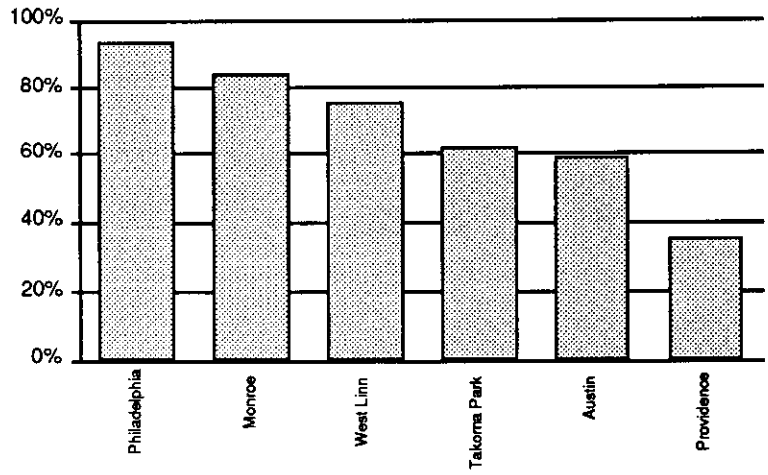
The variation in the cost of materials recovery is partially due to demographic and regional factors. The cost of living, which determines the average hourly wage paid to workers, varies greatly across the country. Household density affects the number of stops per collection route; topography and weather can influence collection efficiency as well as the number of crew members required per vehicle. Even the price of gasoline, which greatly affects transportation expenses, varies across the country. However, the same demographic factors that affect materials recovery will affect refuse collection. Among these variables,

Chart 8.4
Public Sector Curbside Recycling Collection and Processing O&M Costs



Notes: Costs represent the full public sector O&M collection and processing expenses for curbside recycling. Communities for which this information is unavailable are excluded. These costs are not always incurred by the documented community, and may represent County or State expenses. For West Linn, costs represent those incurred by the City's private hauler. Please see Table 8.16 for clarification.

Chart 8.5
Percent of Recycling Collection O&M Cost Spent on Labor



Notes: Many communities are missing because this information is not available. Monroe's figure is labor as a percent of total costs of recyclables and yard waste collection and processing.

labor expenses have perhaps the most significant effect on costs.

In communities with comprehensive curbside collection programs, collection costs account for the largest portion of total operating and maintenance costs. See Chart 8.4. Labor costs in turn account for most of the costs of collection. One industry report found that 69 percent of the total outlay for residential collection consists of labor costs.[16] Chart 8.5 shows labor costs as a portion of operating and maintenance costs for those communities for which this information is available. Hourly wages are often higher in large cities and their suburbs than in rural communities, or in cities in the South or Midwest. Higher wages can lead to higher collection costs. For example, Philadelphia pays its workers $9.50 per hour; labor costs make up more than 90 percent of its $173 per ton cost for municipal curbside collection of recyclables. In contrast, Austin pays its workers $7 per hour; labor costs make up less than 60 percent of its $98 per ton collection cost. Three workers operate each recycling collection vehicle in Philadelphia, while two operate the vehicles in Austin.

Labor costs have the same effect on refuse collection costs as on recycling and composting costs. In West Linn, where hourly wages are almost $15, the private hauler spends $114 per ton (75 percent of which goes for labor) on curbside collection of recyclables, and $144 per ton for refuse collection and disposal. In Philadelphia, collection of recyclables costs $173 per ton, while refuse collection and disposal cost $170 per ton.

Regardless of hourly wage and crew size, the key to keeping down the costs of materials recovery is efficient use of labor resources. Co-collection systems are already proving to be one way to do this. (See side bar on co-collection, page 138.)

While keeping down the costs of materials recovery is an important goal, providing jobs is important to communities as well. Recycling and composting programs employ people in a variety of capacities in both the private and public sectors. For example, processing centers that handle between 2 and 450 tons of recyclables per day employ between 2 and 102 workers—6 to 195 workers per ton-per-day processed. (See Table 8.17.) In recycling, the largest opportunity for job creation is actually in the remanufacturing field, which offers high-paying jobs. Materials recovery also provides employment for low-skilled, handicapped, and prison workers. (See Table 8.18.)

Reducing Program Costs

Whatever program design a community selects, there are ways to make recycling and composting more successful and cost-effective. By studying and comparing the costs incurred by our 30 communities, we have found that communities can reduce their overall materials recovery costs by:

- negotiating favorable conditions in contract arrangements,

Table 8.18
Communities Providing Employment Opportunities for Low-Skilled, Handicapped, or Prison Workers

Community	Non-traditional Labor
Austin, TX	ACCO Waste Paper Processing Center employs 20 developmentally disabled people to hand sort glass. Prison inmates remove leaves from plastic bags at the composting site.
Boulder, CO	Eco-Cycle employs five developmentally disabled people to sort recyclables.
La Crescent, MN	The Houston County Processing Center employs three handicapped people to process recyclables.
Lafayette, LA	In addition to paid employees, some prison laborers are used to separate recyclables.
Monroe, WI	Disabled workers from a local shelter are employed for approximately 8 months out of the year at or below minimum wage to sort recyclables.
Newark, NJ	Several state prison inmates work at the composting site. The City also contracts with the Occupa tional Center (OC) to service one third of the City with curbside collection. The OC is a community-based nonprofit organization that trains and educates handicapped individuals.
Seattle, WA	The City contracts with Seadrunar Recycling, a nonprofit organization committed to drug rehabilitation of juveniles and adults, for weekly pick-up of waste paper at Municipal offices.
Sonoma County, CA	Garbage Reincarnation uses volunteers from local schools, court-referral programs, and mentally disabled to sort and prepare materials for market.
West Linn, OR	Inmates from correctional facilities occasionally work at the drop-off center.

- utilizing drop-off programs in rural areas where curbside programs may not be cost-effective, or to supplement curbside programs,
- maximizing the public's participation and the amount of tonnage recovered,
- reducing the distance and time traveling to materials recovery processing centers or markets,
- utilizing collection vehicles with appropriate capacities to avoid frequent unloading,
- collecting source-separated yard waste for composting,
- taking advantage of private sector or regional processing facilities,
- sorting material en route to increase the quality of material, reduce processing costs, and minimize material rejected,
- integrating materials recovery programs and systems into the existing solid waste management system (rather than viewing them as add-on systems),
- utilizing appropriately designed co-collection systems, and
- making use of existing equipment.

Contracted Programs

As discussed earlier, a little less than one-third of the communities studied contract out for collection and/or processing services. The following strategies have proven effective in reducing costs and maximizing recovery levels in contracted situations:

- making use of competitive bids,
- including locally-based organizations and entreprenuers in the bidding process,
- retaining some portion of materials revenues,

- encouraging haulers to increase the amount of materials collected (e.g., by basing a contract on per ton fees), and
- negotiating refuse collection and disposal contracts that provide discounts for reduced refuse volume due to recycling or source reduction.

Competitive Bids

Communities can ensure lower contract fees through competitive bidding. Seattle has been able to maintain low recycling collection costs ($47 per ton in 1990) due to a 5-year contract obtained through a competitive bidding process.[17] Moreover, because the contracts are based on tonnage recovered, the haulers are provided with a strong incentive to maximize the material they collect. Newark's low per ton collection cost for yard waste—less than $10—is due in part to competitive bidding for yard waste collection. Philadelphia is framing a competitive bid structure that will enable both private companies and the municipal collection crew's union and management to participate in the bidding process.

Nonprofit Organizations

Six of the 30 communities contract with nonprofit recycling organizations for some aspect of their recycling collection or processing. Because nonprofit groups do not operate with a profit margin, communities that contract with such groups may incur lower costs than they would with for-profit companies. Nonprofit organizations typically provide services that extend beyond collection and processing. For example, many engage in extensive recycling and source reduction education programs.

Nonprofit groups in Berkeley provide cost-effective recycling services. In 1990 the City of Berkeley paid the Ecology Center the equivalent of $67 for every ton it collected and processed under its curbside recycling contract, and paid the Community Conservation Center, Inc. (CCC) $10 per ton recycled to operate the Berkeley Buy Back Center. The City also supports the activities of these organizations by providing them equipment and land.[18]

Boulder has one of the lowest processing costs among our 30 communities—$5 per ton. It contracts with Eco-Cycle, a local nonprofit organization, to provide this service. The City contracts with a private hauler to collect recyclables, but stipulates in the contract that the hauler must bring the materials it collects to Eco-Cycle for processing. The revenues from materials sales are then split between the two groups. Eco-Cycle keeps its costs down by using retrofitted equipment, and by assigning prison and community service laborers to certain processing tasks. Both Eco-Cycle (Boulder) and the Ecology Center (Berkeley) lead extensive educational programs in their cities.

Revenue Sharing

Communities can reduce the net costs of materials recovery by writing revenue-sharing agreements into recycling contracts. For instance, Urban Ore, a for-profit salvage/reuse drop-off operation in Berkeley, is required through a license agreement to pay the City 10 percent of its monthly gross revenues.[19] The contract fee paid to Berkeley's nonprofit curbside collection provider, the Ecology Center, is tied to the door price of newspaper, and is designed to cover the difference between the program's cost and the revenues earned from the materials sold. The City of Naperville receives 50 percent of the profit realized by the contractor. (In 1990 no profit was earned.) Columbia receives 50 percent of the average monthly price for aluminum and glass based on figures published in *Recycling Times*, and 70 percent of the indexed price from the *Paper Stock Report* for corrugated cardboard. (In addition, the City pays the processor a $15 per ton processing fee for newspaper.) Dakota County and Montgomery County receive some revenue from the sale of materials even though they contract with private firms to operate and maintain their processing facilities. The private operator of the facility in Montgomery County receives 25 percent of gross revenue, and the County receives 75 percent. Also, as an incentive to use local markets, the operators are responsible for 25 percent of the cost of transporting processed materials to market.

Cities can not only lower recycling costs through revenue-sharing agreements, but they can also help

ensure profitable or break-even contract arrangements for private haulers in light of highly variable market conditions. Seattle's new recycling contract stipulates that the City will share all market risk with its contractors. If prices for recyclables rise above predetermined levels, the City will receive all of the extra revenue in the form of reduced per ton payments. If prices fall, the City will cover all of the loss through higher per ton payments.

Retaining Flexibility to Reduce Refuse Costs in Refuse Contracts

Cities can retain the flexibility to shift resources between materials recovery programs and refuse collection through proper negotiating of refuse and recycling contracts. For example, when Naperville signed its last 5-year refuse collection contract, it was just beginning a pilot curbside program. A clause in the contract stipulated that after 1 year, the hauler, the recycling center, and the City would negotiate a rebate for the City from the hauler based on the volume of material diverted from the landfill by the recycling center. As a result of this clause, the City's refuse hauler gave Naperville a diversion credit of $35 for each ton of materials recycled in 1990. This credit was based on avoided tipping fees, trips to the landfill saved, and collection time saved. The value of the latter two was calculated by estimating the reduction in labor and vehicle costs. (Listed recycling costs for Naperville do not include this $35 per ton diversion credit.) Naperville further reduced its refuse collection costs in 1990 by eliminating one of its two weekly refuse collection days, and instead providing weekly collection of refuse, recyclables, and yard waste. In 1991 the City paid 20 percent less to collect and dispose of refuse.

Newark has requested bids for a new recycling collection contract in one-third of the City. It prefers that the future contractor pick up both recyclables and refuse from these zones so that collection infrastructure and equipment can be shared between these two functions.

Reducing Costs in Publicly-run Programs

Over one-third of the communities studied provide municipal pick-up of recyclables and/or yard waste. The following techniques have proven helpful in keeping down the costs of such programs. Some of these techniques may be applicable to privately operated programs as well.

Maximizing Participation and Tonnage Recovered

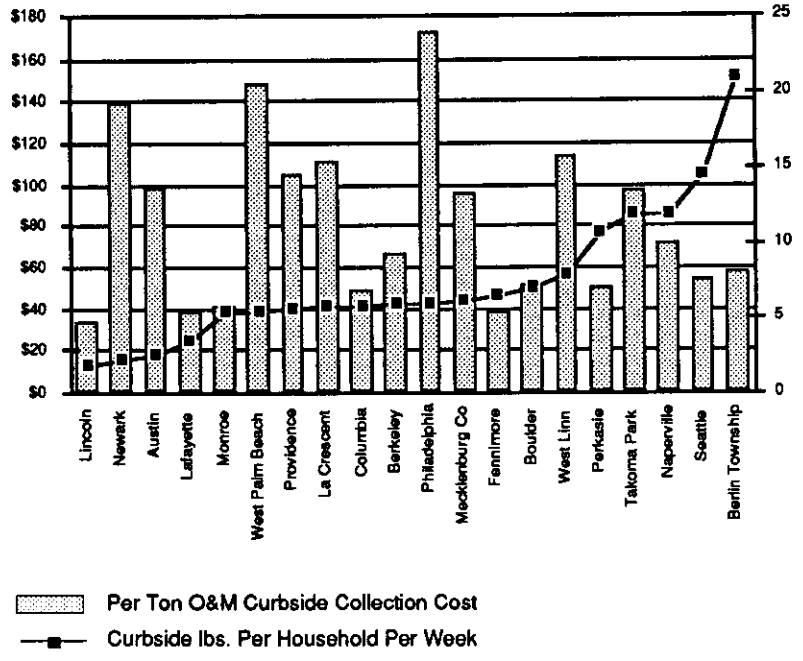
Communities that target a wide range of materials for collection (particularly items that comprise a significant percentage of the waste stream, such as residential mixed paper and yard waste), and secure the participation of all waste generators in collection programs, are able to reach waste recovery rates of 40 percent and above. (See Chapter 5.) Similarly, communities that maximize the amount of material collected, often have low per ton recycling and composting costs. A truck must travel the same route length regardless of how many residents participate in the program. Recycling collection systems become most cost-effective when the amount of material collected at each stop is maximized.

Chart 8.6 compares per ton curbside collection costs for recyclables to pounds recycled per week per household served. Although at first glance there may appear to be no direct correlation, note that six of the nine communities with costs above $80 per ton—Austin, Newark, West Palm Beach, Providence, La Crescent, and Philadelphia—are among those that recover the lowest amount of recyclables per household—all less than 6 pounds per week. In contrast, six of the eleven programs with costs lower than $80 per ton—Perkasie, Seattle, Naperville, Fennimore, Berlin Township, and Boulder—are recycling more than 6 pounds per week.

Austin collects relatively few materials at curbside: newspaper, corrugated cardboard, glass, aluminum, and ferrous cans. West Palm Beach, Providence, and Philadelphia collect only newspaper and food and beverage containers. These four communities are among those with the highest per ton costs. In comparison, Seattle,

Chart 8.6

O&M Collection Costs for Curbside Recycling Programs and Pounds Per Household Recycled



Notes: Berkeley's, Lafayette's, and Seattle's costs include processing. Fennimore's, Monroe's, and Perkasie's cost figures cover the collection of a small amount of drop-off materials. Mecklenburg County's costs represent the City of Charlotte's curbside collection costs.

Naperville, Fennimore, and Berlin Township collect many types of low- and high-grade paper in addition to food and beverage containers. Naperville also collects scrap metal, clean polystyrene containers, and LDPE 6-pack plastic rings. Fennimore and Berlin Township collect all types of PET and HDPE containers.

Because participation rates play a role in increasing recovery levels, they also affect per ton collection costs. Seattle, Fennimore, Berlin Township, and Perkasie, with participation rates of 83 percent, 100 percent, 97 percent, and 100 percent, respectively, all have low per ton recycling collection costs. On the other hand, Austin, Providence, and La Crescent have higher collection costs and participation rates of 40 percent, 74 percent, and 74 percent respectively.

Chart 8.7 presents similar information for yard waste collection. The three programs collecting the most yard waste per household have the lowest per ton costs. Berlin Township and West Palm Beach collect more than 11 pounds per household per week at curbside and have inexpensive collection programs ($7 and $37 per ton, respectively). On the other hand, Lafayette, Monroe, Fennimore, Naperville, and Takoma Park collected less than 11 pounds of yard waste per household per week and have much higher costs.

The City of Austin attributes its low per ton costs to limited yard waste service by a few of its haulers (who collect bagged leaves in their refuse packer trucks during portions of their refuse collection routes) and to the shorter distance haulers have to travel to unload yard waste as compared to refuse or recyclables. If only a few materials are collected, the costs of the existing waste handling system may not be greatly impacted. As communities collect more, they incur additional costs to collect and process recyclables and yard waste above the costs incurred for their traditional refuse collection and handling systems. The more materials communities collect, the more these additional costs can be offset by reduced costs of managing solid waste destined for disposal, and the more costs per ton will decrease. Nevertheless, Austin's and Lincoln's low costs indicate that while the amount collected per household per week may have some correlation to cost per ton, other factors are at play (such as labor costs and set-out and collection method).

Unloading Frequency and Distance to Processing Facilities

Table 8.19 lists curbside collection cost, number of crew members per collection vehicle, number of times the truck must unload per day, truck type

and capacity, and distance to the processing center or transfer station—all of which impact curbside collection efficiency.

The distance to the processing center or transfer station and the number of times a truck must unload appear to have the most substantial impact on curbside collection costs of these variables. Traveling time costs a city money in labor expenses, fuel fees, and truck maintenance. In contrast to driving a collection route to pick up materials, traveling to unload materials is unproductive time and can be considered an add-on cost.

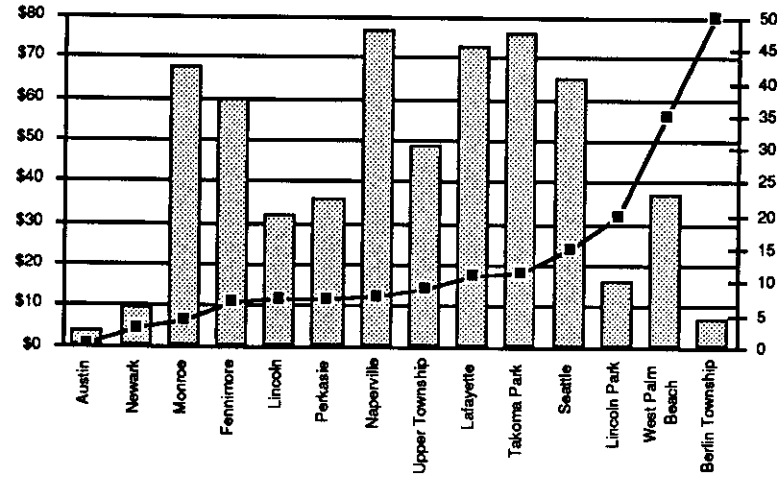
Depending on the collection route, Newark's collection vehicles must travel up to 20 miles to unload recyclable materials; furthermore, the trucks must unload three to four times a day. Newark incurred a curbside collection O&M cost of $140 per ton in 1989. La Crescent incurs a curbside collection cost of $111 per ton; haulers must travel between 10 to 40 miles to the County processing center, and the trucks unload twice per day. In Providence, where the curbside collection O&M costs are $105 per ton, haulers must drive at least 15 miles one to two times per day to unload recyclables at the State processing center. In contrast, Fennimore has a low curbside collection O&M cost of $39 per ton; although the service provider has to unload about six times a day, he travels only 1 mile to the City processing center. Perkasie's per ton collection O&M costs are about $50. Its trucks travel less than a mile to deliver aluminum, steel, and newspapers; 10 miles to deliver plastic; and 15 miles to deliver corrugated cardboard. (While Perkasie's trucks may travel a number of miles to deliver its paper, they do not do this every day. Unlike in the other communities mentioned above, Perkasie delivers materials directly to markets, not to a processing facility.)

Reducing the number of times vehicles must unload can also increase collection efficiency, thus reducing costs. Factors affecting unloading frequency include the capacity of collection vehicles, the density of materials collected, and whether or not materials can be compacted en route.

Some communities are using compactor trucks to collect recyclables, especially waste paper. Compacting material increases truck tonnage capacity and reduces the unloading frequency; this in turn improves collection efficiency, which reduces costs. The fact that Perkasie, Boulder, and Upper Township compact significant portions of their recyclables may contribute to their relatively low recycling collection costs. Perkasie collects mixed waste paper and corrugated cardboard in two different packer trucks, and incurs collection costs of about $50 per ton. Boulder and Upper Township similarly collect paper in separate packer trucks; their collection costs are $51 per ton and $71 per ton, respectively. Columbia uses a packer truck

Chart 8.7

Yard Waste O&M Curbside Collection Costs and Pounds Collected Per Household



Notes: Pounds per household per week was calculated on a 52 week year even for cities with seasonal collection. Fennimore's pounds collected at curbside may include some drop-off material. Lincoln Park, Berlin Township's, and Monroe's curbside costs include a small amount of drop-off expenses. Lafayette's annual tons are prorated based on 650 tons per month for 5 months while the program was in operation. And, its costs also cover the collection of 963 tons at the drop-off. West Palm Beach's curbside cost and tonnage includes a significant amount of residue material that was not composted. Excluding this residue, the City composted 26 lbs./per household at a cost of $50/ton.

Table 8.19
Factors Affecting Collection Efficiency and Costs

Community	Curbside Collection O&M Cost ($/ton)	Distance to IPC (miles)	Number of Times Truck Unloads Per Day	Truck Type	Number of Crew Members	Number of Stops Per Day Per Vehicle
Fennimore, WI	$39	0.5	6	Used BeerPop Truck	2	400-500
Monroe, WI	$50	1	3	Modified Dump Truck	1	750-900
Boulder, CO	$51	0 (a)	NA	Retrofitted Packer Truck	2	NA
Seattle (north), WA	$54	NA (b)	2	18- and 31-cy Trucks	1	400
Perkasie, PA	$58	0-15 (c)	1	Trailer	4	280
Berlin Township, NJ	$58	10	1	Eager Beaver Truck	1-2	600
Berkeley, CA	$63	0-4	1-2	Lodal Trucks	1-2	NA
Upper Township, NJ	$71	0.5-15	1-2	20-cy Packer Truck	3	400
Naperville, IL	$73	0.25-15	1-2	1-ton Truck with Trailer	2-3	NA
La Crescent, MN	$111	10-40	2	Retrofitted Vehicle	3	500
Takoma Park, MD	$97	4-12	1-3	Kahn Sorter Truck	3	800
Providence, RI	$105	15	1-2	31-cy Labrie Truck	1	NA
Newark, NJ	$140	1-20	3-4	23-cy Eagar Beaver Trucks & Trailers	3	NA
West Palm Beach, FL	$148	16-51	1	30-cy Labrie Truck	1	NA
Philadelphia, PA	$173	1-10	1-2	23-cy and 32-cy Lodal Trucks	3	NA
Lafayette, LA	NA	0-15	2-4	15-cy Eagar Beaver Trailers	3	400-900

Key:

cy = cubic yard IPC = Intermediate Processing Center NA = Not Available

Notes:

For details on per ton collection costs, see Table 8.13.

(a) Site is within city limits.

(b) Trucks take one hour for a round trip.

(c) Distance is 10 miles for plastics and 15 miles for newspaper.

to collect old corrugated cardboard; its collection costs are $49 per ton.

Since plastic wastes are a low-density material, collecting them can reduce efficiency. To meet this challenge, several communities such as Monroe[20] and areas of Portland are using plastics compactors on their collection vehicles. The hauler providing collection service in West Linn, which began plastics collection in 1991, uses an on-board compactor. An alternative to the plastic compactor is the on-board plastic grinder, which combines different resins en route; the resins are later separated through a flotation process. This method is being used in Ann Arbor, Michigan, and is being tested by waste haulers in Portland in conjunction with Partek Inc. in Vancouver, Washington, which developed the system.[21] (Before investing in a plastics grinder, communities should ensure that ground plastic meets the specifications of targeted markets.) In communities that target a wide range of materials for collection, including plastics—Berlin Township, Fennimore, Monroe, Naperville, and Upper Township—per ton collection costs remain below $80 per ton.

While seven of our 30 communities have bottle bills in effect in their areas, curbside collection costs are available only for two of these: Berkeley ($67 per ton including processing) and Columbia ($49 per ton)—both in the moderate range. Collection costs in these bottle bill communities might be low as a result of avoiding the collection of high-volume beverage containers.

Yard Waste Composting Programs

Yard waste collection costs vary widely among our 30 communities, but tend to be lower than recycling collection costs. See Tables 8.4 and 8.6. Yard waste is more homogeneous than the various types of recyclables; it can be compacted; and it can be collected in one vehicle. Thus, yard waste collection systems can be very efficient. In addition, a number of our case-study communities have avoided investments in equipment for collecting yard waste by using existing collection vehicles for this purpose. By targeting yard waste for collection, cities can reduce total per ton materials recovery costs.

Several communities collect yard waste with low operating costs. Berlin Township, for example, collects bagged leaves and grass clippings weekly year-round with dump trucks, and loose leaves in the fall with a specially designed scoop. Its average O&M collection costs in 1990 were $7 per ton.[22] In Lincoln Park, bagged leaves and grass clippings are picked up twice a month in the spring and fall with packer trucks. Loose leaves are picked up as needed in the fall with a vacuum pulled by a dump truck. In addition, 40 percent of the yard waste collected in 1990 was collected through the drop-off site. The Township's O&M cost for yard waste collection that year averaged $16 per ton. The City of Newark contracts with three private haulers to collect leaves, grass clippings, brush, and Christmas trees at curbside weekly from October through January. Haulers use packers and dump trucks. The City's cost is $10 per ton. In Lincoln, the City incurred $14 per ton in yard waste O&M collection costs. Private haulers under contract with the City collect leaves, grass clippings, and brush using packer trucks. These materials are set out in 90-gallon toters weekly July through November. Two of the three contracted haulers chose to replace one of their two weekly refuse collection days with yard waste collection, and charged the City only $8 per ton of material collected. (If participation in this voluntary program had been mandatory, this fee probably would have covered costs; however, because the program was voluntary and participation low, the City provided the haulers additional reimbursement based on a nonparticipation formula.) These two haulers determined they could offer yard waste collection service to residential households for $2.70 per month, which is equivalent to the cost of adding a second weekly refuse collection day.

Upper Township and West Palm Beach also have relatively inexpensive yard waste collection programs, at $49 per ton and $37 per ton, respectively, for O&M costs. Both towns collect yard waste year-round using two-person crews with compactor trucks. Takoma Park's program is more expensive, with average O&M costs of $76 per ton in 1990. It collects yard waste year-round, but uses three- to five-person crews. Seattle, Naperville, and Lafayette contract with private haulers for yard waste collection. Lafayette's contract is based on a per household fee and Seattle's on a per ton fee. Naperville pays its hauler the equivalent of $111 per ton for weekly collection of grass clippings and other garden trimmings, April through December. The City undertakes fall leaf collection and brush collection. The following year, the City established a new yard waste collection system in which residents were charged directly per bag of yard waste set out.

Composting costs, like processing costs for recyclables, are highly influenced by the technology utilized, the amount of material composted by the facility, and the number and wages of employees. Many communities are avoiding composting costs by relying on county or private facilities that charge minimal or no tipping fees. For those that are composting their yard waste at local facilities, composting operating costs range from $2 per ton in Berlin Township to $89 per ton in Philadelphia, with most costs in the $15 to $30 range. Capital costs per ton-per-day composted are relatively inexpensive, ranging from virtually $0 in Fennimore to $54,660 in Austin. At Austin's site, a front-end loader mixes yard waste with sewage sludge; the combined material is turned with a windrow turner twice a week, and after several months of composting and curing, is screened. On the other hand, the only equipment Fennimore uses is a 1975 front-end loader to turn windrows.

Communities can substantially reduce both collection and processing costs by promoting backyard composting of organic materials and leaving grass clippings on lawns. (See Chapter 3 for a description of backyard composting programs.)

Outside Processing and Composting Facilities

Local communities can avoid and/or reduce capital and operating costs by sending recyclables and yard waste to processing facilities owned by County or State agencies, or by private firms. (Regional facilities benefit from economies of scale, and the overall operating expenses of such facilities are frequently cheaper than those of municipally scaled facilities. In many instances, total capital costs of regional facilities are higher.) While municipalities typically pay low or no tipping fees to use such facilities, drawbacks include additional transportation costs, little control over the types of materials accepted, and little control over where materials are marketed.

Clearly, if municipalities take advantage of other publicly operated facilities, the costs of these facilities may still be borne by the taxpayer. County and state operations may be funded through such sources as taxes, bond issues, landfill surcharges, and, of course, materials revenues. Private sector recovery enterprises, on the other hand, operate as businesses and cover their costs through the fees they charge and the materials revenues they receive. (If private recycling processors or composters do not charge local,

Co-Collecting Recyclables and Mixed Waste: Problems and Opportunities

Co-collection is an alternative curbside collection method in which refuse and source-separated recyclables are collected simultaneously using the same vehicles. Residents place their recyclables in rigid containers or special bags. Haulers collect all materials at the same time, placing them in the refuse compartment, retrofitted recycling bins, or trailers. There are two basic methods for co-collection: the bag method and the bin method. In the bag method, residents commingle recyclables in one or more color-coded bags and set the bags out at curbside with their refuse. (Some communities are using blue bags, others are using yellow or clear bags.) Haulers collect the bags of recyclables and the bags of refuse together in traditional packer vehicles. In the bin method, residents set out their recyclables in rigid containers alongside their bags of refuse. Haulers collect the recyclables and refuse in collection vehicles that have been retrofitted with recycling bins or trailers. At least 14 communities in the United States have tried either pilot or full-scale co-collection systems. Nine of these are bag systems and five are bin systems.

Co-collection may provide a simple, low-cost approach to the curbside collection of recyclables. In rural areas co-collection may be the only cost-effective option for a curbside program, because collection routes are long and the distance between households is too great to warrant separate collection vehicles.

Whether co-collection systems are cheaper than dedicated curbside recycling systems is not yet clear. Trade-offs in costs occur between collection and processing. Operating and maintenance costs for collecting recyclables will likely be cheaper in a co-collection system, but processing recyclables will be more expensive, especially for the bag system. Bags of recyclables must be sorted from the bags of refuse and then sorted by material. In all the bag systems currently operating, bags of recyclables are manually sorted from bags of refuse. For systems with minimal recycling, handling costs may be low. Removing a few color-coded bags of recyclables from a truck may not impact costs too greatly; as these bags increase in number, the handling cost to separate them from refuse bags will increase. Thus, in communities that plan to maximize recycling, the extra cost of double-handling bags of refuse and recyclables on sorting floors may be high. The processing stage for bagged recyclables is either labor-intensive or capital-intensive, depending on whether sorting is done primarily by hand or by machine. On the other hand, separate collection of recyclables using the bin method or dedicated recycling trucks may require much less sorting and materials preparation, depending on the level of en route sorting.

In Omaha, Nebraska, which uses a bag co-collection method, the per ton collection cost for refuse and recyclables is $32. Omaha's cost to process bagged commingled recyclables is $96 per ton, up from

county, or state governments for handling materials, these operators' costs are typically being covered by materials revenues, not by the taxpayer.)

Providence, La Crescent, West Palm Beach, Austin, San Francisco, Berlin Township, Upper Township, Takoma Park, Newark, and Columbia all avoid the costs of processing recyclables. The State of Rhode Island pays for processing of Providence's recyclables. The counties in which La Crescent, Berlin Township, Upper Township, Takoma Park, and West Palm Beach are located own and operate processing facilities, and do not charge a tipping fee.[23]

In Austin, San Francisco, Newark, and Columbia, processing facilities are privately owned and do not charge a tipping fee. The City of Newark actually received $12 for each ton it delivered to the private processing facility during the base year of study. Relying on private companies for processing recyclables has kept processing costs low in Boulder, Lincoln, and Philadelphia. Their processing costs are $5, $15, and $8 per ton, respectively.[24]

Composting, too, is often undertaken by the private sector or county agencies. Private facilities often charge tipping fees, but by using these facilities communities can avoid incurring capital

$42 a ton in 1991. The City's contracted processor cites the labor-intensive nature of sorting recyclables as the primary reason for the increase in costs. On top of this, the processor charges $6 a ton to separate bags of refuse from bags of recyclables. In Hamburg, New York, where conventional trash trucks pull trailers for sorted recyclables, collection costs for refuse and recyclables are $63 per ton. While processing adds another $41 for every ton recycled, landfilling costs $45 for every ton disposed.

The main disadvantages of the bag co-collection method include glass breakage and material contamination, which may result in lower recovery rates. Glass breakage, in particular, compromises the quality of the materials collected. Communities with bag programs report that from 10 to 25 percent by weight of the collected glass breaks. Pullman, Washington solved this problem by requiring residents to set out glass in separate bags from other recyclables; haulers then place the glass in a side rack on the packer truck. However, other communities have had to reduce the compaction rate on their garbage trucks in order to mitigate material contamination and bag breakage problems. This, of course, reduces vehicle tonnage capacity and increases unloading frequency, which in turn will increase costs. Participation rates for programs requiring residents to buy bags at local stores have been lower than for programs providing recycling containers. As a result, less tonnage will be collected for recycling and per ton recycling costs may be higher than in similar programs with higher participation.

Unlike the bag method, the bin method of co-collection involves an initial capital investment for the purchase and installation of collection bins. This investment is small compared to the costs of new recycling vehicles needed for dedicated curbside recycling programs. A hauler can expect to spend about $20,000 to convert an existing refuse truck to co-collection (including cost of bins, extending frame, and reducing packer area). Similar to more segregated dedicated recycling collection systems, bin co-collection systems have experienced fewer problems with material contamination and processing than the bag co-collection systems. One problem with the bin method has been the inflexibility of compartment capacities. One compartment of one bin may fill up more quickly than the other compartments or the refuse area. (This, of course, also occurs with compartmentalized recycling vehicles.) Loveland Colorado operated a pilot program for several months in which it experienced these problems: different neighborhoods set out different quantities of recyclables and refuse, making it difficult for the City to develop accurate volume estimates for its vehicles. Loveland addressed this problem by designing compartments large enough to handle half of each truck's assigned daily collections rather than designing a truck with compartments that would fill up simultaneously.

Source: Brenda Platt and Jill Zachary, *Co-Collecting Recyclables and Mixed Waste: Problems and Opportunities* (Washington, DC: Institute for Local Self-Reliance), 1992.

costs for equipment and be relieved of operating and marketing responsibilities.

Takoma Park, Upper Township, and West Palm Beach use County composting facilities that charge no tipping fees for a large portion of their yard wastes. While Takoma Park composts the leaves it collects during the fall at a City site and Upper Township incurs costs for brush recovery, the use of County facilities keeps O&M and capital costs low in both these municipalities.

Dakota County avoided capital investments in composting equipment by contracting with a private company to operate two County-owned composting sites. The operator owns all the equipment. In 1990 composting fees were relatively low at $33 per ton.

Berkeley and Seattle also use private composting facilities. Berkeley pays $24.75 per ton of yard waste delivered, and Seattle pays $5.47 per ton for the first 24,000 tons delivered and $18 per ton for any tonnage above that.

As Tables 8.1, 8.2, and 8.7 indicate, the capital cost of the typical composting facility is relatively low, and communities may find it more cost-effective (particularly when considering transportation costs) to operate their own facility rather than pay tipping fees at private sites. Berlin Township, for instance, is applying to a local commission for the right to compost grass clippings and brush on a local site, so as to avoid the $7 per cubic yard tipping fee that it is currently incurring.

Integrating Materials Recovery Into Solid Waste Systems

When implementing materials recovery programs, cities generally incur additional capital and operating expenses. These additional costs can be offset by reduced costs of managing solid waste destined for disposal. While some additional expenses cannot be avoided, communities can reduce such costs by shifting staff and equipment away from refuse collection to materials recovery. Materials recovery programs serve as substitutes for refuse collection and disposal systems not additional programs. Berlin Township, for example, has one of the least expensive curbside recovery programs in our study and utilizes the same staff and much of the same equipment for refuse and recycling activities. Rather than adding a whole new collection system, some communities, such as Perkasie, Naperville, and Takoma Park, have replaced one of their two weekly refuse collection days with recyclable and/or yard waste collection. Takoma Park reorganized its Sanitation Division at the beginning of its curbside program to avoid hiring additional personnel to collect recyclables. The City reduced the number of trucks collecting refuse and converted one of its three-person crews to a recycling crew. After reaching a 36 percent recovery rate in 1990, Takoma Park reduced refuse collection from two days a week to one day in 1991, and split sanitation crews evenly between recycling and refuse collection.

Many communities in our study have avoided new equipment purchases by using pre-existing or shared equipment. In Berkeley, Berlin Township, Fennimore, Columbia, Lincoln, and Monroe, equipment used for collecting refuse or other public works functions (such as front-end loaders and dump trucks) are also used for collection of recyclables and yard waste, and in several cases for processing these materials as well. Table 8.20 lists equipment that communities use for recycling and/or composting that was owned before the initiation of the program.[25] Much of this equipment continues to serve several functions, with recycling and composting accounting for a small percentage of the time they are in operation.

Co-collection systems present another way to more fully integrate recycling into solid waste management. (See side bar "Co-collecting Recyclables and Mixed Waste," page 138.)

Refuse and Materials Recovery Costs

While there is certainly variation in the cost-effectiveness of different materials recovery programs and much room for such programs to lower costs and increase efficiency, the operating cost of materials recovery is less than for refuse collection and disposal in most of our 30 communities for which this information is available.

Chart 8.8 compares materials recovery O&M collection and processing costs to refuse collection and disposal costs. For most of the communities, refuse collection and disposal costs are significantly

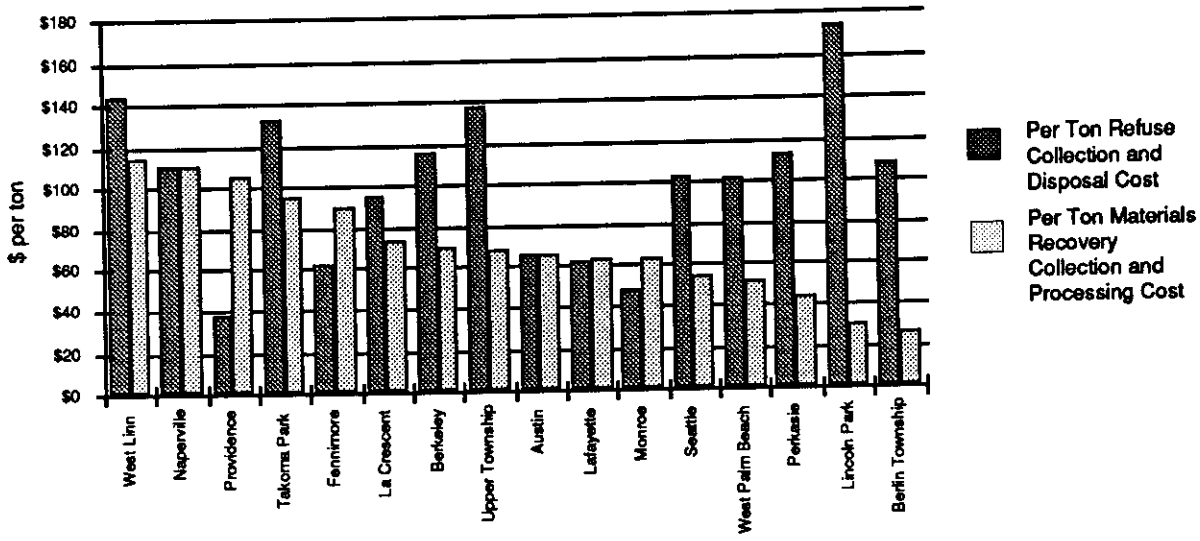
Table 8.20
Shared, Pre-existing, and Retrofitted Equipment

Berkeley, CA	Berkeley uses a packer truck, which predates the program, for yard waste collection.
Berlin Township, NJ	For collection, a loader is used 5% for recycling and 95 percent for DPW use; a 1-ton dump truck is used 20 percent for recycling and 80 percent for composting; a Ford 555 backhoe loader is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a dump truck is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a Ford F800 dump truck is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a 3/4-ton dump truck is used 50 percent for recycling and 50 percent DPW use; a stake body dump truck is used 50 percent for recycling and 50 percent for DPW use.
Boulder, CO	Four front-end loaders are used six percent of the time and 20 trucks are used six percent of the time for mulching. The remainder of the time, the equipment is used by the DPW.
Bowdoinham, ME	A converted Chevy fire truck, which was purchased prior to the onset of the program, is used for processing recyclables.
Columbia, MO	A 25-cubic-yard packer truck, which was used by the DPW for refuse collection prior to the initiation of the recycling program, is utilized for collection of recyclables and compostables.
Dakota County, MN	For the office paper collection program, a used truck was purchased.
Fennimore, WI	For collection of recyclables, a beer/pop truck was purchased and retrofitted. A dump truck is used 10 percent of the time for compost collection; the rest of the time it is used by the DPW. An end-loader, which was purchased prior to the onset of the composting program, is used for composting.
La Crescent, MN	A front-end loader is used for compost 40 percent of the time; the rest of the time it is used by the DPW.
Lincoln, NE	A front-end loader is used for composting 10 percent of the time. The rest of the time, the loader is used by the DPW.
Lincoln Park, NJ	A dump truck is used 30 percent for collecting recyclables and 30 percent for collecting yard waste. The remainder of the time it is used by the DPW.
Mecklenburg Co, NC	Two Mack roll-offs are used 75 percent of the time, and three 24-cubic-yard front-end loaders are used 90 percent of the time at the recycling drop-off. The rest of the time, the equipment is used by the DPW.
Monroe, WI	Two dump trucks used for collecting recyclables were owned prior to the onset of the recycling program; a packer truck utilized for yard waste collection is used 75 percent of the time (the rest of the time it is used by the DPW) and was purchased before the onset of the composting program.
Naperville, IL	A dump truck is used for composting and street maintenance. Two vacuum sweepers are used for yard waste collection 20 percent of the time; the rest of the time they are used by the DPW.
Newark, NJ	A 31-cubic-yard packer truck, which was purchased before the onset of the program, is used for collecting recyclables. A chipper is used for composting six percent of the time; the rest of the time it is used by the DPW.
Takoma Park, MD	Three compactor trucks are used 10 percent of the time for collecting recyclables and 10 percent for collecting yard waste. The rest of the time, they are used by the DPW. The equipment was acquired before the program began.
Upper Township, NJ	A chipper is used for composting 10 percent of the time and the rest of the time by the DPW.
Wapakoneta, OH	A dump truck is used for yard waste collection 10 percent of the time (the rest of the time it is used by the DPW). A 20-cubic-yard packer truck, bought prior to the onset of the commercial waste recycling program, is used for collecting old corrugated cardboard.
West Linn, OR	A 20-cubic-yard packer truck is used for collecting recyclables 20 percent of the time; the rest of the time it is used by the DPW.
West Palm Beach, FL	A flat-bed truck is used for collecting recyclables 40 percent of the time; the rest of the time it is used by the DPW.

Note:
"Percent of the time" refers to the proportion of time the equipment is in use.

Chart 8.8

Net O&M Cost for Materials Recovery Collection and Processing Versus Refuse Collection and Disposal



Notes: Some communities are missing from chart because either their refuse collection and disposal costs or their net O&M per ton collection and processing cost were not available. The per ton refuse collection and disposal cost and the net per ton O&M costs for materials recovery exclude administrative overhead.

higher than the costs for recovery of recyclables and compostables, especially in areas where tipping fees are high, such as Lincoln Park, Upper Township, and West Palm Beach, where 1990 per ton tipping fees were $119, $89, and $84, respectively. In the few areas where costs were lower for refuse collection and disposal than for the materials recovery program, tipping fees were generally quite low—$14 per ton in Providence (1990), $10 per ton in Austin (1989), free for 3 months in 1990 and $32 per ton the remainder of the year in Fennimore, $15 per ton in Monroe (1989). Worth noting is Monroe's calculated savings of $154,000 per year through the 15-year life extension of its landfill due to recycling as well as waste compaction at the landfill.

In Berlin Township, the collection cost for materials recovery is the same as for refuse collection and disposal, but the Township has to pay to market its waste paper ($10 for every ton recycled). Thus, the cost savings are really in the avoided tipping fee, which was $65 per ton in 1990.

When the *Report on Future Expansion of the City of Philadelphia Recycling Curbside Collections* was issued in July 1991, Philadelphia's per ton cost for recycling was beginning to decrease, approaching that for refuse collection and disposal. The total cost for recycling was $134 per ton in the northeast section of the City and $201 per ton in the northwest section. Refuse collection costs were $134 per ton and were projected to increase to $137 in FY 1992. Since July 1991, the cost of recycling has dropped further and come within range of the cost of collecting refuse, spurring a decision to expand curbside collection into a new section of the City. The realization that recycling can be cost-effective compared to refuse collection and disposal, has also led Philadelphia to research methods of increasing its recycling program's efficiency.

Conclusion

This chapter has examined the major factors that determine how much a community will have to spend to recover its waste. While there is much variation in the cost of materials recovery, communities can lower the cost of their recycling programs, and consequently their solid waste systems, by improving the efficiency and design of these programs. While in most cases cities incur additional capital and operating expenses when implementing materials recovery, as the tonnage recovered increases, materials recovery no longer operates as an add-on program but rather can begin to replace a city's refuse collection and disposal infrastructure. Improved market conditions for recyclables, resulting from increased demand for recycled goods, will also serve to lower net materials recovery costs. Yet, materials recovery programs do not have to pay for themselves. Eliminating refuse collection and disposal costs are driving the cost-effectiveness of recycling and composting programs. Where disposal costs remain low, collecting and processing recyclables alone may not be cost-effective. Waste prevention initiatives, yard waste composting, and attracting local manufacturers to use collected scrap may help improve the cost-effectiveness of overall recovery programs.

Notes

[1]This chapter does not provide a comprehensive assessment of the costs of other solid waste systems, nor does it detail all the monetary, environmental, and social benefits associated with materials recovery.

[2]Per ton costs were calculated by dividing annualized capital costs by the annual tonnage recovered that the costs cover. Collection equipment was annualized over a 7-year period, while processing equipment was annualized over a 10-year period. Financing rates and actual pay-back periods were utilized only for those few communities incurring such fees. In Austin, Eager Beaver truck and trailers were financed with a 5-year loan at 10.67%. In Lincoln Park, roll-off truck was amortized over 5 years at a 6% interest rate; equipment for Philadelphia was amortized over 5 years at an 8.5% interest rate.

[3]In most cases, data represent communities' actual recycling and composting expenses; in a few instances, communities provided estimates of the percentage of their public works budget devoted to recycling and composting activities.

[4]In Table 8.11 per ton revenue represents the total revenue received by a community from the sale of recyclable and compostable materials divided by the total tonnage of materials recovered.

[5]Lincoln Park's capital investment is lower than Fennimore's, but its costs only cover a chipper for Christmas trees.

[6]Costs shown in Chart 8.1 for West Linn represent drop-off program costs only, since curbside collection is carried out by the private sector.

[7]Due to inadequate information, the costs for private collection are not evaluated here. These costs are incurred directly by residents, and in most cases, are covered by refuse collection fees.

[8]Curbside recycling bins comprise a large percentage of Lafayette's capital costs. Many communities with contracted service do not incur the cost of bins. This cost may become less significant as the program recovers more material.

[9]This excludes the cost and tonnage of the City's publicly sponsored but privately collected food waste recovery program, which, at $67 per ton, would lower O&M recycling costs to $158 per ton and total costs to $242 per ton. Both recycling totals exclude an unknown amount of administrative expenses incurred by the Department of Sanitation.

[10]Seattle recently renegotiated its contract. In 1993 Waste Management will receive $78 per ton and Rabanco will receive $84 for the collection and processing of recyclable materials. These amounts will be adjusted in accordance with changes in the market price for recyclables. The City anticipates that with predicted improvements in paper markets, the actual per ton cost for recycling will be $71 to $72.

[11]Wapakoneta, Peterborough, and Lincoln Park have drop-off programs. The Borough of Lincoln Park collects newspaper at curbside, and Peterborough has limited private sector curbside service.

[12]Lafayette's low cost of $39 per ton does not represent actual program costs. The Recycling Foundation, a nonprofit organization formed by two owners of a local bottling plant, renegotiated its contract with the City the following year and its contract fee tripled.

[13]The average cost to collect and process recyclables in Rhode Island is estimated at $126 per ton; disposal of residue cost $44 per ton; and lost revenue due to broken glass is estimated at $30 per ton in 1991. For every ton of glass collected for recycling that is actually landfilled, Rhode Island loses $200. Janet Keller, "The nitty-gritty of glass recycling: Reducing glass breakage in collection and processing," *Resource Recycling*, February 1992, 46-55.

[14]Ibid.

[15]According to the Assistant Commissioner of Transportation in New York City, a City that uses glassphalt in paving projects, glassphalt replaces a maximum of 10 percent of the total crushed aggregate added to paving material, and virgin-material-based aggregate is valued at only $10 to $12 per ton. Clear cullet price is for the East Coast. *Recycling Today*, Municipal Edition, February 1992; and Assistant Commissioner Most, New York Department of Transportation, New York City, personal communication, May 1992.

[16]"Privatizing Municipal Waste Services: Saving Dollars and Making Sense," National Solid Waste Management Association, Washington, DC, undated.

[17]See footnote 10.

[18]In 1992 Berkeley negotiated a 7-year, $9.7 million contract with the Ecology Center for the provision of curbside recycling services to the City.

[19]While this arrangement benefits the City of Berkeley, it has not always benefited Urban Ore, which has found that surrendering 10 percent of gross revenues may cause a net loss, especially when gross costs approach gross revenues. A fairer arrangement might be based on a percentage of net revenues.

[20]Monroe purchased a compartmentalized vehicle with an on-board compactor in October 1991.

[21]"Portland Puts Plastic Grinders On Trucks," *Recycling Today*, June 1991.

[22]Berlin Township does not weigh its yard waste. It converts volume to weight using conversion factors supplied by the State of New Jersey Department of Environmental Protection. See Appendix C. National conversion factors are more conservative than these New Jersey figures. Using more conservative figures (500 pounds per 1 cy of compacted leaves) would raise Berlin's collection costs to $9 per ton.

[23]Berlin Township does have to pay private waste paper recyclers to take its waste paper. The County facility does not handle paper. Takoma Park did not start using the Montgomery County processing facility until September 1991, soon after it opened. This facility also does not accept waste paper. The processing costs provided for Takoma Park in Tables 8.13 through 8.17 and in Charts 8.1 and 8.2 reflect costs in 1990, when the City paid a hauler to recycle its commingled food and beverage containers.

[24]The $8 per ton figure for Philadelphia is based on a weighted average. The City delivers its curbside recyclables to two processing facilities. The City is charged $30 per ton at the PTRC and receives $5.08 per ton at The Forge.

[25]Pre-existing equipment is excluded from capital cost figures listed in this chapter.

Appendix A
Data Definitions and Methodology

The data presented in this report are extracted from detailed case studies of recycling and composting programs in 30 U.S. communities. These case studies are published in three volumes by the Institute for Local Self-Reliance as *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results*. Each case study presents detailed information on each community's demographics, annual solid waste generation and recovery, recycling and composting activities in the residential and commercial and institutional sectors, annual amount and breakdown of materials recovered, education and publicity, collection and processing equipment and costs, operating and maintenance costs, and future solid waste management plans.

Communities may define the terms and calculate the amounts of waste and recycling in various ways. To facilitate comparison among programs, we have utilized a uniform methodology wherever possible to determine residential and commercial/institutional waste, municipal solid waste, and total waste generation and recovery levels. See definitions given below. While this report goes to great length to ensure uniform comparisons, in some cases due to the realities of communities' data keeping such comparisons are not possible. Appendix C briefly details for each community any assumptions made to calculate waste generation and recovery rates. *In-Depth Studies of Recycling and Composting Programs* provides more detailed information.

Cost data presented in tables reflect the costs incurred by the jurisdiction documented and do not necessarily include all the costs incurred for recycling and composting operations. In many cases, for example, the private sector undertakes recovery activities independent of the public sector. All capital cost data have been converted into constant 1990 dollars using producer price indices, except where otherwise indicated.

The following definitions apply to this report only and are not meant to represent industry-wide definitions.

Annualized Capital Costs — capital costs have been converted to annual costs by assuming a 7-year amortizaton period for collection equipment and a 10-year amortization period for processing equipment. In most of the communities, equipment was paid in full at the time of purchase; thus in these we have used no interest rate. For the few communities that did finance their equipment, we have used their actual interest rates and pay-back periods. See Table 8.3 notes.

Base Year of Study — the 12-month period over which tonnage, cost, and other program characteristic data apply. Tonnage and cost data are reported on an annual basis and are largely for fiscal year or calendar year 1990, except where noted otherwise in tables. For example, see Table 1.1. In some cases, recent changes in program design and operations are noted in table footnotes.

Co-Collection — curbside collection of refuse and source-separated recyclables simultaneously in the same vehicles. See side bar, pages 138-139.

Collection Capital Costs — costs of acquiring equipment used to collect recyclable or compostable materials. If equipment predated the program, its cost is excluded.

Commercial/Institutional Waste Recovered, Disposed, and Generated — the annual tonnage of waste recovered, disposed, and generated by the commercial and institutional sectors (excluding medical wastes). The commercial sector includes theaters, retail establishments, hotels, and restaurants. The institutional sector includes hospitals and schools.

Commingled Collection — collection programs in which residents are required to place glass, metal and plastic containers in a single receptacle.

Composted Waste — discarded organic materials processed into a soil amendment, fertilizer, and/or mulch.

Composting — recovering discarded organic materials for processing into a soil amendment, fertilizer, and/or mulch.

Composting Rate — the tonnage of source-separated organic materials collected for composting divided by the tonnage of waste generated (waste composted, recycled, plus disposed). West Palm Beach's composting rate excludes noncompostable residue materials collected in yard waste collection routes.

Construction and Demolition (C&D) Debris Recovered, Disposed, and Generated — the annual tonnage of waste recovered, disposed, and generated as a result of construction and demolition activities. This waste may include concrete, asphalt, tree stumps and other wood wastes, metal, and bricks. (While C&D waste often burdens municipal solid waste collection and disposal systems, the U.S. EPA and the National Recycling Coalition exclude C&D debris from the definition of municipal solid waste.)

Deposit Containers Recycled — the annual tonnage of beverage containers recycled as a result of state or local bottle bills.

Disposed Waste — waste landfilled or incinerated.

Generated Waste — sum of waste recovered and waste disposed.

Grasscycling — leaving grass clippings on mowed lawns in order to avoid collection and disposal of this organic material.

Intermediate Processing — preparing collected recyclable materials for end-use manufacturing. Processing typically includes sorting, contaminant removal, and crushing or baling.

Mandatory — whether citizens are required to source-separate materials for recycling. In several communities, citizens may be required to set out certain materials at curbside for recycling. In others it may simply be illegal to set these out with refuse. Not all materials collected are designated as mandatory.

Municipal Solid Waste (MSW) Recovered, Disposed, and Generated — sum of residential and commercial/institutional wastes recovered, disposed, and generated. In some cases, MSW also includes deposit containers recovered, yard waste composted from landscapers, and waste self-hauled to disposal and recovery facilities. MSW excludes construction and demolition debris and manufacturing wastes.

Municipal Solid Waste (MSW) Recovery Rate — see Percent MSW Recovered.

Operating and Maintenance (O&M) Costs — ongoing expenses that include such items as equipment leasing and maintenance, utilities, labor, administrative expenses, licenses, supplies, insurance, residue disposal, marketing fees, contract fees, and publicity programs. In this study, materials recovery O&M costs are broken down into four basic categories: collection, processing and marketing, administration, and education/publicity.

Participation Rate (%) — the portion of households served that take part in the curbside collection program for recyclable materials. Refer to the case studies in *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results* (Washington, DC: Institute for Local Self-Reliance, 1992), for an explanation of the specific method of calculation.

Per Ton Costs — these represent costs on a per ton basis and are calculated by dividing the annual tons recovered *due to the program itself* into annual program costs. For instance, Newark's per ton operating and maintenance collection cost of $112 is based on the tonnage collected through publicly sponsored recycling activities, not on the total tonnage recovered in the City. Tables specify what costs represent; that is, total operating and maintenance costs, collection costs alone, total gross costs including annualized capital costs, or net costs. Net cost was calculated by subtracting revenues from the gross cost.

Percent C&D Recovered — construction and demolition debris recycled and composted divided by the total C&D debris generated (based on tonnages).

Percent Commercial/Institutional Materials Recovered — the sum of commercial and institutional materials recycled and composted divided by the total commercial and institutional waste generated (based on tonnages). See definition for Recovery Rate.

Percent MSW Recycled, Composted, and Recovered — the portion by weight of municipal solid waste generated that is recycled, composted, and recovered (based on tonnages). See definitions for Recycling Rate, Composting Rate, and Recovery Rate.

Percent Residential Materials Recovered — the sum of residential materials recycled and composted divided by the total residential waste generated (based on tonnages). See definition for Recovery Rate.

Percent Total Waste Recovered — the sum of MSW and C&D materials recycled and composted divided by the total waste generated (based on tonnages). See definitions for MSW, C&D, and Total Waste.

Private Sector Waste — waste collected by private haulers independent of the public sector. This typically includes waste generated by commercial and institutional establishments and large multi-unit households. Where indicated, private sector waste may also include C&D debris. See Appendix C for community-specific information.

Processing Capital Costs (Composting) — costs of acquiring equipment used to process—compost, chip, or mulch—organic materials. Processing or composting equipment typically includes shredders or chippers and front-end loaders. If equipment predated the program, its cost was excluded.

Processing Capital Costs (Recycling) — costs of acquiring equipment used to process recyclable materials in preparation for marketing to end users. Processing typically includes sorting, contaminant removal, and crushing or baling. If equipment predated the program, its cost was excluded.

Public Sector Waste — waste collected by public crews or by private haulers under public contract. This typically includes waste generated by single-family households and small multi-unit buildings. Public sector waste may also include waste generated by small businesses. See Appendix C for community-specific information.

Recovered Waste — sum of waste recycled and waste composted.

Recovery Rate — the sum of materials recycled and composted divided by the waste generated.

Recycled Waste — discarded products and packaging materials recovered for reuse and/or processing into new products. (For two-thirds of the communities documented the tonnage of recycled waste represents materials collected for recycling.)

Recycling — recovering discarded products and packaging materials for reuse and/or processing into new products. In this report, recycling does not include composting.

Recycling Rate — the tonnage of material collected for recycling—generally including any material rejected during processing—divided by the tonnage of waste generated. (If rejected material is subtracted, recycling rates may drop by 1 to 2 percent for these communities. Approximately one-third of communities were able to provide data on actual tonnages marketed after processing. For these communities, recycling rates

were calculated using marketed tonnages. See Appendix C. No communities reported having to dispose of collected materials, but a few reported needing to store certain recyclables until market conditions improved.)

Refuse — waste destined for disposal facilities (incinerators or landfills).

Reject Rate — the percentage by weight of recyclables or compostable materials entering a processing or composting facility that is disposed of as residue.

Residential Waste Recovered, Disposed, and Generated — the annual tonnage of waste recovered, disposed, and generated from single-family and multi-unit residences and their yards. In some communities, residential waste cannot be separated from commercial/institutional waste. See Appendix C for further clarification.

Salvage/Reuse — the repair, refurbishing, washing, or just the simple recovering of discarded products, appliances, furniture, and building materials for use again as originally intended.

Segregated Collection — programs in which residents are required to set out food and beverage containers in two or more receptacles.

Self-hauled Waste — waste brought to recovery or disposal sites by residents or business/institutional establishments. This waste cannot be divided into residential and commercial/institutional.

Source Reduction — waste prevention; that is, avoiding waste generation.

Source Separation — segregation of recyclable materials or yard waste from mixed waste on the household or business level to facilitate recycling and composting of these materials.

Tipping Fees — the fees charged to haulers for delivering materials at recovery or disposal facilities.

Total Recovery Rate — see Percent Total Waste Recovered.

Total Waste Recovered, Disposed, and Generated — the sum of MSW and C&D debris recovered, disposed, and generated.

Year Data Collected — indicates the base year of study. Data typically pertain to 1990. Where indicated, data may represent 1989 or 1991 program year conditions.

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Appendix C
Waste Generation Calculations

Waste generation rates used in this report are based on tonnage figures provided by recycling coordinators and other local officials, who may have estimated the data or relied on other sources, such as private haulers. In several cases, communities measure materials in cubic yards and use conversion factors to calculate tonnage figures. ILSR staff have estimated tonnage recovered, using commonly accepted conversion factors, in a few instances when communities did not calculate tonnage figures. (The Sample Conversion Factors in this appendix lists all conversion factors used.) Waste figures may at times exclude untracked components of the waste stream. For example, residential waste handled by the private sector is sometimes excluded from residential figures. See ILSR's *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results* for further information on how tonnage figures were derived. The following table provides a community-by-community summary of which figures were estimated and how, and what, if any, component of the waste stream may be excluded.

Community	Description of Assumptions and Estimates Made for Calculating Waste Generation, and Identification of Any Untracked Waste Stream Components
Austin, TX	Total waste disposed is based on an average state waste generation rate of 6.2 pounds of residential, commercial, and C&D waste per person per day (provided by the Texas Department of Health). While the City tracks tonnage figures of waste disposed from single-family households, duplexes, and three- to four-unit buildings (excluding bulky items such as furniture and tires), it does not track the tonnage disposed from condominiums, apartment buildings with more than four units, from commercial and institutional establishments, or from construction and demolition sites. Waste generated from buildings with more than four units (64,652 households—33 percent of total) is based on the following City of Austin statistics and estimates: 2.2 persons per household and 2.35 lbs./capita/day. The tonnage of Christmas trees recovered is not tracked and thus is excluded from waste generation and recovery figures. Recycled tonnage represents marketed material.
Berkeley, CA	MSW generation figures provided by the City of Berkeley are based on 1988-89 annual data estimated from quarterly waste composition samplings. Because no major demographic or economic changes occurred in Berkeley between 1989 and 1990, the City believes there has been no significant change in waste generation rates. Figures for waste recovered are actual tonnage figures for FY 1991. MSW recycled tonnage represent marketed material. Annual tonnages of concrete and asphalt recovered were estimated from 6 months worth of data. The City does not separately track residential and commercial/institutional material.
Berlin Township, NJ	Total MSW is based on a per capita waste generation rate of 0.6 tons per year, which is based on actual waste sampling undertaken at the Township's local landfill. The tonnage of commercial waste generated is untracked and is estimated by subtracting residential waste figures from total MSW. Berlin Township estimates wood waste and brush using conversion factors of 5.5 cubic yards/ton for wood waste and 8.0 cubic yards/ton for brush. The figures for grass clippings mulched is based on a conversion factor of 2.7 cubic yards/uncompacted ton. The tonnage of leaves composted is based on conversion factors of 2 cubic yards/ton of compacted leaves and 2.86 cubic yards/ton of vacuumed leaves.
Boulder, CO	Although the City of Boulder does not track actual tonnages of waste disposed, the private contractor handling 80% of the City's MSW and C&D disposed does track tonnages. Citywide figures are based on 125% of the contractor's tonnages. Some of the materials collected at supermarkets for recycling are not tracked and thus excluded from waste generation and recovery figures. The tonnage of brush chipped and recovered is based on a conversion factor of 300 lbs./cubic yard. The tonnage figure for food waste recovered is based on a conversion factor of 900 lbs./cubic yard. The tonnage of Christmas trees is based on 20 lbs./tree. Recycled tonnages represent collected material.

Bowdoinham, ME	The Bowdoinham Town Solid Waste Manager estimated the tonnage of MSW disposed from cubic yards using a conversion factor of 250 lbs./cubic yard, which was based on weighing a 1-cubic-yard pallet box of refuse three times during 1990. The tonnages of leaves and grass clippings composted are based on a conversion factor of 500 lbs./cubic yard. The tonnage of recyclables includes 43 tons of deposit containers, based on a State estimate that 7% of total waste generated is recovered through the State bottle bill. Recycled tonnage represents recycled material. Because MSW contains material from only 15 businesses, Bowdoinham's MSW data is frequently used in this report in lieu of residential figures, which are unavailable.
Columbia, MO	MSW figures are not available as C&D material is not tracked separately from commercial/institutional waste. Tonnage figures for waste landfilled are extrapolated from the results of a 4-week weighing period in August 1989. While curbside recycling tonnages are tracked, the tonnages of residential waste recovered through drop-off sites, deposit containers, and recyclables collected from the commercial sector are based on a study by a private consultant. The tonnage of Christmas trees collected at curbside for recovery, and of grass clippings and leaves dropped off by residents and landscapers at the City's mulch site are untracked and thus excluded from waste generation and recovery figures. The tonnage of 39,000 pallets recovered were estimated by a private consultant, who used a conversion factor of 30 lbs./pallet.
Dakota County, MN	C&D disposed and recovered is not available. Landscaping waste recovered cannot be broken down into residential and commercial/institutional but is included under total MSW. MSW includes tires. The tonnage of the 1,060 Christmas trees recovered by private haulers is based on a County estimate of 15.1 lbs./tree.
Fennimore, WI	MSW does not include bulky items such as tires and appliances. C&D is not tracked. Recycled tonnage represents collected material. Grass clippings, some leaves, garden waste, and food scraps—which are dropped off by residents—are composted together; tonnages are based on a conversion factor of 102 lbs./cubic yard. The tonnage of leaves collected at curbside is estimated by ILSR staff using a conversion factor of 350 lbs./cubic yard and using estimates by the City that there were 48 truckloads of leaves in 1990 and 7.5 cubic yards/truck.
King County, WA	The Washington State Department of Ecology provided MSW waste recovered and disposed tonnage figures for King County. (ILSR excluded 102,850 tons of ferrous scrap such as auto hulks that did not qualify as C&D or MSW.) C&D waste figures are not available as this waste is handled by the private sector. The County estimated the tonnages of residential, commercial/institutional, and self-hauled waste disposed by assuming 10% of total MSW disposed was from self-haul sites, and 60% of the remaining tonnage was residential. Recycled tonnage typically represents marketed material.
La Crescent, MN	Bulky items disposed such as furniture are included with residential waste landfilled. Tires, collected for recovery, are burned; tonnages are included with residential waste incinerated. The tonnages of grass clippings and leaves composted are based on weights of grass clippings and leaves measured separately for 2 weeks in summer and in fall, the percent of participating households in the drop-off program, and the total number of households. Recycled tonnage represents marketed material.
Lafayette, LA	C&D is not tracked. Tires are included in waste disposed. Lafayette bases its yard waste tonnages on a conversion factor of 500 lbs./cubic yard. Commercial/institutional recyclables contain a small amount of residential material recovered through drop-off sites. Other commercial materials are recovered but not tracked (white goods, motor oil, batteries, and scrap metal, plus old corrugated cardboard from many supermarkets). Recycled tonnage represents marketed material.
Lincoln, NE	Some yard waste is self-hauled to a transfer station for composting; this tonnage is included in total MSW but not in residential or commercial/institutional. Tires are included in residential and commercial waste disposed. The tonnage of recyclables are extrapolated from 1990 Lancaster County tonnage data. The Lincoln Office of Recycling estimates that 85% of the recyclables recovered in Lancaster County are from the City of Lincoln. Recycled tonnage represents collected material.

Lincoln Park, NJ	Residential tonnage recovered includes some commercial material brought to the drop-off sites and excludes 99 tons of recyclables collected by a private hauler from two condominiums. This latter tonnage is included under commercial/institutional waste, as is the corresponding waste disposed. Tires are included in residential and commercial/institutional waste recovered. Recovered tonnage excludes waste paper recycled by a printer as this material did not meet our definition of MSW. The Borough uses a combination of conversion factors and actual weight samples to determine tonnages of yard waste. Conversion factors are 35 bags/ton of bagged leaves, 2.86 cubic yards/ton of vacuumed leaves, 2 cubic yards/ton of compacted leaves, 8 cubic yards/ton of stumps and logs, and 4 cubic yards/ton of wood chips. Recycled tonnage represents collected material.
Mecklenburg County, NC	Bulky items and tires are included in MSW. C&D is not available. Less than 4% of residential recyclables is actually commercial waste collected at County drop-off sites. Hurricane Hugo greatly increased 1990 composting figures; FY 89 tonnage composted at drop-off sites is used and extrapolated from compostables collected and weighed during a 7-month period. Recycled tonnage represents marketed material.
Monroe, WI	Residential waste excludes waste from approximately 371 households (8% of total households) in buildings with three or more units. The tonnage of recyclables collected through the drop-off was estimated by the City and is included in residential waste figures. C&D tonnages are based on data provided by the largest commercial hauler and on the City's data that the hauler collects 70% of its C&D waste. Recycled tonnage represents marketed material.
Naperville, IL	Residential waste figures represent waste handled by the public sector only, which services one- to four-unit households and condominiums. Residential waste excludes material generated by 6,500 multi-unit households (21% of total households). Recyclables delivered to the drop-off by multi-unit households, businesses, and some other residential sources, are not included in residential waste figures. Commercial/institutional waste disposed and recovered is not tracked and are unavailable. The tonnage of leaves composted was estimated by the City based on volume amounts. The tonnage of Christmas trees was estimated by ILSR staff, based on 20 lbs./tree. Recycled tonnage represents collected material.
Newark, NJ	Public sector figures exclude large multi-unit buildings served by private haulers and include a small amount of material from the commercial sector collected at the municipal drop-off site. Private sector figures include multi-unit buildings and some C&D. The figures for waste recovered and generated do not include 147,176 tons of metal scrap reported as recovered by private haulers because this tonnage could not be confirmed as part of Newark's municipal solid waste or C&D stream. The City of Newark calculated the tonnage of yard waste composted using a conversion factor of 8 cubic yards/ton and the tonnage of brush and Christmas trees composted using a conversion factor of 4 cubic yards/ton.
Perkasie, PA	Only tonnage figures for waste handled by the public sector are available. This is largely residential waste and excludes waste generated by condominiums and apartments, but includes refuse and recyclables from 15 small businesses served by DPW. Some bulky waste (such as mattresses and furniture) is included in residential waste figures, but tires and appliances, which are disposed by a private hauler, are not. C&D debris is not tracked. ILSR staff estimated the tonnage of brush, leaves, and Christmas trees Perkasie composts and chips based on volume amounts and the following conversion factors: 4 cubic yards/ton of brush, 350 lbs/uncompacted cubic yard of leaves, and 20 lbs./Christmas tree.
Peterborough, NH	Waste generation and recovery figures are based on tonnage data from the Town Recycling Center and the hauler serving both the commercial/institutional sector and 80% of those residents who do not use the Center. The breakdown of the Center's materials into residential and commercial/institutional figures is based on estimates by the Recycling Coordinator that 95% of recyclables and refuse are residential. The City's hauler also collects C&D waste; tonnage figures for this waste were based on volume amounts using 364 lbs./cubic yard.
Philadelphia, PA	Municipal solid waste can only be broken down into publicly collected waste and privately collected waste. Public sector materials recovered are from 33% of all households up to six units in size, from block corners, drop-off sites, municipal office buildings, and from City leaf collection programs. Waste disposed is collected from 524,505 single- to six-unit households, businesses with less than six employees, and from municipal street sweepings. Private haulers serve households with seven or more units and the commercial/institutional sector. Materials self-hauled to landfills are included with private sector figures. The tonnage of recyclable materials self-hauled to drop-off centers or private scrap yards is not tracked and thus not included in waste generation and recovery figures. Motor oil is collected throughout the City for recovery; tonnages are also unavailable. Leaves and Christmas trees recovered are not weighed. Tonnage figures are estimated by the City, based on the total number of trucks delivering leaves to the composting site.
Portland, OR	Tonnages of waste recovered were calculated by City Recycling Office based on per capita recycling averages for the metropolitan region. MSW includes deposit containers and bulky items such as white goods and wooden pallets but excludes tires and construction debris. The tonnage composted represents source-separated yard waste composted and does not include waste composted through the City's mixed waste composting facility in 1990. Recycled tonnage represents marketed material.

Providence, RI	Residential waste recycled and disposed includes only materials collected from one- to six-unit buildings and public housing, and excludes refuse and recyclables from buildings greater than six units (tonnage for which is not tracked and thus not included in waste generation and recovery figures). Commercial/institutional waste disposed and recovered was estimated from 34 establishments that submitted recycling reports to the State. C&D waste is not tracked. Recycled tonnage represents collected material.
San Francisco, CA	Residential materials recovered include recyclable materials collected at curbside, through drop-off and buy-back centers, and some bulky items self-hauled to the transfer station. Other recyclables self-hauled to the transfer station are included in MSW but cannot be broken down into residential and commercial/institutional. Much of the data comes from a waste composition study of the City's waste stream by a consulting firm.
Seattle, WA	Commercial/institutional figures for waste recycled are based on City extrapolations from 1988 actual tonnages. Materials self-hauled to the City's transfer stations are included in MSW but cannot be broken down into residential and commercial/institutional. C&D waste disposed is not tracked. Recycled tonnage represents marketed material.
Sonoma County, CA	MSW includes most bulky items such as white goods, office furniture, and tires. The tonnage of tires recycled is estimated based on the County Recycling Coordinator's estimate that 30% of tires recovered are retread or reused, and 70% are incinerated. ILSR used a conversion factor of 20 lbs./tire to calculate tonnage. Recycled tonnage represents collected material.
Takoma Park, MD	Only waste generation and recovery figures handled by the public sector, which is largely single-family residential waste, are available. Residential waste figures include buildings of 12 units or less (2,936 households are in buildings greater than 12 units—42% of total households.) The City Recycling Coordinator estimated the tonnage of leaves composted based on the number of full truck loads of leaves, the number of days leaves were collected, and a conversion factor of 500 lbs./cubic yard. Recycled tonnage represents collected material.
Upper Township, NJ	Waste generation and recovery figures can only be broken down into publicly collected materials and privately collected materials. Public sector figures include recyclable materials from 3,780 single-family households, 80 households in duplexes, and 222 businesses. Public sector waste disposed excludes the 222 businesses, this waste is handled by the private sector. Private sector materials include C&D waste. Recycled tonnage represents collected material.
Wapakoneta, OH	MSW figures cannot be broken down into residential and commercial/institutional. MSW excludes bulky items such as tires and wood waste. C&D waste is untracked. MSW recycled includes a small amount delivered to the recycling center by out-of-town residents. The City estimated the tonnage of refuse and recyclables collected from businesses by the private sector. Tonnages of yard waste composted were estimated by the Ohio EPA and the City.
West Linn, OR	MSW figures are based on the former City Recycling Coordinator's estimate that 80% of total waste is MSW. MSW waste disposed cannot be broken down into residential and commercial/institutional. Figures include waste disposed and recovered from 60 households on the outskirts of West Linn and bulky items such as white goods. Per capita residential waste generation rates have been calculated using an estimate provided by the former Recycled Coordinator that 87% of MSW disposed is residential material. C&D is based on the former City Recycling Coordinator's estimate that 20% of total waste is C&D, and that 30% of this is recovered.
W. Palm Beach, FL	Waste generated includes bulky items such as tires and furniture. Tonnage recovered by private buy-back centers and scrap yards is not tracked and thus not included in waste generation and recovery figures. Recycled tonnage represents marketed material.

Sample Conversion Factors

MIXED MSW (compacted)

Conversions Used By Communities:

785 lbs/cy (0.39 tons/cy) or 2.55 cy/ton
Source: *Solid Waste Management Plan Revision,* Sonoma Co., CA, May 1990.

1 ton/3.2 cy or 1 cy/625 lbs.
Source: Naperville, IL

Conversions Found in the Literature:

500 - 700 lbs/cy (0.25 - 0.35 tons/cy) or 2.8 - 4 cy/ton
Source: *Solid Waste Data: A Compilation of Statistics on Solid Waste Management Within the United States,* US EPA, August, 1981.

600 lbs/cy (0.3 tons/cy) or 3.3 cy/ton
Source: *Association of New Jersey Recyclers (ANJR), Directory,* 1987.

MIXED MSW (uncompacted)

200 lbs/cy
Source: *Solid Waste Data: A Compilation of Statistics on Solid Waste Management Within the United States,* US EPA, August 1981.

MIXED YARD WASTE (average compaction)

Conversions Found in the Literature:

600 lbs/cy
Source: *Yard Waste Composting,* US EPA, April 1989.

Conversions Used By Communities:

620 lbs/cy
Source: Recycled Wood Products, Berkeley, CA

650-750 lbs/cy
Source: Portland, OR

660 lbs/cy
Source: West Palm Beach, FL

MIXED YARD WASTE (loose)

200-250 lbs/cy . or 9 cy/ton
Source: Portland, OR

LEAVES (average compaction)

500 lbs/cy (320 - 500 lbs/cy)
Source: *Yard Waste Composting — A Study of Eight Programs,* US EPA, April 1989.

450 lbs/cy
Source: *ANJR Directory,* 1987.

1,000 lbs/cy
Source: New Jersey Department of Environmental Protection

LEAVES (vacuumed)

700 lbs/cy
Source: New Jersey Department of Environmental Protection

LEAVES (loose)
250 - 350 lbs/cy
Source: *ANJR Directory*, 1987.

CHIPPED BRUSH
500 lbs/cy
Source: National Recycling Coalition, 1989

COMPOST (finished)
1,500 lbs/cy
Source: *Yard Waste Composting*, US EPA, April, 1989.

CHRISTMAS TREES
20 lbs/tree
Source: *Summary of County-Wide Christmas Tree Recycling Project 1990-1991*, Garbage Reincarnation, Inc., Sonoma Co., CA.

15.1 lbs/tree
Source: Dakota County, MN

FOOD WASTE
500 lbs/cy (residential)
800 - 1000 lbs/cy (commercial)
Source: Suhr, J.L., Higgins, A.J. and Derr, D.A., *Feasibility of Food Waste Recycling in New Jersey: Fourth Quarterly Report to the Office of Recycling*, 1984.

900 lbs/cy (commercial)
Source: *Asheville/Buncombe County Solid Waste Alternatives: Planning Workbook*, ILSR, March 1985.

GRASS CLIPPINGS (Compacted)
1,090 lbs/cy
Source: Naperville, IL

1,050-1,110 lbs/cy
Source: New Jersey Department of Environmental Protection

WATER
8.345 lbs/gal
Source: Lindeburg, Michael R., *Engineering Unit Conversions, 2nd ed.*, 1990.

USED MOTOR OIL
7 lbs/gal (6.5 - 7.5 lbs/gal)
Source: *ANJR Directory*, 1987. Range was arrived at by converting API gravity for 25-50% crude oil to specific gravity (*Perry's Chemical Engineers' Handbook, 6th ed.*).

CONCRETE/ASPHALT (broken)
1.5 tons/cy
Source: American Rock and Asphalt, Richmond, CA.

MIXED WOOD WASTE (C&D)
364 lbs./cy
Source: New Jersey Department of Environmental Protection

Appendix D
Procurement

Because state and local government expenditures represent approximately 13 percent of the gross national product, local governments can have substantial affect on the development of recycled material markets.* Furthermore, by purchasing recycled materials, local governments can serve as models for local businesses to emulate.

Twelve of our communities have some type of recycled-product procurement programs, ranging from price preferences to requirements for purchasing recycled or reusable materials. See Table D. In Dakota County, Minnesota; King County, Washington; Lincoln, Nebraska; Sonoma County, California; and Newark, New Jersey, such programs are mandated by law.

Model Procurement Program

As of December 1990, the City of Newark adopted a comprehensive procurement ordinance formalizing a mandatory preferential purchasing policy. Purchasing Agents are required to review their existing product and service specifications to determine if the use of recycled and reusable products is excluded. The agents must incorporate to the maximum extent practicable recycled materials, reusable products, and products designed to be recycled. Newark's ordinance was adopted to stimulate demand for materials it recycles. The City uses, at the minimum, U.S. EPA guidelines in its procurement process. The main products targeted for procurement are paper, paper products, retread tires, lubricating oils, and fly ash in cement and concrete. For example, high-grade printing and writing paper must have a 50 percent waste paper content. For lubricating oils, hydraulic fluids, and gear oils the minimum content is 25 percent. In 1991 the City purchased over $200,000 worth of recycled goods, or approximately 50 percent of all purchases. It also purchases refillable laser cartridges for laser printers.

In an effort to encourage the procurement of products made from recycled materials, the City of Newark and the New Jersey Public Interest Research Group (NJPIRG) have joined forces to promote this concept among mayors and municipal purchasing agents throughout the State of New Jersey.

*Schrader, *Creating Markets: Key to Successful State and Local Recycling Programs*, Center for Policy Alternatives, Washington, D.C., November 1990, p. 4; and telephone conversation with Rich Braddock, Procurement Analyst, EPA, Washington, D.C., January 1991.

Table D
Communities With Procurement Programs

Community	Required By Law (a)	Type of Procurement Program
Austin, TX	No	City agencies have a 10% price preference for purchasing recycled products.
Berkeley, CA	No	The City has instituted a recycled product purchasing preference program.
Boulder, CO	No	The City has a 5% price preference to purchase recycled paper products.
Dakota County, MN	Yes/County	Government offices are required to purchase recycled or reusable materials as long as the cost does not exceed 10% of the purchase price of unrecycled materials.
King County, WA	Yes/County	A County ordinance was adopted establishing rules and policies for the procurement of a range of recycled products including paper products, building insulation, retread tires, cement, cement concrete with fly ash, and re-refined oil for County agencies.
La Crescent, MN	No	The County allows a 10% price preference for the purchase of recycled paper and other recycled products such as re-refined motor oil and recycled plastic picnic tables.
Lincoln, NE	Yes/State	City departments are required to purchase recycled paper.
Newark, NJ	Yes/City	There is a City ordinance requiring municipal agencies to purchase recycled products to the maximum extent practicable.
Philadelphia, PA	No	The City allows a 10% price preference for recycled products for municipal procurement.
Portland, OR	No	The procurement policy directs the City to purchase recycled motor oil, compost, bark dust and retread tires whenever appropriate and available. The City also has a 5% price preference for the purchase of recycled paper products.
Seattle, WA	No	All City departments are directed to print letterhead on 100% recycled paper. Seattle's municipal offices procure envelopes and copier paper made from recycled paper fiber.
Sonoma County, CA	Yes/City (b)	City offices are required to purchase recycled materials whenever practicable.

Notes:

(a) Indicates if there are state, county, or locally mandated legislative requirements to procure supplies made from recycled materials.

(b) A requirement of only the City of Santa Rosa, and Rohnert Park.

Appendix E
Guelph, Ontario's Wet/Dry Collection System: Results and Projected Costs

Table E.1
Results of Pilot Collection Program and Proposed Collection and Processing for Full-Scale System

Pilot study years	1989/90/91/92 (ongoing)	
Total households	825	
	Two-Stream Separation	**Three-Stream Separation**
Set-out	(1) Wet fraction—organic waste such as food waste and yard waste; soiled paper, foil, plastic, and other materials; diapers	(1) Wet fraction—organic waste including food waste and yard waste
	(2) Dry fraction—recyclables and nonrecyclables	(2) Dry recyclables—including paper, plastic, glass, and metal
		(3) Residual refuse
Collection (proposed)	Dual-compartmentalized packer trucks used to co-collect wet and dry fractions	Two vehicles utilized—one dual com-compartment, one single compartment (proposed)
Processing (proposed for full-scale program —in pilot, dry wastes were not processed)	Wet fraction is taken to a composting facility, where inorganic wet waste is screened out and the remainder is composted; dry waste is sent to a sorting facility where recyclables are separated from non-recyclables. Residuals from both the wet and dry streams are landfilled.	Wet waste is taken to a composting facility; the dry recyclables are taken to a recycling facility, and the refuse is landfilled.
Participation	High (99 percent)	High (99 percent)
Satisfaction	High (82-88 percent of residents slightly or very satisfied)	High (82-88 percent of residents slightly or very satisfied)
Convenience	64 percent found system convenient	62 percent found system convenient.
Containers	Preference for bins over bags. Bins recovered slightly cleaner wet waste.	Preference for bins over bags. Bins recovered cleaner wet waste.
Recovery	95.5 percent of organic materials recovered (84 percent of wet waste organic)	83.1 of organic materials recovered (97 percent of wet waste organic)

	Two-Stream Separation (cont.)	**Three-Stream Separation** (cont.)
Recovery	89.9 percent of potentially recyclable material recovered clean in dry container (52 percent of dry waste recyclable)	78.1 percent of potentially recyclable material recovered clean (68 percent of dry waste recyclable)
Marketability	95.2 percent of recyclables recovered were uncontaminated and marketable. Compost meets rigorous proposed Ontario and Canadian standards.	98.5 percent of recyclables recovered were uncontaminated and marketable. Compost meets rigorous proposed Ontario and Canadian standards.
Diversion Rate (with current markets)	68 percent (with carts)	62 percent (with carts)
Advantages/ Disadvantages	• Recovered a larger percentage (14 percentage more) of organic materials • Recovered a larger percent (15 percent more) of recyclables • Recyclables slightly more contaminated and less marketable (but total recovery still higher in two-stream) • Greater flexibility. If markets make it unprofitable to recover a certain material, sorting plant employees can easily be trained not to pull out this material • Collection time and costs lower as one vehicle is used to co-collect wet and dry fractions • Considered easier to implement in multi-unit dwellings and commercial settings • Requires greater emphasis on source reduction to reduce the amount of nonrecyclable, noncompostable, and hazardous material in waste stream • Requires separate collection of household hazardous materials, since all material is handled by workers. Household hazardous can be more easily diverted from landfill.	• Recovered a smaller percentage of organic materials • Recovered a smaller percent of clean recyclables • Recyclables slightly (3 percent) less contamination and more marketable (that is, no longer is placed in "garbage" stream) • Less flexibility in responding to market changes; have to reeducate population on sorting procedures when an item becomes marketable • Two collection vehicles utilized • Considered more difficult to implement in multi-unit dwellings and commercial settings • Less emphasis on source reduction, since nonrecyclable and noncompostable materials are landfilled as a third stream • Separate collection of household hazardous materials recommended, but not imperative. Household hazardous placed in garbage means it will ultimately be landfilled.

Source: Janet L. Laird, Waste Management Coordinator City Engineer's Department, Guelph, Ontario, personal communication, February and July 1992.

Table E.2
Projected Costs for Guelph, Ontario's Two-stream Wet/Dry Collection Program[a]

Number Serviced	130,000 people countywide (program will first be implemented in Guelph, a city of 92,500 people and 24,000 single-family households)
Waste Generation (projected for 2003)	93,700 tons (84,999 metric tonnes) dry waste 63,900 tons (58,000 metric tonnes) wet waste 156,500 tons (142,000 metric tonnes) total processable waste
Anticipated Diversion (Marketed Material)	50 percent (at least)
Collection	
Capital and Operating	Divided automatic side-loading packer trucks will probably be utilized to collect both wet and dry fractions. Trucks are priced at $100,000 each. The City does not currently know how many vehicles it will purchase, and may retrofit existing trucks for some routes. Operating costs are anticipated to be the same as for refuse collection. Each truck will be operated by one crew member and will service an estimated 400 households per day. (Current refuse runs service 600 to 700 households per truck per day.)
Processing Dry Stream	
Capital Costs	$3.2 million ($3.6 million Canadian) building $5.5 million ($6.2 million Canadian) equipment
Subtotal	$8.7 million ($9.8 million Canadian)
Annual Throughput	93,700 tons
Daily Throughput (assuming 260 days of operation)	360 tons
Capital Processing Costs	$24,200 per TPD processed
Processing Wet Stream	
Capital Costs	
Receiving	$0.5 million ($0.6 million Canadian) building $1 million ($1.2 million Canadian) equipment
Processing	$2.2 million ($2.5 million Canadian) building $1.4 million ($1.6 million Canadian) equipment $.05 million ($.25 million Canadian) bio filter
Subtotal	$5.4 million ($6.2 Canadian)
Annual Throughput	63,900 tons
Daily Throughput (assuming 260 days of operation)	250 tons
Capital Processing Costs	$21,600 per TPD Processed
Household Containers	$97 each ($110 each Canadian)

Grand Total Wet and Dry Capital Costs	$8.7 million dry $5.4 million wet $2.4 million containers $16.5 million **$34 million** ($39 million Canadian) including land, administration building, construction costs, mobile equipment, testing equipment , and household hazardous waste drop-off site
Annual Throughput	156,500 tons (142,000 metric tonnes)
Daily Throughput (assuming 260 days per year of operation)	600 tons
Grand Total Capital Costs	$57,000 per TPD
Total Processing Operating Costs for Wet and Dry (excluding landfilling but including anticipated revenue for recyclables and a zero dollar revenue for compost)	$5.9 million ($6.7 million Canadian) per year—including collection costs of $2.9 million $38 per ton

Notes: $1 Canadian = $0.88 U.S., 1 metric tonne = 1.1025 short ton

(a) Guelph has not yet finalized its decision to implement a two-stream rather than a three-stream collection program.

Source: Janet L. Laird, Waste Management Coordinator City Engineer's Department, Guelph, Ontario, personal communication, February and July 1992.

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