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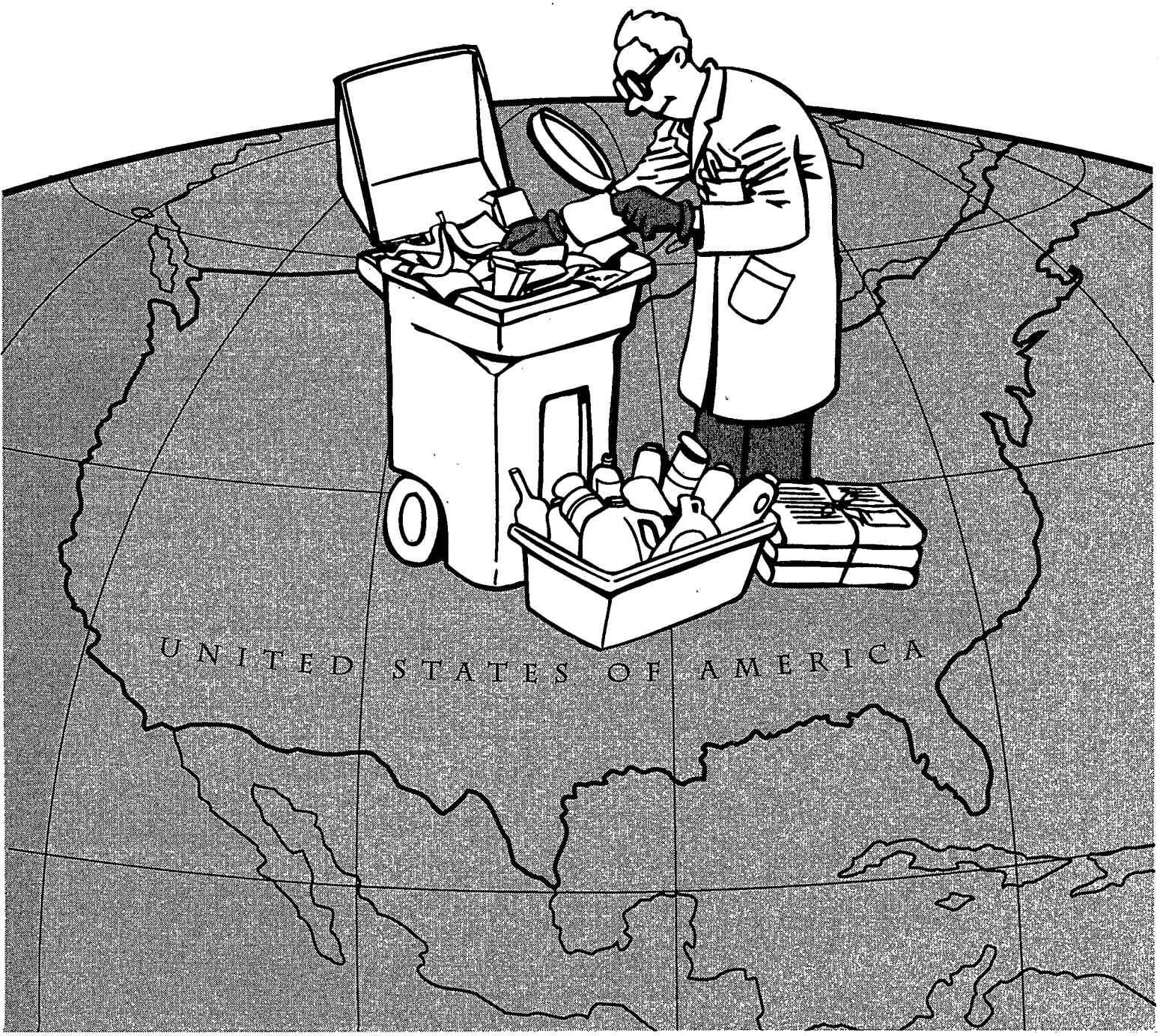

CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES:

1998 UPDATE

Prepared for

U.S. Environmental Protection Agency
Municipal and Industrial Solid Waste Division
Office of Solid Waste
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by

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CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1998 UPDATE

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CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1998 UPDATE

Executive Summary

FEATURES OF THIS REPORT

This report is the latest in a series of reports published by the U.S. Environmental Protection Agency (EPA) describing the national municipal solid waste (MSW) stream. The report characterizes the national solid waste stream for 1997. It also discusses trends and highlights changes that have occurred over the years, both in the types of wastes generated and in the ways they are managed. Although the report does not specifically address local and regional variations in the waste stream, the data in the report can be used to develop approximate estimates of MSW generation and composition in defined areas.

This report includes information on:

- Total MSW generation, recovery, and discards from 1960 to 1997.
- Per capita generation and discard rates.
- Materials (e.g., paper, glass, metals, plastic) that comprise MSW, as well as products (e.g., durable and nondurable goods, containers, packaging) found in the waste stream.
- Aggregate data on the infrastructure for MSW management, including estimates of the number of curbside recycling programs, drop-off centers, materials recovery facilities, and composting programs in the United States.
- Trends in MSW management from 1960 to 1997, including source reduction, recovery for recycling (including composting), and disposal via combustion and landfilling.
- Projections of MSW generation to the year 2005.

REPORT HIGHLIGHTS

In 1997, 217 million tons of MSW were generated in the U.S., or 4.4 pounds per person per day. Paper and yard trimmings account for over 51 percent of total generation. Of the total of 217 million tons of MSW generated, 28 percent was recycled, up from 10 percent in 1980 and 16 percent in 1990.

The 217 million tons of municipal solid waste (MSW) generated in 1997 was nearly 8 million tons more than in 1996, when MSW generation was 209 million tons. Historically, the increase in waste generation has been correlated with increased economic activity, and moderated by decreases in waste generation caused by source reduction activities such as backyard composting and leaving grass trimmings on the lawn. On a per capita basis, half of the increase in total MSW generation was offset by increased recycling.

- Between 1996 and 1997, almost all product categories increased in tonnage. This correlates with increased per capita consumer expenditures. The exceptions were glass and yard trimmings.

- Paper and paperboard products made up the largest percentage of all the materials in MSW, increasing by 4.2 million tons to 83.8 million tons, or 38.6 percent of total generation, in 1997. This increase was due to a rebound in newsprint production, and more production of printing and writing papers, containerboard (corrugated boxes), boxboard, and tissue paper.

- Yard trimmings comprised the second largest material category, estimated at 27.7 million tons, or 12.8 percent of total generation, in 1997. This compared to 35.0 million tons (17.1 percent of total generation) in 1990. This decline is largely due to state legislation affecting yard trimmings disposal in landfills, and due to source reduction measures such as backyard composting and leaving grass trimmings on the yard. From 1996 to 1997, the per capita generation of yard trimmings decreased by only 0.2 million tons.

- Recycling (including composting) recovered 28 percent (61 million tons) of MSW in 1997, up from 27 percent (57 million tons) in 1996.*

* Data shown for years prior to 1997 have been adjusted to reflect the latest revisions to the data and methodology, and therefore may differ slightly from the same measure reported in previous updates.

- There were nearly 9,000 curbside recycling programs in the United States in 1997, as well as more than 12,000 drop-off centers for recyclables. About 380 materials recovery facilities helped process the recyclables collected. About 3,500 yard trimmings composting programs were reported, up from about 2,300 reported in 1996.

- Recovery of paper and paperboard reached 42 percent (35 million tons) in 1997, accounting for more than half of the total MSW recovered. With greater generation of paper, more was available for recycling.

- In addition, 11.5 million tons of yard trimmings were recovered for composting in 1997, accounting for the second largest fraction of total recovery. The percentage of yard trimmings composted (41 percent) has more than doubled since 1992. This is due to increased numbers of yard trimmings facilities, more material being handled at facilities, and bans of yard trimmings from landfills by 22 states. From 1996 to 1997, however, composting increased by just one million tons, suggesting that much of the impact of the states' bans of yard trimmings from landfills had already taken place.

- The per capita discard rate (after recovery for recycling, including composting) was 3.2 pounds per person per day in 1997, up from 3.1 pounds per person per day in 1996.

- Landfills managed 55 percent of MSW generated (120 million tons), about the same percentage as in 1996. Combustion facilities managed 17 percent (37 million tons) of total MSW generated, about the same as in 1996.

TRENDS IN MSW MANAGEMENT

Table ES-1 and Figure ES-1 show the trends in MSW generation, materials recovery, and disposal over time.

Waste Generation

- The waste generation figure of 217 million tons per year in 1997 is an increase of nearly 8 million tons from 1996, when MSW generation was 209 million tons. Looking at the longer term trend, generation increased steadily from 88 million tons in 1960 to 214 million tons in 1994. Generation decreased slightly in 1995 and 1996, then increased again in 1997. Increases in waste generation since 1960 have been correlated with increased economic activity as measured by gross domestic product and personal consumption expenditures. The waste generation has been limited by source reduction activities such as an increase in yard

trimmings being composted on-site, and more grass trimmings being left on lawns.

- The decrease in waste generation in 1995 was due in large part to decreases in yard trimmings. This continued in 1996, and was supported by paper and paperboard generation decreases in 1996 as well. In 1997, generation of paper and paperboard increased by 4.2 million tons, compared to 1996, accounting for about half of the increase in waste generation over the last year.

- The per capita MSW generation rate for 1997 was 4.4 pounds per person per day, compared to 4.3 pounds per person per day in 1996. The longer term trend shows that the per capita waste generation rate increased from 2.7 pounds per person per day in 1960 to 4.5 pounds per person per day in 1990—decreasing to 4.4 in 1995, 4.3 in 1996, then rising again to 4.4 in 1997. Again, these changes are correlated with economic activity, but limited by source reduction. The per capita waste generation increase from 1996 to 1997 would have been even higher had no source reduction activities taken place.

Recycling, Including Composting

- From 1996 to 1997 the recycling rate increased from 27 percent to 28 percent. This compares to a 10 percent recycling rate in 1980 and a 16 percent rate in 1990 (Figure ES-2).

- Although the rate of growth of recycling, including composting, is not as high as it was in the early 1990s, the tonnage of material recycled and composted has continued to grow, as has the per capita recycling rate.

- From 1996 to 1997 the per capita MSW generation rate, which is strongly correlated with economic activity, increased by 0.12 pounds per person per day. Half of this (0.06 pounds per person per day) went to increased recycling and half of this (0.06 pounds per person per day) went to increased disposal.

Disposal

- In the 1960s and early 1970s, a large percentage of MSW was burned. Through the mid-1980s, incineration declined considerably and landfills became more difficult to site. MSW generation continued to rise, however, while materials recovery rates increased slowly. As a result, the burden on the nation's landfills grew dramatically. Although there are now fewer municipal solid waste landfills, their average size has increased and capacity at the national level does not appear to be a problem. Regional dislocations do, however, sometimes occur. As recovery rates have increased, while combustion remained relatively constant, the percentage of MSW discarded to landfills has steadily decreased.

Table ES-1

GENERATION, MATERIALS RECOVERY, COMPOSTING, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 1997
(In millions of tons and percent of total generation)

Thousands of Tons								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	88.1	121.1	151.6	205.2	214.2	211.4	209.2	217.0
Recovery for recycling	5.6	8.0	14.5	29.0	42.2	45.3	46.4	48.6
Recovery for composting*	Neg.	Neg.	Neg.	4.2	8.5	9.6	10.9	12.1
Total Materials Recovery	5.6	8.0	14.5	33.2	50.6	54.9	57.3	60.7
Discards after recovery	82.5	113.0	137.1	172.0	163.6	156.5	151.9	156.3
Combustion**	27.0	25.1	13.7	31.9	32.5	35.5	36.1	36.7
Discards to landfill, other disposal†	55.5	87.9	123.4	140.1	131.1	120.9	115.8	119.6
Pounds per Person per Day								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	2.68	3.25	3.66	4.50	4.50	4.40	4.32	4.44
Recovery for recycling	0.17	0.22	0.35	0.64	0.89	0.94	0.96	1.00
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.18	0.20	0.23	0.25
Total Materials Recovery	0.17	0.22	0.35	0.73	1.06	1.14	1.18	1.24
Discards after recovery	2.51	3.04	3.31	3.77	3.44	3.26	3.14	3.20
Combustion**	0.82	0.67	0.33	0.70	0.68	0.74	0.75	0.75
Discards to landfill, other disposal†	1.69	2.36	2.98	3.07	2.75	2.52	2.39	2.45
Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	265,253	267,645
Percent of Total Generation								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.2%	19.7%	21.5%	22.2%	22.4%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	4.0%	4.5%	5.2%	5.6%
Total Materials Recovery	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%
Discards after recovery	93.6%	93.4%	90.4%	83.8%	76.4%	74.0%	72.6%	72.0%
Combustion**	30.6%	20.7%	9.0%	15.5%	15.2%	16.8%	17.3%	16.9%
Discards to landfill, other disposal†	63.0%	72.6%	81.4%	68.3%	61.2%	57.2%	55.4%	55.1%

* Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.

** Includes combustion of MSW in mass burn or refuse-derived fuel form, incineration without energy recovery, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel).

† Discards after recovery minus combustion.

Details may not add to totals due to rounding.

Source: Franklin Associates

Figure ES-1. Total municipal solid waste generation and management, 1960 to 1997

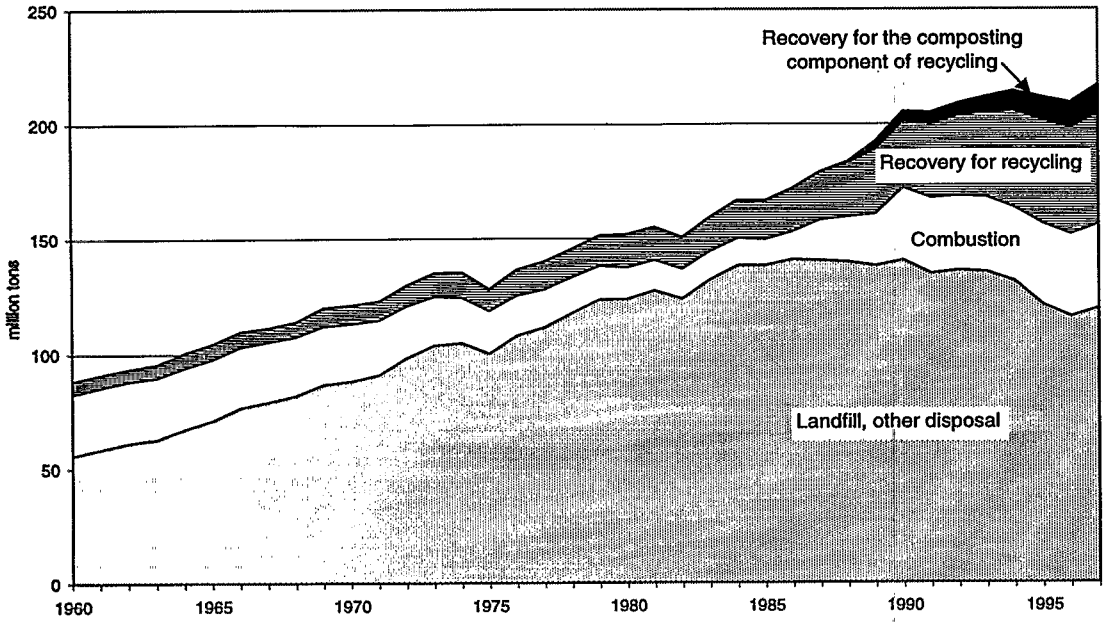
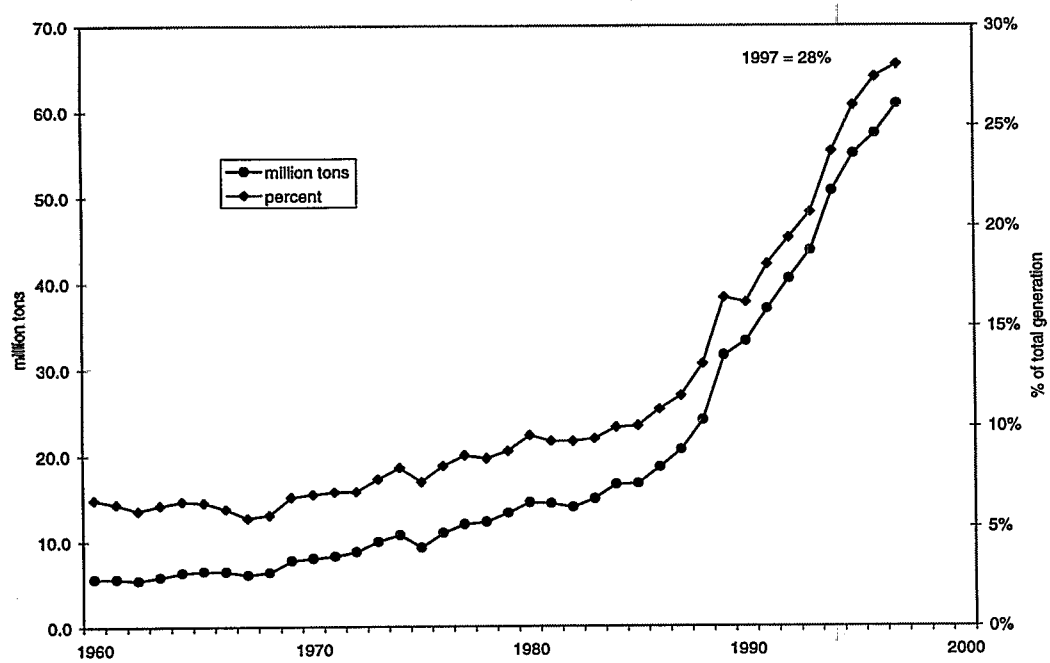


Figure ES-2. MSW recovery tonnages and rates, 1960 to 1997



DEFINITIONS AND METHODOLOGY

Municipal solid waste (MSW) includes wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. Examples of waste from these categories include appliances, automobile tires, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wood pallets, and cafeteria wastes. MSW does not include wastes from other sources, such as construction and demolition debris, automobile bodies, municipal sludges, combustion ash, and industrial process wastes that might also be disposed in municipal waste landfills or incinerators.

Source reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system (see **Generation**). Reuse is a source reduction activity involving the recovery or reapplication of a package, used product, or material in a manner that retains its original form or identity. Reuse of products such as refillable glass bottles, reusable plastic food storage containers, or refurbished wood pallets are examples of source reduction.

Generation refers to the amount (weight or volume) of materials and products that enter the waste stream before recycling (including composting), landfilling, or combustion takes place.

Recovery of materials means removing MSW from the waste stream for the purpose of recycling (including composting). Recovery for recycling as defined for this report includes purchases of postconsumer recovered materials plus net exports of the materials. Recovery of yard trimmings includes diverting yard trimmings from disposal to a composting facility. For some materials, recovery for uses such as highway construction or insulation is considered recovery along with materials used in remanufacturing processes.

Combustion includes combustion of mixed MSW, fuel prepared from MSW, or a separated component of MSW (such as rubber tires), with or without energy recovery.

Discards include the municipal solid waste remaining after recycling (including composting). These discards are usually combusted or disposed of in landfills, although some MSW is littered, stored, or disposed on site, particularly in rural areas.

♦ ♦ ♦

Methodology. There are two primary methods for conducting a waste characterization study. The first is a source-specific approach in which the individual components of the waste stream are sampled, sorted, and weighed. Although this method is useful for defining a local waste stream, extrapolating from a limited number of studies can produce a skewed or misleading picture if used for a nationwide characterization of waste. Atypical circumstances encountered during sampling or errors in the sample would be greatly magnified when expanded to represent the nation's entire waste stream. The second method, which is used in this report, is called the "material flows methodology." EPA's Office of Solid Waste and its predecessors in the Public Health Service sponsored work in the 1960s and early 1970s to develop the material flows methodology. This methodology is based on production data (by weight) for the materials and products in the waste stream, with adjustments for imports, exports, and product lifetimes.

MUNICIPAL SOLID WASTE IN 1997

EPA has established a target recycling goal of 35 percent by the year 2005, while maintaining the per capita generation of solid waste at 4.3 pounds per person per day. The nation appears to be on-track to meet that goal, but it will take continued commitment from business, industry, government and the public to do so. As economic growth results in more products and materials being generated, there will be an increased need to utilize existing recycling and composting facilities, further develop this infrastructure, buy recycled products, and invest in source reduction activities such as grasscycling and composting.

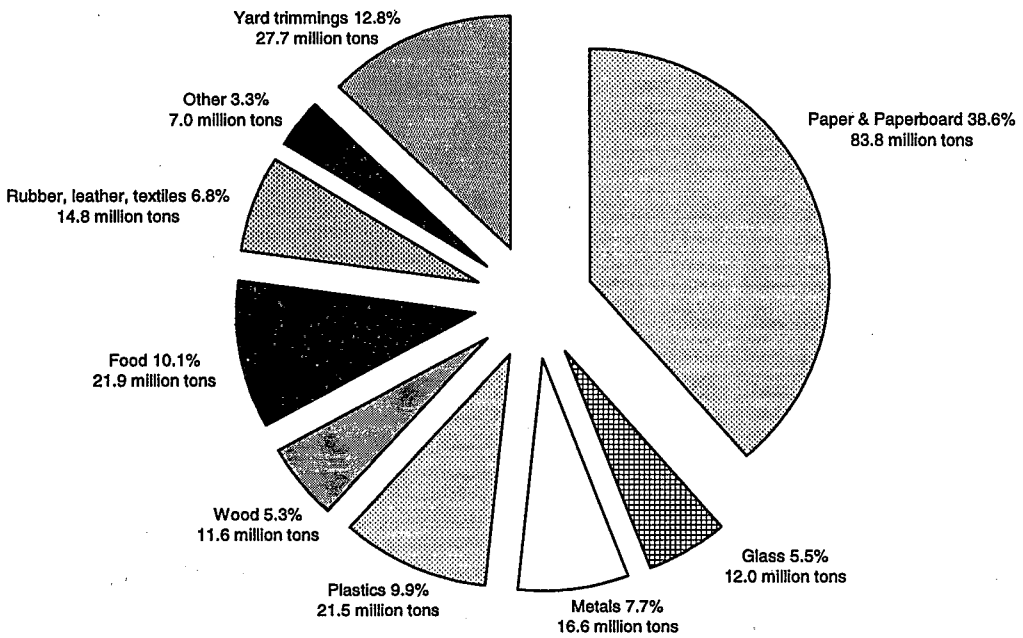
EPA has two ways of analyzing the 217 million tons of MSW generated each year. The first is by major material categories, such as paper, glass, metals, plastics, wood, food, and yard trimmings. The second is by several major product categories. Each material category (except for food wastes and yard trimmings) is made up of many different products. Products in MSW are grouped into three main categories: (1) durable goods (e.g., appliances), (2) nondurable goods (e.g., newspapers), and (3) containers and packaging. These product categories generally contain each type of MSW material, with some exceptions. The durable goods category contains no paper and paperboard. The nondurable goods category includes only small amounts of metals and essentially no glass or wood. The containers and packaging category includes only very small amounts of rubber, leather, and textiles.

Materials in MSW

In 1997, MSW generation totaled 217 million tons. Figure ES-3 provides a breakdown, by weight, of the MSW materials generated in 1997. Paper and paperboard products made up the largest component of MSW generated (39 percent), and yard trimmings comprised the second largest material component (13 percent). Glass, metals, plastics, wood, and food wastes each constituted between 5 and 10 percent of the total MSW generated. Rubber, leather, and textiles combined made up about 7 percent of MSW, while other miscellaneous wastes made up approximately 3 percent of the MSW generated in 1997.

A portion of each material category in MSW was recycled or composted in 1997, as illustrated in Table ES-2. It should be noted, however, that recovery rates for some products within a material category are higher than the overall recovery rate for the material category, because some products are not recovered at all. For example, aluminum cans were recovered at a rate of 60 percent, but the overall recovery rate for aluminum was 31 percent. Likewise,

Figure ES-3. Materials generated in MSW by weight, 1997
(Total weight = 217 million tons)



even though corrugated containers were recovered at a rate of 67 percent, the overall recovery rate for paper and paperboard was 42 percent.

Products in MSW

Figure ES-4 shows the breakdown, by weight, of MSW products generated in 1997. Containers and packaging comprised the largest portion of products generated, at 33 percent (72 million tons) of total MSW generation. Nondurable goods were the second largest fraction, comprising about 27 percent (59 million tons). The third main category of products is durable goods, which comprised 15 percent (33 million tons) of total MSW generation.

Table ES-3 shows the generation and recovery of the product categories in MSW. Recovery of **containers and packaging** was the highest of the three product categories—39 percent of containers and packaging generated in 1997 were recovered for recycling. About 49 percent of aluminum packaging was recovered (mostly aluminum beverage cans), while 61 percent of steel packaging (mostly cans) was recovered. Paper and paperboard packaging recovery was estimated at 54 percent; corrugated containers accounted for most of that figure.

Table ES-2

GENERATION AND RECOVERY OF MATERIALS IN MSW, 1997
(In millions of tons and percent of generation of each material)

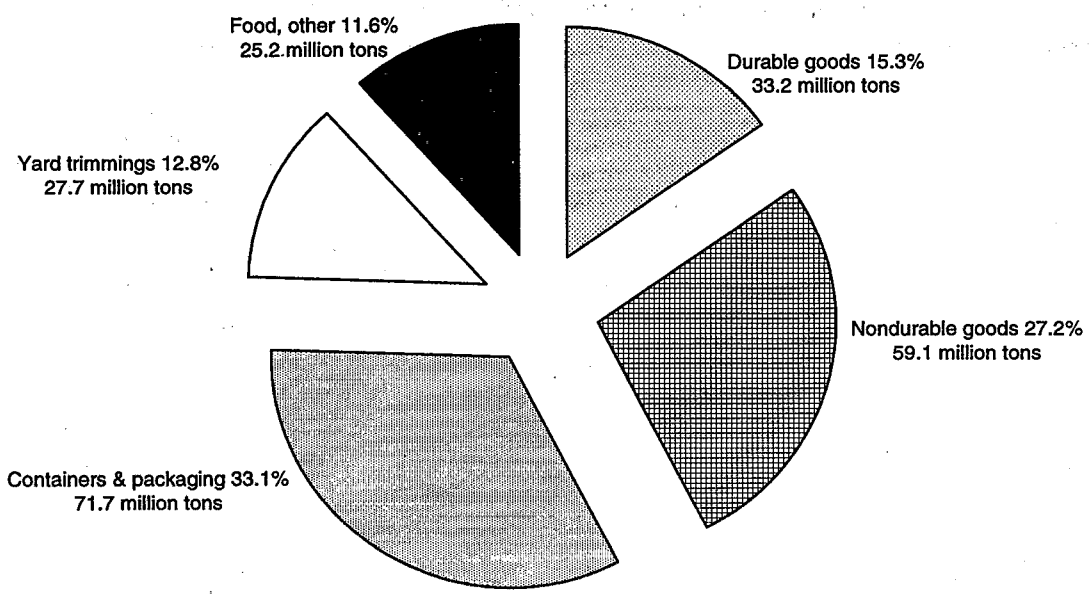
	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Paper and paperboard	83.8	34.9	41.7%
Glass	12.0	2.9	24.3%
Metals			
Steel	12.3	4.7	38.4%
Aluminum	3.0	0.9	31.2%
Other nonferrous metals*	1.3	0.8	65.4%
Total metals	16.6	6.5	39.1%
Plastics	21.5	1.1	5.2%
Rubber and leather	6.6	0.8	11.7%
Textiles	8.2	1.1	12.9%
Wood	11.6	0.6	5.1%
Other materials	3.8	0.8	20.2%
Total Materials in Products	164.1	48.6	29.6%
Other wastes			
Food, other**	21.9	0.6	2.6%
Yard trimmings	27.7	11.5	41.4%
Miscellaneous inorganic wastes	3.3	Neg.	Neg.
Total Other Wastes	52.9	12.1	22.8%
TOTAL MUNICIPAL SOLID WASTE	217.0	60.7	28.0%

Includes wastes from residential, commercial, and institutional sources.
* Includes lead from lead-acid batteries.
** Includes recovery of paper for composting.
Neg. = Less than 50,000 tons or 0.05 percent.

Approximately 28 percent of glass containers were recovered overall, while about 8 percent of wood packaging (mostly pallets removed from service) was recovered for recycling. About 9 percent of plastic containers and packaging was recovered in 1997, mostly soft drink, milk, and water bottles.

Overall recovery of **nondurable goods** was 25 percent in 1997. Newspapers constituted the largest portion of this recovery, with 55 percent of newspapers generated

Figure ES-4. Products generated in MSW by weight, 1997
(Total weight = 217 million tons)



being recovered for recycling. High-grade office papers and magazines were also recovered in significant quantities in 1997, at an estimated 51 percent and 23 percent, respectively.

About 16 percent of clothing and other textile nondurable products also were recovered for recycling.

Overall, **durable goods** were recovered at a rate of 17 percent in 1997. Nonferrous metals had one of the highest recovery rates, at 65 percent, due to the high rate of lead recovery from lead-acid batteries. Nearly 31 percent of ferrous metals were recovered from appliances and miscellaneous durable goods. Excluding retreads and tire-derived fuel use, over 22 percent of tires also were recovered for recycling.

Residential and Commercial Sources of MSW

Sources of MSW, as characterized in this report, include both residential and commercial locations. Residential waste (including waste from multi-family dwellings) is estimated to be 55 to 65 percent of total MSW generation. Commercial waste (including waste from schools, some industrial sites where packaging is generated, and businesses)

Table ES-3

GENERATION AND RECOVERY OF PRODUCTS IN MSW BY MATERIAL, 1997
(In millions of tons and percent of generation of each product)

	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Durable goods			
Ferrous metals	9.2	2.8	30.8%
Aluminum	0.9	Neg.	Neg.
Other non-ferrous metals	1.3	0.8	64.8%
Total metals	11.4	3.7	32.2%
Glass	1.4	Neg.	Neg.
Plastics	6.7	0.3	4.4%
Rubber and leather	5.8	0.8	13.4%
Wood	4.5	Neg.	Neg.
Textiles	2.5	0.2	6.7%
Other materials	1.0	0.8	76.4%
Total durable goods	33.2	5.7	17.0%
Nondurable goods			
Paper and paperboard	44.4	13.8	31.0%
Plastics	5.4	Neg.	<1%
Rubber and leather	0.8	Neg.	Neg.
Textiles	5.6	0.9	15.9%
Other materials	2.9	Neg.	Neg.
Total nondurable goods	59.1	14.7	24.8%
Containers and packaging			
Steel	3.1	1.9	61.0%
Aluminum	1.9	0.9	48.5%
Total metals	5.0	2.8	56.2%
Glass	10.6	2.9	27.6%
Paper and paperboard	39.5	21.1	53.5%
Plastics	9.4	0.8	8.7%
Wood	7.1	0.6	8.3%
Other materials	0.1	Neg.	Neg.
Total containers and packaging	71.7	28.3	39.4%
Other wastes			
Food wastes	21.9	0.6 *	2.6%
Yard trimmings	27.7	11.5	41.4%
Miscellaneous inorganic wastes	3.3	Neg.	Neg.
Total other wastes	52.9	12.1	22.8%
TOTAL MUNICIPAL SOLID WASTE	217.0	60.7	28.0%

Includes wastes from residential, commercial, and institutional sources.

* Includes recovery of paper for composting.

Neg. = less than 50,000 tons or 0.05 percent.

constitutes between 35 and 45 percent. Local and regional factors, such as climate and level of commercial activity, contribute to these variations.

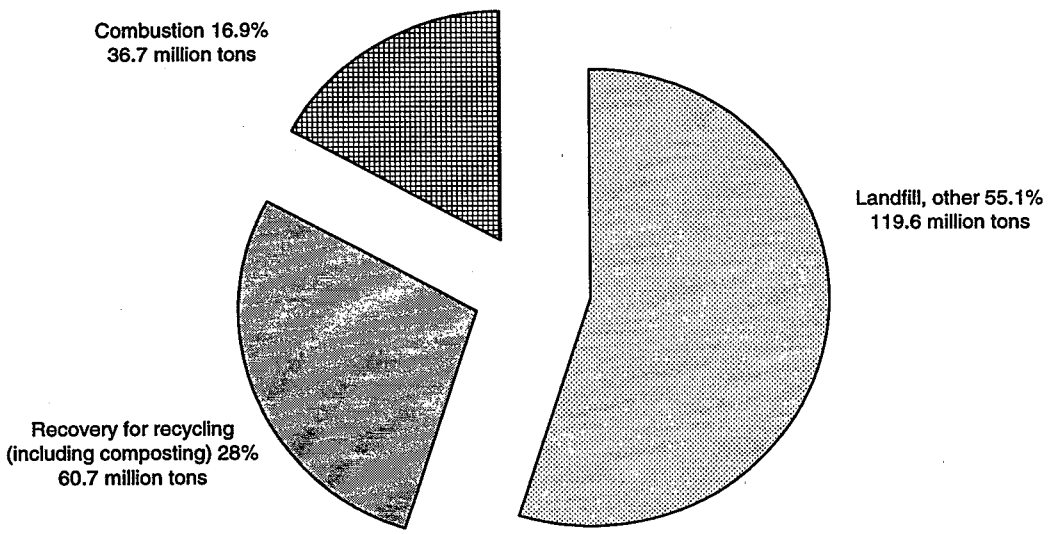
MANAGEMENT OF MSW

EPA's integrated waste management hierarchy includes the following components:

- Source reduction (or waste prevention) (including reuse of products and backyard composting of yard trimmings)
- Recycling (including composting)
- Waste combustion (preferably with energy recovery) and landfilling.

Figure ES-5 shows how much MSW was recovered for recycling (including composting) and how much was disposed of by combustion and landfilling in 1997. Twenty-eight percent (61 million tons) of MSW was recycled and composted; an estimated 17 percent (37 million tons) was combusted (nearly all with energy recovery); and the remainder, 55 percent (119 million tons), was landfilled. (Relatively small amounts of this total undoubtedly were littered or self-disposed rather than landfilled.)

Figure ES-5. Management of MSW in the U.S., 1997
(Total weight = 217 million tons)



Source Reduction

Source reduction includes the design, manufacture, purchase, or use of materials, such as products and packaging, to reduce their amount or toxicity before they enter the MSW management system. Some examples of source reduction activities are:

- Designing products or packaging to reduce the quantity or the toxicity of the materials used, or to make them easy to reuse.
- Reusing existing products or packaging, for example, refillable bottles, reusable pallets, and reconditioned barrels and drums.
- Lengthening the lives of products to postpone disposal.
- Using packaging that reduces the amount of damage or spoilage to the product.
- Managing nonproduct organic wastes (e.g., food scraps and yard trimmings) through on-site composting or other alternatives to disposal (e.g., leaving grass clippings on the lawn).

Product source reduction activities are not quantified at the national level in this report.

Recovery

Recovery for recycling (including composting) continues to be one of the most effective waste management techniques. Approximately 51 percent of the U.S. population (136 million people) had access to the nation's nearly 9,000 curbside recycling programs in 1997. Seventy-five percent of the programs were in the Northeast and Midwest. In addition, over 12,000 drop-off centers for recyclables were reported in 1997. About 380 materials recovery facilities helped process the recyclables collected in 1997. An estimated 3,500 yard trimmings composting programs (not backyard composting) existed in 1997; the majority of these programs were in the Northeast and Midwest.

Combustion

Most MSW combustion in the United States involves the recovery of an energy product (generally steam or electricity). Total MSW combustion with energy recovery, referred to as waste-to-energy combustion, had a design capacity of 101,000 tons per day in 1997. There were 112 waste-to-energy combustion facilities in the United States in 1997;

about 38 percent of these were located in the Northeast, accounting for about 48 percent of total design capacity. There is a small amount of capacity (2,400 tons per day) for incineration without energy recovery.

Landfilling

Although the number of landfills in the United States is decreasing, landfill capacity has remained relatively constant. In 1997, approximately 2,200 municipal solid waste landfills were reported in the contiguous United States, with the Southeast and West having the greatest number of landfills. Forty-two states had landfills reporting more than 10 years of capacity remaining. Only six states reported having less than 10 years of capacity left.

PROJECTIONS OF MSW GENERATION AND MANAGEMENT

MSW Generation

Projections of municipal solid waste generation were made for the years 2000 and 2005. The projections for most materials and products were based on linear trends, that is, it was assumed that generation would continue to grow (or decline) based on past experience. It was assumed that there will be no dramatic changes in the next eight years.

Projected generation by material is shown in Table ES-4. Generation of waste from products made of paper and paperboard, metals, plastics, wood, and other materials such as rubber and textiles is projected to continue to increase. Only glass is projected to decline.

Food waste is projected to increase at the same rate as population. Generation of yard trimmings has been decreasing due to state legislation regulating their disposal (e.g., landfill bans on disposal of yard trimmings). While no new legislation of this type was identified, an increasing number of communities have been instituting variable rate collection programs (pay-as-you-throw). Since these programs tend to decrease the amount of yard trimmings disposed, it was assumed that generation of yard trimmings will remain constant from 2000 to 2005.

The long term historical trend has been for generation of manufactured products to increase (Figure ES-6). Diversion of yard trimmings from disposal has served to hold down the overall growth of MSW; however, the overall trend is still up.

Table ES-4

PROJECTIONS OF MATERIALS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 2000 AND 2005
(In thousands of tons and percent of total generation)

	Million tons		% of total	
Materials	**2000**	**2005**	**2000**	**2005**
Paper and Paperboard	87.7	94.8	39.3%	39.6%
Glass	11.9	11.2	5.3%	4.7%
Metals	17.6	18.7	7.9%	7.8%
Plastics	23.4	26.7	10.5%	11.2%
Wood	14.0	15.8	6.3%	6.6%
Others	19.7	22.2	8.8%	9.3%
Total Materials in Products	174.3	189.4	78.1%	79.1%
Other Wastes				
Food Wastes	22.5	23.5	10.1%	9.8%
Yard Trimmings	23.0	23.0	10.3%	9.6%
Miscellaneous Inorganic Wastes	3.4	3.6	1.5%	1.5%
Total Other Wastes	48.9	50.1	21.9%	20.9%
Total MSW Generated	223.2	239.5	100.0%	100.0%

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
Source: Franklin Associates

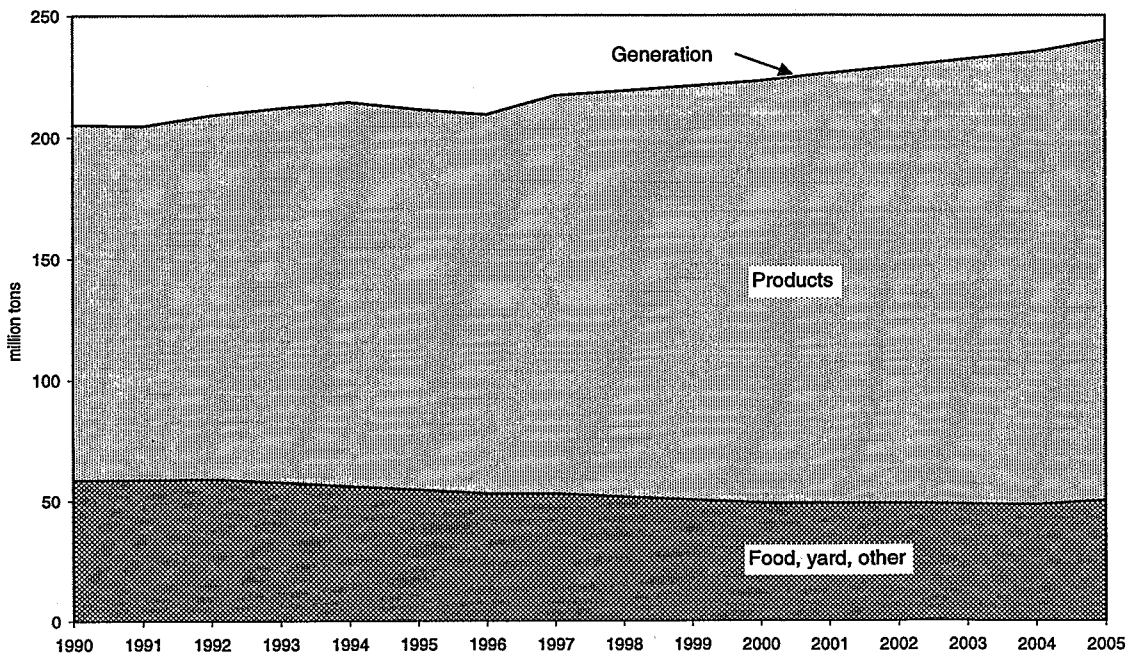
MSW Management

Projections of recycling (including composting) were made in scenarios of 30 percent and 32 percent recovery in 2000 and 32 percent and 35 percent in 2005. These projections were made in the context of an extensive recovery and processing infrastructure already in place, on the one hand, and very poor markets for most recovered materials for the past two years, on the other hand. The poor markets are not just domestic in origin, but also reflect worldwide economic conditions.

The more conservative scenario—30 percent recovery in 2000 and 32 percent in 2005—assumes continued modest growth in recovery. The more optimistic scenario—32 percent recovery in 2000 and 35 percent in 2005—assumes that market difficulties will be corrected in time to stimulate additional recovery.

Under the conservative scenario for recovery, discards of MSW to combustion or landfill would be virtually the same in 2000 as in 1997, and would be 4 percent higher in 2005 than in 1997. If a modest increase in MSW combustion is projected, MSW landfilled will decline slightly in 2000 and increase by 4 percent in 2000 compared to 1997. If recovery for recycling (including composting) could be increased to 35 percent of generation in 2005, MSW landfilled would decrease to 117.6 million tons, compared to 119.5 million tons in 1997.

Figure ES-6. Historical and projected MSW, by category



Chapter 1

INTRODUCTION AND METHODOLOGY

BACKGROUND

This report is the most recent in a series of reports sponsored by the U.S. Environmental Protection Agency to characterize municipal solid waste (MSW) in the United States. Together with the previous reports, this report provides a historical database for a 37-year characterization (by weight) of the materials and products in MSW.

Management of the nation's municipal solid waste (MSW) continues to be a high priority issue for many communities as we near the turn of the century. Increasingly, the concept of integrated solid waste management—source reduction of wastes before they enter the waste stream, recovery of generated wastes for recycling (including composting), and environmentally sound disposal through combustion facilities and landfills that meet current standards—is being used by communities as they plan for the future.

There are many regional variations that require each community to examine its own waste management needs. Such factors as local and regional availability of suitable landfill space, proximity of markets for recovered materials, population density, commercial and industrial activity, and climatic and groundwater variations all may motivate each community to make its own plans.

Identifying the components of the waste stream is an important step toward addressing the issues associated with the generation and management of municipal solid wastes. MSW characterizations, which analyze the quantity and composition of the municipal solid waste stream, involve estimating how much MSW is generated, recycled (including composting), combusted, and disposed of in landfills. By determining the makeup of the waste stream, waste characterizations also provide valuable data for setting waste management goals, tracking progress toward those goals, and supporting planning at the national, state, and local levels. For example, waste characterizations can be used to highlight opportunities for source reduction and recycling and provide information on any special management issues that should be considered.

Readers should note that this report characterizes the municipal solid waste stream of *the nation as a whole*. Local and regional variations are not addressed, but suggestions for use of the information in this report by local planners are included in this chapter.

HOW THIS REPORT CAN BE USED

The data in this report provide a nationwide picture of municipal solid waste generation and management. The historical perspective is particularly useful in establishing trends and highlighting the changes that have occurred over the years, both in types of wastes generated and in the ways they are managed. This perspective on MSW and its management

is useful in assessing national solid waste management needs and policy. The report is, however, of equal or greater value as a solid waste management planning tool for state and local governments and private firms.

A common error in using this report is to assume that *all* nonhazardous wastes are included. As shown later in this chapter, municipal solid waste as defined here does *not* include construction and demolition wastes,* industrial process wastes, or a number of other wastes that may well go to a municipal waste landfill.

At the local or state level, the data in this report can be used to develop approximate (but quick) estimates of MSW generation in a defined area. That is, the data on generation of MSW per person nationally may be used to estimate generation in a city or other local area based on the population in that area. This can be of value when a "ballpark" estimate of MSW generation in an area is needed. For example, communities may use such an estimate to determine the potential viability of regional versus single community solid waste management facilities. This information can help define solid waste management planning areas and the planning needed in those areas. However, for communities making decisions where knowledge of the amount and composition of MSW is crucial, e.g., where a solid waste management facility is being sited, local estimates of the waste stream should be made.

Another useful feature of this report for local planning is the information provided on MSW trends. Changes over time in total MSW generation and the mix of MSW materials can affect the need for and use of various waste management alternatives. Observing trends in MSW generation can help in planning an integrated waste management system that includes facilities sized and designed for years of service.

While the national average data are useful as a checkpoint against local MSW characterization data, any differences between local and national data should be examined carefully. There are many possible reasons for these differences, for example:

- Scope of waste streams may differ. That is, a local landfill may be receiving construction and demolition wastes in addition to MSW, but this report addresses MSW only.

- Per capita generation of some products, such as newspapers and telephone directories, varies widely depending upon the average size of the publications. Typically, rural areas will generate less of these products on a per person basis than urban areas.

- The level of commercial activity in a community will influence the generation rate of some products, such as office paper, corrugated boxes, wood pallets, and food wastes from restaurants.

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* Information on construction and demolition debris can be found in ***Characterization of Building-Related Construction and Demolition Debris in the United States***. EPA530-R-98-010. May 1998.

- Variations in economic activity can affect waste generation in both the residential and the commercial sectors.

- Variations in climate and local waste management practices will greatly influence generation of yard trimmings. For instance, yard trimmings exhibit strong seasonal variations in most regions of the country. Also, the level of backyard composting in a region will affect generation of yard trimmings.

- Generation and discards of other products will be affected by local and state regulations and practices. Deposit laws, bans on landfilling of specific products, and variable rate pricing for waste collection are examples of practices that can influence a local waste stream.

While caution should be used in applying the data in this report, for some areas, the national breakdown of MSW by material may be the only such data available for use in comparing and planning waste management alternatives. Planning a curbside recycling program, for example, requires an estimate of household recyclables that may be recovered. If resources are not available to adequately estimate these materials by other means, local planners may turn to the national data. This is useful in areas that can reasonably be expected to have typical/average MSW generation or in areas where appropriate adjustments in the data can be made to account for local conditions.

In summary, the data in this report can be used in the following ways for local planning:

- to develop approximate estimates of total MSW generation in an area

- to check locally developed MSW data for accuracy and consistency

- to help estimate quantities of recyclables and other MSW components in an area

- to account for trends in total MSW generation and the generation of individual components.

MUNICIPAL SOLID WASTE IN PERSPECTIVE

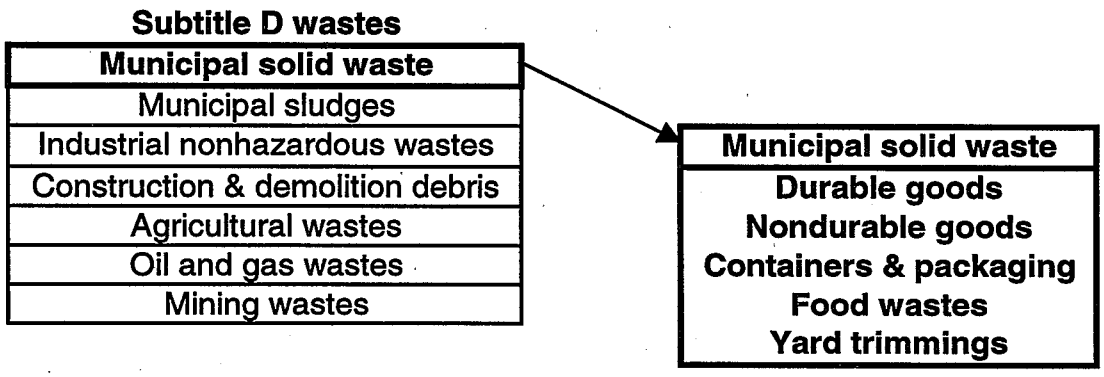
Municipal Solid Waste Defined

Municipal solid waste as defined for this report includes durable goods, nondurable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes (Figure 1). Municipal solid wastes characterized in this report come from residential, commercial, institutional, and industrial sources. Some examples of the types of MSW that come from each of the broad categories of sources are:

Sources and Examples	Example Products
Residential (single- and multi-family homes)	Newspapers, clothing, disposable tableware, food packaging, cans and bottles, food scraps, yard trimmings
Commercial (office buildings, retail and wholesale establishments, restaurants)	Corrugated boxes, food wastes, office papers, disposable tableware, paper napkins, yard trimmings
Institutional (schools, libraries, hospitals, prisons)	Cafeteria and restroom trash can wastes, office papers, classroom wastes, yard trimmings
Industrial (packaging and administrative; *not* process wastes)	Corrugated boxes, plastic film, wood pallets, lunchroom wastes, office papers.

The material flows methodology used in this report does not readily lend itself to the quantification of wastes according to their source. For example, corrugated boxes may be unpacked and discarded from residences, commercial establishments such as grocery stores, institutions such as schools, or factories. The methodology estimates only the total quantity of such boxes generated, not their places of disposal or recovery for recycling.

Figure 1. Municipal solid waste in the universe of Subtitle D wastes



Other Subtitle D Wastes

Some people assume that "municipal solid waste" must include everything that is landfilled in Subtitle D landfills. (Subtitle D of the Resource Conservation and Recovery Act deals with wastes other than the hazardous wastes covered under Subtitle C.) As shown in

Figure 1, however, RCRA Subtitle D includes many kinds of wastes. It has been common practice to landfill wastes such as municipal sludge, nonhazardous industrial wastes, residue from automobile salvage operations, and construction and demolition wastes along with MSW, but these other kinds of wastes *are not included in the estimates presented in this report.*

The Solid Waste Management Hierarchy

EPA's 1989 Agenda for Action endorsed the concept of integrated waste management, by which municipal solid waste is reduced or managed through several different practices, which can be tailored to fit a particular community's needs. The components of the hierarchy are:

- source reduction (including reuse of products and backyard composting of yard trimmings)
- recycling of materials (including composting)
- waste combustion (preferably with energy recovery) and landfilling.

With the exception of source reduction, this updated characterization report includes estimates of the quantities of MSW managed by each practice in the hierarchy.

METHODOLOGIES FOR CHARACTERIZING MUNICIPAL SOLID WASTE

The Two Methodologies

There are two basic approaches to estimating quantities of municipal solid waste. The first method, which is site-specific, involves sampling, sorting, and weighing the individual components of the waste stream. This method is useful in defining a local waste stream, especially if large numbers of samples are taken over several seasons. Results of sampling also increase the body of knowledge about variations due to climatic and seasonal changes, population density, regional differences, and the like. In addition, quantities of MSW components such as food and yard trimmings can only be estimated through sampling and weighing studies.

A disadvantage of sampling studies based on a limited number of samples is that they may be skewed and misleading if, for example, atypical circumstances were experienced during the sampling. These circumstances could include an unusually wet or dry season, delivery of some unusual wastes during the sampling period, or errors in the sampling methodology. Any errors of this kind will be greatly magnified when a limited number of samples are taken to represent a community's entire waste stream for a year. Magnification of errors could be even more serious if a limited number of samples was relied upon for making the national estimates of MSW. Also, extensive sampling would be prohibitively expensive for making the national estimates. An additional disadvantage of sampling studies is that they do not provide information about trends unless performed in a consistent manner over a long period of time.

The second approach to quantifying and characterizing the municipal solid waste stream—the method used for this report—utilizes a material flows approach to estimate the waste stream on a nationwide basis. In the late 1960s and early 1970s, EPA's Office of Solid Waste and its predecessors at the Public Health Service sponsored work that began to develop this methodology. This report represents the latest version of this database that has been evolving for over 20 years.

The material flows methodology is based on production data (by weight) for the materials and products in the waste stream. Generation data is the result of making specific adjustments to the production data by each material and product category. Adjustments are made for imports and exports and for diversions from MSW (e.g., for building materials made of plastic and paperboard). Adjustments are also made for the lifetimes of products. Finally, food wastes and yard trimmings and a small amount of miscellaneous inorganic wastes are accounted for by compiling data from a variety of waste sampling studies.

One problem with the material flows methodology is that product residues associated with other items in MSW (usually containers) are not accounted for. These residues would include, for example, food left in a jar, detergent left in a box or bottle, dried paint in a can, etc. Some household hazardous wastes, e.g., pesticide left in a can, are also included among these product residues.

Definition of Terms

The material flows methodology produces an estimate of total municipal solid waste generation in the United States, by material categories and by product categories.

The term ***generation*** as used in this report refers to the weight of materials and products as they enter the waste management system from residential, commercial, institutional, and industrial sources and before materials recovery or combustion takes place. Preconsumer (industrial) scrap is not included in the generation estimates. Source reduction activities (e.g., backyard composting of yard trimmings) take place *ahead of* generation.

Source reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system. Reuse is a source reduction activity involving the recovery or reapplication of a package, used product, or material in a manner that retains its original form or identity. Reuse of products such as refillable glass bottles, reusable plastic food storage containers, or refurbished wood pallets is considered source reduction, not recycling.

Recovery of materials as estimated in this report includes products and yard trimmings removed from the waste stream for the purpose of recycling (including composting). For recovered products, recovery equals reported purchases of postconsumer recovered material (e.g., glass cullet, old newspapers) plus net exports (if any) of the material. Thus, recovery of old corrugated containers (OCC) is the sum of OCC purchases by paper mills plus net exports of OCC. If recovery as reported by a data source includes converting or fabrication (preconsumer) scrap, the preconsumer scrap is *not* counted towards

the recovery estimates in this report. Imported secondary materials are also not counted in recovery estimates in this report. For some materials, additional uses, such as glass used for highway construction or newspapers used to make insulation, are added into the recovery totals.

Combustion of MSW was estimated with and without energy recovery. Combustion with energy recovery is often called "waste-to-energy," while combustion without energy is called incineration in this report. Combustion of separated materials—wood, rubber from tires, paper, and plastics—is included in the estimates of combustion in this report.

Discards include the MSW remaining after recovery for recycling (including composting). These discards would presumably be combusted or landfilled, although some MSW is littered, stored or disposed on-site, or burned on-site, particularly in rural areas. No good estimates for these other disposal practices are available, but the total amounts of MSW involved are presumed to be small.

MATERIALS AND PRODUCTS NOT INCLUDED IN THESE ESTIMATES

As noted earlier, other Subtitle D wastes (illustrated in Figure 1) are not included in these estimates, even though some may be managed along with MSW (e.g., by combustion or landfilling). Household hazardous wastes, while generated as MSW with other residential wastes, are not identified separately in this report. Transportation equipment (including automobiles and trucks) is not included in the wastes characterized in this report.

Certain other materials associated with products in MSW are often not accounted for because the appropriate data series have not yet been developed. These include, for example, inks and other pigments and some additives associated with packaging materials. Considerable additional research would be required to estimate these materials, which constitute a relatively small percentage of the waste stream.

Some adjustments are made in this report to account for packaging of imported goods, but there is little available documentation of these amounts.

OVERVIEW OF THIS REPORT

Following this introductory chapter, Chapter 2 presents the results of the municipal solid waste characterization (by weight). Estimates of MSW generation, recovery, and discards are presented in a series of tables, with discussion. Detailed tables and figures summarizing 1996 MSW generation, recovery, and discards of products in each material category are included.

In Chapter 3 of the report, estimates of 1997 MSW management by the various alternatives are summarized. These include recovery for recycling (including composting), combustion, and landfilling. Also presented is a discussion of source reduction practices. Summaries of the infrastructure currently available for each waste management alternative are also included in Chapter 3.

Chapter 4 features projections of municipal solid waste generation and management, by material and by product, to the year 2005.

A brief discussion of the material flows methodology is presented in Appendix A. In Appendix B, the MSW characterization data summarized in previous chapters of the report are presented again from different perspectives. These perspectives include: estimates of residential versus commercial sources, organic/inorganic fractions of MSW, generation and discards by individual, ranking of products by weight, and MSW volume estimates.

Chapter 1

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Chapter 2

CHARACTERIZATION OF MUNICIPAL SOLID WASTE BY WEIGHT

INTRODUCTION

The tables and figures in this chapter present the results of the update of EPA's municipal solid waste characterization report through 1997. The data presented also incorporate some revisions to previously reported data for 1996 and, in some instances, to data for earlier years. The revisions are generally due to revisions in the various source data series used to prepare this report.

The findings are presented in two ways: a breakdown of municipal solid waste (MSW) by material, and a breakdown by product (both by weight and by percentage of generation or discards). While some products, for example, paper towels, are made up of a single material—paper—other products, for example, rubber tires, contain more than one material, such as rubber, ferrous metals, and textiles. Thus the materials summary tables represent an aggregation of the materials that go into all the products in MSW. (Note that the totals for the materials tables and the products tables are the same.)

The summary tables and figures provide information on generation of each material and product, and recovery for recycling (including composting, if any). Tables and figures displaying discards of materials and products after recovery for recycling (including composting) follow.

Recovery means that the materials have been removed from the municipal solid waste stream. Recovery of materials in products means that the materials are reported to have been purchased by an end-user or exported. For yard trimmings, recovery includes estimates of the trimmings delivered to a composting facility (not backyard composting). Under these definitions, residues from a materials recovery facility (MRF) or other waste processing facility are counted as generation (and, of course, discards), since they are not purchased by an end-user. Residues from an end-user facility (e.g., sludges from a paper deinking mill) are considered to be industrial process wastes that are no longer part of the municipal solid waste stream.

Additional detail is provided for some of the materials and products in MSW that are of the most interest to planners: paper, glass, metals, plastics, and rubber and leather.

MATERIALS IN MUNICIPAL SOLID WASTE

Generation, recovery, and discards of materials in MSW, by weight and by percentage of generation or discards, are summarized in Tables 1 through 3. Following these tables, each material is discussed in detail.

Table 1

MATERIALS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	29,990	44,310	55,160	72,730	80,840	81,670	79,680	83,840
Glass	6,720	12,740	15,130	13,100	13,350	12,830	12,290	12,010
Metals								
Ferrous	10,300	12,360	12,620	12,640	11,780	11,640	11,830	12,330
Aluminum	340	800	1,730	2,810	3,050	2,960	2,950	3,010
Other Nonferrous	180	670	1,160	1,100	1,350	1,260	1,260	1,270
Total Metals	*10,820*	*13,830*	*15,510*	*16,550*	*16,180*	*15,860*	*16,040*	*16,610*
Plastics	390	2,900	6,830	17,130	19,260	18,900	19,760	21,460
Rubber and Leather	1,840	2,970	4,200	5,790	6,210	6,030	6,200	6,590
Textiles	1,760	2,040	2,530	5,810	7,260	7,400	7,720	8,240
Wood	3,030	3,720	7,010	12,210	11,280	10,440	10,840	11,570
Other **	70	770	2,520	3,190	3,700	3,650	3,690	3,760
Total Materials in Products	54,620	83,280	108,890	146,510	158,080	156,780	156,220	164,080
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,500	21,740	21,850	21,910
Yard Trimmings	20,000	23,200	27,500	35,000	31,500	29,690	27,920	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	58,700	56,100	54,580	52,970	52,890
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970
	Percent of Total Generation							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	34.0%	36.6%	36.4%	35.4%	37.7%	38.6%	38.1%	38.6%
Glass	7.6%	10.5%	10.0%	6.4%	6.2%	6.1%	5.9%	5.5%
Metals								
Ferrous	11.7%	10.2%	8.3%	6.2%	5.5%	5.5%	5.7%	5.7%
Aluminum	0.4%	0.7%	1.1%	1.4%	1.4%	1.4%	1.4%	1.4%
Other Nonferrous	0.2%	0.6%	0.8%	0.5%	0.6%	0.6%	0.6%	0.6%
Total Metals	*12.3%*	*11.4%*	*10.2%*	*8.1%*	*7.6%*	*7.5%*	*7.7%*	*7.7%*
Plastics	0.4%	2.4%	4.5%	8.3%	9.0%	8.9%	9.4%	9.9%
Rubber and Leather	2.1%	2.5%	2.8%	2.8%	2.9%	2.9%	3.0%	3.0%
Textiles	2.0%	1.7%	1.7%	2.8%	3.4%	3.5%	3.7%	3.8%
Wood	3.4%	3.1%	4.6%	6.0%	5.3%	4.9%	5.2%	5.3%
Other **	0.1%	0.6%	1.7%	1.6%	1.7%	1.7%	1.8%	1.7%
Total Materials in Products	62.0%	68.8%	71.8%	71.4%	73.8%	74.2%	74.7%	75.6%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.0%	10.3%	10.4%	10.1%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.7%	14.0%	13.3%	12.8%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	26.2%	25.8%	25.3%	24.4%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Includes electrolytes in batteries and fluff pulp, feces, and urine in disposable diapers.

Details may not add to totals due to rounding.

Source: Franklin Associates

Table 2

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1997
(In thousands of tons and percent of generation of each material)

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	5,080	6,770	11,740	20,230	29,470	32,700	33,180	34,920
Glass	100	160	750	2,630	3,110	3,140	3,170	2,920
Metals								
Ferrous	50	150	370	2,230	3,990	4,130	4,400	4,730
Aluminum	Neg.	10	310	1,010	1,020	930	930	940
Other Nonferrous	Neg.	320	540	730	980	810	840	830
Total Metals	*50*	*480*	*1,220*	*3,970*	*5,990*	*5,870*	*6,170*	*6,500*
Plastics	Neg.	Neg.	20	370	940	990	1,060	1,110
Rubber and Leather	330	250	130	370	500	540	590	770
Textiles	50	60	160	660	870	900	950	1,060
Wood	Neg.	Neg.	Neg.	130	360	450	490	590
Other **	Neg.	300	500	680	910	750	780	760
Total Materials in Products	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	480	570	520	580
Yard Trimmings	Neg.	Neg.	Neg.	4,200	8,000	9,000	10,390	11,490
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700
	Percent of Generation of Each Material							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	16.9%	15.3%	21.3%	27.8%	36.5%	40.0%	41.6%	41.7%
Glass	1.5%	1.3%	5.0%	20.1%	23.3%	24.5%	25.8%	24.3%
Metals								
Ferrous	0.5%	1.2%	2.9%	17.6%	33.9%	35.5%	37.2%	38.4%
Aluminum	Neg.	1.3%	17.9%	35.9%	33.4%	31.4%	31.5%	31.2%
Other Nonferrous	Neg.	47.8%	46.6%	66.4%	72.6%	64.3%	66.7%	65.4%
Total Metals	*0.5%*	*3.5%*	*7.9%*	*24.0%*	*37.0%*	*37.0%*	*38.5%*	*39.1%*
Plastics	Neg.	Neg.	0.3%	2.2%	4.9%	5.2%	5.4%	5.2%
Rubber and Leather	17.9%	8.4%	3.1%	6.4%	8.1%	9.0%	9.5%	11.7%
Textiles	2.8%	2.9%	6.3%	11.4%	12.0%	12.2%	12.3%	12.9%
Wood	Neg.	Neg.	Neg.	1.1%	3.2%	4.3%	4.5%	5.1%
Other **	Neg.	39.0%	19.8%	21.3%	24.6%	20.5%	21.1%	20.2%
Total Materials in Products	10.3%	9.6%	13.3%	19.8%	26.7%	28.9%	29.7%	29.6%
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.2%	2.6%	2.4%	2.6%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	25.4%	30.3%	37.2%	41.4%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	15.1%	17.5%	20.6%	22.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Recovery of electrolytes in batteries; probably not recycled.
Neg. = Less than 5,000 tons or 0.05 percent.
^ Includes recovery of paper for composting.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 3

MATERIALS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	24,910	37,540	43,420	52,500	51,370	48,970	46,500	48,920
Glass	6,620	12,580	14,380	10,470	10,240	9,690	9,120	9,090
Metals								
Ferrous	10,250	12,210	12,250	10,410	7,790	7,510	7,430	7,600
Aluminum	340	790	1,420	1,800	2,030	2,030	2,020	2,070
Other Nonferrous	180	350	620	370	370	450	420	440
Total Metals	*10,770*	*13,350*	*14,290*	*12,580*	*10,190*	*9,990*	*9,870*	*10,110*
Plastics	390	2,900	6,810	16,760	18,320	17,910	18,700	20,350
Rubber and Leather	1,510	2,720	4,070	5,420	5,710	5,490	5,610	5,820
Textiles	1,710	1,980	2,370	5,150	6,390	6,500	6,770	7,180
Wood	3,030	3,720	7,010	12,080	10,920	9,990	10,350	10,980
Other **	70	470	2,020	2,510	2,790	2,900	2,910	3,000
Total Materials in Products	49,010	75,260	94,370	117,470	115,930	111,440	109,830	115,450
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,020	21,170	21,330	21,330
Yard Trimmings	20,000	23,200	27,500	30,800	23,500	20,690	17,530	16,240
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	54,500	47,620	45,010	42,060	40,820
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270
	Percent of Total Discards							
Materials	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Paper and Paperboard	30.2%	33.2%	31.7%	30.5%	31.4%	31.3%	30.6%	31.3%
Glass	8.0%	11.1%	10.5%	6.1%	6.3%	6.2%	6.0%	5.8%
Metals								
Ferrous	12.4%	10.8%	8.9%	6.1%	4.8%	4.8%	4.9%	4.9%
Aluminum	0.4%	0.7%	1.0%	1.0%	1.2%	1.3%	1.3%	1.3%
Other Nonferrous	0.2%	0.3%	0.5%	0.2%	0.2%	0.3%	0.3%	0.3%
Total Metals	*13.1%*	*11.8%*	*10.4%*	*7.3%*	*6.2%*	*6.4%*	*6.5%*	*6.5%*
Plastics	0.5%	2.6%	5.0%	9.7%	11.2%	11.4%	12.3%	13.0%
Rubber and Leather	1.8%	2.4%	3.0%	3.2%	3.5%	3.5%	3.7%	3.7%
Textiles	2.1%	1.8%	1.7%	3.0%	3.9%	4.2%	4.5%	4.6%
Wood	3.7%	3.3%	5.1%	7.0%	6.7%	6.4%	6.8%	7.0%
Other **	0.1%	0.4%	1.5%	1.5%	1.7%	1.9%	1.9%	1.9%
Total Materials in Products	59.4%	66.6%	68.8%	68.3%	70.9%	71.2%	72.3%	73.9%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	12.9%	13.5%	14.0%	13.6%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	14.4%	13.2%	11.5%	10.4%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.1%	2.1%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	29.1%	28.8%	27.7%	26.1%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Includes electrolytes in batteries and fluff pulp, feces, and urine in disposable diapers.

Details may not add to totals due to rounding.

Source: Franklin Associates

Paper and Paperboard

The many products made of paper and paperboard, taken collectively, are the largest component of MSW. The wide variety of products that comprise the paper and paperboard materials total is illustrated in Table 4 and Figures 2 and 3. In this report, these products are classified as either nondurable goods or as containers and packaging, with nondurable goods being the larger category.

Table 4

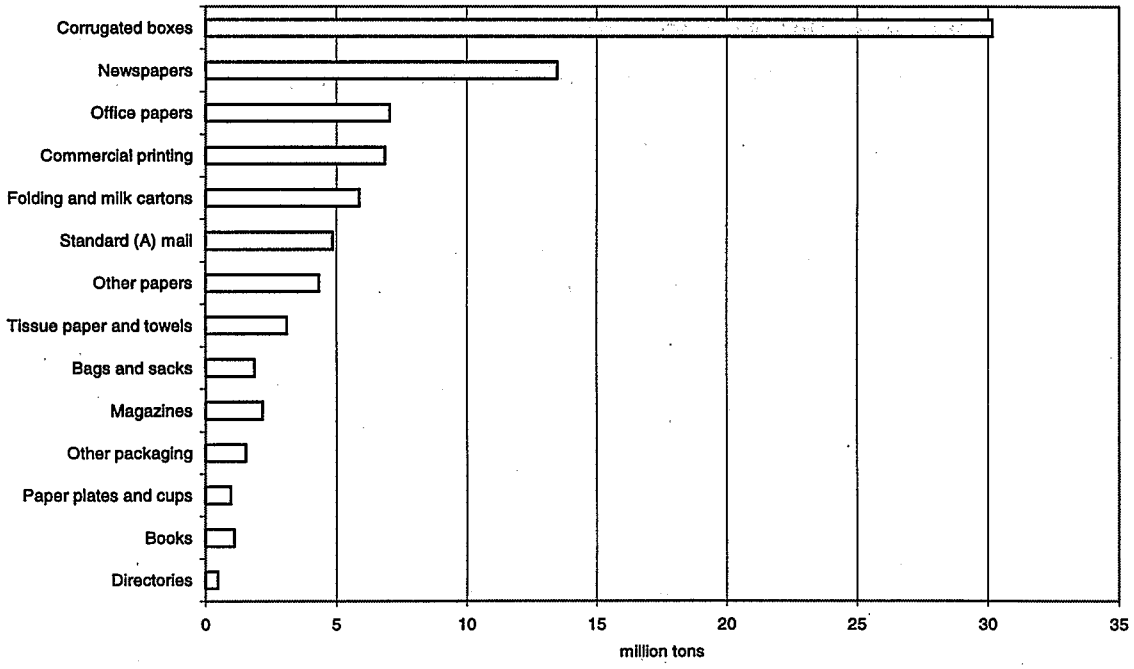
PAPER AND PAPERBOARD PRODUCTS IN MSW, 1997
(In thousands of tons and percent of generation)

Product Category	Generation (Thousands tons)	Recovery (Thousands tons)	Recovery (Percent of generation)	Discards (Thousands tons)
Nondurable Goods				
Newspapers				
Newsprint	10,960	6,170	56.3%	4,790
Groundwood inserts	2,530	1,200	47.4%	1,330
Total Newspapers	13,490	7,370	54.6%	6,120
Books	1,110	190	17.1%	920
Magazines	2,170	500	23.0%	1,670
Office Papers	7,040	3,570	50.7%	3,470
Directories	470	70	14.9%	400
Standard (A) Mail*	4,850	950	19.6%	3,900
Other Commercial Printing	6,860	1,130	16.5%	5,730
Tissue Paper and Towels	3,100	Neg.	Neg.	3,100
Paper Plates and Cups	970	Neg.	Neg.	970
Other Nonpackaging Paper**	4,330	Neg.	Neg.	4,330
Total Paper and Paperboard Nondurable Goods	44,390	13,780	31.0%	30,610
Containers and Packaging				
Corrugated Boxes	30,160	20,290	67.3%	9,870
Milk Cartons	460	10	2.2%	460
Folding Cartons	5,420	560	10.3%	4,860
Other Paperboard Packaging	220	Neg.	Neg.	220
Bags and Sacks	1,870	280	15.0%	1,590
Wrapping Papers	50	Neg.	Neg.	50
Other Paper Packaging	1,270	Neg.	Neg.	1,270
Total Paper and Paperboard Containers and Packaging	39,450	21,140	53.6%	18,310
Total Paper and Paperboard	83,840	34,920	41.7%	48,920

* Formerly called Third Class Mail by the U.S. Postal Service.
** Includes tissue in disposable diapers, paper in games and novelties, cards, etc.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

Source: Franklin Associates

Figure 2. Paper and paperboard products generated in MSW, 1997

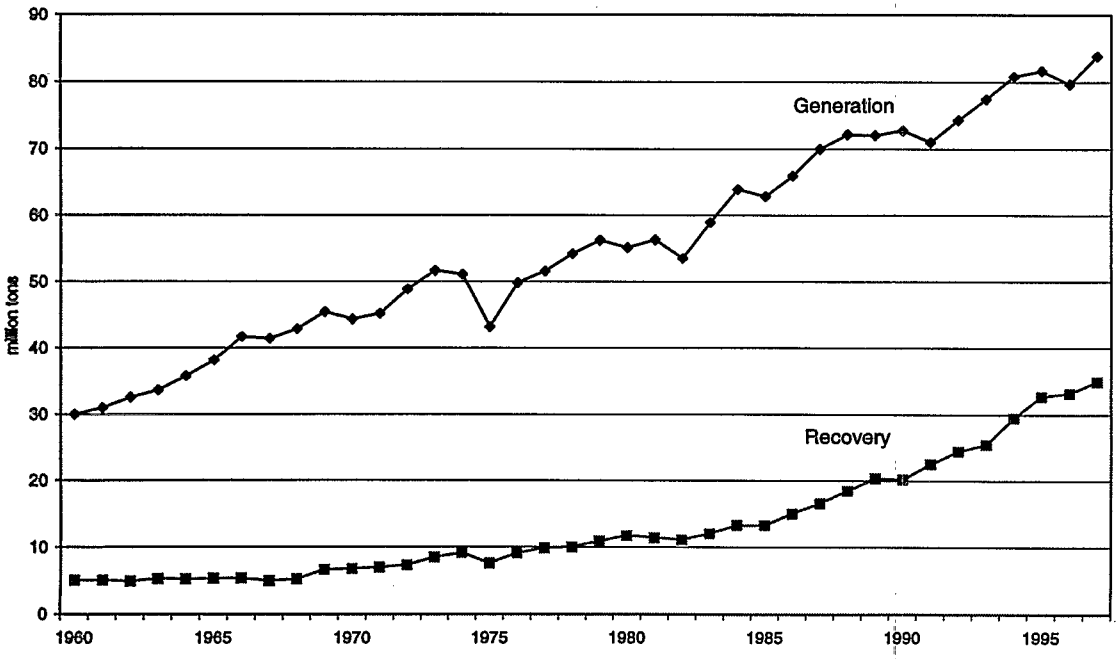


Total generation of paper and paperboard in MSW has grown from 30 million tons in 1960 to 83.8 million tons in 1997 (Table 1). As a percentage of total MSW generation, paper represented 34 percent in 1960 (Table 1). The percentage has varied over time, but increased to 38.6 percent of total MSW generation in 1997. As Figure 3 illustrates, paper generation declined in 1996, but came back strongly in 1997.

(The sensitivity of paper products to economic conditions can be observed in Figure 3. The tonnage of paper generated in 1975—a severe recession year—was actually less than the tonnage in 1970, and the percentage of total generation was also less in 1975. Similar but less pronounced declines in paper generation can be seen in other recession years.)

Generation. Estimates of paper and paperboard generation are based on statistics published by the American Forest & Paper Association (AF&PA). These statistics include data on new supply (production plus net imports) of the various paper and paperboard grades that go into the products found in MSW. The AF&PA new supply statistics are adjusted to deduct converting scrap, which is generated when sheets of paper or paperboard are cut to make products such as envelopes or boxes. Converting scrap rates vary from product to product; the rates used in this report were developed as part of a 1992 report for the Recycling Advisory Council with a few more recent revisions as new data became available. Various deductions are also made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings or toilet tissue.

Figure 3. Paper generation and recovery, 1960 to 1997



Recovery. Estimates of recovery of paper and paperboard products for recycling are based on annual reports of recovery published by AF&PA. The AF&PA reports include recovery of paper and paperboard purchased by U.S. paper mills, plus exports of recovered paper, plus a small amount estimated to have been used in other products such as animal bedding. Recovery as reported by AF&PA includes both preconsumer and postconsumer paper.

To estimate recovery of postconsumer paper products for this EPA report, estimates of recovery of converting scrap and returned overissue newspapers are deducted from the total recovery amounts reported by AF&PA. In earlier versions of this EPA report, a simplifying assumption that all converting scrap is recovered was made. For recent updates, various converting scrap recovery rates ranging from 70 percent to 98 percent were applied to the estimates for 1990 through 1997. The converting scrap recovery rates were developed for a 1992 report for the Recycling Advisory Council. Because converting scrap and overissue are deducted, the paper recovery rates presented in this report are always lower than the total recovery rates published by AF&PA.

When recovered paper is repulped, and often deinked, at a recycling paper mill, considerable amounts of sludge are generated in amounts varying from 5 percent to 35 percent of the paper feedstock. Since these sludges are generated at an industrial site, they are considered to be industrial process waste, not municipal solid waste; therefore they have been removed from the municipal waste stream.

Recovery of paper and paperboard for recycling is at the highest rate overall compared to most other materials in MSW. As Table 4 shows, 67.3 percent of all corrugated boxes were recovered for recycling in 1997. Newspapers were recovered at a rate of 54.6 percent, and high grade office papers at 50.7 percent, with lesser percentages of other papers being recovered also. Approximately 34.9 million tons of postconsumer paper were recovered in 1997—41.7 percent of total paper and paperboard generation.

Discards After Recovery. After recovery of paper and paperboard for recycling, discards were 48.9 million tons in 1997, or 31.2 percent of total MSW discards.

Glass

Glass is found in MSW primarily in the form of containers (Table 5 and Figures 4 and 5), but also in durable goods like furniture, appliances, and consumer electronics. In the container category, glass is found in beer and soft drink bottles, wine and liquor bottles, and bottles and jars for food, cosmetics, and other products. More detail on these products is included in the later section on products in MSW.

Generation. Glass accounted for 6.7 million tons of MSW in 1960, or 7.6 percent of total generation. Generation of glass continued to grow over the next two decades, but then glass containers were widely displaced by other materials, principally aluminum and plastics. Thus the tonnage of glass in MSW declined in the 1980s, from approximately 15.1 million tons in 1980 to 13.2 million tons in 1985. Beginning about 1987, however, the decline in

Table 5

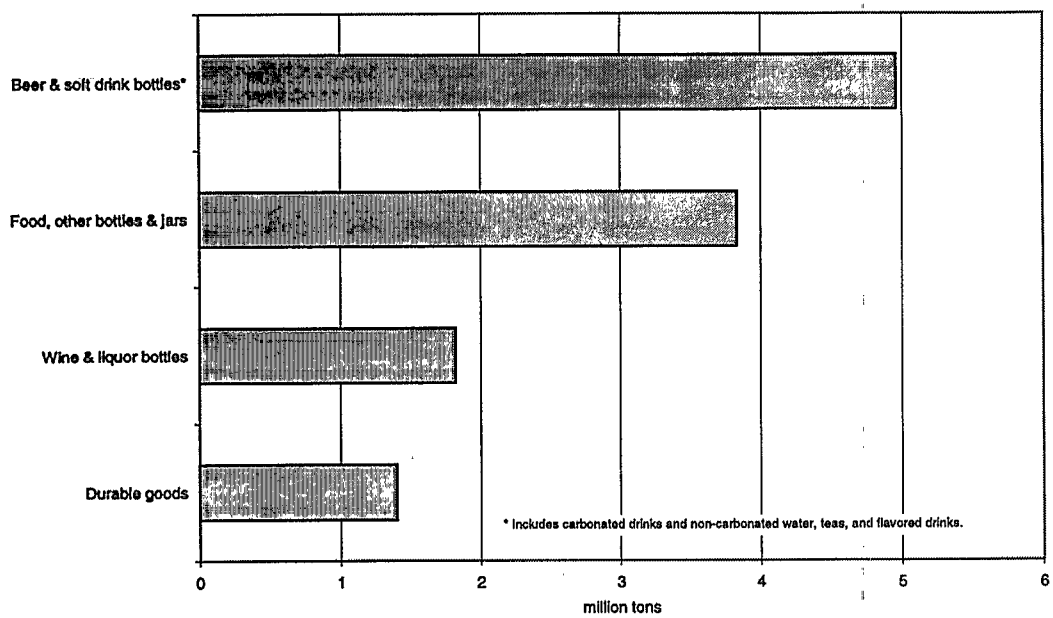
GLASS PRODUCTS IN MSW, 1997
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods*	1,400	Neg.	Neg.	1,400
Containers and Packaging				
Beer and Soft Drink Bottles	4,960	1,550	31.3%	3,410
Wine and Liquor Bottles	1,820	440	24.2%	1,380
Food and Other Bottles and Jars	3,830	930	24.3%	2,900
Total Glass Containers	10,610	2,920	27.5%	7,690
Total Glass	12,010	2,920	24.3%	9,090

* Glass as a component of appliances, furniture, consumer electronics, etc.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

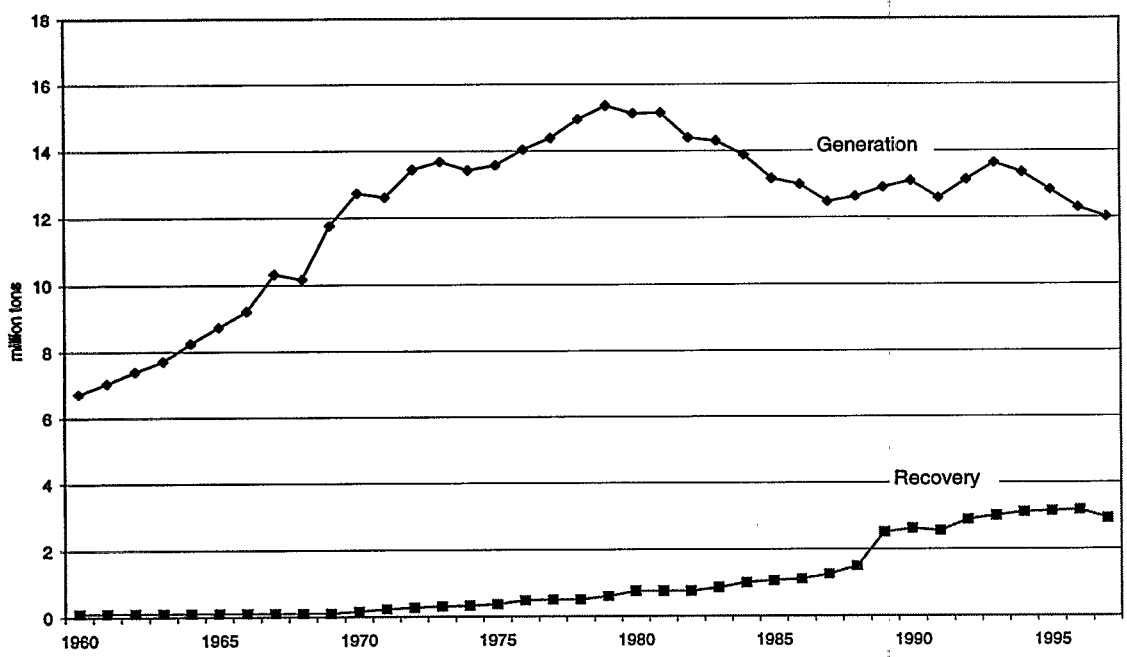
Source: Franklin Associates.

Figure 4. Glass products generated in MSW, 1997



generation of glass containers slowed (Figure 5), and glass generation in 1997 was 12.0 million tons, about the same as 1987. During the 1990s glass generation has varied from 12.4 to 13.6 million tons per year. Glass was 10 percent of MSW generation in 1980, declining to 5.5 percent in 1997.

Figure 5. Glass generation and recovery, 1960 to 1997



Recovery. Published estimates indicate that 2.9 million tons of glass containers were recovered for recycling in 1997. Based on 1997 glass generation, an estimated 27.6 percent of glass containers was recovered for recycling, with a 24.4 percent recovery rate for all glass in MSW. Most of the recovered glass went into new glass containers, but a portion went to other uses such as fiberglass and glasphalt for highway construction. The Glass Packaging Institute reported a recovery rate of 35.2 percent for glass containers in 1997; this recovery rate includes an allowance for refilling of bottles. Since this EPA report classifies refilling as reuse (source reduction) rather than recovery for recycling, the recovery rate estimated for this report is 27.6 percent of glass containers.

Discards After Recovery. Recovery for recycling lowered discards of glass to 9.1 million tons in 1997 (5.8 percent of total MSW discards).

Ferrous Metals

By weight, ferrous metals (iron and steel) are the largest category of metals in MSW (Figure 6 and Table 6). The largest quantities of ferrous metals in MSW are found in durable goods such as appliances, furniture, tires, and other miscellaneous durable goods. Containers and packaging are the other source of ferrous metals in MSW. Large quantities of ferrous metals are found in construction materials and in transportation products such as automobiles, locomotives, and ships, but these are not counted as MSW in this report.

Total generation and recovery of all metals in MSW from 1960 to 1997 are shown in Figure 7.

Figure 6. Metal products generated in MSW, 1997

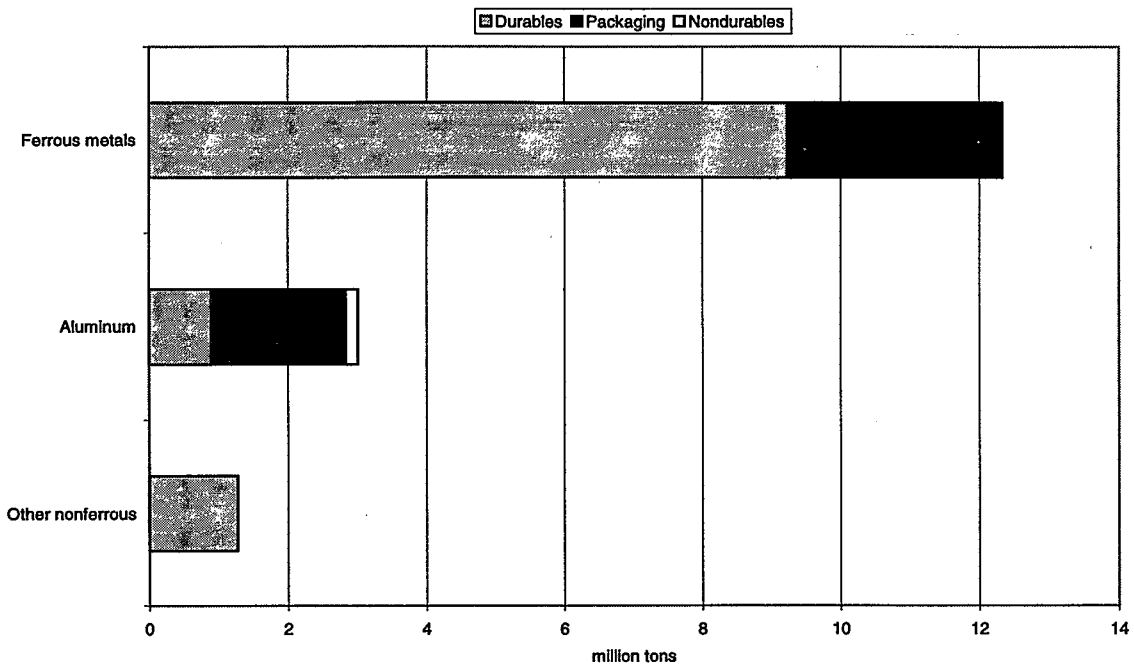


Table 6

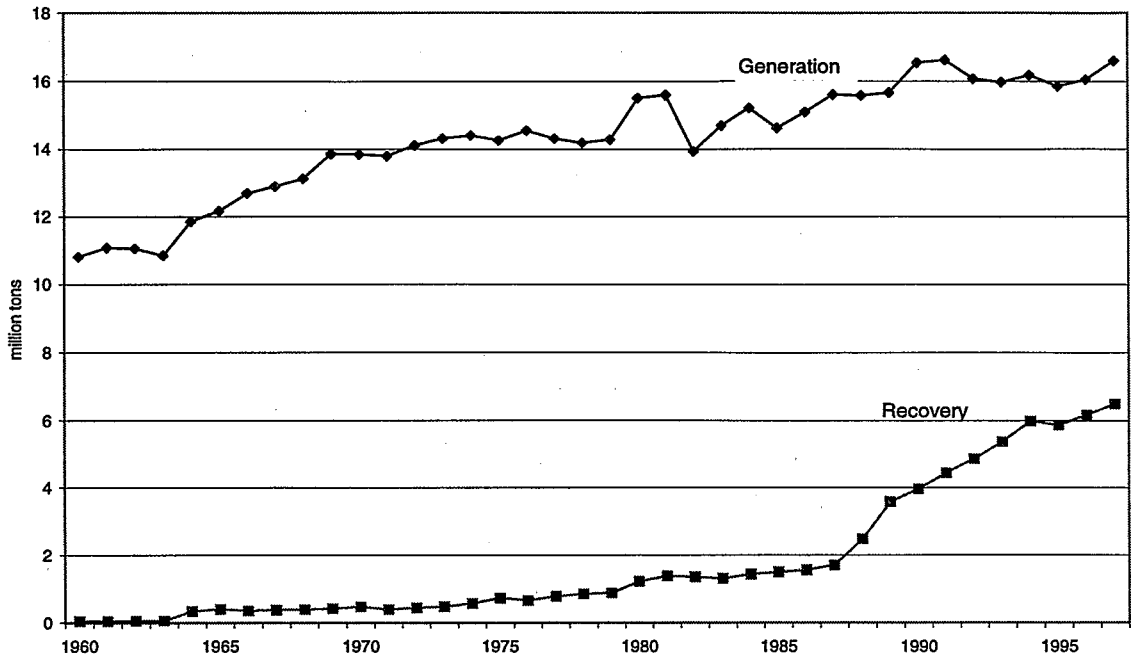
METAL PRODUCTS IN MSW, 1997
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Ferrous metals*	9,230	2,840	30.8%	6,390
Aluminum**	890	Neg.	Neg.	890
Lead†	880	830	94.3%	50
Other nonferrous metals‡	390	Neg.	Neg.	390
Total Metals in Durable Goods	11,390	3,670	32.2%	7,720
Nondurable Goods				
Aluminum	180	Neg.	Neg.	180
Containers and Packaging				
Steel				
Food and other cans	2,860	1,730	60.5%	1,130
Other steel packaging	240	160	66.7%	80
Total Steel Packaging	3,100	1,890	61.0%	1,210
Aluminum				
Beer and soft drink cans	1,530	910	59.5%	620
Food and other cans	50	Neg.	7.0%	50
Foil and closures	360	30	8.3%	330
Total Aluminum Packaging	1,940	940	48.5%	1,000
Total Metals in Containers and Packaging	5,040	2,830	56.2%	2,210
Total Metals	16,610	6,500	39.1%	10,110
Ferrous	12,330	4,730	38.4%	7,600
Aluminum	3,010	940	31.2%	2,070
Other nonferrous	1,270	830	65.4%	440

* Ferrous metals in appliances, furniture, tires, and miscellaneous durables.
** Aluminum in appliances, furniture, and miscellaneous durables.
† Lead in lead-acid batteries.
‡ Other nonferrous metals in appliances and miscellaneous durables.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.
Source: Franklin Associates

Generation. Approximately 10.3 million tons of ferrous metals were generated in 1960. Like glass, the tonnages grew during the 1960s and 1970s, but began to drop as lighter materials like aluminum and plastics replaced steel in many applications. Generation of ferrous metals did, however, increase to 12.7 million tons in 1991, then dropped to 12.3 million tons in 1997. The percentage of ferrous metals generation in MSW has declined from 11.7 percent in 1960 to 5.7 percent in 1997.

Figure 7. Metals generation and recovery, 1960 to 1997



Recovery. The renewed emphasis on recovery and recycling in recent years has included ferrous metals. Based on data from the Steel Recycling Institute, recovery of ferrous metals from appliances ("white goods") was estimated to be 2.3 million tons of the total ferrous in appliances in 1997. Overall recovery of ferrous metals from durable goods (large and small appliances, furniture, and tires) was estimated to be 30.8 percent (2.8million tons) in 1997 (Table 6).

Steel food cans and other cans were estimated to be recovered at a rate of 60.5 percent (1.7 million tons) in 1997. Approximately 160,000 tons of other steel packaging, mostly steel barrels and drums, was estimated to have been recovered for recycling in 1997.

Discards After Recovery. Discards of ferrous metals after recovery were 7.6 million tons in 1997, or 4.9 percent of total discards.

Aluminum

The largest source of aluminum in MSW is aluminum cans and other packaging (Table 6 and Figure 6). Other sources of aluminum are found in durable and nondurable goods.

Generation. In 1997, nearly 2.0 million tons of aluminum were generated as containers and packaging, while approximately 1.0 million tons were found in durable and nondurable goods. The total—3.0 million tons—represented 1.4 percent of total MSW

generation in 1997. Aluminum generation was only 340,000 tons (0.4 percent of MSW generation) in 1960.

Recovery. Aluminum beverage containers were recovered at a rate of 59.5 percent of generation (0.9 million tons) in 1997, and 48.5 percent of all aluminum in containers and packaging was recovered for recycling in 1997.

Discards After Recovery. In 1997, about 2.1 million tons of aluminum were discarded in MSW after recovery, which was 1.3 percent of total MSW discards.

Other Nonferrous Metals

Other nonferrous metals (e.g., lead, copper, zinc) are found in durable products such as appliances, consumer electronics, etc. Lead in lead-acid batteries is the most prevalent nonferrous metal (other than aluminum) in MSW. (Note that only lead-acid batteries from passenger cars, trucks, and motorcycles are included. Lead-acid batteries used in large equipment or industrial applications are not included.)

Generation. Generation of other nonferrous metals in MSW totaled 1.3 million tons in 1997. Lead in batteries accounted for 880,000 tons of this amount. Generation of these metals has increased slowly, up from 180,000 tons in 1960. As a percentage of total generation, nonferrous metals have never exceeded one percent.

Recovery. Recovery of the other nonferrous metals was 830,000 tons in 1997, with most of this being lead recovered from batteries. It was estimated that 94.3 percent of battery lead was recovered in 1997.

Discards After Recovery. In 1997, 440,000 tons of nonferrous metals were discarded in MSW. Percentages of total discards remained less than one percent over the entire period.

Plastics

Plastics are a rapidly growing segment of MSW. Plastics are found in durable and nondurable goods and in containers and packaging, with the latter being the largest category of plastics in MSW (Table 7 and Figure 8).

In durable goods, plastics are found in appliances, furniture, casings of lead-acid batteries, and other products. (Note that plastics in transportation products generally are not included in this report.) As shown in Table 7, a wide range of resin types is found in durable goods. While some detail is provided in Table 7 for resins in durable goods, there are hundreds of different resin formulations used in appliances, carpets, and other durable goods; a complete listing is beyond the scope of this report.

Plastics are found in such nondurable products as disposable diapers, trash bags, cups, eating utensils, sporting and recreational equipment, medical devices, household items such as shower curtains, etc. The plastic foodservice items are generally made of clear or foamed

Table 7

PLASTICS IN PRODUCTS IN MSW, 1997
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of Gen.)	Discards (Thousand tons)
Durable Goods				
PET	360	30		330
HDPE	490	60		430
PVC	390	Neg.		390
LDPE/LLDPE	580	Neg.		580
PP	1,090	100		990
PS	560	Neg.		560
Other resins	3,190	100		3,090
Total Plastics in Durable Goods	6,660	290	4.4%	6,370
Nondurable Goods				
Plastic Plates and Cups				
LDPE/LLDPE	20			20
PS	840	Neg.		840
Subtotal Plastic Plates and Cups	860			860
Trash Bags				
HDPE	220			220
LDPE/LLDPE	600			600
Subtotal Trash Bags	820			820
All other nondurables*				
PET	180			180
HDPE	350			350
PVC	510			510
LDPE/LLDPE	1,340			1,340
PP	740			740
PS	490			490
Other resins	90			90
Subtotal All Other Nondurables	3,700			3,700
Total Plastics in Nondurable Goods, by resin				
PET	180			180
HDPE	570			570
PVC	510			510
LDPE/LLDPE	1,960			1,960
PP	740			740
PS	1,330	Neg.		1,330
Other resins	90			90
Total Plastics in Nondurable Goods	5,380	0	0.0%	5,380
Plastic Containers & Packaging				
Soft drink bottles				
PET	750	280		470
HDPE	Neg.	Neg.		Neg.
Subtotal Soft Drink Bottles	750	280	37.3%	470
Milk and water bottles				
HDPE	670	210	31.3%	460

HDPE=High density polyethylene
LDPE=Low density polyethylene
LLDPE=Linear Low density polyethylene
PET=Polyethylene terephthalate
PP=Polypropylene
PS=Polystyrene
PVC=Polyvinyl chloride

Source: Franklin Associates.

Table 7 (continued)

PLASTICS IN PRODUCTS IN MSW, 1997
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of Gen.)	Discards (Thousand tons)
Plastic Containers & Packaging, cont.				
Other plastic containers				
PET	480	50		430
HDPE	810	150		660
PVC	80	Neg.		80
LDPE/LLDPE	30	Neg.		30
PP	80	Neg.		80
PS	50	Neg.		50
Other resins	10	Neg.		10
Subtotal Other Containers	1,540	200	13.0%	1,340
Bags, sacks, & wraps				
HDPE	590	0		590
PVC	60			60
LDPE/LLDPE	2,440	100		2,340
PP	500			500
PS	60			60
Subtotal Bags, Sacks, & Wraps	3,650	100	2.7%	3,550
Other Plastics Packaging**				
PET	130	Neg.		130
HDPE	1,500	Neg.		1,500
PVC	280	Neg.		280
LDPE/LLDPE	370	Neg.		370
PP	380	20		360
PS	100	10		90
Other resins	50	20		50
Subtotal Other Packaging	2,810	50	1.8%	2,760
Total Plastics in Containers & Packaging, by resin				
PET	1,360	330		1,030
HDPE	3,570	360		3,210
PVC	420	Neg.		420
LDPE/LLDPE	2,840	100		2,740
PP	960	20		940
PS	210	10		200
Other resins	60	Neg.		60
Total Plastics in Containers & Pkg	9,420	820	8.7%	8,600
Total Plastics in MSW, by resin				
PET	1,900	360		1,540
HDPE	4,630	420		4,210
PVC	1,320	Neg.		1,320
LDPE/LLDPE	5,380	100		5,280
PP	2,790	120		2,670
PS	2,100	10		2,090
Other resins	3,340	100		3,240
Total Plastics in MSW	21,460	1,110	5.2%	20,350

HDPE=High density polyethylene
LDPE=Low density polyethylene
LLDPE=Linear Low density polyethylene
PET=Polyethylene terephthalate
PP=Polypropylene
PS=Polystyrene
PVC=Polyvinyl chloride

* All other nondurables include plastics in disposable diapers, clothing, footwear, etc.
** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.
Neg. = Less than 5,000 tons or 0.05 percent. Details may not add to totals due to rounding.

Source: Franklin Associates.

polystyrene, while trash bags are made of high-density polyethylene or low-density polyethylene. A wide variety of other resins are used in other nondurable goods.

Plastic resins are also used in a variety of container and packaging products such as polyethylene terephthalate (PET) soft drink bottles, high-density polyethylene (HDPE) bottles for milk and water, and a wide variety of other resin types used in other plastic containers, bags, sacks, wraps, lids, etc.

Generation. Production data on plastics resin use in products is taken from the ***Modern Plastics*** annual statistical issue and the American Plastics Council annual plastic recovery survey. The basic data are adjusted for product service life, fabrication losses, and net imports of plastic products to derive generation of plastics in the various products in MSW.

Plastics made up an estimated 390,000 tons of MSW generation in 1960. The quantity has increased relatively steadily to 21.5 million tons in 1997 (Figure 9). As a percentage of MSW generation, plastics were less than one percent in 1960, increasing to 9.9 percent in 1997.

Figure 8. Plastics products generated in MSW, 1997

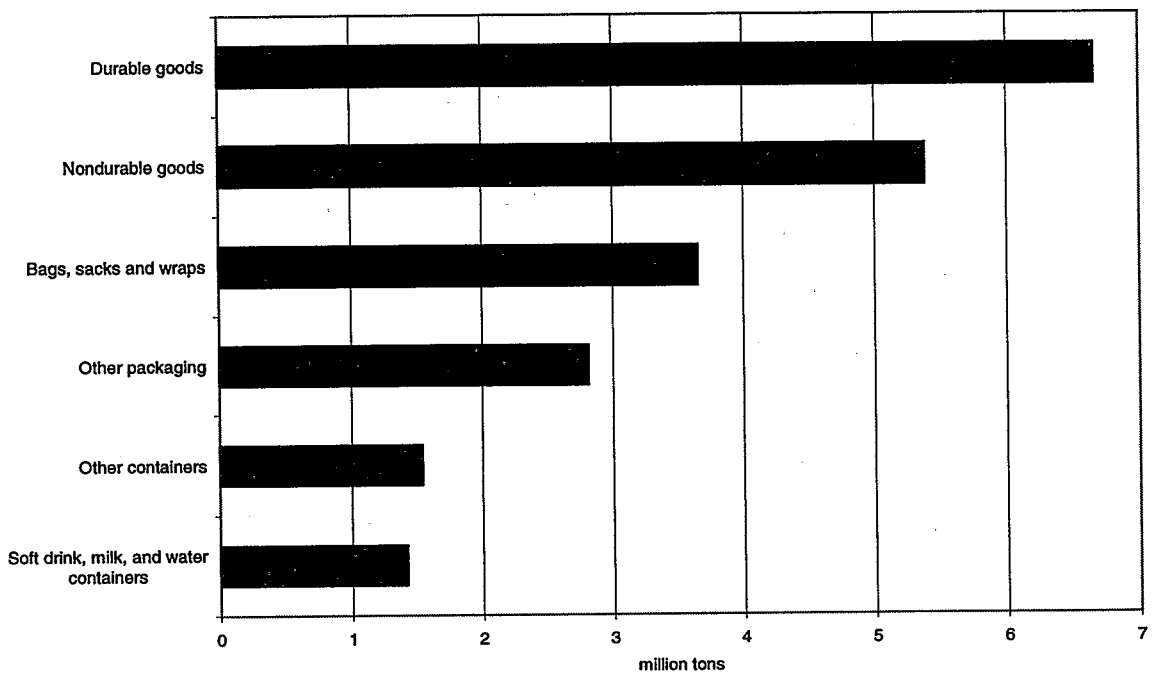
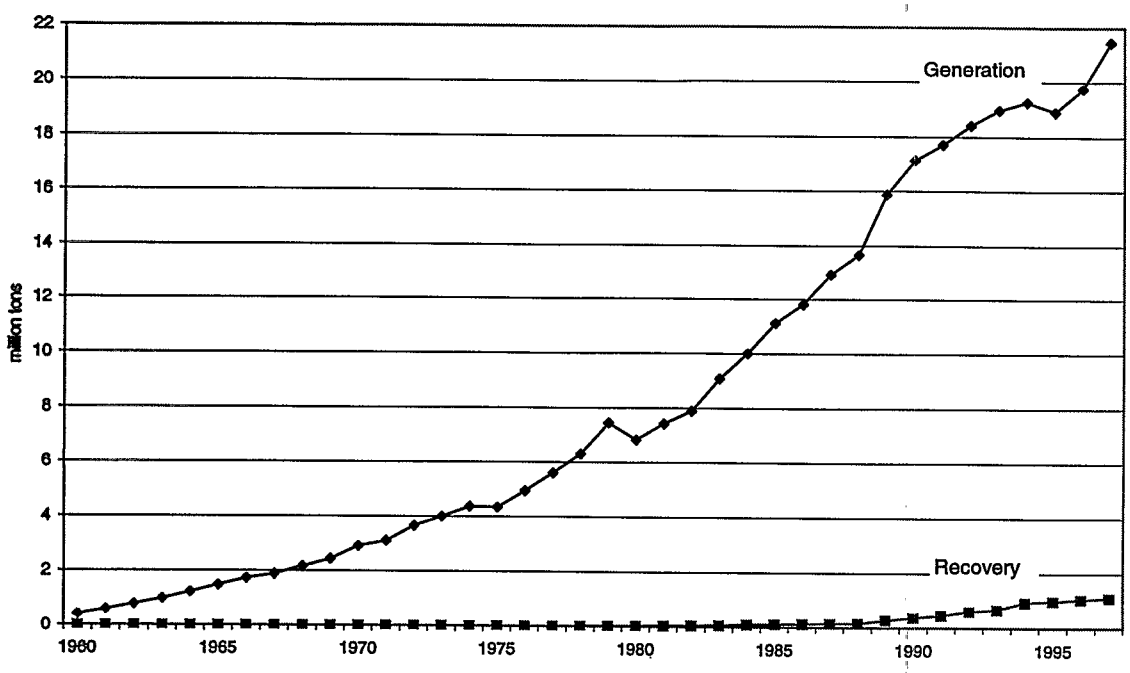


Figure 9. Plastics generation and recovery, 1960 to 1997



Recovery for Recycling. While overall recovery of plastics for recycling is relatively small—1.1 million tons, or 5.2 percent of plastics generation in 1997 (Table 9)—recovery of some plastic containers has generally increased. Plastic (PET) soft drink bottles were recovered at a rate of 37.3 percent in 1997. Recovery of high-density polyethylene milk and water bottles was estimated at about 31.3 percent in 1997. Significant recovery of plastics from lead-acid battery casings and from some other containers was also reported. The primary source of data on plastics recovery is an annual survey conducted for the American Plastics Council (APC).

Discards After Recovery. Discards of plastics in MSW after recovery were 20.3 million tons, or 13 percent of total MSW discards.

Other Materials

Rubber and Leather. The predominant source of rubber in MSW is rubber tires from automobiles and trucks (Table 8). Other sources of rubber and leather include clothing and footwear and other miscellaneous durable and nondurable products. These other sources are quite diverse, including such items as gaskets on appliances, furniture, and hot water bottles, for example.

Generation. Generation of rubber and leather in MSW has shown slow growth over the years, increasing from 1.8 million tons in 1960 to 6.6 million tons in 1997. One reason for the relatively slow rate of growth is that tires have been made smaller and longer-wearing than in earlier years.

As a percentage of total MSW generation, rubber and leather has been about 3 percent for many years.

Recovery for Recycling. The only recovery for recycling identified in this category is rubber from tires, and that was estimated to be 770,000 tons (22.3 percent of rubber in tires in 1997) (Table 8). (This recovery estimate does not include tires retreaded or energy recovery from tires.) Overall, 11.7 percent of rubber and leather in MSW was recovered in 1997.

Discards After Recovery. Discards of rubber and leather after recovery were 5.8 million tons in 1997 (3.7 percent of total discards).

Textiles. Textiles in MSW are found mainly in discarded clothing, although other sources were identified to be furniture, carpets, tires, footwear, and other nondurable goods such as sheets and towels.

Table 8

RUBBER AND LEATHER PRODUCTS IN MSW, 1997
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Rubber in Tires*	3,450	770	22.3%	2,680
Other Durables**	2,320	Neg.	Neg.	2,320
Total Rubber & Leather Durable Goods	5,770	770	13.3%	5,000
Nondurable Goods				
Clothing and Footwear	570	Neg.	Neg.	570
Other Nondurables	230	Neg.	Neg.	230
Total Rubber & Leather Nondurable Goods	800	Neg.	Neg.	800
Containers and Packaging	20	Neg.	Neg.	20
Total Rubber & Leather	6,590	770	11.7%	5,820

* Automobile and truck tires. Does not include other materials in tires.
** Includes carpets and rugs and other miscellaneous durables.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

Source: Franklin Associates.

Generation. An estimated 8.2 million tons of textiles were generated in 1997 (3.8 percent of total MSW generation).

Recovery for Recycling and Discards. Significant amounts of textiles are recovered for reuse. However, the reused garments and wiper rags re-enter the waste stream eventually, so this is considered a diversion rather than recovery for recycling and, therefore, not included in the recovery for recycling estimates. Since data on elapsed time from recovery of textiles for reuse to final discard is limited, it was assumed that reused textiles re-enter the waste stream the same year that they are first discarded. It was estimated that 12.9 percent of textiles in clothing and items such as sheets and pillowcases was recovered for export or reprocessing in 1997 (1.1 million tons) leaving discards of 7.2 million tons of textiles in 1997.

Wood. The sources of wood in MSW include furniture, miscellaneous durable goods (e.g., cabinets for electronic equipment), wood packaging (crates, pallets), and some other miscellaneous products.

Generation. Generation of wood in MSW was 11.6 million tons in 1997 (5.3 percent of total MSW generation).

Recovery for Recycling and Discards. Wood pallet recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 590,000 tons in 1997.

About 200 million pallets—representing over 5 million tons of wood packaging—were estimated to be refurbished and returned to service in 1997. This EPA report classifies pallets refurbished and returned to service as reuse (source reduction) rather than recovery for recycling. Therefore, the 5 million tons represents a reduction in the amount of wood packaging discarded to the waste stream (i.e., a reduction in waste generation) rather than an increase in recycling.

Accounting for pallet reuse and recovery for recycling, wood discards were 11.0 million tons in 1997, or 7 percent of total MSW discards.

Other Products. Generation of "other products" waste is mainly associated with disposable diapers, which are discussed under the section on Products in Municipal Solid Waste. The only other significant source of materials in this category is the electrolytes and other materials associated with lead-acid batteries that are not classified as plastics or nonferrous metal.

Food Wastes

Food wastes included here consist of uneaten food and food preparation wastes from residences, commercial establishments (restaurants, fast food establishments), institutional sources such as school cafeterias, and industrial sources such as factory lunchrooms. Food waste generated during the preparation and packaging of food products is considered industrial waste and therefore not included in MSW food waste estimates.

Generation. No production data are available for food wastes. Food wastes from residential and commercial sources were estimated using data from sampling studies in various parts of the country in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and numbers of prisoners and students in institutions. Generation of food wastes was estimated to be nearly 22 million tons in 1997.

Recovery for Composting and Discards. Beginning in 1994 for this series of reports, a significant amount of food waste composting from commercial sources was identified. As the data source (a survey published by ***BioCycle*** magazine) has improved, it has become apparent that some other composted materials (e.g., paper and industrial food processing wastes) have been included with food wastes classified as MSW in the past. For the 1997 estimate, a more careful separation of MSW food composted resulted in an estimate of approximately 285,000 tons.

Another very recent survey of paper composting conducted by the American Forest & Paper Association yielded an estimate of approximately 160,000 tons of paper composted in 1997. Finally, another ***BioCycle*** survey yielded an estimate of approximately 135,000 tons of MSW composted (after an adjustment to avoid double counting the AF&PA survey). The total—580,000 tons of food wastes and other organic materials composted—is shown in the recovery tables on the line where only food waste recovery was shown in previous reports.

Yard Trimmings

Yard trimmings* include grass, leaves, and tree and brush trimmings from residential, institutional, and commercial sources.

Generation. In earlier versions of this report, generation of yard trimmings was estimated using sampling studies and population data. While in past years generation of yard trimmings had been increasing steadily as population and residential housing grew (i.e., constant generation on a per capita basis), in recent years there has been a new trend, local and state legislation on yard trimmings disposal in landfills.

Legislation affecting yard trimmings disposal in landfills was tabulated, using published sources. In 1992, 11 states and the District of Columbia —accounting for over 28 percent of the nation's population—had in effect legislation banning or discouraging yard trimmings disposal in landfills. The tabulation of existing legislation also shows that by 1998, 22 states and the District of Columbia, representing more than 50 percent of the nation's population, had legislation affecting disposal of yard trimmings. This has led to an increase in backyard composting and the use of mulching mowers to allow grass trimmings to remain in place.

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* Although there are limited data available on the composition of yard trimmings, it is estimated that the average composition by weight is about 50 percent grass, 25 percent brush, and 25 percent leaves. These are "ballpark" numbers that will vary widely according to climate and region of the country.

Using these facts, it was estimated that the effect of this legislation was no increase in yard trimmings generation (i.e., entering the waste management system) between 1990 and 1992 (i.e., the increase in yard trimmings due to natural population increases was offset by source reduction efforts). Furthermore, with 50 percent of the population having yard trimmings legislation in 1997, it was also estimated that yard trimmings declined approximately 6 percent annually between 1992 and 1997. An estimated 27.7 million tons of yard trimmings were generated in MSW in 1997 (this compares to an estimated 35 million tons of yard trimmings generated in 1992).

Recovery for Composting and Discards. Recovery for composting of yard trimmings was estimated using a previous survey which estimated tonnages composted by facilities along with updated 1997 data on numbers of yard waste composting facilities. Also, data compiled by ***BioCycle*** magazine indicates that there were about 3,000 composting facilities for yard trimmings in 1992, increasing to almost 3,500 facilities in 1997.

Removal of yard trimmings for composting was estimated to be 41.4 percent of generation in 1997 (11.5 million tons), leaving 16.2 million tons of yard trimmings to be discarded. (It should be noted that the estimated 11.5 million tons recovered for composting does not include yard trimmings recovered for landspreading disposal.)

It should also be noted that these recovery estimates do not account for backyard composting by individuals or practices such as less bagging of grass clippings; since the yard trimming estimates are based on sampling studies at the landfill or transfer station, they are based on the quantities received there. These source reduction practices are further discussed in Chapter 3.

Miscellaneous Inorganic Wastes

This relatively small category of MSW is also derived from sampling studies. It is not well defined and often shows up in sampling reports as "fines" or "other." It includes soil, bits of concrete, stones, and the like.

Generation, Recovery, and Discards. This category contributed an estimated 3.3 million tons of MSW in 1997. No recovery of these products was identified; discards are the same as generation.

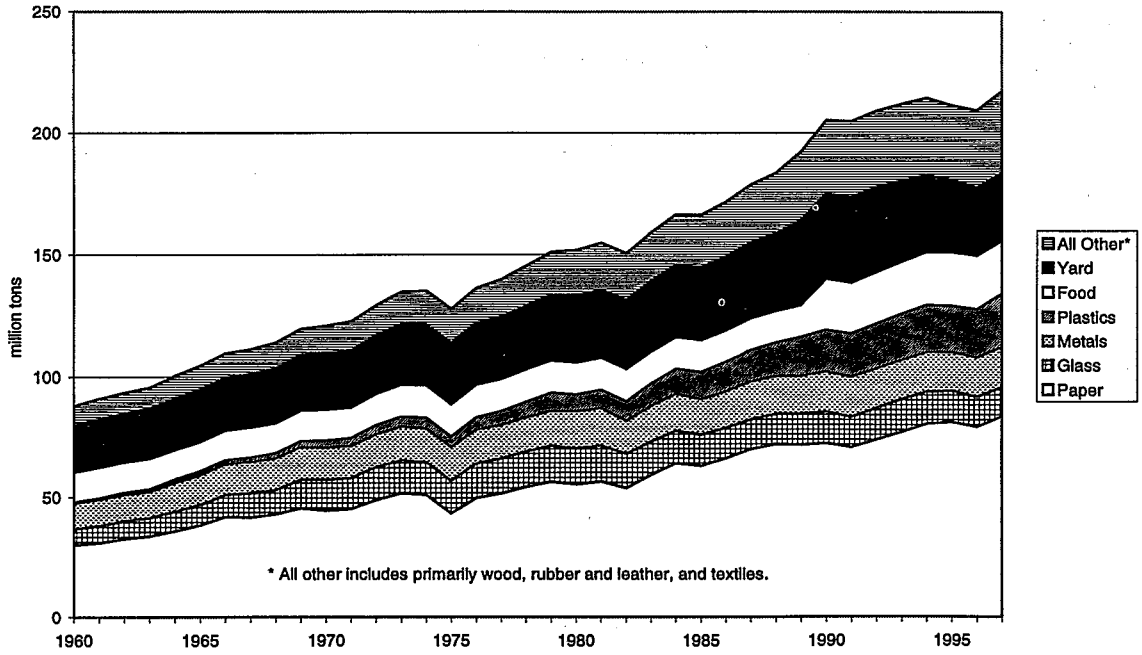
Summary of Materials in Municipal Solid Waste

Generation. Changing quantities and composition of municipal solid waste generation are illustrated in Figure 10. Generation of MSW has grown relatively steadily, from 88.1 million tons in 1960 to 217 million tons in 1997.

Over the years paper and paperboard has been the dominant material generated in MSW, accounting for 38.6 percent of generation in 1997. Yard trimmings, the second largest material component of MSW (12.8 percent of MSW generation) have been declining as a percentage of MSW in recent years due to state and local legislated landfill bans and increased emphasis on backyard composting and other source reduction measures such as the

use of mulching mowers. Metals account for 7.7 percent of MSW generation and have remained fairly constant as a source of MSW, while glass increased until the 1980s and has since declined or shown a slower rate of increase. In 1997 glass represented 5.5 percent of MSW generation. Food wastes have remained fairly constant in terms of MSW tonnage (10.1 percent of generation). Plastics have increasingly been used in a variety of products and thus have been a rapidly growing component of MSW. In terms of tonnage contributed they ranked fourth in 1997 (behind paper, yard trimmings, and food waste), and account for 9.9 percent of MSW generation.

Figure 10. Generation of materials in MSW, 1960 to 1997



Recovery and Discards. The effect of recovery on MSW discards is illustrated in Figure 11. Recovery of materials for recycling and composting grew at a rather slow pace during most of the historical period covered by this data series, increasing only from 6.4 percent of generation in 1960 to 10.9 percent in 1985. Renewed interest in recycling (including composting) as waste management alternatives came about in the late 1980s, and the recovery rate in 1990 was estimated to be 16.2 percent of generation, increasing to 28 percent in 1997.

Estimated recovery of materials (including composting) is shown in Figure 12. In 1997, recovery of paper and paperboard dominated materials recovery at 58 percent of total tonnage recovered. Recovery of other materials, while generally increasing, contributes much less tonnage, reflecting in part the relatively smaller amounts of materials generated in those categories.

Figure 11. Recovery and discards of MSW,* 1960 to 1997

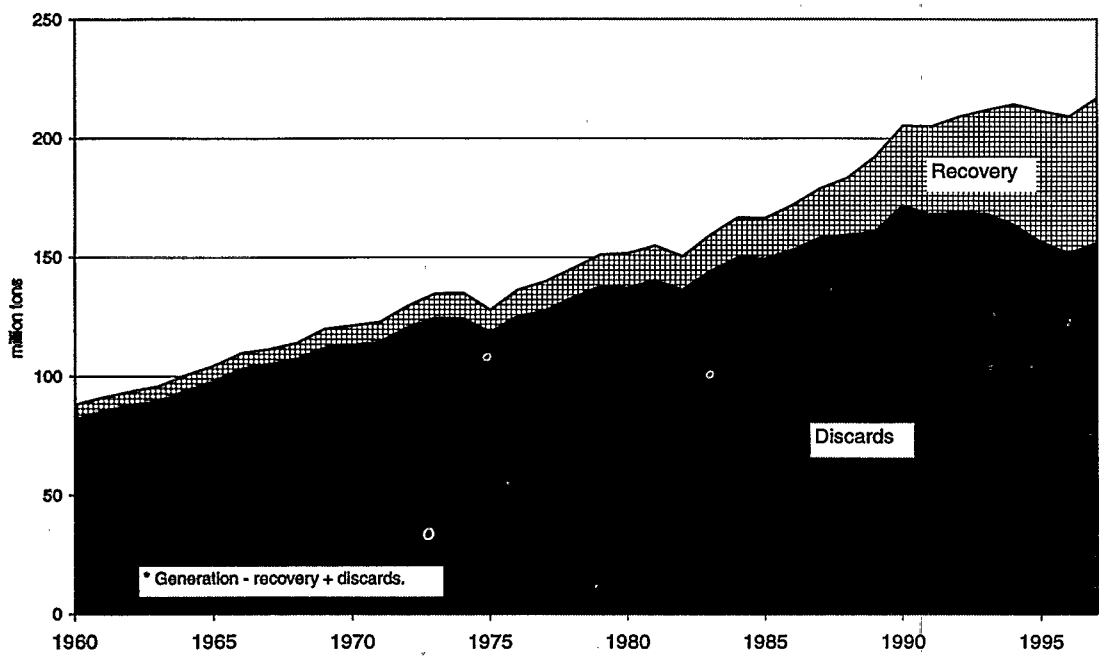
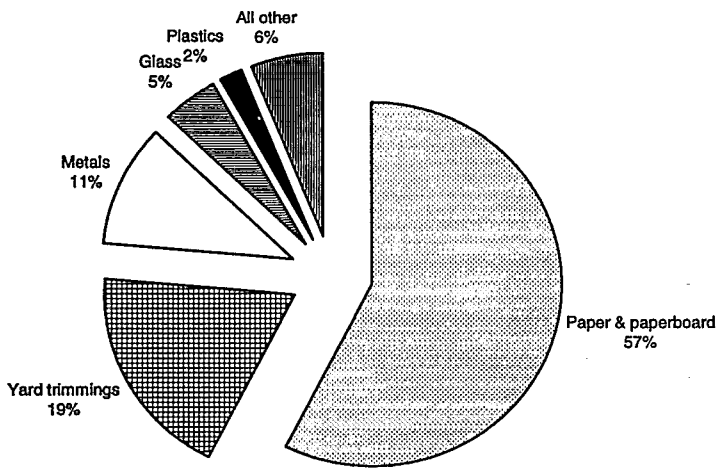


Figure 12. Materials recovery,* 1997



* In percent by weight of total recovery

Figure 13. Materials generated and discarded in municipal solid waste, 1997
(In percent of total generation and discards)

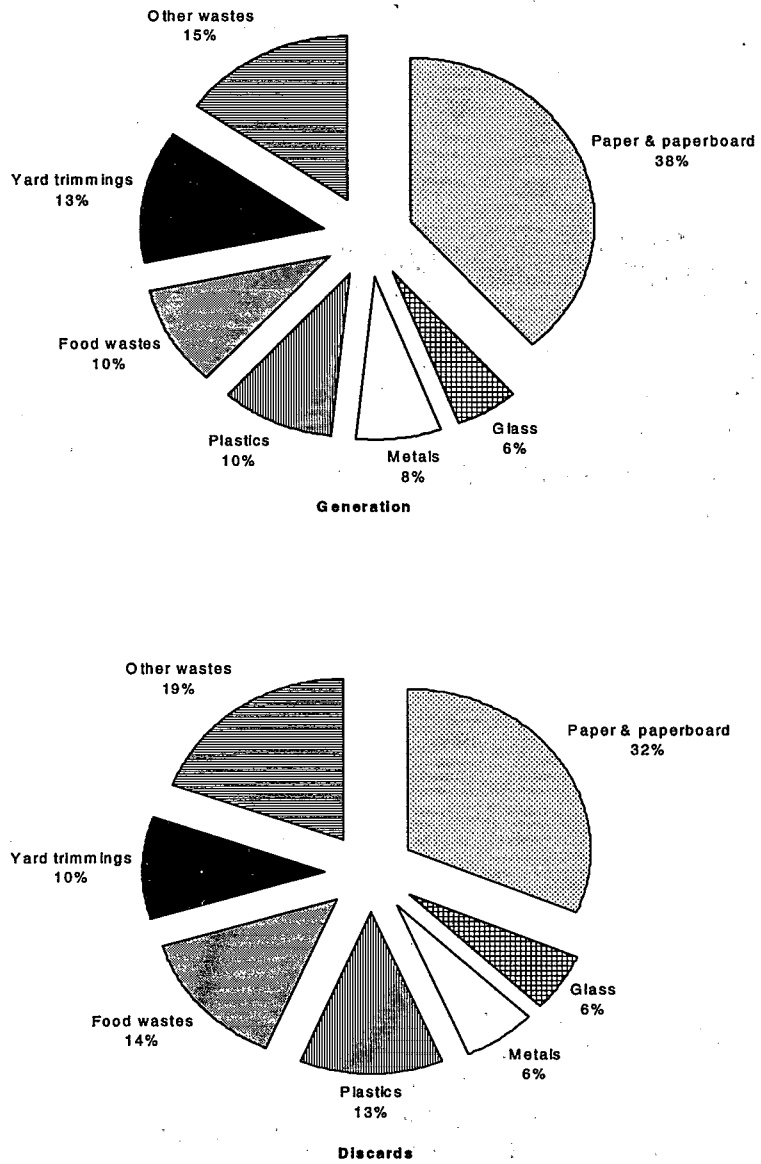


Figure 13 illustrates the effect of recovery of materials for recycling, including composting, on the composition of MSW discards. For example, paper and paperboard were 38.7 percent of MSW generated in 1997, but after recovery, paper and paperboard were 31.3 percent of discards. Materials that have little or no recovery exhibit a larger percentage of MSW discards compared to generation.

PRODUCTS IN MUNICIPAL SOLID WASTE

Generation, recovery, and discards of products in municipal solid waste are shown in a series of tables in this section. (Note that the totals for these tables are the same as the previous series of tables for materials in MSW.) The products in MSW are categorized as durable goods, nondurable goods, and containers and packaging. Generation, recovery, and discards of these products are summarized in Tables 9 through 11. Each product category is discussed in more detail below, with detailed tables highlighting the products in each.

Durable Goods

Durable goods generally are defined as products having a lifetime of three years or more, although there are some exceptions. In this report, durable goods include large and small appliances, furniture and furnishings, carpets and rugs, rubber tires, lead-acid automotive batteries, and miscellaneous durable goods (e.g., luggage, consumer electronics) (see Tables 12 through 14).* These products are often called "oversize and bulky" in municipal solid waste management practice, and they are generally handled in a somewhat different manner than other components of MSW. That is, they are often picked up separately, and may not be mixed with other MSW at the landfill, combustor, or other waste management facility. Durable goods are made up of a wide variety of materials. In order of tonnage in MSW in 1997, these include: ferrous metals, plastics, rubber and leather, wood, textiles, glass, other nonferrous metals (e.g., lead, copper), and aluminum.

Generation of durable goods in MSW totaled 33.2 million tons in 1997 (15.3 percent of total MSW generation). After recovery for recycling, 27.6 million tons of durable goods remained as discards in 1997.

Major Appliances. Major appliances in MSW include refrigerators, washing machines, water heaters, etc. They are often called "white goods" in the trade. Data on unit production of appliances are taken from ***Appliance Manufacturer Market Profile***. The unit data are converted to weight using various conversion factors developed over the years, plus data on the materials composition of the appliances. Adjustments are also made for the estimated lifetimes of the appliances, which range up to 20 years.

Generation of these waste products in MSW has increased very slowly; it was estimated to be 3.6 million tons in 1997 (1.7 percent of total MSW). In general, appliances have increased in quantity but not in average weight over the years. Ferrous metals are the predominant materials in major appliances, but other metals, plastics, glass, and other materials are also present.

Data on recovery of ferrous metals from major appliances are taken from a survey conducted by the Steel Recycling Institute. Recovery of ferrous metals from shredded appliances was estimated to be 2.3 million tons in 1997, leaving 1.3 million tons of appliances to be discarded.

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* Automobiles and other transportation equipment are not included in this report.

Table 9

CATEGORIES OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,120	31,140	31,660	33,230
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	56,850	57,250	55,510	59,100
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	70,110	68,390	69,050	71,750
***Total Product** Wastes*	54,620	83,280	108,890	146,510	158,080	156,780	156,220	164,080
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,500	21,740	21,850	21,910
Yard Trimmings	20,000	23,200	27,500	35,000	31,500	29,690	27,920	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	58,700	56,100	54,580	52,970	52,890
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	14.5%	14.7%	15.1%	15.3%
Nondurable Goods *(Detail in Table 15)*	19.7%	20.7%	22.7%	25.4%	26.5%	27.1%	26.5%	27.2%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.7%	32.4%	33.0%	33.1%
***Total Product** Wastes*	62.0%	68.8%	71.8%	71.4%	73.8%	74.2%	74.7%	75.6%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.0%	10.3%	10.4%	10.1%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.7%	14.0%	13.3%	12.8%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	26.2%	25.8%	25.3%	24.4%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.
** Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 10

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1997
(In thousands of tons and percent of generation of each category)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	350	940	1,360	3,460	5,090	5,010	5,300	5,650
Nondurable Goods *(Detail in Table 16)*	2,390	3,730	4,670	8,800	12,610	13,610	13,550	14,680
Containers and Packaging *(Detail in Table 20)*	2,870	3,350	8,490	16,780	24,450	26,720	27,540	28,300
***Total Product** Wastes*	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	480	570	520	580
Yard Trimmings	Neg.	Neg.	Neg.	4,200	8,000	9,000	10,390	11,490
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700
	Percent of Generation of Each Category							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	3.5%	6.4%	6.2%	11.6%	16.4%	16.1%	16.7%	17.0%
Nondurable Goods *(Detail in Table 16)*	13.8%	14.9%	13.6%	16.9%	22.2%	23.8%	24.4%	24.8%
Containers and Packaging *(Detail in Table 21)*	10.5%	7.7%	16.1%	26.0%	34.9%	39.1%	39.9%	39.4%
***Total Product** Wastes*	10.3%	9.6%	13.3%	19.8%	26.7%	28.9%	29.7%	29.6%
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.2%	2.6%	2.4%	2.6%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	25.4%	30.3%	37.2%	41.4%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	15.1%	17.5%	20.6%	22.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Other than food products.
^ Includes recovery of paper for composting.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 11

CATEGORIES OF PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 14)*	9,570	13,720	20,440	26,350	26,030	26,130	26,360	27,580
Nondurable Goods *(Detail in Table 17)*	14,940	21,330	29,750	43,370	44,240	43,640	41,960	44,420
Containers and Packaging *(Detail in Table 22)*	24,500	40,210	44,180	47,750	45,660	41,670	41,510	43,450
Total Product** Wastes	49,010	75,260	94,370	117,470	115,930	111,440	109,830	115,450
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,020	21,170	21,330	21,330
Yard Trimmings	20,000	23,200	27,500	30,800	23,500	20,690	17,530	16,240
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	54,500	47,620	45,010	42,060	40,820
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 14)*	11.6%	12.1%	14.9%	15.3%	15.9%	16.7%	17.4%	17.6%
Nondurable Goods *(Detail in Table 17)*	18.1%	18.9%	21.7%	25.2%	27.0%	27.9%	27.6%	28.4%
Containers and Packaging *(Detail in Table 23)*	29.7%	35.6%	32.2%	27.8%	27.9%	26.6%	27.3%	27.8%
Total Product** Wastes	59.4%	66.6%	68.8%	68.3%	70.9%	71.2%	72.3%	73.9%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	12.9%	13.5%	14.0%	13.6%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	14.4%	13.2%	11.5%	10.4%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.1%	2.1%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	29.1%	28.8%	27.7%	26.1%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Other than food products.

Details may not add to totals due to rounding.

Source: Franklin Associates

Small Appliances. This category includes items such as toasters, hair dryers, electric coffeepots, and the like. Information on shipments of small appliances was obtained from Department of Commerce data. Information on weights and materials composition of discarded small appliances was obtained through interviews. It was estimated that 830,000 tons of small appliances were generated in 1997. A small amount of ferrous metals in small appliances is recovered through magnetic separation.

Furniture and Furnishings. Data on sales of furniture and furnishings are provided by the Department of Commerce in dollars. These data are converted to tons using factors developed for this study over the years. Adjustments are made for imports and exports, and adjustments are made for the lifetimes of the furniture.

Generation of waste furniture and furnishings in MSW has increased from 2.2 million tons in 1960 to 7.5 million tons in 1997 (3.5 percent of total MSW). No significant recovery of materials from furniture was identified. Wood is the largest material category in furniture, with ferrous metals second. Plastics, glass, and other materials are also found in furniture.

Carpets and Rugs. An industry publication, ***Carpet and Rug Industrial Review***, publishes data on carpet sales in square yards. These data are converted to tons using various factors developed for this report. An estimated 2.3 million tons of carpets and rugs were generated in MSW in 1997, which was 1.1 percent of total generation.

A small amount of recycling of carpet fiber was identified—estimated to be about one percent recovery in 1997.

Vehicle Tires. The methodology for estimating generation of rubber tires for automobiles and trucks is based on data on replacement tires purchased and vehicles deregistered as reported by the U.S. Department of Commerce. It is assumed that for each replacement tire purchased, a used tire enters the waste management system, and that tires on deregistered vehicles also enter the waste management system. Retreaded tires are treated as a diversion out of the waste stream; they are assumed to re-enter the waste stream after two years of use.

The quantities of tires in units are converted to weight and materials composition using factors developed for this series of reports. In addition to rubber, tires include relatively small amounts of textiles and ferrous metals. Generation of rubber tires increased from 1.1 million tons in 1960 to 4.3 million tons in 1997 (2.0 percent of total MSW).

Data on recovery of tires in recent years are based on data from the Scrap Tire Management Council. Rubber recovery from tires has been increasing in recent years. In 1997, an estimated 22.3 percent of the weight of tires generated was recovered for recycling, leaving 3.3 million tons to be discarded. (Tires going to combustion facilities as fuel are included in the combustion estimates in Chapter 3.)

Lead-Acid Batteries. The methodology for estimating generation of lead-acid batteries is similar to the methodology for rubber tires as described above. An estimated 1.8

million tons of lead-acid batteries from automobiles, trucks, and motorcycles were generated in MSW in 1997 (less than one percent of total generation).

Data on recovery of batteries has been provided by the Battery Council International. Recovery of batteries for recycling has fluctuated between 60 percent and 98 percent or higher; recovery has increased since 1980 as a growing number of communities have restricted batteries from disposal at landfills or combustion facilities. In 1997, 93.3 percent of the lead in these batteries was estimated to be recovered for recycling as well as substantial quantities of the polypropylene battery casings; so discards after recycling of these batteries were decreased to 120,000 tons in 1997. (Some electrolytes and other materials in batteries are removed from the municipal solid waste stream along with recovered lead and polypropylene; these materials are counted as "recovered" along with the recyclable materials.)

Miscellaneous Durable Goods. Miscellaneous durable goods include consumer electronics such as television sets, video cassette recorders, personal computers, luggage, sporting equipment, and the like. An estimated 12.9 million tons of these goods were generated in 1997, amounting to 5.9 percent of MSW generated. In addition to ferrous metals, this category includes plastics, glass, rubber, wood, and other metals.

As estimated 690,000 tons of ferrous metals were estimated to be recovered from this category through pre-combustion and post-combustion magnetic separation at MSW combustion facilities in 1997, decreasing discards to 12.2 million tons.

Nondurable Goods

The Department of Commerce defines nondurable goods as those having a lifetime of less than three years, and this definition was followed for this report to the extent possible.

Products made of paper and paperboard comprise the largest portion of nondurable goods. Other nondurable products include paper and plastic plates, cups, and other disposable food service products; disposable diapers; clothing and footwear; linens; and other miscellaneous products. (See Tables 15 through 17.)

Generation of nondurable goods in MSW was 59.1 million tons in 1997 (27.2 percent of total generation). Recovery of paper products in this category is quite significant, resulting in 14.7 million tons of nondurable goods recovered in 1997 (24.8 percent of nondurables generation). This means that 44.4 million tons of nondurable goods were discarded in 1997 (28.4 percent of total MSW discards).

Paper and Paperboard Products. Generation, recovery, and discards of paper and paperboard products in nondurable goods are summarized in Tables 15 through 17. A summary for 1997 was shown earlier in Table 4. After showing a decline in 1996, generation of nondurable paper products increased in 1997. Each of the paper and paperboard product categories in nondurable goods is discussed briefly below.

Table 12

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	1,630	2,170	2,950	3,310	3,280	3,420	3,520	3,610
Small Appliances**				460	650	710	780	830
Furniture and Furnishings	2,150	2,830	4,760	6,790	6,980	7,170	7,320	7,510
Carpets and Rugs**				1,660	2,120	2,230	2,310	2,330
Rubber Tires	1,120	1,890	2,720	3,610	4,080	3,770	3,910	4,260
Batteries, lead acid	Neg.	820	1,490	1,510	2,010	1,810	1,810	1,780
Miscellaneous Durables	5,020	6,950	9,880	12,470	12,000	12,030	12,010	12,910
Total Durable Goods	9,920	14,660	21,800	29,810	31,120	31,140	31,660	33,230
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	56,850	57,250	55,510	59,100
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	70,110	68,390	69,050	71,750
Total Product Wastes†	54,620	83,280	108,890	146,510	158,080	156,780	156,220	164,080
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,500	21,740	21,850	21,910
Yard Trimmings	20,000	23,200	27,500	35,000	31,500	29,690	27,920	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	58,700	56,100	54,580	52,970	52,890
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	1.8%	1.8%	1.9%	1.6%	1.5%	1.6%	1.7%	1.7%
Small Appliances**				0.2%	0.3%	0.3%	0.4%	0.4%
Furniture and Furnishings	2.4%	2.3%	3.1%	3.3%	3.3%	3.4%	3.5%	3.5%
Carpets and Rugs**				0.8%	1.0%	1.1%	1.1%	1.1%
Rubber Tires	1.3%	1.6%	1.8%	1.8%	1.9%	1.8%	1.9%	2.0%
Batteries, Lead-Acid	Neg.	0.7%	1.0%	0.7%	0.9%	0.9%	0.9%	0.8%
Miscellaneous Durables	5.7%	5.7%	6.5%	6.1%	5.6%	5.7%	5.7%	6.0%
Total Durable Goods	11.3%	12.1%	14.4%	14.5%	14.5%	14.7%	15.1%	15.3%
Nondurable Goods *(Detail in Table 15)*	19.7%	20.7%	22.7%	25.4%	26.5%	27.1%	26.5%	27.2%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.7%	32.4%	33.0%	33.1%
Total Product Wastes†	62.0%	68.8%	71.8%	71.4%	73.8%	74.2%	74.7%	75.6%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.0%	10.3%	10.4%	10.1%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.7%	14.0%	13.3%	12.8%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	26.2%	25.8%	25.3%	24.4%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1990.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates.

Table 13

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1997
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	10	50	130	1,070	1,910	2,070	2,200	2,320
Small Appliances**				10	10	10	10	10
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs**				Neg.	10	20	20	20
Rubber Tires	330	250	150	440	620	670	730	950
Batteries, lead acid	Neg.	620	1,040	1,470	1,980	1,620	1,700	1,660
Miscellaneous Durables	10	20	40	470	560	620	640	690
Total Durable Goods	350	940	1,360	3,460	5,090	5,010	5,300	5,650
Nondurable Goods	2,390	3,730	4,670	8,800	12,610	13,610	13,550	14,680
(Detail in Table 16)								
Containers and Packaging	2,870	3,350	8,490	16,780	24,450	26,720	27,540	28,300
(Detail in Table 20)								
Total Product Wastes†	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	480	570	520	580
Yard Trimmings	Neg.	Neg.	Neg.	4,200	8,000	9,000	10,390	11,490
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700
	Percent of Generation of Each Product							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	0.6%	2.3%	4.4%	32.3%	58.2%	60.5%	62.5%	64.3%
Small Appliances**				2.2%	1.5%	1.4%	1.3%	1.2%
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs**				Neg.	0.5%	0.9%	0.9%	0.9%
Rubber Tires	29.5%	13.2%	5.5%	12.2%	15.2%	17.8%	18.7%	22.3%
Batteries, Lead-Acid	Neg.	75.6%	69.8%	97.4%	98.5%	89.5%	93.9%	93.3%
Miscellaneous Durables	0.2%	0.3%	0.4%	3.8%	4.7%	5.2%	5.3%	5.3%
Total Durable Goods	3.5%	6.4%	6.2%	11.6%	16.4%	16.1%	16.7%	17.0%
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	22.2%	23.8%	24.4%	24.8%
(Detail in Table 16)								
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	34.9%	39.1%	39.9%	39.4%
(Detail in Table 21)								
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	26.7%	28.9%	29.7%	29.6%
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	2.2%	2.6%	2.4%	2.6%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	25.4%	30.3%	37.2%	41.4%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	15.1%	17.5%	20.6%	22.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 14

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	1,620	2,120	2,820	2,240	1,370	1,350	1,320	1,290
Small Appliances**				450	640	700	770	820
Furniture and Furnishings	2,150	2,830	4,760	6,790	6,980	7,170	7,320	7,510
Carpets and Rugs**				1,660	2,110	2,210	2,290	2,310
Rubber Tires	790	1,640	2,570	3,170	3,460	3,100	3,180	3,310
Batteries, lead acid	Neg.	200	450	40	30	190	110	120
Miscellaneous Durables	5,010	6,930	9,840	12,000	11,440	11,410	11,370	12,220
Total Durable Goods	9,570	13,720	20,440	26,350	26,030	26,130	26,360	27,580
Nondurable Goods	14,940	21,330	29,750	43,370	44,240	43,640	41,960	44,420
(Detail in Table 17)								
Containers and Packaging	24,500	40,210	44,180	47,750	45,660	41,670	41,510	43,450
(Detail in Table 22)								
Total Product Wastes†	49,010	75,260	94,370	117,470	115,930	111,440	109,830	115,450
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,020	21,170	21,330	21,330
Yard Trimmings	20,000	23,200	27,500	30,800	23,500	20,690	17,530	16,240
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	54,500	47,620	45,010	42,060	40,820
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods								
Major Appliances	2.0%	1.9%	2.1%	1.3%	0.8%	0.9%	0.9%	0.8%
Small Appliances**				0.3%	0.4%	0.4%	0.5%	0.5%
Furniture and Furnishings	2.6%	2.5%	3.5%	3.9%	4.3%	4.6%	4.8%	4.8%
Carpets and Rugs**				1.0%	1.3%	1.4%	1.5%	1.5%
Rubber Tires	1.0%	1.5%	1.9%	1.8%	2.1%	2.0%	2.1%	2.1%
Batteries, Lead-Acid	Neg.	0.2%	0.3%	0.0%	0.0%	0.1%	0.1%	0.1%
Miscellaneous Durables	6.1%	6.1%	7.2%	7.0%	7.0%	7.3%	7.5%	7.8%
Total Durable Goods	11.6%	12.1%	14.9%	15.3%	15.9%	16.7%	17.4%	17.6%
Nondurable Goods	18.1%	18.9%	21.7%	25.2%	27.0%	27.9%	27.6%	28.4%
(Detail in Table 17)								
Containers and Packaging	29.7%	35.6%	32.2%	27.8%	27.9%	26.6%	27.3%	27.8%
(Detail in Table 23)								
Total Product Wastes†	59.4%	66.6%	68.8%	68.3%	70.9%	71.2%	72.3%	73.9%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	12.9%	13.5%	14.0%	13.6%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	14.4%	13.2%	11.5%	10.4%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.1%	2.1%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	29.1%	28.8%	27.7%	26.1%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1990.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates.

Table 15

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,120	31,140	31,660	33,230
Nondurable Goods								
Newspapers	7,110	9,510	11,050	13,430	13,680	13,140	12,560	13,490
Books and Magazines	1,920	2,470	3,390					
Books**				970	1,180	1,150	940	1,110
Magazines**				2,830	2,250	2,530	1,970	2,170
Office Papers	1,520	2,650	4,000	6,410	6,970	6,640	6,570	7,040
Directories**				610	470	490	470	470
Standard (A) Mail***				3,820	4,400	4,620	4,510	4,850
Other Commercial Printing	1,260	2,130	3,120	4,460	6,080	6,770	6,260	6,860
Tissue Paper and Towels	1,090	2,080	2,300	2,960	2,860	2,970	2,980	3,100
Paper Plates and Cups	270	420	630	650	870	970	950	970
Plastic Plates and Cups†			190	650	810	780	810	860
Trash Bags**				780	940	780	860	810
Disposable Diapers	Neg.	350	1,930	2,700	2,980	3,010	3,050	3,140
Other Nonpackaging Paper	2,700	3,630	4,230	3,840	4,470	4,270	4,050	4,270
Clothing and Footwear	1,360	1,620	2,170	4,010	4,870	5,070	5,340	5,760
Towels, Sheets and Pillowcases**				710	750	740	750	750
Other Miscellaneous Nondurables	100	200	1,410	3,340	3,270	3,320	3,440	3,450
Total Nondurable Goods	17,330	25,060	34,420	52,170	56,850	57,250	55,510	59,100
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	70,110	68,390	69,050	71,750
Total Product Wastes‡	54,620	83,280	108,890	146,510	158,080	156,780	156,220	164,080
Other Wastes	33,500	37,780	42,750	58,700	56,100	54,580	52,970	52,890
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	14.5%	14.7%	15.1%	15.3%
Nondurable Goods								
Newspapers	8.1%	7.9%	7.3%	6.5%	6.4%	6.2%	6.0%	6.2%
Books and Magazines	2.2%	2.0%	2.2%					
Books**				0.5%	0.6%	0.5%	0.4%	0.5%
Magazines**				1.4%	1.1%	1.2%	0.9%	1.0%
Office Papers	1.7%	2.2%	2.6%	3.1%	3.3%	3.1%	3.1%	3.2%
Directories**				0.3%	0.2%	0.2%	0.2%	0.2%
Standard (A) Mail***				1.9%	2.1%	2.2%	2.2%	2.2%
Other Commercial Printing	1.4%	1.8%	2.1%	2.2%	2.8%	3.2%	3.0%	3.2%
Tissue Paper and Towels	1.2%	1.7%	1.5%	1.4%	1.3%	1.4%	1.4%	1.4%
Paper Plates and Cups	0.3%	0.3%	0.4%	0.3%	0.4%	0.5%	0.5%	0.4%
Plastic Plates and Cups†			0.1%	0.3%	0.4%	0.4%	0.4%	0.4%
Trash Bags**				0.4%	0.4%	0.4%	0.4%	0.4%
Disposable Diapers	Neg.	0.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.4%
Other Nonpackaging Paper	3.1%	3.0%	2.8%	1.9%	2.1%	2.0%	1.9%	2.0%
Clothing and Footwear	1.5%	1.3%	1.4%	2.0%	2.3%	2.4%	2.6%	2.7%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.4%	0.4%	0.3%
Other Miscellaneous Nondurables	0.1%	0.2%	0.9%	1.6%	1.5%	1.6%	1.6%	1.6%
Total Nondurables	19.7%	20.7%	22.7%	25.4%	26.5%	27.1%	26.5%	27.2%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.7%	32.4%	33.0%	33.1%
Total Product Wastes‡	62.0%	68.8%	71.8%	71.4%	73.8%	74.2%	74.7%	75.6%
Other Wastes	38.0%	31.2%	28.2%	28.6%	26.2%	25.8%	25.3%	24.4%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 16

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1997
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	350	940	1,360	3,460	5,090	5,010	5,300	5,650
Nondurable Goods								
Newspapers	1,820	2,250	3,020	5,110	6,250	7,010	6,800	7,370
Books and Magazines	100	260	280					
Books**				100	220	220	170	200
Magazines**				300	630	650	470	500
Office Papers	250	710	870	1,700	2,940	3,040	3,490	3,570
Directories**				40	50	60	60	70
Standard (A) Mail***				200	690	710	770	950
Other Commercial Printing	130	340	350	700	1,050	1,120	950	1,130
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	10	10	10	10	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	40	110	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	50	60	150	520	640	660	700	760
Towels, Sheets and Pillowcases**				120	130	130	130	130
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurable Goods	2,390	3,730	4,670	8,800	12,610	13,610	13,550	14,680
Containers and Packaging *(Detail in Table 20)*	2,870	3,350	8,490	16,780	24,450	26,720	27,540	28,300
Total Product Wastes‡	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Other Wastes	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700
	Percent of Generation of Each Product							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	3.5%	6.4%	6.2%	11.6%	16.4%	16.1%	16.7%	17.0%
Nondurable Goods								
Newspapers	25.6%	23.7%	27.3%	38.0%	45.7%	53.3%	54.1%	54.6%
Books and Magazines	5.2%	10.5%	8.3%					
Books**				10.3%	18.6%	19.1%	18.1%	18.0%
Magazines**				10.6%	28.0%	25.7%	23.9%	23.0%
Office Papers	16.4%	26.8%	21.8%	26.5%	42.2%	45.8%	53.1%	50.7%
Directories**				6.6%	10.6%	12.2%	12.8%	14.9%
Standard (A) Mail***				5.2%	15.7%	15.4%	17.1%	19.6%
Other Commercial Printing	10.3%	16.0%	11.2%	15.7%	17.3%	16.5%	15.2%	16.5%
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	1.5%	1.2%	1.3%	1.2%	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	1.5%	3.0%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	Neg.	Neg.	Neg.	13.0%	13.1%	13.0%	13.1%	13.2%
Towels, Sheets and Pillowcases**				16.9%	17.3%	17.6%	17.3%	17.3%
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurables	13.8%	14.9%	13.6%	16.9%	22.2%	23.8%	24.4%	24.8%
Containers and Packaging *(Detail in Table 21)*	10.5%	7.7%	16.1%	26.0%	34.9%	39.1%	39.9%	39.4%
Total Product Wastes‡	10.3%	9.6%	13.3%	19.8%	26.7%	28.9%	29.7%	29.6%
Other Wastes	Neg.	Neg.	Neg.	7.2%	15.1%	17.5%	20.6%	22.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 17

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 14)*	9,570	13,720	20,440	26,350	26,030	26,130	26,360	27,580
Nondurable Goods								
Newspapers	5,290	7,260	8,030	8,320	7,430	6,130	5,760	6,120
Books and Magazines	1,820	2,210	3,110					
Books**				870	960	930	770	910
Magazines**				2,530	1,620	1,880	1,500	1,670
Office Papers	1,270	1,940	3,130	4,710	4,030	3,600	3,080	3,470
Directories**				570	420	430	410	400
Standard (A) Mail***				3,620	3,710	3,910	3,740	3,900
Other Commercial Printing	1,130	1,790	2,770	3,760	5,030	5,650	5,310	5,730
Tissue Paper and Towels	1,090	2,080	2,300	2,960	2,860	2,970	2,980	3,100
Paper Plates and Cups	270	420	630	650	870	970	950	970
Plastic Plates and Cups†			190	640	800	770	800	860
Trash Bags**				780	940	780	860	810
Disposable Diapers	Neg.	350	1,930	2,700	2,980	3,010	3,050	3,140
Other Nonpackaging Paper	2,660	3,520	4,230	3,840	4,470	4,270	4,050	4,270
Clothing and Footwear	1,310	1,560	2,020	3,490	4,230	4,410	4,640	5,000
Towels, Sheets and Pillowcases**				590	620	610	620	620
Other Miscellaneous Nondurables	100	200	1,410	3,340	3,270	3,320	3,440	3,450
Total Nondurable Goods	14,940	21,330	29,750	43,370	44,240	43,640	41,960	44,420
Containers and Packaging *(Detail in Table 22)*	24,500	40,210	44,180	47,750	45,660	41,670	41,510	43,450
Total Product Wastes‡	49,010	75,260	94,370	117,470	115,930	111,440	109,830	115,450
Other Wastes	33,500	37,780	42,750	54,500	47,620	45,010	42,060	40,820
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 14)*	11.6%	12.1%	14.9%	15.3%	15.9%	16.7%	17.4%	17.6%
Nondurable Goods								
Newspapers	6.4%	6.4%	5.9%	4.8%	4.5%	3.9%	3.8%	3.9%
Books and Magazines	2.2%	2.0%	2.3%					
Books**				0.5%	0.6%	0.6%	0.5%	0.6%
Magazines**				1.5%	1.0%	1.2%	1.0%	1.1%
Office Papers	1.5%	1.7%	2.3%	2.7%	2.5%	2.3%	2.0%	2.2%
Directories**				0.3%	0.3%	0.3%	0.3%	0.3%
Standard (A) Mail***				2.1%	2.3%	2.5%	2.5%	2.5%
Other Commercial Printing	1.4%	1.6%	2.0%	2.2%	3.1%	3.6%	3.5%	3.7%
Tissue Paper and Towels	1.3%	1.8%	1.7%	1.7%	1.7%	1.9%	2.0%	2.0%
Paper Plates and Cups	0.3%	0.4%	0.5%	0.4%	0.5%	0.6%	0.6%	0.6%
Plastic Plates and Cups†			0.1%	0.4%	0.5%	0.5%	0.5%	0.6%
Trash Bags**				0.5%	0.6%	0.5%	0.6%	0.5%
Disposable Diapers	Neg.	0.3%	1.4%	1.6%	1.8%	1.9%	2.0%	2.0%
Other Nonpackaging Paper	3.2%	3.1%	3.1%	2.2%	2.7%	2.7%	2.7%	2.7%
Clothing and Footwear	1.6%	1.4%	1.5%	2.0%	2.6%	2.8%	3.1%	3.2%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.4%	0.4%	0.4%
Other Miscellaneous Nondurables	0.1%	0.2%	1.7%	1.9%	2.0%	2.1%	2.3%	2.2%
Total Nondurables	18.1%	18.9%	21.7%	25.2%	27.0%	27.9%	27.6%	28.4%
Containers and Packaging *(Detail in Table 23)*	29.7%	35.6%	32.2%	27.8%	27.9%	26.6%	27.3%	27.8%
Total Product Wastes‡	59.4%	66.6%	68.8%	68.3%	70.9%	71.2%	72.3%	73.9%
Other Wastes	40.6%	33.4%	31.2%	31.7%	29.1%	28.8%	27.7%	26.1%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

- Newspapers are by far the largest single component of the nondurable goods category, at 13.5 million tons generated in 1997 (6.2 percent of total MSW). In 1997, 54.6 percent of newspapers generated were recovered for recycling, leaving 6.1 million tons discarded (3.9 percent of total MSW discarded). Estimates of newspaper generation are broken down into newsprint (the majority of the weight of newspapers) and the groundwood* inserts (primarily advertising) that are a significant portion of the total weight of newspapers. This breakdown is shown in Table 4.

- Books amounted to approximately 1.1 million tons, or 0.5 percent of total MSW generation, in 1997. Recovery of books is not well documented, but it was estimated that approximately 200,000 tons of books were recovered in 1997. Books are made of both groundwood and chemical pulp.

- Magazines accounted for an estimated 2.2 million tons, or 1.0 percent of total MSW generation, in 1997. Like books, recovery of magazines is not well documented. It was estimated that 500,000 tons of magazines were recovered in 1997. Magazines are predominately made of coated groundwood, but some uncoated groundwood and chemical pulps are also used.

- Many different kinds of papers are generated in offices. For this report, office-type paper estimates include the high grade papers such as copier paper, computer printout, stationery, etc. (7.0 million tons, or 3.2 percent of total MSW generation, in 1997). These papers are almost entirely made of uncoated chemical pulp, although some amounts of groundwood are also used. It should be noted that some of these office-type papers are generated at locations other than offices, including homes and institutions such as schools. Also, other kinds of papers (e.g., newspapers, magazines, and packaging) are generated in offices, but are accounted for in other categories. An estimated 3.6 million tons of office-type papers were recovered in 1997.

- Directories were estimated to generate 470,000 tons (0.2 percent of total MSW) in 1997. These directories are made of groundwood. It was estimated that 70,000 tons of directories were recovered in 1997. The Yellow Pages Publishers Association (YPPA) publishes data on paper use in directories.

- Standard (A) mail** includes catalogs and other direct bulk mailings; these amounted to an estimated 4.9 million tons, or 2.2 percent of MSW generation, in 1997. Both groundwood and chemical pulps are used in these mailings. It was estimated that 950,000 tons were recovered in 1997. The U.S. Postal Service is implementing a program to increase recovery of bulk mail in the future.

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* Groundwood papers, like newsprint, are made primarily from pulp prepared by a mechanical process. The other major type of wood pulp is prepared by a chemical process. The nature of the pulp (groundwood vs. chemical) affects the potential uses for the recovered paper.

** Standard (A) mail was formerly called Third Class mail by the U.S. Postal Service.

- Other commercial printing includes a wide range of paper items: brochures, reports, menus, invitations, etc. Both groundwood and chemical pulps are used in these varied items. Generation was estimated at 6.9 million tons, or 3.2 percent of MSW generation, in 1997, with recovery estimated at 1.1 million tons.

- Tissue paper and towels generation includes facial and sanitary tissues and napkins, but not bathroom tissue, which is nearly all diverted from MSW into the wastewater treatment system. Tissue paper and towels (not including bathroom tissue) amounted to 3.1 million tons (1.4 percent of total MSW generation) in 1997. No significant recovery of tissue products was identified for recycling, although there is some composting of these items.

- Paper plates and cups include paper plates, cups, bowls, and other food service products used in homes, in commercial establishments like restaurants, and in institutional settings such as schools. Generation of these products was estimated at 970,000 tons (0.4 percent of total MSW generation) in 1997. No significant recovery for recycling of these products was identified.

- Other nonpackaging papers—including posters, photographic papers, cards and games, etc.—accounted for 4.3 million tons (2.0 percent of total MSW generation) in 1997. No significant recovery for recycling of these papers was identified.

Overall, generation of paper and paperboard products in nondurable goods was 44.4 million tons in 1997 (Table 4). While newspapers were recovered at the highest rate, other paper products, such as books, magazines, and office papers, were also recovered for recycling, and the overall recovery rate for paper in nondurables was 31 percent in 1997. Thus 30.6 million tons of paper in nondurables were discarded in 1997.

Plastic Plates and Cups. This category includes plastic plates, cups, glasses, dishes and bowls, hinged containers, and other containers used in food service at home, in restaurants and other commercial establishments, and in institutional settings such as schools. These items are made primarily of polystyrene resin. An estimated 860,000 tons of these products were generated in 1997, or 0.4 percent of total MSW (see Table 15). No significant recovery for recycling was identified in 1997.

Disposable Diapers. This category includes estimates of both infant diapers and adult incontinence products. Generation was estimated using data on sales of the products along with information on average weights and composition. An estimated 3.1 million tons of disposable diapers were generated in 1997, or 1.4 percent of total MSW generation. (This tonnage includes an adjustment for the urine and feces contained within the discarded diapers.) The materials portion of the diapers includes wood pulp, plastics (including the super-absorbent materials now present in most diapers), and tissue paper.

No significant recycling or composting of disposable diapers was identified in 1997.

Clothing and Footwear. Generation of clothing and footwear was estimated to be 5.8 million tons in 1997 (2.7 percent of total MSW). Textiles, rubber, and leather are major materials components of this category, with some plastics present as well. Generation estimates for these products are based on sales data from the Department of Commerce along with data on average weights for each type of product included. Adjustments are made for net imports of these products based on Department of Commerce data.

The Council for Textile Recycling has reported on recovery of textiles for exports, reprocessing, and reuse. Based on their data, it was estimated that 760,000 tons of textiles in clothing were recovered for export or recycling in 1997. (Reuse is not counted as recycling and is discussed in Chapter 3.)

Towels, Sheets, and Pillowcases. An estimated 750,000 tons of towels, sheets, and pillowcases were generated in 1997. Generation was estimated using a methodology similar to that for clothing. An estimated 130,000 tons of these textiles were recovered for export or recycling in 1997.

Other Miscellaneous Nondurables. Generation of other miscellaneous nondurables was estimated to be 3.5 million tons in 1997 (1.6 percent of MSW). The primary material component of miscellaneous nondurables is plastics, although some aluminum, rubber, and textiles are also present. Typical products in miscellaneous nondurables include shower curtains and other household items, disposable medical supplies, novelty items, and the like.

Generation of plastic products in miscellaneous nondurables is taken from resin sales data published annually in ***Modern Plastics***. Generation of other materials in these nondurable products is estimated based on information in past reports in this series.

Containers and Packaging

Containers and packaging make up a major portion of MSW, amounting to 71.7 million tons of generation in 1997 (33.1 percent of total generation). Generation, recovery, and discards of containers and packaging are shown in detail in Tables 18 through 23.

There is substantial recovery of many container and packaging products, especially corrugated containers. In 1997, 39.4 percent of containers and packaging generated was recovered for recycling. Because of this recovery, containers and packaging comprised 27.8 percent of total MSW discards in 1997.

Containers and packaging in MSW are made of several materials: paper and paperboard, glass, steel, aluminum, plastics, wood, and small amounts of other materials. Material categories are discussed separately below.

Glass Containers. Glass containers include beer and soft drink bottles (which includes carbonated drinks and non-carbonated waters, teas, and flavored drinks containing not more than 10 percent fruit juice), wine and liquor bottles, and bottles and jars for food, cosmetics, and other products. Generation of glass containers is estimated using Department

Table 18

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,120	31,140	31,660	33,230
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	56,850	57,250	55,510	59,100
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1,400	5,580	6,740	5,640	5,250	5,120	5,100	4,960
Wine and Liquor Bottles	1,080	1,900	2,450	2,030	1,800	1,790	1,940	1,820
Food and Other Bottles & Jars	3,710	4,440	4,780	4,160	5,000	4,620	3,940	3,830
Total Glass Packaging	6,190	11,920	13,970	11,830	12,050	11,530	10,980	10,610
Steel Packaging								
Beer and Soft Drink Cans	640	1,570	520	150	10	Neg.	Neg.	Neg.
Food and Other Cans	3,760	3,540	2,850	2,540	2,990	2,690	2,820	2,860
Other Steel Packaging	260	270	240	200	220	210	170	240
Total Steel Packaging	4,660	5,380	3,610	2,890	3,220	2,900	2,990	3,100
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	100	850	1,550	1,720	1,590	1,540	1,530
Other Cans	Neg.	60	40	20	40	40	40	50
Foil and Closures	170	410	380	330	340	350	360	360
Total Aluminum Packaging	170	570	1,270	1,900	2,100	1,980	1,940	1,940
Paper & Paperboard Pkg								
Corrugated Boxes	7,330	12,760	17,080	24,010	28,140	28,800	29,020	30,160
Milk Cartons**			790	510	520	510	460	460
Folding Cartons**			3,820	4,300	5,150	5,310	5,390	5,420
Other Paperboard Packaging	3,840	4,830	230	290	300	260	230	220
Bags and Sacks**			3,380	2,440	2,300	1,980	1,950	1,870
Wrapping Papers**			200	110	80	70	50	50
Other Paper Packaging	2,940	3,810	850	1,020	1,070	1,150	1,260	1,270
Total Paper & Board Pkg	14,110	21,400	26,350	32,680	37,560	38,080	38,360	39,450
Plastics Packaging								
Soft Drink Bottles**			260	430	600	650	700	760
Milk Bottles**			230	530	580	620	650	670
Other Containers	60	910	890	1,430	1,380	1,180	1,280	1,540
Bags and Sacks**			390	940	1,320	1,200	1,360	1,520
Wraps**			840	1,530	1,770	1,710	1,860	2,130
Other Plastics Packaging	60	1,180	790	2,040	2,250	2,220	2,300	2,810
Total Plastics Packaging	120	2,090	3,400	6,900	7,900	7,580	8,150	9,430
Wood Packaging	2,000	2,070	3,940	8,180	7,120	6,170	6,480	7,030
Other Misc. Packaging	120	130	130	150	160	150	150	190
Total Containers & Pkg	27,370	43,560	52,670	64,530	70,110	68,390	69,050	71,750
Total Product Wastes†	54,620	83,280	108,890	146,510	158,080	156,780	156,220	164,080
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,500	21,740	21,850	21,910
Yard Trimmings	20,000	23,200	27,500	35,000	31,500	29,690	27,920	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	58,700	56,100	54,580	52,970	52,890
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
** Not estimated separately prior to 1980.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 19

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total generation)

	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods	11.3%	12.1%	14.4%	14.5%	14.5%	14.7%	15.1%	15.3%
(Detail in Table 12)								
Nondurable Goods	19.7%	20.7%	22.7%	25.4%	26.5%	27.1%	26.5%	27.2%
(Detail in Table 15)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1.6%	4.6%	4.4%	2.7%	2.5%	2.4%	2.4%	2.3%
Wine and Liquor Bottles	1.2%	1.6%	1.6%	1.0%	0.8%	0.8%	0.9%	0.8%
Food and Other Bottles & Jars	4.2%	3.7%	3.2%	2.0%	2.3%	2.2%	1.9%	1.8%
Total Glass Packaging	7.0%	9.8%	9.2%	5.8%	5.6%	5.5%	5.2%	4.9%
Steel Packaging								
Beer and Soft Drink Cans	0.7%	1.3%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	4.3%	2.9%	1.9%	1.2%	1.4%	1.3%	1.3%	1.3%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Steel Packaging	5.3%	4.4%	2.4%	1.4%	1.5%	1.4%	1.4%	1.4%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	0.1%	0.6%	0.8%	0.8%	0.8%	0.7%	0.7%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Packaging	0.2%	0.5%	0.8%	0.9%	1.0%	0.9%	0.9%	0.9%
Paper & Paperboard Pkg								
Corrugated Boxes	8.3%	10.5%	11.3%	11.7%	13.1%	13.6%	13.9%	13.9%
Milk Cartons**			0.5%	0.2%	0.2%	0.2%	0.2%	0.2%
Folding Cartons**			2.5%	2.1%	2.4%	2.5%	2.6%	2.5%
Other Paperboard Packaging	4.4%	4.0%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Bags and Sacks**			2.2%	1.2%	1.1%	0.9%	0.9%	0.9%
Wrapping Papers**			0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Other Paper Packaging	3.3%	3.1%	0.6%	0.5%	0.5%	0.5%	0.6%	0.6%
Total Paper & Board Pkg	16.0%	17.7%	17.4%	15.9%	17.5%	18.0%	18.3%	18.2%
Plastics Packaging								
Soft Drink Bottles**			0.2%	0.2%	0.3%	0.3%	0.3%	0.4%
Milk Bottles**			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.7%	0.6%	0.6%	0.6%	0.7%
Bags and Sacks**			0.3%	0.5%	0.6%	0.6%	0.7%	0.7%
Wraps**			0.6%	0.7%	0.8%	0.8%	0.9%	1.0%
Other Plastics Packaging	0.1%	1.0%	0.5%	1.0%	1.1%	1.1%	1.1%	1.3%
Total Plastics Packaging	0.1%	1.7%	2.2%	3.4%	3.7%	3.6%	3.9%	4.3%
Wood Packaging	2.3%	1.7%	2.6%	4.0%	3.3%	2.9%	3.1%	3.2%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	31.1%	36.0%	34.7%	31.4%	32.7%	32.4%	33.0%	33.1%
Total Product Wastes†	62.0%	68.8%	71.8%	71.4%	73.8%	74.2%	74.7%	75.6%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.0%	10.3%	10.4%	10.1%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.7%	14.0%	13.3%	12.8%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	26.2%	25.8%	25.3%	24.4%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
** Not estimated separately prior to 1980.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 20

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	350	940	1,360	3,460	5,090	5,010	5,300	5,650
Nondurable Goods *(Detail in Table 16)*	2,390	3,730	4,670	8,800	12,610	13,610	13,550	14,680
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	90	140	730	1,890	1,650	1,670	1,680	1,550
Wine and Liquor Bottles	10	10	20	210	470	470	480	440
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	520	990	1,000	1,010	930
Total Glass Packaging	100	150	750	2,620	3,110	3,140	3,170	2,920
Steel Packaging								
Beer and Soft Drink Cans	10	20	50	40	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	20	60	150	590	1,550	1,510	1,640	1,730
Other Steel Packaging	Neg.	Neg.	Neg.	60	60	50	50	160
Total Steel Packaging	30	80	200	690	1,610	1,560	1,690	1,890
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	10	310	990	990	900	900	910
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	20	30	30	30	30
Total Aluminum Pkg	Neg.	10	320	1,010	1,020	930	930	940
Paper & Paperboard Pkg								
Corrugated Boxes	2,520	2,760	6,390	11,530	16,210	18,480	19,360	20,290
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.	10
Folding Cartons**			520	340	1,010	1,080	850	560
Other Paperboard Packaging			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	200	420	340	250	280
Wrapping Papers**			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	220	350	300	Neg.	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	2,740	3,110	7,210	12,070	17,640	19,900	20,460	21,140
Plastics Packaging								
Soft Drink Bottles**			10	140	320	300	280	270
Milk Bottles**			Neg.	20	170	190	200	210
Other Containers	Neg.	Neg.	Neg.	20	140	150	190	200
Bags and Sacks**			Neg.	30	30	40	50	40
Wraps**			Neg.	30	30	40	50	50
Other Plastics Packaging	Neg.	Neg.	Neg.	20	20	20	30	50
Total Plastics Packaging	Neg.	Neg.	10	260	710	740	800	820
Wood Packaging	Neg.	Neg.	Neg.	130	360	450	490	590
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	2,870	3,350	8,490	16,780	24,450	26,720	27,540	28,300
Total Product Wastes†	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	480	570	520	580
Yard Trimmings	Neg.	Neg.	Neg.	4,200	8,000	9,000	10,390	11,490
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 21

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of generation of each product)

Percent of Generation of Each Product								
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 13)*	3.5%	6.4%	6.2%	11.6%	16.4%	16.1%	16.7%	17.0%
Nondurable Goods *(Detail in Table 16)*	13.8%	14.9%	13.6%	16.9%	22.2%	23.8%	24.4%	24.8%
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	6.4%	2.5%	10.8%	33.5%	31.4%	32.6%	32.9%	31.3%
Wine and Liquor Bottles	Neg.	Neg.	Neg.	10.3%	26.1%	26.3%	24.7%	24.2%
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	12.5%	19.8%	21.6%	25.6%	24.3%
Total Glass Packaging	1.6%	1.3%	5.4%	22.1%	25.8%	27.2%	28.9%	27.5%
Steel Packaging								
Beer and Soft Drink Cans	1.6%	1.3%	9.6%	26.7%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	Neg.	1.7%	5.3%	23.2%	51.8%	56.1%	58.2%	60.5%
Other Steel Packaging	Neg.	Neg.	Neg.	30.0%	27.3%	23.8%	29.4%	66.7%
Total Steel Packaging	Neg.	1.5%	5.5%	23.9%	50.0%	53.8%	56.5%	61.0%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	10.0%	36.5%	63.9%	57.6%	56.6%	58.4%	59.5%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	6.1%	8.8%	8.6%	8.3%	8.3%
Total Aluminum Pkg	Neg.	1.8%	25.2%	53.2%	48.6%	47.0%	47.9%	48.5%
Paper & Paperboard Pkg								
Corrugated Boxes	34.4%	21.6%	37.4%	48.0%	57.6%	64.2%	66.7%	67.3%
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Folding Cartons**			Neg.	Neg.	19.6%	20.3%	15.8%	10.3%
Other Paperboard Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	Neg.	18.3%	17.2%	12.8%	15.0%
Wrapping Papers**			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	7.5%	9.2%	35.3%	Neg.	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	19.4%	14.5%	27.4%	36.9%	47.0%	52.3%	53.3%	53.6%
Plastics Packaging								
Soft Drink Bottles**			3.8%	32.6%	53.3%	46.2%	40.0%	35.5%
Milk Bottles**			Neg.	3.8%	29.3%	30.6%	30.8%	31.3%
Other Containers	Neg.	Neg.	Neg.	1.4%	10.1%	12.7%	14.8%	13.0%
Bags and Sacks**			Neg.	3.2%	2.3%	3.3%	3.7%	2.6%
Wraps**			Neg.	2.0%	1.7%	2.3%	2.7%	2.3%
Other Plastics Packaging	Neg.	Neg.	Neg.	1.0%	0.9%	0.9%	1.3%	1.8%
Total Plastics Packaging	Neg.	Neg.	Neg.	3.8%	9.0%	9.8%	9.8%	8.7%
Wood Packaging	Neg.	Neg.	Neg.	1.6%	5.1%	7.3%	7.6%	8.4%
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	10.5%	7.7%	16.1%	26.0%	34.9%	39.1%	39.9%	39.4%
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	26.7%	28.9%	29.7%	29.6%
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	2.2%	2.6%	2.4%	2.6%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	25.4%	30.3%	37.2%	41.4%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	15.1%	17.5%	20.6%	22.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 22

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods	9,570	13,720	20,440	26,350	26,030	26,130	26,360	27,580
(Detail in Table 14)								
Nondurable Goods	14,940	21,330	29,750	43,370	44,240	43,640	41,960	44,420
(Detail in Table 17)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1,310	5,440	6,010	3,750	3,600	3,450	3,420	3,410
Wine and Liquor Bottles	1,070	1,890	2,430	1,820	1,330	1,320	1,460	1,380
Food and Other Bottles & Jars	3,710	4,440	4,780	3,640	4,010	3,620	2,930	2,900
Total Glass Packaging	6,090	11,770	13,220	9,210	8,940	8,390	7,810	7,690
Steel Packaging								
Beer and Soft Drink Cans	630	1,550	470	110	10	Neg.	Neg.	Neg.
Food and Other Cans	3,740	3,480	2,700	1,950	1,440	1,180	1,180	1,130
Other Steel Packaging	260	270	240	140	160	160	120	80
Total Steel Packaging	4,630	5,300	3,410	2,200	1,610	1,340	1,300	1,210
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	90	540	560	730	690	640	620
Other Cans	Neg.	60	40	20	40	40	40	50
Foil and Closures	170	410	380	310	310	320	330	330
Total Aluminum Pkg	170	560	950	890	1,080	1,050	1,010	1,000
Paper & Paperboard Pkg								
Corrugated Boxes	4,810	10,000	10,690	12,480	11,930	10,320	9,660	9,870
Milk Cartons**			790	510	520	510	460	450
Folding Cartons**			3,300	3,960	4,140	4,230	4,540	4,860
Other Paperboard Packaging	3,840	4,830	230	290	300	260	230	220
Bags and Sacks**			3,380	2,240	1,880	1,640	1,700	1,590
Wrapping Papers**			200	110	80	70	50	50
Other Paper Packaging	2,720	3,460	550	1,020	1,070	1,150	1,260	1,270
Total Paper & Board Pkg	11,370	18,290	19,140	20,610	19,920	18,180	17,900	18,310
Plastics Packaging								
Soft Drink Bottles**			250	290	280	350	420	490
Milk Bottles**			230	510	410	430	450	460
Other Containers	60	910	890	1,410	1,240	1,030	1,090	1,340
Bags and Sacks**			390	910	1,290	1,160	1,310	1,480
Wraps**			840	1,500	1,740	1,670	1,810	2,080
Other Plastics Packaging	60	1,180	790	2,020	2,230	2,200	2,270	2,760
Total Plastics Packaging	120	2,090	3,390	6,640	7,190	6,840	7,350	8,610
Wood Packaging	2,000	2,070	3,940	8,050	6,760	5,720	5,990	6,440
Other Misc. Packaging	120	130	130	150	160	150	150	190
Total Containers & Pkg	24,500	40,210	44,180	47,750	45,660	41,670	41,510	43,450
Total Product Wastes†	49,010	75,260	94,370	117,470	115,930	111,440	109,830	115,450
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,020	21,170	21,330	21,330
Yard Trimmings	20,000	23,200	27,500	30,800	23,500	20,690	17,530	16,240
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,100	3,150	3,200	3,250
Total Other Wastes	33,500	37,780	42,750	54,500	47,620	45,010	42,060	40,820
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1980.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 23

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1997
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total discards)

	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Durable Goods *(Detail in Table 14)*	11.6%	12.1%	14.9%	15.3%	15.9%	16.7%	17.4%	17.6%
Nondurable Goods *(Detail in Table 17)*	18.1%	18.9%	21.7%	25.2%	27.0%	27.9%	27.6%	28.4%
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1.6%	4.8%	4.4%	2.2%	2.2%	2.2%	2.3%	2.2%
Wine and Liquor Bottles	1.3%	1.7%	1.8%	1.1%	0.8%	0.8%	1.0%	0.9%
Food and Other Bottles & Jars	4.5%	3.9%	3.5%	2.1%	2.5%	2.3%	1.9%	1.9%
Total Glass Packaging	7.4%	10.4%	9.6%	5.4%	5.5%	5.4%	5.1%	4.9%
Steel Packaging								
Beer and Soft Drink Cans	0.8%	1.4%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	4.5%	3.1%	2.0%	1.1%	0.9%	0.8%	0.8%	0.7%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Steel Packaging	5.6%	4.7%	2.5%	1.3%	1.0%	0.9%	0.9%	0.8%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	0.1%	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.2%	0.4%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Pkg	0.2%	0.5%	0.7%	0.5%	0.7%	0.7%	0.7%	0.6%
Paper & Paperboard Pkg								
Corrugated Boxes	5.8%	8.8%	7.8%	7.3%	7.3%	6.6%	6.4%	6.3%
Milk Cartons**			0.6%	0.3%	0.3%	0.3%	0.3%	0.3%
Folding Cartons**			2.4%	2.3%	2.5%	2.7%	3.0%	3.1%
Other Paperboard Packaging	4.7%	4.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Bags and Sacks**			2.5%	1.3%	1.1%	1.0%	1.1%	1.0%
Wrapping Papers**			0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Other Paper Packaging	3.3%	3.1%	0.4%	0.6%	0.7%	0.7%	0.8%	0.8%
Total Paper & Board Pkg	13.8%	16.2%	14.0%	12.0%	12.2%	11.6%	11.8%	11.7%
Plastics Packaging								
Soft Drink Bottles**			0.2%	0.2%	0.2%	0.2%	0.3%	0.3%
Milk Bottles**			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.8%	0.8%	0.7%	0.7%	0.9%
Bags and Sacks**			0.3%	0.5%	0.8%	0.7%	0.9%	0.9%
Wraps**			0.6%	0.9%	1.1%	1.1%	1.2%	1.3%
Other Plastics Packaging	0.1%	1.0%	0.6%	1.2%	1.4%	1.4%	1.5%	1.8%
Total Plastics Packaging	0.1%	1.8%	2.5%	3.9%	4.4%	4.4%	4.8%	5.5%
Wood Packaging	2.4%	1.8%	2.9%	4.7%	4.1%	3.7%	3.9%	4.1%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	29.7%	35.6%	32.2%	27.8%	27.9%	26.6%	27.3%	27.8%
Total Product Wastes†	59.4%	66.6%	68.8%	68.3%	70.9%	71.2%	72.3%	73.9%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	12.9%	13.5%	14.0%	13.6%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	14.4%	13.2%	11.5%	10.4%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.1%	2.1%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	29.1%	28.8%	27.7%	26.1%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1980.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

of Commerce data. Adjustments are made for imports and exports of both empty glass containers and containers holding products, e.g., imported beer.

Generation of these glass containers was 10.6 million tons in 1997, or 4.9 percent of MSW generation (Tables 18 and 19). This is a slight decrease in generation compared to 1996.

The Glass Packaging Institute's reported recovery rate for glass containers includes reuse of refillable bottles. Since refilling is defined as reuse rather than recycling in this report, the refilled bottles are not counted as recovery here. An estimated 2.9 million tons of glass containers were recovered for recycling in 1997, or 27.5 percent of generation. Glass container discards were 7.7 million tons in 1997, or 4.9 percent of total MSW discards.

Steel Containers and Packaging. Steel food and other cans, and other steel packaging (e.g., steel barrels and drums), totaled 3.1 million tons in 1997 (1.4 percent of total MSW generation), with most of that amount being cans for food products (Tables 18 and 19). Generation estimates are based on data supplied by the Steel Recycling Institute (SRI), the Reusable Industrial Packaging Association, and the Can Manufacturers Institute (CMI). Estimates include adjustments for net imports.

Recovery data for steel containers and packaging were provided by the Steel Recycling Institute. An estimated 1.9 million tons of steel packaging were recovered in 1997, or 61 percent of generation. The SRI estimates include recovery from residential sources, pre-combustion and post-combustion magnetic separation of steel cans and other ferrous products at MSW combustion facilities, and recycling of drums and barrels not suitable for reconditioning.

Aluminum Containers and Packaging. Aluminum containers and packaging include beer and soft drink cans (including all carbonated and non-carbonated soft drinks, tea, tonic, waters and juice beverages), other cans, and foil and closures. Aluminum can generation has been estimated based on can shipments data from the Can Manufacturers Institute and can weight data from the Aluminum Association, while data on other aluminum packaging is based on Department of Commerce data.

In 1996, the Can Manufacturers Association began publishing data on consumption of beverages in cans. The consumption data are adjusted for imports and exports of beverages in cans, and therefore are more accurate for generation calculations than shipments alone. The generation methodology for 1996 and 1997 was therefore revised to use consumption data. Total aluminum container and packaging generation in 1997 was 1.9 million tons, or 0.9 percent of total MSW generation.

Aluminum can recovery data has been obtained from the Aluminum Association. For this report, the aluminum can recovery methodology has been revised to account for imports of used beverage cans (UBC); these imports have been increasing in recent years. The imported UBC were subtracted from the tonnage of UBC reported by the Aluminum

Association to have been melted by U.S. end-users and recovered for export.* The effect of this change is to lower the aluminum beverage can recovery rate.

Recovery of aluminum beverage cans in 1997 was 0.9 million tons, or 59.5 percent of generation. Recovery of all aluminum packaging was estimated to be 48.5 percent of total generation in 1997. After recovery for recycling, 1.0 million tons of aluminum packaging were discarded in 1997.

Paper and Paperboard Containers and Packaging. Corrugated boxes are the largest single product category of MSW at 30.2 million tons generated, or 13.9 percent of total generation, in 1997. Corrugated boxes also represent the largest single category of product recovery, at 20.3 million tons of recovery in 1997 (67.3 percent of boxes generated were recovered). After recovery, 9.9 million tons of corrugated boxes were discarded, or 6.3 percent of MSW discards in 1997.

Other paper and paperboard packaging in MSW includes milk cartons, folding boxes (e.g., cereal boxes, frozen food boxes, some department store boxes), bags and sacks, wrapping papers, and other paper and paperboard packaging. Overall, paper and paperboard containers and packaging totaled 39.5 million tons of MSW generation in 1997, or 18.2 percent of total generation.

While recovery of corrugated boxes is by far the largest component of paper packaging recovery, smaller amounts of other paper packaging products are recovered (estimated at 850,000 tons in 1997). The overall recovery rate for paper and paperboard packaging in 1997 was 53.6 percent. Other paper packaging such as folding boxes and sacks is mostly recovered as mixed papers.

Plastic Containers and Packaging. Many different plastic resins are used to make a variety of packaging products. Some of these include polyethylene terephthalate (PET) soft drink bottles, high-density polyethylene HDPE milk jugs, film products (including bags and sacks) made of low-density polyethylene (LDPE and LLDPE), and containers and other packaging (including coatings, closures, etc.) made of polyvinyl chloride, polystyrene, polypropylene, and other resins. Estimates of generation of plastic containers and packaging are based on data on resin sales by end use published annually by ***Modern Plastics***, a trade publication, and the American Plastics Council annual plastic recovery survey.

Plastic containers and packaging have exhibited rapid growth in MSW, with generation increasing from 120,000 tons in 1960 (0.1 percent of generation) to 9.4 million tons in 1997 (4.3 percent of MSW generation). (Note: plastic packaging as a category in this report does not include single-service plates and cups and trash bags, which are classified as nondurable goods.)

Estimates of recovery of plastic products are based on data published annually by the American Plastics Council. Plastic soft drink bottles were estimated to have been recovered

* Note, however, that the imported UBC do contribute to recycled aluminum content in can sheet and other aluminum products.

at a 35.5 percent rate in 1997 (270,000 tons). Recovery of plastic milk and water bottles was estimated to have been 210,000 tons, or 31.3 percent of generation. Overall, recovery of plastic containers and packaging was estimated to be 820,000 tons, or 8.7 percent in 1997. Discards of plastic packaging were thus 8.6 million tons in 1997, or 5.5 percent of total MSW discards.

Wood Packaging. Wood packaging includes wood crates and pallets (mostly pallets). Data on production of wood packaging is from the Wooden Pallet and Container Association, as well as other studies on the pallet industry (Busch, Reddy, Araman). In 1997, 7.0 million tons of wood pallets and other wood packaging were estimated to have been generated, or 3.2 percent of total MSW generation.

Wood pallets recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 590,000 tons in 1997.

Nearly 200 million pallets—representing over 5 million tons of wood packaging—were estimated to be refurbished and returned to service in 1997. This EPA report classifies pallets refurbished and returned to service as reuse (source reduction) rather than recovery for recycling. Therefore, the 5 million tons represents a reduction in the amount of wood packaging discarded to the waste stream (i.e., a reduction in generation) rather than an increase in recycling.

Accounting for pallet reuse and recovery for recycling, wood packaging discards were 6.4 million tons in 1997, or 4.1 percent of total MSW discards.

Other Packaging. Estimates are included for some other miscellaneous packaging such as bags made of textiles, small amounts of leather, and the like. These latter quantities are not well documented, but were estimated to amount to 190,000 tons generated in 1997.

Summary of Products in Municipal Solid Waste

Changing quantities and composition of municipal solid waste generation by product category are illustrated in Figure 14. This figure shows graphically that generation of durable goods has increased very gradually over the years. Nondurable goods and containers and packaging have accounted for the large increases in MSW generation.

The materials composition of nondurable goods in 1997 is shown in Figure 15. Paper and paperboard made up 75 percent of nondurables in MSW generation, with plastics contributing 9 percent, and textiles 10 percent. Other materials contributed lesser percentages. After recovery for recycling, paper and paperboard were 68 percent of nondurable discards, with plastics being 12 percent, and textiles 11 percent.

The materials composition of containers and packaging in MSW in 1997 is shown in Figure 16. By weight, paper and paperboard products made up 55 percent of containers and packaging generation, with glass second at 15 percent of containers and packaging

generation. Plastics accounted for 13 percent of containers and packaging generation, wood was 10 percent, and metals were 7 percent.

Recovery for recycling makes a significant change, with paper and paperboard being 42 percent of containers and packaging discards after recovery takes place. Glass containers accounted for 18 percent of discards of containers and packaging, plastics was 20 percent, wood was 15 percent, and metals were 5 percent.

Some additional perspectives on products in municipal solid waste are included in Appendix B of this report.

Figure 14. Generation of products in MSW, 1960 to 1997

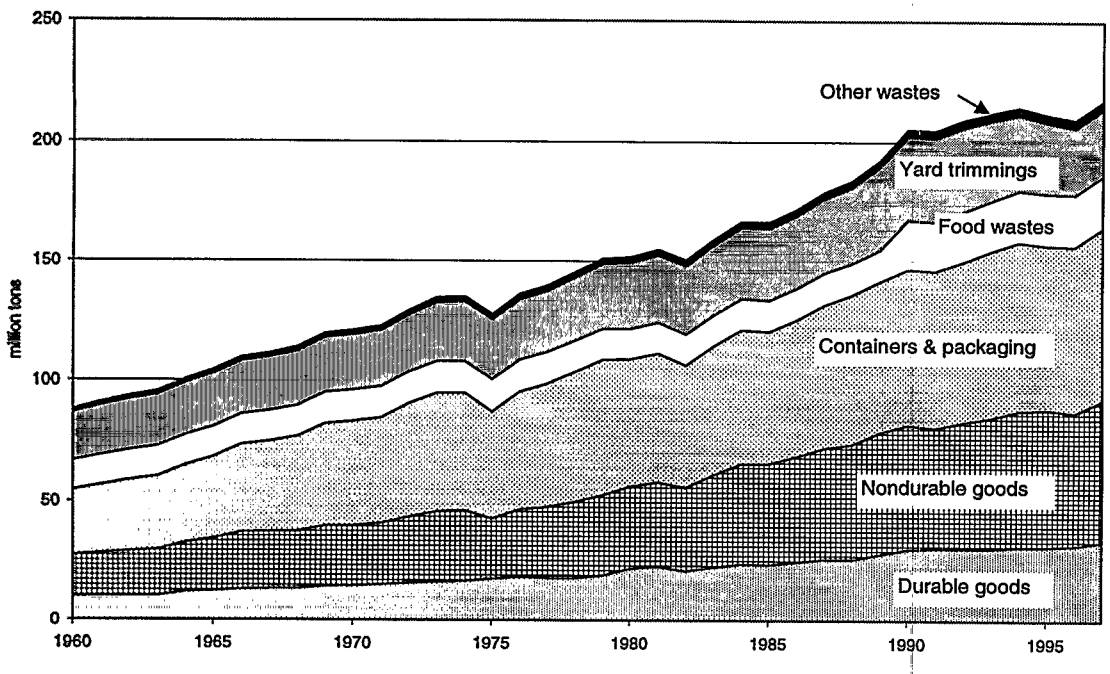


Figure 15. Nondurable goods generated and discarded in municipal solid waste, 1997
(In percent of total generation and discards)

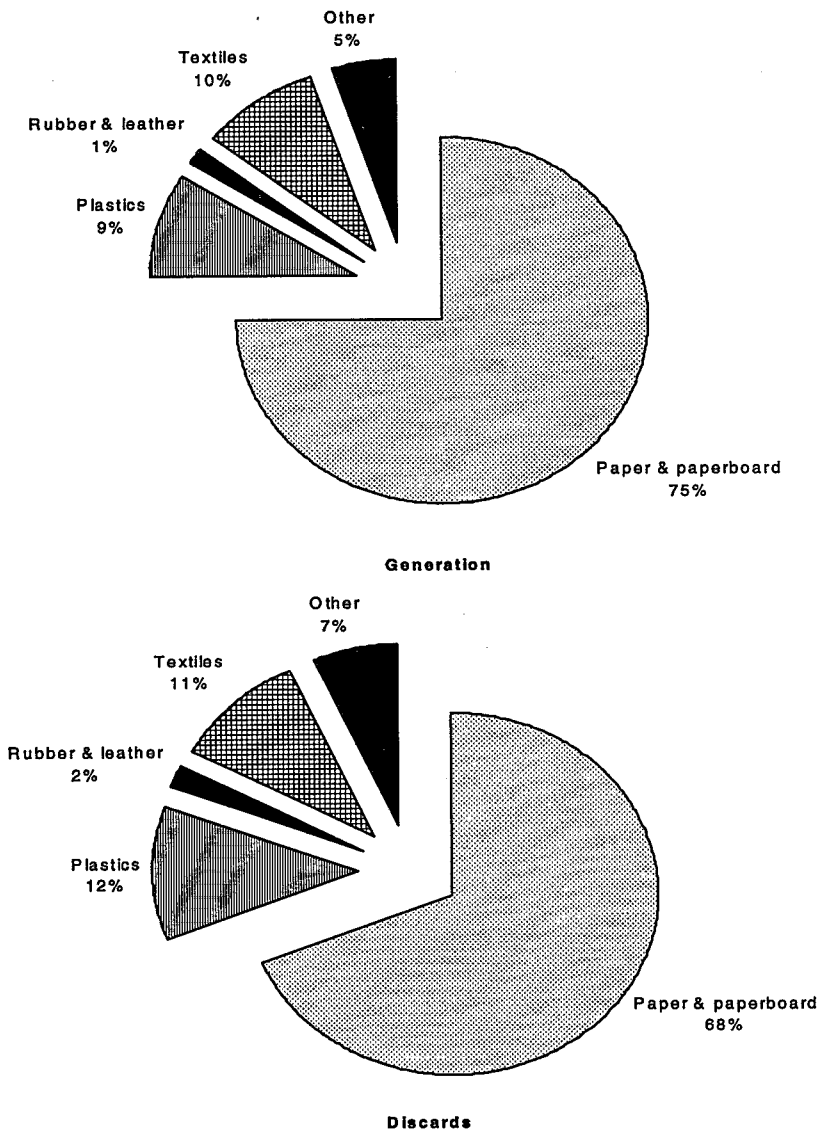
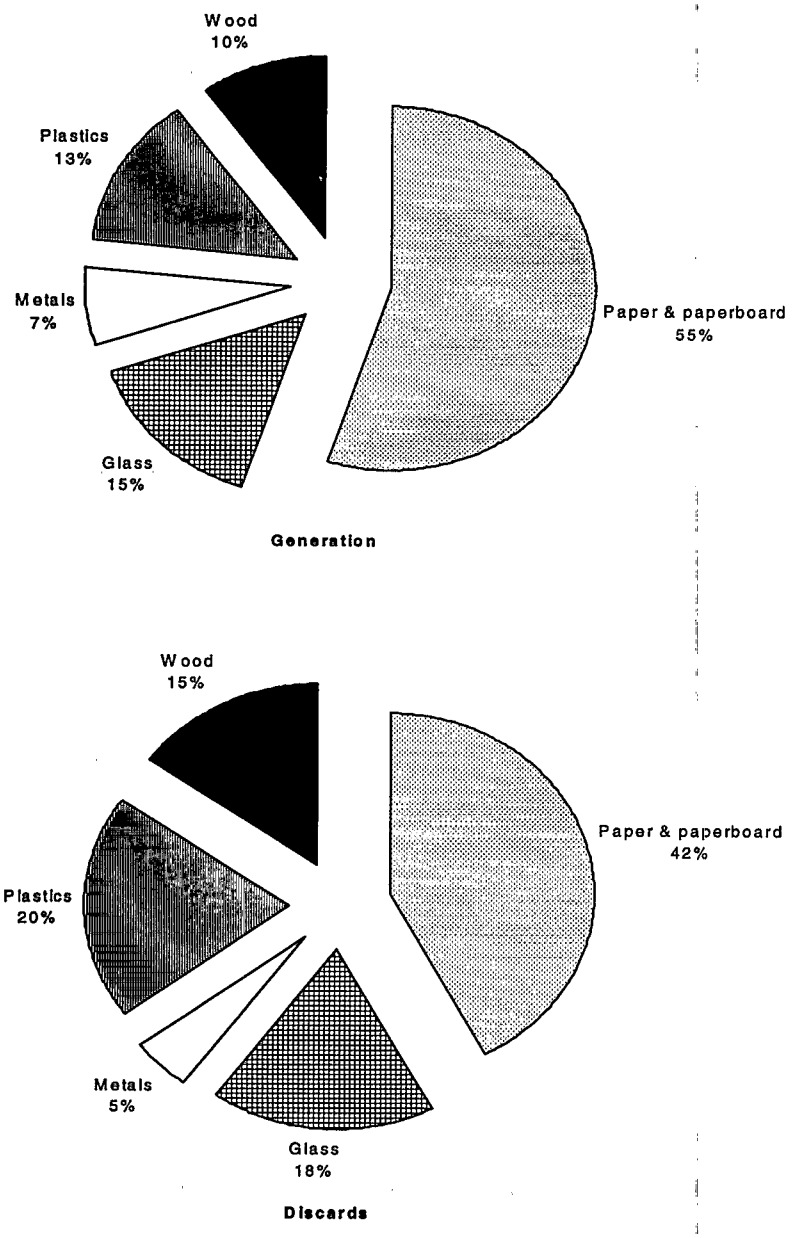


Figure 16. Containers and packaging generated and discarded in municipal solid waste, 1997
(In percent of total generation and discards)



SUMMARY

The data presented in this chapter can be summarized by the following observations:

MSW Generation

- Total generation of municipal solid waste in 1997 was 217 million tons, which was up from 1995 (211.4 million tons) and 1996 (209.2 million tons).
- Paper and paperboard products made up the largest percentage of all the materials in MSW, increasing by 4.2 million tons to 83.8 million tons, or 38.6 percent of total generation, in 1997.
- Yard trimmings comprised the second largest material category, estimated at 27.7 million tons, or 12.8 percent of total generation, in 1997. This compared to 35.0 million tons (17.1 percent of total generation) in 1990. This decline is largely due to state legislation affecting yard trimmings disposal in landfills, including source reduction measures such as backyard composting and leaving grass trimmings on the yard.
- Plastic products increased by 1.7 million tons from 1996 to 1997. Plastics used for containers and packaging accounted for the majority of this increase.
- Between 1996 and 1997, all product categories (except glass) increased in tonnage. Only yard trimmings declined as a category.

MSW Recovery

- Recovery of materials in MSW increased from 57.3 million tons in 1996 (27.4 percent of total generation) to 60.7 million tons in 1997 (28 percent of generation).
- Recovery of products in MSW increased by 2.2 million tons. Recovery of paper and paperboard products accounted for most of this increase by growing 1.7 million tons. Recovery of other wastes (yard trimmings and food wastes) increased by 1.2 million tons, from 20.6 percent to 22.8 percent of generation.
- Containers and packaging led the major product categories in tonnage and percentage recovery, increasing from 27.5 million tons in 1996 to 28.3 million tons (39.4 percent of generation) in 1997. Nondurable goods had the second highest tonnage recovery in 1997—14.7 million tons, or 24.8 percent of generation.
- Measured by tonnage, the most-recovered products and materials in 1997 were corrugated boxes (20.3 million tons), yard trimmings (11.5 million tons), newspapers (7.4 million tons), high grade office papers (3.6 million tons), glass containers (2.9 million tons), and steel from large appliances (2.3 million tons).

Collectively, these products accounted for nearly 80 percent of total MSW recovery in 1997.

- Measured by percentage of generation, products with the highest recovery rates in 1997 were lead-acid batteries (93.3 percent), corrugated boxes (67.3 percent), steel in major appliances (64.3 percent), steel cans (60.5 percent), aluminum beverage cans (59.5 percent), and newspapers (54.6 percent).

Long Term Trends

- Generation of MSW has increased (except in recession years), from 88.1 million tons in 1960 to 217 million tons in 1997. In 1995 and 1996 both the tonnage of materials in products and total MSW declined. In 1997, however, the tonnage of MSW generated increased again.

- Generation of paper and paperboard, the largest material component of MSW, has increased in almost every year (1996 was an exception). Yard trimmings, the second largest component, have been declining in recent years due to state legislation affecting yard trimmings disposal in landfills and source reduction measures at residences. Generation of other materials is generally on an upward trend, although generation of glass in 1997 was lower than in 1980, and generation of metals in 1997 was about the same as in 1990.

- In percentage of total MSW generation, recovery for recycling (including composting) did not exceed 15 percent until 1990. Growth in the recovery rate to current levels (28 percent) reflects a rapid increase in the infrastructure for recovery starting in the late 1980s.

- Recovery (as a percentage of generation) of most materials in MSW has increased dramatically over the 37 years for which statistics have been tabulated. Some examples:

	1960	1980	1997
Paper and paperboard	17%	21%	42%
Glass	2%	5%	24%
Metals	1%	8%	39%
Plastics	–	<1%	5%
Yard trimmings	–	–	41%

Chapter 2

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Chapter 3

MANAGEMENT OF MUNICIPAL SOLID WASTE

INTRODUCTION

EPA's tiered integrated waste management strategy includes the following components:

1. Source reduction (including reuse of products and backyard composting of yard trimmings)
2. Recycling of materials (including composting)
3. Waste combustion (preferably with energy recovery) and landfilling.

Characterization of historical municipal solid waste (MSW) management is a component of this report (overview in Figure 17). Estimates of historical recovery of materials for recycling, including yard trimmings for composting, are presented in Chapter 2. Estimates of MSW combustion are presented in this chapter, and quantities of waste landfilled are estimated by subtracting combustion and recovery for recycling (including composting) from total MSW generation.

Also included in this chapter is a discussion of the current MSW management infrastructure. Current solid waste collection, processing, and disposal programs and facilities are highlighted with tables and figures.

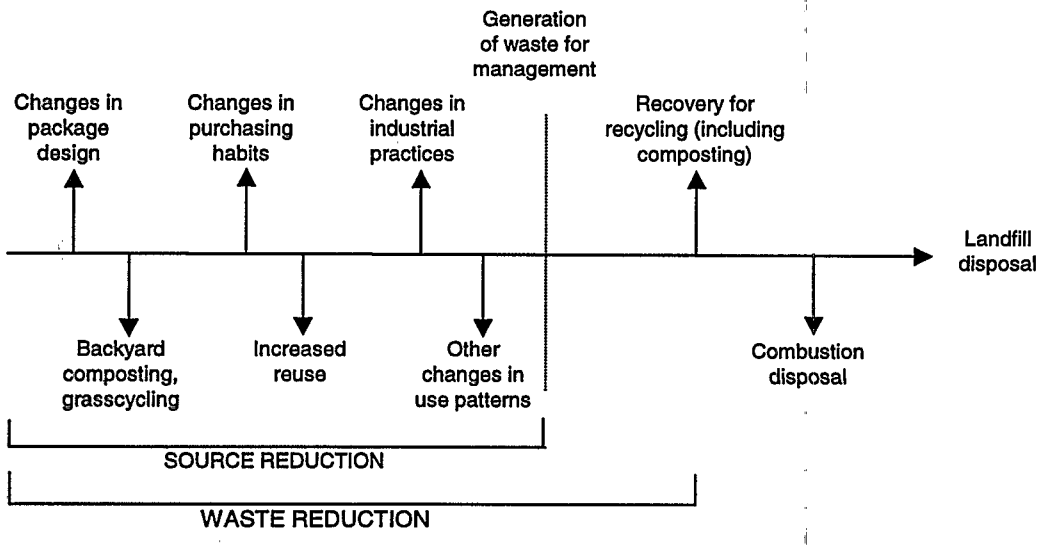
While source reduction is not quantified as a line item in this report, a discussion of source reduction activities is included in this chapter. Source reduction activities have the effect of reducing MSW generation, while other management alternatives deal with MSW once it is generated.

SOURCE REDUCTION

Source reduction is gaining more attention as an important solid waste management option. Source reduction, often called "waste prevention," is defined by EPA as "any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce the amount or toxicity before they become municipal solid waste. Prevention also refers to the reuse of products or materials." Thus, source reduction activities affect the waste stream before the point of generation. In this report, MSW is considered to have been generated if it is placed at curbside or in a receptacle such as a dumpster for pickup, or if it is taken by the generator to another site for recycling (including composting) or disposal.

Source reduction measures encompass a very broad range of activities by private citizens, communities, commercial establishments, institutional agencies, and

Figure 17. Diagram of solid waste management



Source: Franklin Associates

manufacturers and distributors. Example source reduction actions are shown in Table 24 and further discussed in this chapter. In general, source reduction activities include:

- Redesigning products or packages so as to reduce the quantity of materials or the toxicity of the materials used, by substituting lighter materials for heavier ones and lengthening the life of products to postpone disposal.
- Using packaging that reduces the amount of damage or spoilage to the product.
- Reducing amounts of products or packages used through modification of current practices by processors and consumers.
- Reusing products or packages already manufactured.
- Managing non-product organic wastes (food wastes, yard trimmings) through backyard composting or other on-site alternatives to disposal.

Source Reduction Through Redesign

Since source reduction of products and packages can save money through reducing materials and energy costs, manufacturers and packaging designers have been pursuing these activities for many years. Combined with other source reduction measures, redesign can have a significant effect on material use and eventual discards. Design for source reduction can take several approaches.

Table 24

SELECTED EXAMPLES OF SOURCE REDUCTION PRACTICES

Source Reduction Practice	MSW Product Categories			
	Durable Goods	Nondurable Goods	Containers & Packaging	Organics
Redesign				
Materials reduction	• Downgauge metals in appliances	• Paperless purchase orders	• Concentrates	• Xeriscaping
Materials substitution	• Use of composites in appliances and electronic circuitry		• Cereal in bags • Coffee brick • Multi-use products	
Lengthen life	• High mileage tires • Electronic components reduce moving parts	• Regular servicing • Look at warranties • Extend warranties	• Design for secondary uses	
Consumer Practices				
	• Purchase long lived products	• Repair • Duplexing • Sharing • Reduce unwanted mail	• Purchasing: products in bulk, concentrates	
Reuse				
By design	• Modular design	• Envelopes	• Pallets • Returnable secondary packaging	
Secondary	• Borrow or rent for temporary use • Give to charity • Buy or sell at garage sales	• Clothing • Waste paper scratch pads	• Loosefill • Grocery sacks • Dairy containers • Glass and plastic jars	
Reduce/Eliminate Toxins				
	• Eliminate PCBs	• Soy ink, waterbased • Waterbased solvents • Reduce mercury	• Replace lead foil on wine bottles	
Reduce Organics				
Food wastes				• Backyard composting • Vermi-composting
Yard trimmings				• Backyard composting • Grasscycling

Source: Franklin Associates

Materials substitution can make a product or package lighter. For example, there has been a continuous trend of substitution of lighter materials such as plastics and aluminum for materials such as glass and steel. The substitution may also involve a flexible package instead of a rigid package. A product or package can be redesigned to reduce weight or volume. Toxic materials in products or packaging can be replaced with non-toxic substitutes. Considerable efforts have been made in this area in the past few years.

Lengthening product life delays the time when the products enter the municipal waste stream. The responsibility for lengthening product life lies partly with manufacturers and partly with consumers. Products can be designed to last longer and be easier to repair. Since some of these design modifications may make products more expensive, at least initially, manufacturers must be willing to invest in new product development and consumers must demand the products and be willing to pay for them to make the goal work. Consumers and manufacturers must also be willing to care for and repair products.

Modifying Practices to Reduce Materials Use

Businesses and individuals can often modify their current practices to reduce the amounts of waste generated. In a business office, electronic mail can replace printed memoranda and data. Reports can be copied on both sides of the paper (duplexed). Modifying practices can be combined with other source reduction measures to reduce generation and limit material use.

Individuals (and businesses) can request removal from mailing lists to reduce the amount of mail received and discarded. When practical, products can be purchased in large sizes or in bulk to minimize the amount of packaging per unit of product. Concentrated products can also reduce packaging requirements; some of these products, such as fabric softeners and powdered detergent, are designed to be used with refillable containers.

Reuse of Products and Packages

Similar to lengthening product life, reuse of products and packages delays the time when the items must finally be discarded as waste. When a product is reused, presumably purchase and use of a new product is delayed, although this may not always be true.

Many of the products characterized for this report are reused in sizable quantities (e.g., furniture, wood pallets, clothing, etc.). The recovery of products and materials for recycling (including composting) as characterized in Chapter 2 does *not* include reuse of products, but reuse is discussed in this section.

Durable Goods. There is a long tradition of reuse of durable goods such as large and small appliances, furniture, and carpets. Often this is done informally as individuals pass on used goods to family members and friends. Other durable goods are donated to charitable organizations for resale or use by needy families. Some communities and other organizations have facilitated exchange programs for citizens, and there are for-profit retail stores that deal in used furniture, appliances, and carpets. Other goods are resold by individuals at garage sales, flea markets, and the like. Borrowing and sharing items like tools can also reduce the number of products to be discarded ultimately. There is generally a lack of data on the volume of durable goods reused in the United States, and what the ultimate effect on MSW generation might be.

Nondurable Goods. While nondurable goods by their very nature are designed for short term use and disposal, there is considerable reuse of some items classified as nondurable. In particular, footwear, clothing, and other textile goods are often reused. Much of the reuse is accomplished through the same types of channels as those described above for durable goods. That is, private individuals, charitable organizations, and retail outlets (consignment shops) all facilitate reuse of discarded clothing and footwear. In addition, considerable amounts of textiles are reused as wiping cloths before being discarded.

Another often-cited waste prevention measure is the use of washable plates, cups, napkins, towels, diapers, etc. instead of the disposable variety. (This will reduce solid waste but will have other environmental effects, such as increased water and energy use.) Other

reusable items are available, for example: reusable air filters, reusable coffee filters, reconditioned printer cartridges, etc.

Containers and Packaging. Containers and packaging can be reused in two ways: they can be used again for their original purpose, or they can be used in other ways.

Glass bottles are a prime example of reuse of a container for its original purpose. Refillable glass beer and soft drink bottles can be collected, washed, and refilled for use again. Some years ago large numbers of refillable glass soft drink bottles were used, but these have largely been replaced by single-use glass bottles, plastic bottles, and aluminum cans. Considerable numbers of beer bottles are collected for refilling, often by restaurants and taverns, where the bottles can easily be collected and returned by the distributor. The Glass Packaging Institute estimates that refillable glass bottles achieve a rate of 8 trips (refillings) per bottle.

Another example in this category is the use of refurbished wood pallets for shipping palletized goods. The National Wooden Pallet & Container Association estimates that over 60 percent of new wood pallets produced are reusable. It is also common practice to recondition steel drums and barrels for reuse.

Many other containers and packages can be recycled, but are not often reused. Some refillable containers (e.g., plastic laundry softener bottles) have been introduced; the original container can be refilled using concentrate purchased in small packages. This practice can achieve a notable source reduction in packaging. As another example, some grocery stores will allow customers to reuse grocery sacks, perhaps allowing a refund for each sack brought back for reuse. Also, many parcel shippers will take back plastic packaging "peanuts" for reuse.

Many ingenious reuses for containers and packaging are possible in the home. People reuse boxes, bags, jars, jugs, and cans for many purposes around the house. There are no reliable estimates as to how these activities affect the waste stream.

Management of Organic Materials

Food wastes and yard trimmings combined made up about 23 percent of MSW generation in 1997, so source reduction measures aimed at these products can have an important effect on waste generation. Composting is the usual method for recovering these organic materials. As defined in this report, composting of organic materials after they are taken to a central composting facility is a waste management activity comparable to recovery for recycling. Estimates for these composting activities are included in this chapter.

Composting or other reduction management measures that take place at the point of generation (e.g., the yard of a home or business) is source reduction. Backyard composting of yard trimmings and some food discards is not a new practice, but in recent years publicity and education programs have encouraged more people to participate. There also is a trend toward

leaving grass clippings on lawns, sometimes through the use of mulching mowers. Other actions that will complement the increase in yard trimmings management include: establishment of variable rates for collection of wastes (also known as unit-based pricing or pay-as-you-throw), which encourage residents to reduce the amount of wastes set out; improved technology (mulching mowers); xeriscaping (landscaping with plants that use minimal water and generate minimal waste); and legislative regulations (e.g., landfill bans).

Part of the impetus for source reduction of yard trimmings is the large number of state regulations discouraging landfilling or other disposal of yard trimmings. The Composting Council and other sources report that in 1992, 12 states (amounting to over 28 percent of the nation's population) had in effect legislation affecting management of yard trimmings. In 1998, 24 states plus the District of Columbia (amounting to approximately 52 percent of the nation's population) had in effect legislation affecting disposal of yard trimmings. There is considerable anecdotal evidence indicating that when these bans go into effect, people find ways to source reduce.

RECOVERY FOR RECYCLING (INCLUDING COMPOSTING)

Recyclables Collection

Before recyclable materials can be processed and recycled into new products, they must be collected. Most residential recycling involves curbside recyclables collection, drop-off programs, buy-back operations, and/or container deposit systems. Collection of recyclables from commercial establishments is usually separate from residential recyclables collection programs.

Curbside Recyclables Collection. In 1997, nearly 9,000 curbside recyclables collection programs were reported in the U.S. As shown in Table 25 and Figure 18, the extent of residential curbside recycling programs varies tremendously by geographic region, with the most extensive curbside collection occurring in the Northeast.

In 1997 slightly over one-half (51 percent) of the U.S. population, or 136 million persons, had access to curbside recyclables collection programs. The Northeast region had the largest population served--43 million persons. In the Northeast about 83 percent of the population had access to curbside recyclables collection, while in the South 39 percent of the population had access to curbside recycling. Most of the programs were located in the Northeast and Midwest regions of the country.

Drop-off Centers. Drop-off centers typically collect residential materials, although some accept materials from businesses. They are found in locations such as grocery stores, sheltered workshops, charitable organizations, city-sponsored sites, and apartment complexes. Types of materials collected vary greatly; however, drop-off centers can usually accept a greater variety of materials than a curbside collection program.

It is difficult to quantify drop-off centers in the U.S. It is estimated that there were 12,694 programs in 1997, according to a ***BioCycle*** survey (Goldstein 1998). In some areas,

Table 25

NUMBER AND POPULATION SERVED BY CURBSIDE RECYCLABLES COLLECTION PROGRAMS, 1997

Region	Number of Programs	Population (in millions)	Population Served (1) (in thousands)	(%)
NORTHEAST	3,406	51,890	43,200	83%
SOUTH	1,344	93,656	36,952	39%
MIDWEST	3,357	62,455	26,970	43%
WEST	862	57,684	29,107	50%
U.S. Total	8,969	265,685	136,229	51%

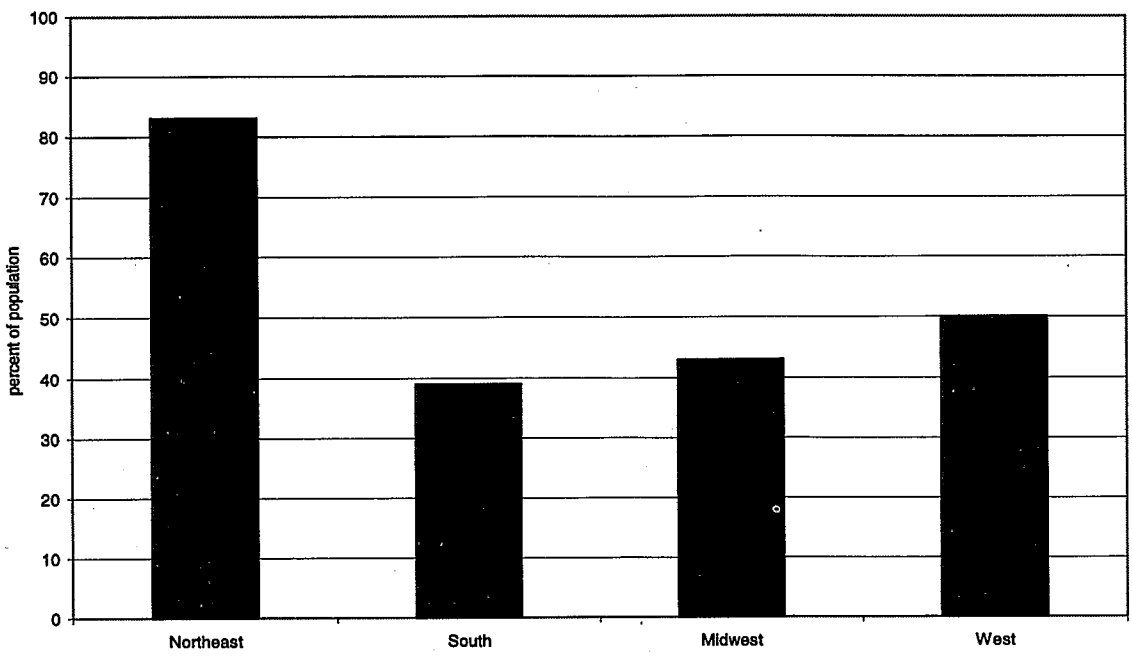
(1) Percent of population served by curbside programs was calculated using population of states reporting data.

Source: Statistical Abstract 1997, Bureau of the Census 1997, BioCycle 1998.

particularly those with sparse population, drop-off centers may be the only option for collection of recyclable materials. In other areas, they supplement other collection methods.

Buy-back Centers. A buy-back center is typically a commercial operation that pays individuals for recovered materials. This could include scrap metal dealers, aluminum can

Figure 18. Population served by curbside recycling, 1997

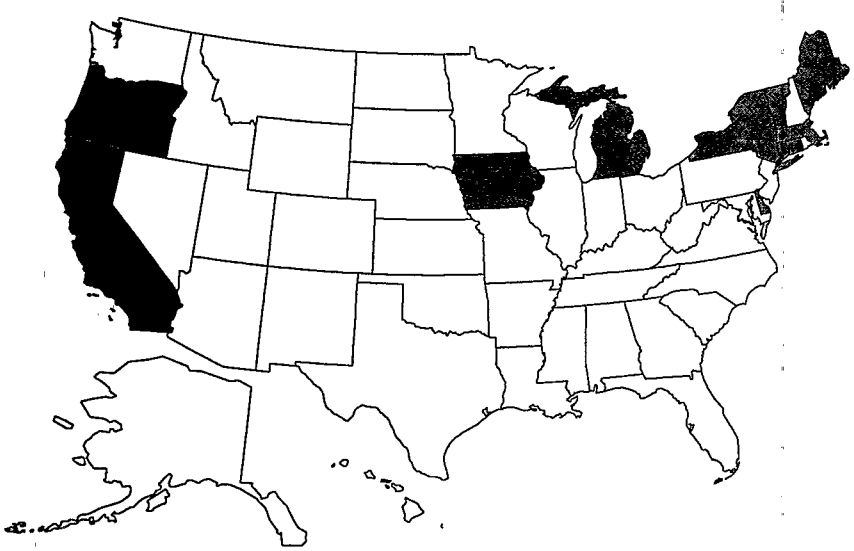


centers, waste haulers, or paper dealers. Materials are collected by individuals, small businesses, and charitable organizations.

Deposit Systems. Nine states have container deposit systems: Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont (Figure 19). In these programs, the consumer pays a deposit on beverage containers at the point of purchase, which is redeemed on return of the empty containers. California has a similar system where containers can be redeemed, but the consumer pays no deposit. With the exception of California, no new deposit laws have been enacted since the early 1980s, due in part to the convenience and economics of curbside recycling.

Deposit systems generally target beverage containers (primarily beer and soft drink), which account for less than 4 percent of total MSW generation. It is estimated that about 35 percent of all recovery of beverage containers comes from the 9 traditional deposit states mentioned above, and an additional 20 percent of recovered beverage containers comes from California. (Note: These recovery estimates reflect not only containers redeemed by consumers for deposit, but also containers recovered through existing curbside and drop-off recycling programs. Containers recovered through these programs eventually are credited to the distributor and counted towards the redemption rate.)

Figure 19. States with deposit/redemption legislation



Commercial Recyclables Collection. The largest quantity of recovered materials comes from the commercial sector. Old corrugated containers (OCC) and office papers are widely collected from commercial establishments. Grocery stores and other retail outlets that require corrugated packaging are part of an infrastructure that brings in the most recovered material. OCC is often baled at the retail outlet and picked up by a paper dealer.

Office paper (e.g., white, mixed color, computer paper, etc.) is part of another commercial recyclables collection infrastructure. Depending on the quantities generated, businesses (e.g., banks, institutions, schools, printing operations, etc.) can sort materials and have them picked up by a paper dealer, or self deliver the materials to the recycler. It should be noted that commercial operations also make recycling available for materials other than paper.

Multi-family residence recycling could be classified as either residential or commercial recyclables collection. Multi-family refuse is usually handled as a commercial account by waste haulers. It is also the same waste hauler that makes recycling available to multi-family dwellings (typically 5 or more units), which could resemble a drop-off center.

Recyclables Processing

Processing recyclable materials is performed at materials recovery facilities (MRFs), mixed waste processing facilities, and mixed waste composting facilities. Some materials are sorted at the curb and require less attention. Other materials are sorted into streams at the curb, such as a paper stream and a container stream, with additional sorting at a facility (MRF). Mixed waste can also be processed to pull out recyclable and compostable materials.

Materials Recovery Facilities. Materials recovery facilities vary widely across the U.S., depending on the incoming materials and the technology and labor used to sort the materials. In 1997, 380 MRFs were operating in the U.S., with an estimated total daily throughput of 32,000 tons per day (Table 26). Like curbside collection programs, the most extensive recyclables processing throughput occurs in the Northeast (Figure 20).

The majority of MRFs are considered low technology, meaning the materials are predominantly sorted manually. MRFs classified as high technology sort recyclables using eddy currents, magnetic pulleys, optical sensors, and air classifiers. As MRFs change and grow, many low technology MRFs add high tech features and high technology MRFs include manual sorting, making the difference between high and low technology MRFs less definitive.

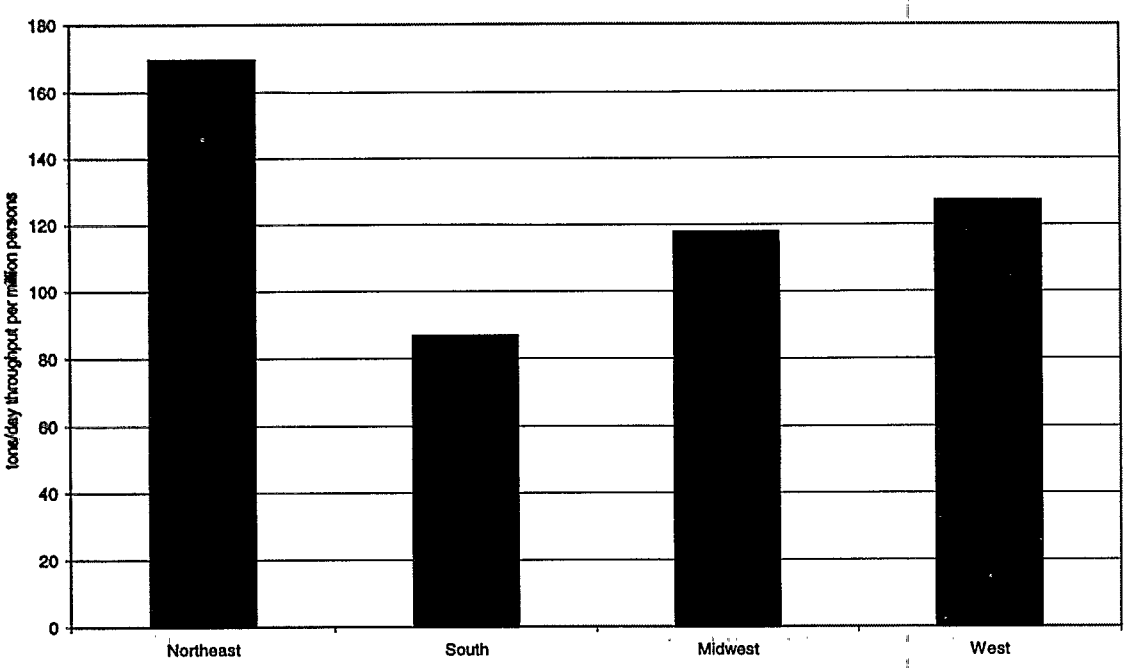
Table 26

MATERIALS RECOVERY FACILITIES, 1997

Region	Number	Estimated Throughput (tpd)
NORTHEAST	103	8,815
SOUTH	118	8,233
MIDWEST	76	7,535
WEST	84	7,505
U.S. Total	380	32,088

Source: Governmental Advisory Associates, Inc. 1998.

Figure 20. MRF throughput, 1997



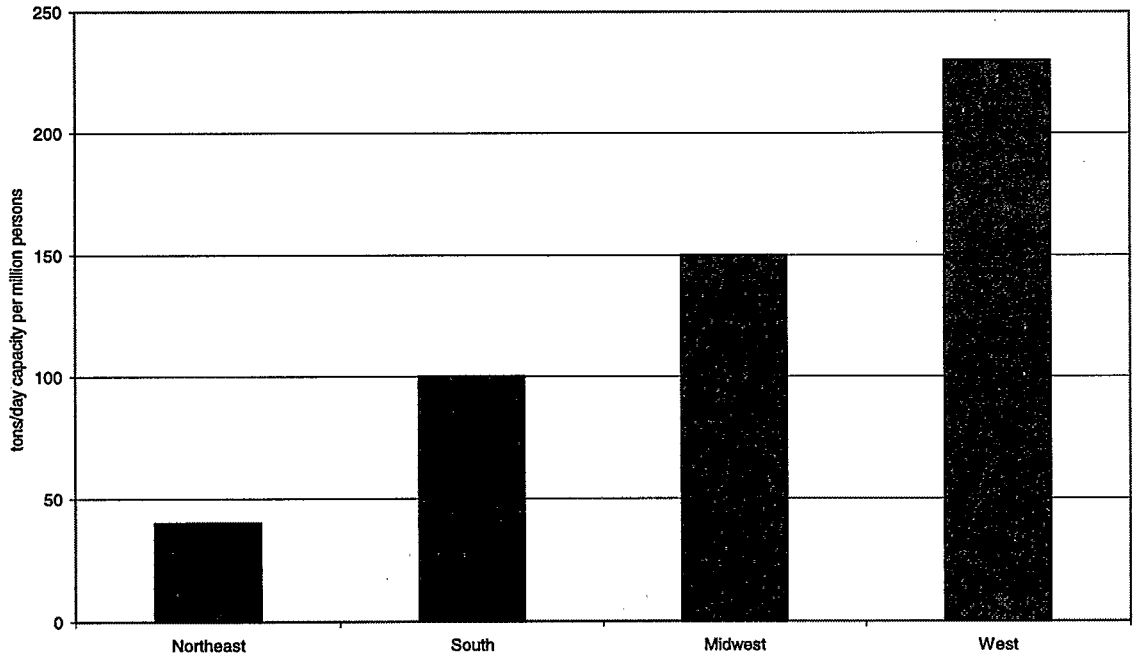
Source: Governmental Advisory Associates 1998

Mixed Waste Processing. Mixed waste processing facilities are less common than conventional MRFs, but there are several facilities in operation in the U.S., as shown in Figure 21. Mixed waste processing facilities receive waste just as if it were going to a landfill. The mixed waste is loaded on conveyors and, using both mechanical and manual (high and low technology) sorting, recyclable materials are removed for further processing. In 1997, there were reported 58 mixed waste processing facilities in the U.S., handling about 34,800 tons of waste per day (Governmental 1998). The West region has the largest concentration of these processing facilities.

Mixed Waste Composting. Mixed waste composting starts with unsorted MSW. Large items are removed, as well as ferrous and other metals, depending on the type of operation. Mixed waste composting takes advantage of the high percentage of organic components of MSW, such as paper, food wastes and yard trimmings, wood, and other materials. In 1997, there were 14 mixed waste composting facilities, predominantly in the Midwest, as shown in Figure 22. These facilities handled about 670 tons per day in 1997.

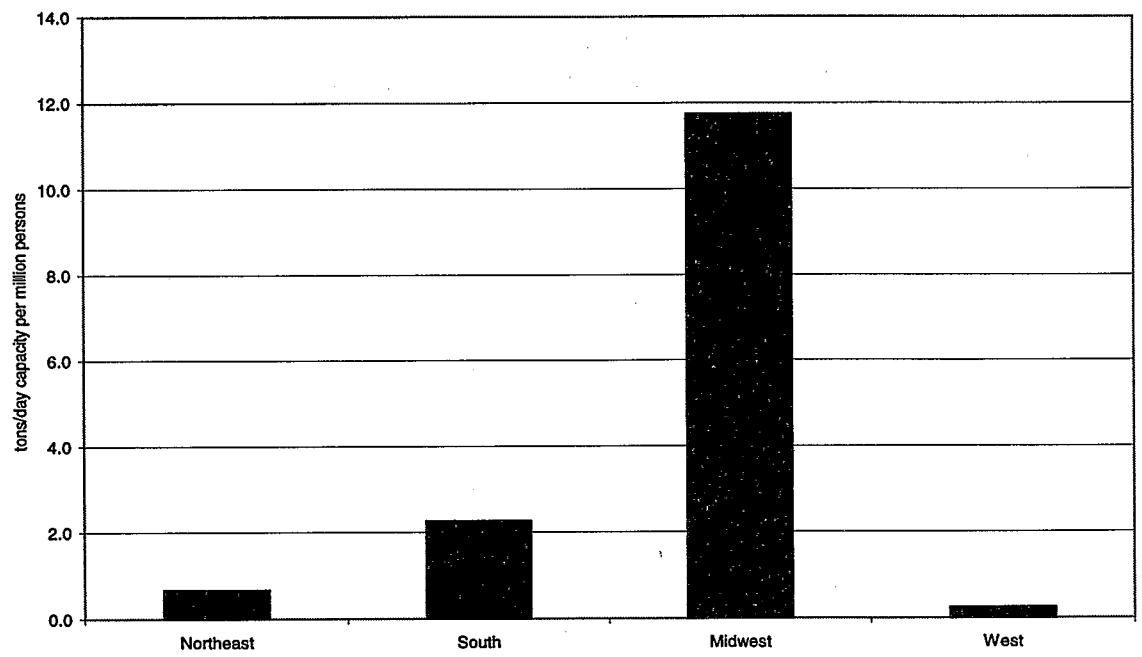
Yard Trimmings Composting. Yard trimmings composting is much more prevalent than mixed waste composting. On-site management of yard trimmings is not included in this section, but is discussed in the source reduction section. In 1997, 3,484 yard trimmings composting programs reported (BioCycle 1998). About 73 percent of these programs are in the Northeast and Midwest regions, as shown in Figure 23. Based on 11.5 million tons of yard trimmings recovered for composting in the United States (Chapter 2), yard trimmings composting facilities handled approximately 31,500 tons per day in 1997.

Figure 21. Mixed waste processing capacity, 1997



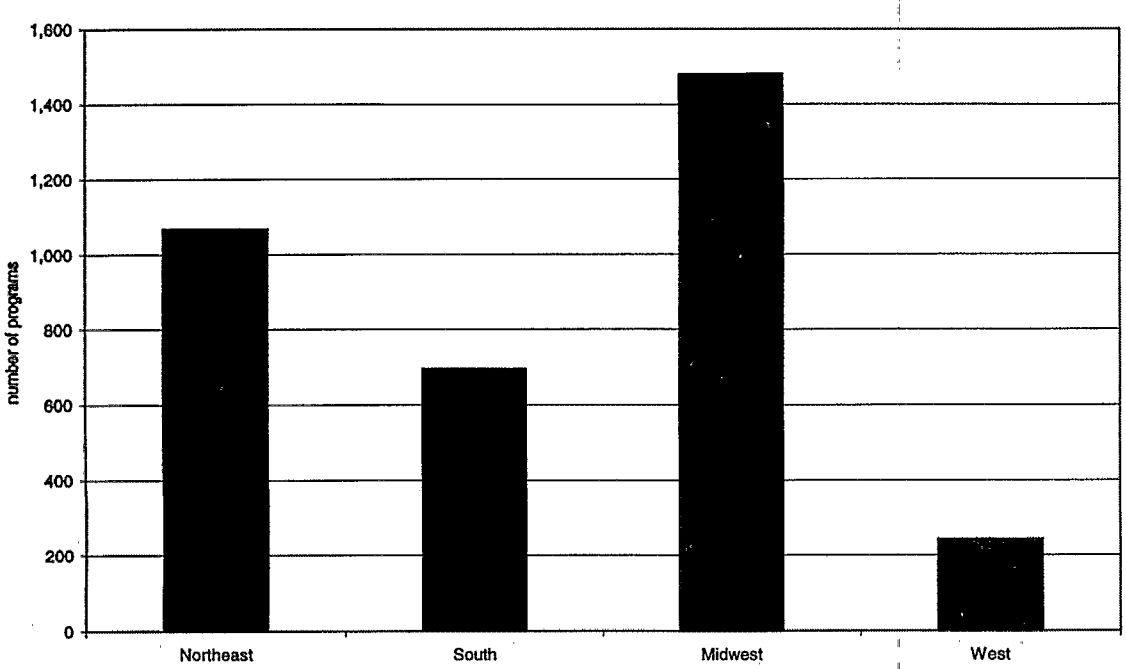
Source: Governmental Advisory Associates 1998

Figure 22. MSW composting capacity, 1997



Source: BioCycle 1998

Figure 23. Yard trimmings composting programs, 1997



Source: BioCycle 1998

COMBUSTION

Most of the municipal solid waste combustion currently practiced in this country incorporates recovery of an energy product (generally steam or electricity). The resulting energy reduces the amount needed from other sources, and the sale of the energy helps to offset the cost of operating the facility. In past years, it was common to burn municipal solid waste in incinerators as a volume reduction practice; energy recovery became more prevalent in the 1980s.

Total U.S. MSW combustion with energy recovery, referred to as waste-to-energy (WTE) combustion, had a 1997 design capacity of 101,000 tons per day. There were 112 WTE facilities in 1997 (Table 27). The Northeastern and Southern regions had most of the MSW combustion capacity in 1997 (Figure 24). In addition to WTE combustion, there was an additional 2,450 daily tons of capacity for incineration without energy recovery.

In addition to facilities combusting mixed MSW (processed or unprocessed), there is a small but growing amount of combustion of source-separated MSW. In particular, there is considerable interest in using rubber tires as fuel in dedicated facilities or as fuel in cement kilns. In addition, there is combustion of wood wastes and some paper and plastic wastes, usually in boilers that already burn some other type of solid fuel. For this report, it was estimated that about 2.5 million tons of MSW were combusted in this manner in 1997, with tires contributing a majority of the total.

Table 27

MUNICIPAL WASTE COMBUSTORS, 1997

	Waste-to-energy facilities (1)		Incinerators (2)	
Region	**Number**	**Design Capacity (tons/day)**	**Number**	**Design Capacity (tons/day)**
NORTHEAST	43	48,150	12	430
SOUTH	36	34,150	2	95
MIDWEST	22	13,590	3	1,700
WEST	11	5,470	2	220
U.S. Total	112	101,360	19	2,445

(1) Waste-to-energy includes mass burn, modular, and refuse-derived fuel combustion facilities with energy recovery.

(2) Incinerators provide combustion without energy recovery. Data have not been updated by source since 1995.

Source: Integrated Waste Services Association, 1997.

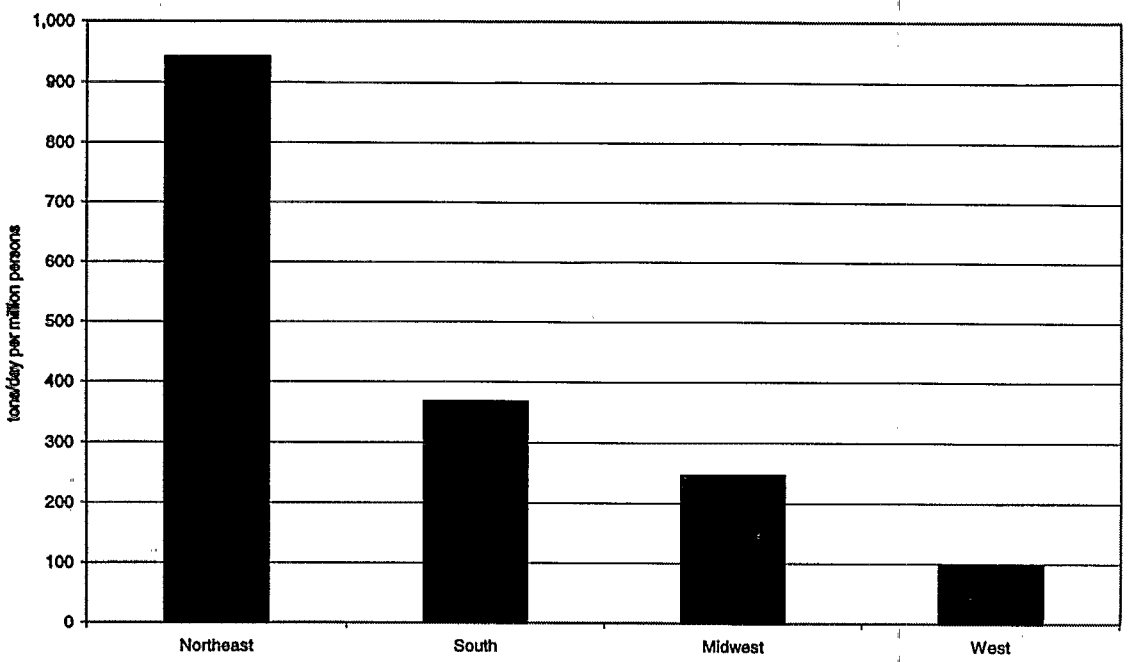
In most cases the facilities have a stated daily capacity, but they normally operate at less than capacity over the course of a year. It was assumed for this report that throughput over a year of operation is 90 percent of rated capacity. The total throughput of MSW through all combustion facilities was an estimated 36.7 million tons, or 17 percent of MSW generation, in 1997.

RESIDUES FROM WASTE MANAGEMENT FACILITIES

Whenever municipal wastes are processed, residues will remain. For the purposes of this report, it is assumed that most of these residues are landfilled. Materials processing facilities (MRFs) and compost facilities generate some residues when processing various recovered materials. These residues include materials that are unacceptable to end users (e.g., broken glass, wet newspapers), other contaminants (e.g., products made of plastic resins that are not wanted by the end user), or dirt. While residue generation varies widely, 5 to 10 percent is probably typical for a MRF. Residues from a MRF or compost facility are generally landfilled. Since the recovery estimates in this report are based on recovered materials purchased by end users rather than materials entering a processing facility, the residues are counted with other disposed materials.

When municipal solid waste is combusted, a residue (usually called ash) is left behind. Years ago this ash was commonly disposed of along with municipal solid waste, but combustor ash is *not* counted as MSW in this report because it generally must be managed

Figure 24. MSW combustion capacity, 1997



separately*. (There are a number of efforts underway to reuse ash.) As a general "rule of thumb," MSW combustor ash amounts to about 25 percent (dry weight) of unprocessed MSW input. This percentage will vary from facility to facility depending upon the types of waste input and the efficiency and configuration of the facility.

LANDFILL

Although the number of landfills is decreasing, the capacity has remained relatively constant. In 1997, approximately 2,200 municipal solid waste landfills were reported in the contiguous U.S. New landfills are now much larger than in the past.

Table 28 and Figure 25 show the number of landfills in each region. The Southeast and West had the greatest number of landfills. Forty-two states had more than 10 years of capacity left. Only one state reported having less than 5 years of capacity remaining.

SUMMARY OF HISTORICAL AND CURRENT MSW MANAGEMENT

This summary provides some perspective on historical and current municipal solid waste management practices in the U.S. The results are summarized in Table 29 and Figure 26.

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* Note that many combustion facilities do magnetic separation of residues to recovery ferrous metals, e.g., steel cans and steel in other miscellaneous durable goods. This recovered steel is included in the total recovery of ferrous metals in MSW reported in Chapter 2.

Table 28

LANDFILL FACILITIES, 1997

Region	Number of Landfills *	Number of States with Years Capacity Remaining		
		> 10 yr	5 to 10 yr	< 5 yr
NORTHEAST	180	6	2	1
SOUTHEAST	778	16	0	0
MIDWEST	474	9	3	0
WEST	778	11	0	0
U.S. Total *	2,210	42	5	1

* Excludes landfills reported in Alaska (296) and Hawaii (8).
Source: BioCycle, April 1998 and Waste Age, May 1996.

Figure 25. Number of landfills in the U.S., 1997

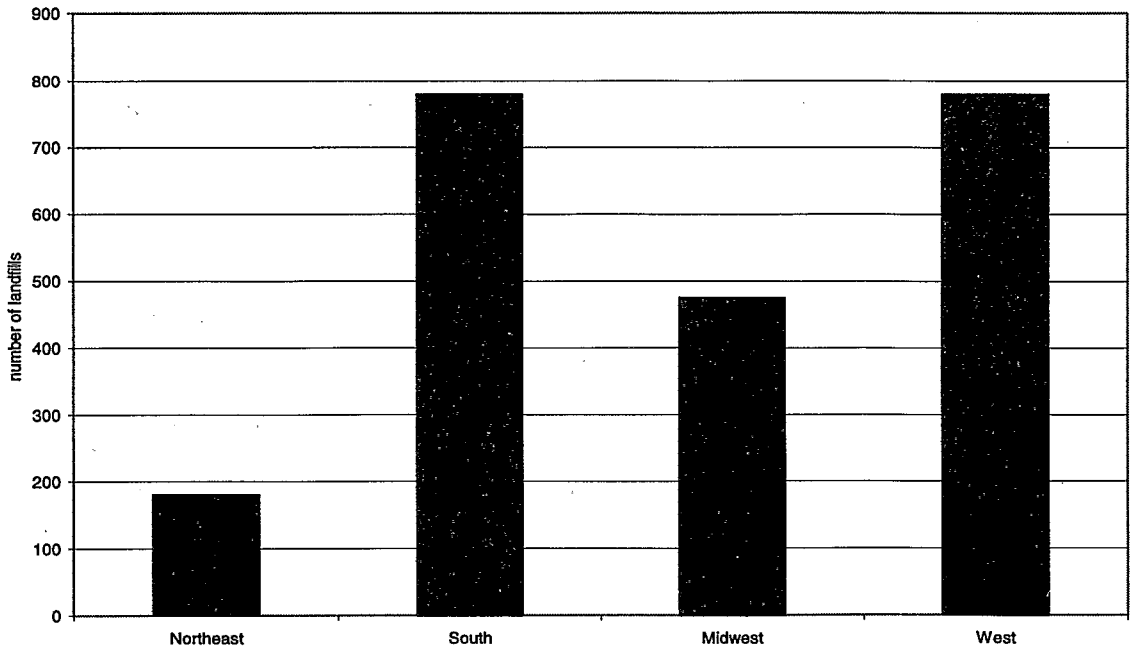


Table 29

GENERATION, MATERIALS RECOVERY, COMPOSTING, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 1997
(In thousands of tons and percent of total generation)

	Thousands of Tons							
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	88,120	121,060	151,640	205,210	214,180	211,360	209,190	216,970
Recovery for recycling	5,610	8,020	14,520	29,040	42,150	45,340	46,390	48,630
Recovery for composting*	Neg.	Neg.	Neg.	4,200	8,480	9,570	10,910	12,070
Total Materials Recovery	5,610	8,020	14,520	33,240	50,630	54,910	57,300	60,700
Discards after recovery	82,510	113,040	137,120	171,970	163,550	156,450	151,890	156,270
Combustion**	27,000	25,100	13,700	31,900	32,490	35,540	36,090	36,700
Discards to landfill, other disposal†	55,510	87,940	123,420	140,070	131,060	120,910	115,800	119,570

	Pounds per Person per Day							
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	2.68	3.25	3.66	4.50	4.50	4.40	4.32	4.44
Recovery for recycling	0.17	0.22	0.35	0.64	0.89	0.94	0.96	1.00
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.18	0.20	0.23	0.25
Total Materials Recovery	0.17	0.22	0.35	0.73	1.06	1.14	1.18	1.24
Discards after recovery	2.51	3.04	3.31	3.77	3.44	3.26	3.14	3.20
Combustion**	0.82	0.67	0.33	0.70	0.68	0.74	0.75	0.75
Discards to landfill, other disposal†	1.69	2.36	2.98	3.07	2.75	2.52	2.39	2.45
Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	265,253	267,645

	Percent of Total Generation							
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1996**	**1997**
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.2%	19.7%	21.5%	22.2%	22.4%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	4.0%	4.5%	5.2%	5.6%
Total Materials Recovery	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.4%	28.0%
Discards after recovery	93.6%	93.4%	90.4%	83.8%	76.4%	74.0%	72.6%	72.0%
Combustion**	30.6%	20.7%	9.0%	15.5%	15.2%	16.8%	17.3%	16.9%
Discards to landfill, other disposal†	63.0%	72.6%	81.4%	68.3%	61.2%	57.2%	55.4%	55.1%

* Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.
** Includes combustion of MSW in mass burn or refuse-derived fuel form, incineration without energy recovery, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel).
† Discards after recovery minus combustion.
Details may not add to totals due to rounding.

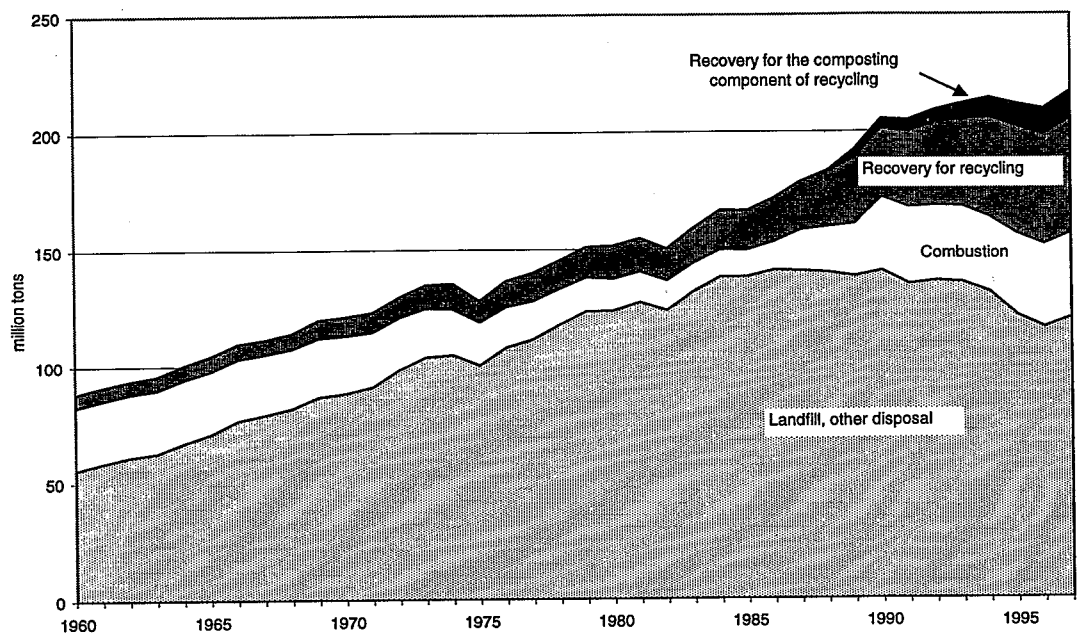
Source: Franklin Associates

Historically, municipal solid waste generation has grown relatively steadily (from 88 million tons in 1960 to 214 million tons in 1994). After peaking in 1994, MSW generation (both in product and non-product waste categories) declined in 1995 and 1996. In 1996 MSW generation was less than 210 million tons. In 1997, however, generation increased to 217 million tons.

In the 1960s and early 1970s a large percentage of MSW was burned, with little recovery for recycling. Landfill disposal typically consisted of open dumping, often accompanied with open burning of the waste to reduce its volume. Through the mid-1980s, incineration declined considerably and landfills became difficult to site, and waste generation continued to increase. Materials recovery rates increased very slowly in this time period, and the burden on the nation's landfills grew dramatically. As Figure 26 graphically shows, discards of MSW to landfill or other disposal apparently peaked in the 1986-1987 period, then began to decline as materials recovery and combustion increased. Although there are now fewer municipal solid waste landfills, their average size has increased and capacity at the national level does not appear to be a problem. Regional dislocations sometimes occur, however.

Recovery of products and yard trimmings increased steadily, while combustion has stayed relatively constant—15 to 17 percent of total MSW generation. As a result, MSW discards to landfills have generally decreased in the 1990s. About 120 million tons of MSW were landfilled in 1997. As a percentage of total MSW generation, landfilling has consistently decreased—from 83.2 percent of generation in 1986 to 55.1 percent in 1997.

Figure 26. Municipal solid waste management, 1960 to 1997



Chapter 3

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Chapter 4

PROJECTIONS OF MUNICIPAL SOLID WASTE GENERATION AND MANAGEMENT

INTRODUCTION

This chapter includes projections of municipal solid waste generation for the years 2000 and 2005. *It should be emphasized that these projections are not predictions.* The effects of source reduction are difficult to measure at a national level, but almost certainly are affecting MSW generation. No one can foresee with accuracy changes in the economy (e.g., booms and recessions), which also affect the municipal waste stream. In addition, it is difficult to predict which innovations and new products will affect the amounts and types of MSW generation.

In spite of these limitations, it is useful to look at projections characterizing MSW based on past trends, since it is clear that the composition of the waste stream does change over time. New products (e.g., disposable products) are introduced, and materials are used in new ways (e.g., composite materials replace simpler products). Planners thus may choose to use different projections than those presented here, but anyone assuming that the current mix of materials in the waste stream will remain constant is disregarding the experience of the past.

OVERVIEW AND ASSUMPTIONS

This chapter includes projections of municipal solid waste generation through the year 2005. In making these projections, it was assumed that overall, products in MSW would continue to grow at a rate higher than population growth and lower than growth of Gross Domestic Product (GDP). (See Chapter 5 of EPA report 530-R-94-042, ***Characterization of Municipal Solid Waste in the United States: 1994 Update***, for an explanation of the correlation of MSW generation with these demographic and economic factors.) Projections for most materials and products were made using linear trends based on generation between 1980 and 1997. Exceptions are discussed in the text.

It should be noted that some trend projections in this report are notably different than previously projected. Some products have grown (or declined) at slower or faster rates than would be expected based on the experience of previous years.

MATERIALS GENERATION IN MUNICIPAL SOLID WASTE

Projections of materials generated in MSW (by weight) are summarized in Table 30 and Figure 27, and a discussion of each material category follows.

Table 30

PROJECTIONS OF MATERIALS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 1997, 2000, AND 2005
(In thousands of tons and percent of total generation)

Materials	Thousands of tons			% of total		
	1997	2000	2005	1997	2000	2005
Paper and Paperboard	83,840	87,700	94,770	38.6%	39.3%	39.6%
Glass	12,010	11,850	11,200	5.5%	5.3%	4.7%
Metals						
Steel	12,330	12,890	13,590	5.7%	5.8%	5.7%
Aluminum	3,010	3,430	3,780	1.4%	1.5%	1.6%
Other Nonferrous	1,270	1,300	1,340	0.6%	0.6%	0.6%
Total Metals	*16,610*	*17,620*	*18,710*	*7.7%*	*7.9%*	*7.8%*
Plastics	21,460	23,420	26,730	9.9%	10.5%	11.2%
Rubber and Leather	6,590	6,920	7,660	3.0%	3.1%	3.2%
Textiles	8,240	8,850	10,240	3.8%	4.0%	4.3%
Wood	11,570	13,960	15,810	5.3%	6.3%	6.6%
Other	3,760	3,960	4,290	1.7%	1.8%	1.8%
Total Materials in Products	164,080	174,280	189,410	75.6%	78.1%	79.1%
Other Wastes						
Food Wastes	21,910	22,550	23,480	10.1%	10.1%	9.8%
Yard Trimmings	27,730	23,000	23,000	12.8%	10.3%	9.6%
Miscellaneous Inorganic Wastes	3,250	3,400	3,650	1.5%	1.5%	1.5%
Total Other Wastes	52,890	48,950	50,130	24.4%	21.9%	20.9%
Total MSW Generated	216,970	223,230	239,540	100.0%	100.0%	100.0%

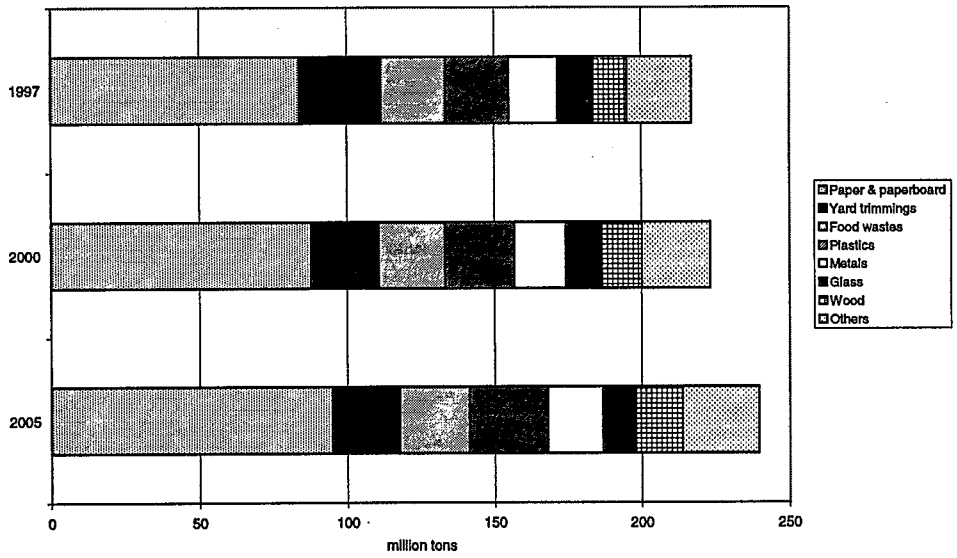
* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
Source: Franklin Associates

Paper and Paperboard

Previous projections of paper and paperboard generation were revised using the following information: revised data for 1995 and 1996 and new data for 1997 from the American Forest & Paper Association, historical and projected per capita consumption of paper and paperboard products, and the ratio of total paper and paperboard to real Gross Domestic Product (GDP). The paper and paperboard projections were not based solely on trend analysis.

Projections of paper and paperboard generation are lower than those for previous years. New supply (consumption) of paper and paperboard declined in 1995 and 1996, in contrast to increases of between 3 to 5 percent for the previous three years. (Consumption did increase markedly in 1997, partly as a result of inventory depletion in 1996.)

Figure 27. Materials generated in MSW, 1997, 2000, and 2005



Projections of paper and paperboard generation were based on past trends, with some slowing of growth projected for newsprint and paper packaging other than corrugated boxes. These grades of paper are showing the effects of decreased newspaper readership and some source reduction and materials substitution in packaging. Two grades are continuing to show increased consumption—containerboard (corrugated boxes) and printing-writing papers (e.g., office papers, commercial printing, and direct mail).

Paper and paperboard is projected to continue to be the dominant material in MSW, growing from a generation of 83.8 million tons in 1997 to 87.7 million tons and 94.8 million tons in 2000 and 2005, respectively. This would amount to 39.3 percent of MSW generation in 2000.

Glass

Glass products (mostly packaging) have been declining both in tonnage and in percent of MSW generation since 1993. This trend is projected to continue, with the percentage of glass in MSW continuing to decline. Glass generation is projected to decline from 12 million tons in 1997 to 11.9 million tons and 11.2 million tons in 2000 and 2005, respectively. For 2000 this represents 5.3 percent of projected total MSW generation.

Steel

Cans made of steel declined as a percentage of MSW in the 1970s and 1980s due to material substitution and light-weighting practices of can manufacturers. Since 1995, steel cans have been increasing in tonnage generated. Also, more steel enters MSW as a component of durable goods than as containers. Since durable goods are an increasing component of MSW, total steel in MSW was projected to increase from 12.3 million tons in

1997 to 12.9 million tons and 13.6 million tons in 2000 and 2005, respectively. The percentage of steel in MSW is projected to decline to 5.8 percent of total generation in 2000 and 5.8 percent in 2010.

Aluminum

Containers and packaging represent the primary source of aluminum in MSW, although some aluminum is present in durable and nondurable goods. Aluminum in MSW has grown, and the growth is projected to continue, to 3.4 million tons and 3.8 million tons in 2000 and 2005, respectively. Because of its light weight, aluminum represents a small percentage of MSW generation—1.4 percent in 1997, and a projected 1.5 percent in 2000 and 1.6 percent in 2005.

Other Nonferrous Metals

Other nonferrous metals (e.g., lead, copper, and zinc) are found in durable goods like appliances, furniture, and batteries. Lead-acid (automotive) batteries comprise the majority of this category. Generation of lead-acid batteries is projected to continue to increase modestly, along with small increases in other nonferrous metals. Other nonferrous metals were estimated to be about 1.3 million tons generated in 1997 and are projected to be about 1.3 million tons in 2000 and 2005. These metals are expected to continue to be less than one percent (0.6 percent) of total MSW generation.

Plastics

Generation of plastics in MSW has grown very rapidly, with average annual growth rates of over 9 percent experienced during the 1970s and 1980s. Growth in plastics generation has continued in the 1990s—however, the annual growth rate has slowed to approximately 3 percent per year during this decade. Based on this historical trend, plastics in MSW are expected to continue to increase in tonnage, but at a projected rate closer to the 1990s. Plastics in MSW are projected to continue to increase both in tonnage (from 21.5 million tons in 1997 to 23.4 million tons and 26.7 million tons in 2000 and 2005, respectively) and in percentage of total MSW generation (from 9.9 percent of MSW in 1995 to 11.2 percent in 2005).

Wood Wastes

Wood wastes (in furniture and other durable goods and in pallets and other packaging) have been increasing in MSW. In 1997, about 61 percent of the wood generated was in wood pallets, which are mostly used to transport packaged products, e.g., in corrugated boxes, a growing MSW category. The tonnage of wood wastes generated is projected to grow from 11.6 million tons in 1997 to 14.0 million tons and 15.8 million tons in 2000 and 2005, respectively. The percentage of wood wastes is projected to increase from 5.3 percent in 1997 to 6.6 percent of total MSW generation in 2005.

Other Materials

Other materials in MSW—including rubber, leather, and textiles—are projected to have modest growth in tonnage and percentages of total MSW generation. Tonnage is projected to increase from 21.8 million tons in 1997 to 23.1 million tons and 25.8 million tons in 2000 and 2005, respectively. As a percentage these materials collectively account for about 10 percent of total MSW in 1997, increasing to 10.8 percent in 2005.

Food Wastes

Food wastes were projected to remain at a constant rate of generation per capita through 2005. The tonnage of food wastes is projected to increase from 21.9 million tons in 1997 to 22.6 million tons and 23.5 million tons in 2000 and 2005, respectively.* The percentage of food wastes in total MSW would stay about the same—10.1 percent in 1997 and 2000, declining to 9.8 percent of generation in 2005.

Yard Trimmings

As discussed in Chapter 2, legislation regulating disposal of yard trimmings in 24 states and the District of Columbia, along with vigorous efforts to promote management of grass and leaves at home in many areas, has reduced generation of yard trimmings in many states and the nation as a whole. Generation of yard trimmings is estimated to have decreased from 35 million tons in 1990 to 27.7 million tons in 1997 due in large part to these programs.

In addition, many communities have been instituting variable rate collection programs ("pay-as-you-throw"). Because these programs provide a financial incentive to residents to reduce and recycle, significant reductions of waste disposed have been experienced in many communities. Waste reductions of 20 to 30 percent, or more, have been reported, and more than 4,000 communities have these programs (Canterbury 1997, Skumatz 1997). Since yard trimmings make up a sizeable portion of the residential waste stream, their on-site management offers residents substantial cost savings.

Because of these programs in effect and coming on-line, generation of yard trimmings is projected to decline to 23 million tons by 2000 (10.3 percent of generation). In addition, these programs are projected to overcome the effects of population growth by keeping generation at 23 million tons in 2005 (9.6 percent of generation).

Projected Growth Rates for Materials in MSW

Projected growth rates by decade for the various materials generated in MSW are shown in Table 31. Projected population growth rates (from the Bureau of the Census) are included as well; the Bureau of the Census forecasts an approximate 0.4 percent growth rate from 1990 to 2005. (See Appendix B for waste characterization data expressed on a per capita basis.)

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* Note that estimates of food waste generation were revised upward starting with the 1997 Update.

Table 31

AVERAGE ANNUAL RATES OF INCREASE (OR DECREASE)* OF GENERATION OF MATERIALS IN MSW
(In annual percent by weight)

	1960-1970	1970-1980	1980-1990	1990-1997	1997-2000	2000-2005
Paper and paperboard	4.0%	2.2%	2.8%	2.1%	1.5%	1.6%
Glass	6.6%	1.7%	-1.4%	-1.2%	-0.4%	-1.1%
Metals	2.5%	1.2%	0.6%	0.1%	2.4%	1.0%
Plastics	22.2%	8.9%	9.6%	3.3%	3.0%	2.7%
Textiles	1.5%	2.2%	8.7%	5.1%	2.4%	3.0%
Rubber and leather	4.9%	3.5%	3.3%	1.9%	1.6%	2.1%
Wood	2.1%	6.5%	5.7%	-0.8%	6.5%	2.5%
All other materials**	6.4%	6.5%	2.5%	2.0%	0.7%	2.1%
Food wastes	0.5%	0.2%	4.8%	0.7%	1.0%	0.8%
Yard trimmings	1.5%	1.7%	2.4%	-3.3%	-6.0%	0.0%
Total MSW	3.2%	2.3%	3.1%	1.0%	1.0%	1.4%
Population†	1.3%	1.1%	0.9%	0.4%	0.4%	0.4%

* Annual rates of increase or decrease calculated on end points.
** Electrolytes in batteries, wood pulp and moisture in disposable diapers, miscellaneous inorganics.
† Based on population estimates from U.S. Dept. of Commerce, Bureau of the Census.
Note: Beginning in 1990, the numbers reflect substantial changes in the methodology for estimating wood and food wastes. (See Chapter 2.)
Source: Franklin Associates

Paper and paperboard, metals, plastics, textiles, rubber and leather, and wood are all projected to increase faster than population, while glass is projected to decline. Food wastes are projected to increase at or below one percent per year through 2005. Yard trimmings are projected to decline, then remain constant.

Overall, municipal solid waste generation is projected to increase at a rate of one percent annually between 1997 and 2000. For the period 2000 through 2005, the annual growth rate for municipal solid waste is projected to be 1.4 percent annually.

PRODUCT GENERATION IN MUNICIPAL SOLID WASTE

Projected generation of products in MSW (by weight) is summarized in Table 32 and Figure 28. All categories (except for yard trimmings) are projected to grow in tonnage. (See Chapter 2 for a discussion of the decline in yard trimmings generation.) Containers and packaging are projected to remain the largest single category at over 34 percent of total generation, with nondurables being the second largest category, at 28 percent of total MSW generation. More detailed observations on the projected growth in the individual product categories follow.

Table 32

PROJECTIONS OF CATEGORIES OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 1997, 2000, AND 2005
(In thousands of tons and percent of total generation)

	Thousands of tons			% of total		
Products	**1997**	**2000**	**2005**	**1997**	**2000**	**2005**
Durable Goods *(Detail in Table 33)*	33,230	35,590	38,960	15.3%	15.9%	16.3%
Nondurable Goods *(Detail in Table 34)*	59,100	62,190	67,680	27.2%	27.9%	28.3%
Containers and Packaging *(Detail in Table 35)*	71,750	76,500	82,770	33.1%	34.3%	34.6%
Total Product Wastes**	164,080	174,280	189,410	75.6%	78.1%	79.1%
Other Wastes						
Food Wastes	21,910	22,550	23,480	10.1%	10.1%	9.8%
Yard Trimmings	27,730	23,000	23,000	12.8%	10.3%	9.6%
Miscellaneous Inorganic Wastes	3,250	3,400	3,650	1.5%	1.5%	1.5%
Total Other Wastes	52,890	48,950	50,130	24.4%	21.9%	20.9%
Total MSW Generated	216,970	223,230	239,540	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion.
** Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Figure 28. Products generated in MSW, 1997, 2000, and 2005

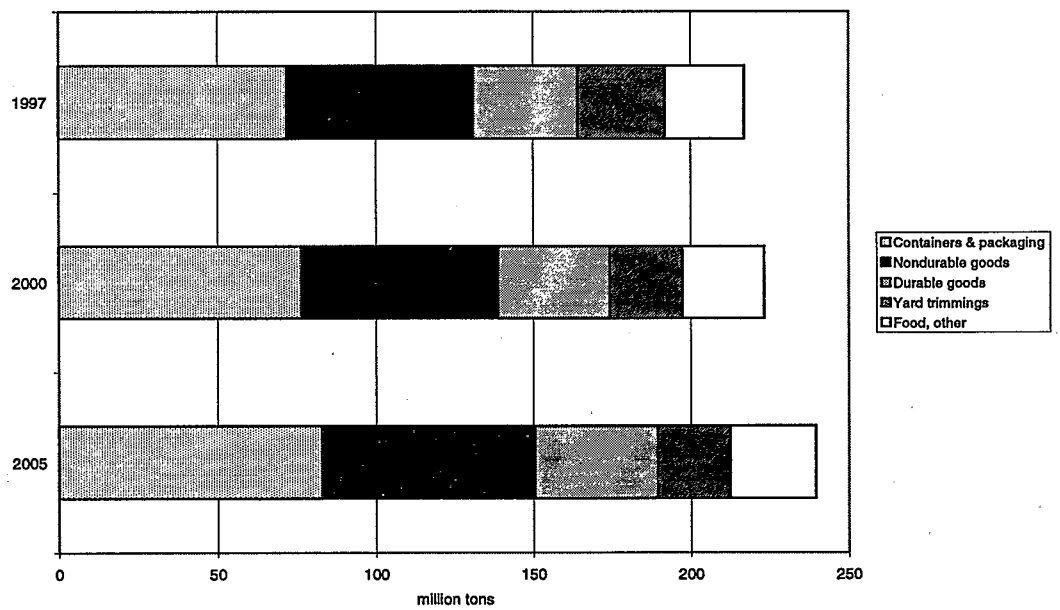


Table 33

PROJECTIONS OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 1997, 2000, AND 2005
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of tons			% of total		
Products	**1997**	**2000**	**2005**	**1997**	**2000**	**2005**
Durable Goods						
Major Appliances	3,610	3,640	3,510	1.7%	1.6%	1.5%
Small Appliances	830	990	1,260	0.4%	0.4%	0.5%
Furniture and Furnishings	7,510	8,330	9,410	3.5%	3.7%	3.9%
Carpets and Rugs	2,330	2,710	3,240	1.1%	1.2%	1.4%
Rubber Tires	4,260	4,270	4,610	2.0%	1.9%	1.9%
Batteries, Lead-Acid	1,780	1,800	1,880	0.8%	0.8%	0.8%
Miscellaneous Durables	12,910	13,850	15,050	6.0%	6.2%	6.3%
Total Durable Goods	33,230	35,590	38,960	15.3%	15.9%	16.3%
Nondurable Goods *(Detail in Table 34)*	59,100	62,190	67,680	27.2%	27.9%	28.3%
Containers and Packaging *(Detail in Table 35)*	71,750	76,500	82,770	33.1%	34.3%	34.6%
Total Product Wastes**	164,080	174,280	189,410	75.6%	78.1%	79.1%
Other Wastes						
Food Wastes	21,910	22,550	23,480	10.1%	10.1%	9.8%
Yard Trimmings	27,730	23,000	23,000	12.8%	10.3%	9.6%
Miscellaneous Inorganic Wastes	3,250	3,400	3,650	1.5%	1.5%	1.5%
Total Other Wastes	52,890	48,950	50,130	24.4%	21.9%	20.9%
Total MSW Generated	216,970	223,230	239,540	100.0%	100.0%	100.0%
Population (thousands)	267,645	271,237	276,990			

* Generation before materials recovery or combustion.
** Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Durable Goods

Overall, durable goods are projected to increase in both tonnage and percent of total MSW generation (Table 33 and Figure 29). The trends in generation of major appliances, carpet and rugs, and furniture and furnishings are well established by production numbers, since lifetimes of up to 20 years are assumed. Generation of rubber tires and lead-acid batteries is projected based on historical trends, which are generally exhibiting constant rates of growth. Durable goods are projected to account for about 15 to 16 percent of MSW generation and are projected to increase to 35.6 million tons and 39 million tons in 2000 and

2005, respectively. For durable goods, this represents a growth rate of about 2.3 percent annually between 1997 and 2000, and 1.8 percent annually between 2000 and 2005.

Nondurable Goods

Similar to durable goods, nondurable goods are projected to increase in both tonnage and percent of total MSW generation (Table 34 and Figure 30). Generation of nondurable goods is projected to be 62.2 million tons and 67.7 million tons in 2000 and 2005, respectively. Generation of nondurable goods is projected to grow approximately 1.7 percent annually, accounting for about 28 percent of total MSW generation in 2000 and 2005.

Most of the nondurable paper products are projected to continue to grow at rates higher than population growth. Strong growth rates are projected for paper products such as books and magazines, office paper, mail, paper used in commercial printing, and other nonpackaging paper. Newspaper generation is an exception—newspapers are expected be generated at rates well below population growth.

Clothing and footwear and other textiles also are projected to increase in tonnage, to 8.1 million tons by 2005. Finally, other miscellaneous nondurables, which include many items made of plastics, are expected to continue to increase at rates well above population growth.

Figure 29. Historical and projected generation of durable goods

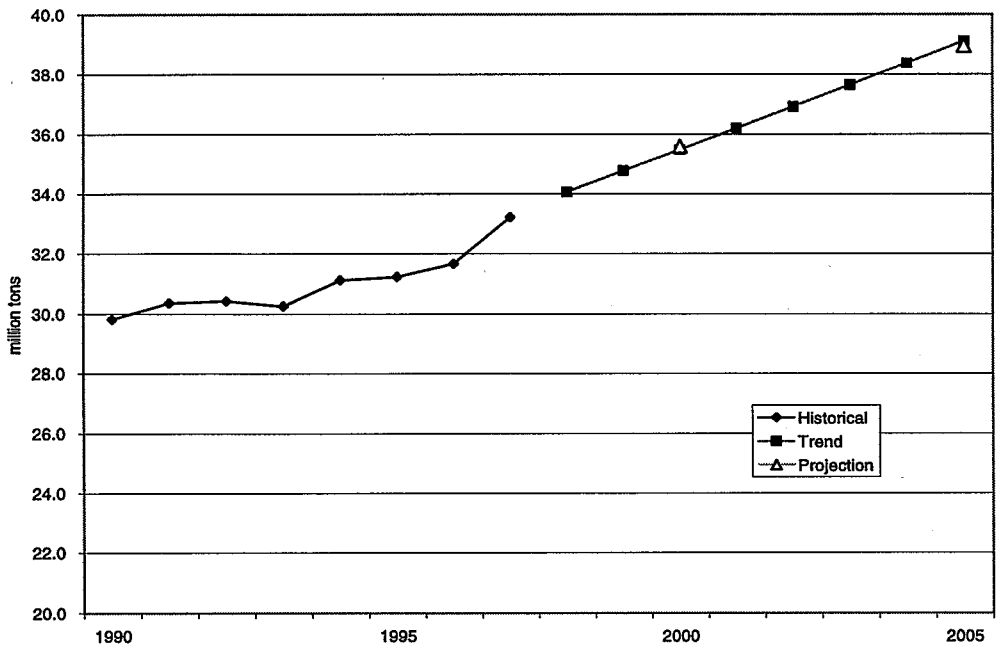


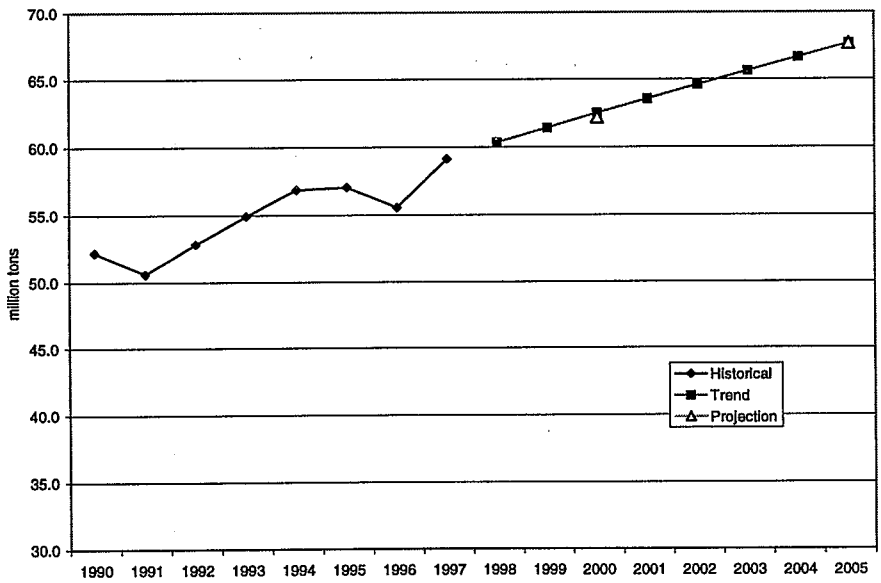
Table 34

PROJECTIONS OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 1997, 2000, AND 2005
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of tons			% of total		
Products	**1997**	**2000**	**2005**	**1997**	**2000**	**2005**
Durable Goods *(Detail in Table 33)*	33,230	35,590	38,960	15.3%	15.9%	16.3%
Nondurable Goods						
Newspapers	13,490	13,560	13,750	6.2%	6.1%	5.7%
Books	1,110	1,190	1,400	0.5%	0.5%	0.6%
Magazines	2,170	2,540	3,050	1.0%	1.1%	1.3%
Office Papers	7,040	7,420	8,020	3.2%	3.3%	3.3%
Directories	470	490	590	0.2%	0.2%	0.2%
Standard (A) Mail**	4,850	5,080	5,510	2.2%	2.3%	2.3%
Other Commercial Printing	6,860	7,150	7,500	3.2%	3.2%	3.1%
Tissue Paper and Towels	3,100	3,270	3,420	1.4%	1.5%	1.4%
Paper Plates and Cups	970	990	1,030	0.4%	0.4%	0.4%
Plastic Plates and Cups	860	1,030	1,260	0.4%	0.5%	0.5%
Trash Bags	810	890	950	0.4%	0.4%	0.4%
Disposable Diapers	3,140	3,320	3,630	1.4%	1.5%	1.5%
Other Nonpackaging Paper	4,270	4,270	4,950	2.0%	1.9%	2.1%
Clothing and Footwear	5,760	6,160	7,280	2.7%	2.8%	3.0%
Towels, Sheets, & Pillowcases	750	790	830	0.3%	0.4%	0.3%
Other Misc. Nondurables	3,450	4,040	4,510	1.6%	1.8%	1.9%
Total Nondurable Goods	59,100	62,190	67,680	27.2%	27.9%	28.3%
Containers and Packaging *(Detail in Table 35)*	71,750	76,500	82,770	33.1%	34.3%	34.6%
Total Product Wastes+	164,080	174,280	189,410	75.6%	78.1%	79.1%
Other Wastes						
Food Wastes	21,910	22,550	23,480	10.1%	10.1%	9.8%
Yard Trimmings	27,730	23,000	23,000	12.8%	10.3%	9.6%
Miscellaneous Inorganic Wastes	3,250	3,400	3,650	1.5%	1.5%	1.5%
Total Other Wastes	52,890	48,950	50,130	24.4%	21.9%	20.9%
Total MSW Generated	216,970	223,230	239,540	100.0%	100.0%	100.0%
Population (thousands)	267,645	271,237	276,990			

* Generation before materials recovery or combustion.
** Formerly called Third Class Mail by the U.S. Postal Service.
\+ Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Figure 30. Historical and projected generation of nondurable goods



Containers and Packaging

Containers and packaging—the largest single category of MSW—are projected to continue to grow through 2005 (Table 35 and Figure 31). Generation was 71.8 million tons in 1997, with an increase projected to 76.5 million tons and 82.8 million tons in 2000 and 2005, respectively. In percentage of total MSW, containers and packaging were 33.1 percent in 1997, with a projected increase to 34.6 percent in 2005. The average growth rates for containers and packaging are projected to be 2.2 percent annually through 2000, then 1.6 percent annually from 2000 to 2005.

Glass. Tonnage of glass containers generated is projected to decline to 10.4 million tons and 9.6 million tons in 2000 and 2005, respectively. Glass containers are projected to continue to be a declining percentage of MSW generation (4 percent of total generation in 2005).

Steel. Since 1990, steel cans have been a relatively constant percentage of MSW generation. Generation of steel containers and packaging is projected to increase less than one percent annually through 2005. Steel packaging generation is expected to increase to about 3.1 million in 2000 and 2005, respectively. As a percentage of MSW generation, steel packaging is projected to be constant at about 1.3 to 1.4 percent of total generation.

Aluminum. Tonnage of aluminum packaging has been increasing steadily over the historical period, and this trend is projected to continue. Aluminum packaging is projected to increase to 2.3 million tons and 2.5 million tons in 2000 and 2005, respectively. Aluminum packaging is projected to continue to be about one percent of MSW generation.

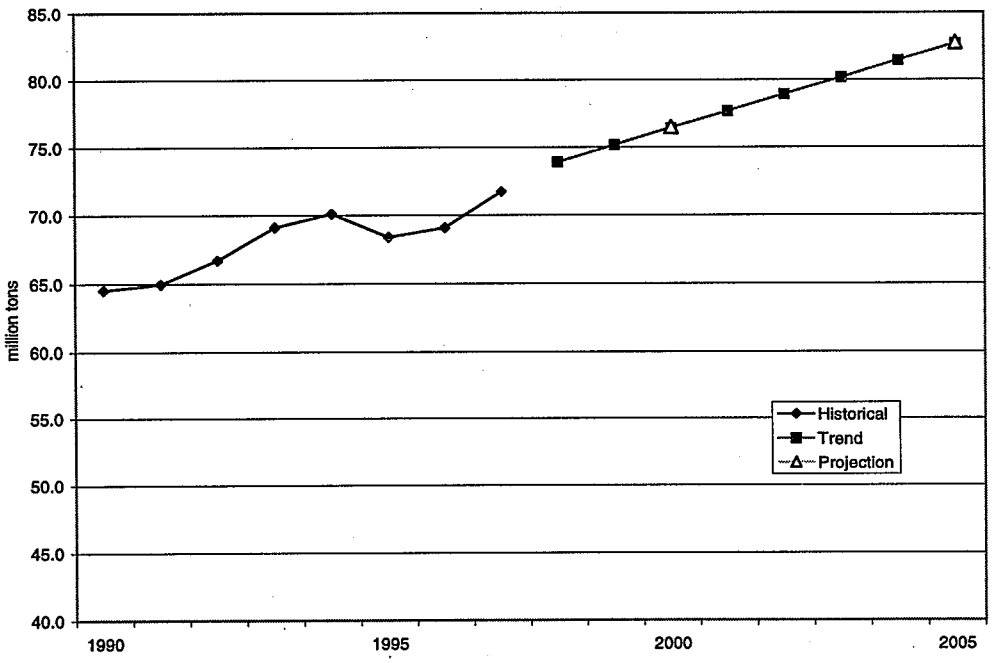
Table 35

PROJECTIONS OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM: 1997, 2000, AND 2005
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons and percent of total generation)

	Thousands of tons			% of total		
Products	**1997**	**2000**	**2005**	**1997**	**2000**	**2005**
Durable Goods *(Detail in Table 33)*	33,230	35,590	38,960	15.3%	15.9%	16.3%
Nondurable Goods *(Detail in Table 34)*	59,100	62,190	67,680	27.2%	27.9%	28.3%
Containers and Packaging						
Glass Packaging						
Beer and Soft Drink Bottles	4,960	4,640	4,190	2.3%	2.1%	1.7%
Wine and Liquor Bottles	1,820	1,630	1,440	0.8%	0.7%	0.6%
Food and Other Bottles & Jars	3,830	4,080	3,950	1.8%	1.8%	1.6%
Total Glass Packaging	10,610	10,350	9,580	4.9%	4.6%	4.0%
Steel Packaging						
Beer and Soft Drink Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	2,860	2,890	2,930	1.3%	1.3%	1.2%
Other Steel Packaging	240	200	210	0.1%	0.1%	0.1%
Total Steel Packaging	3,100	3,090	3,140	1.4%	1.4%	1.3%
Aluminum Packaging						
Beer and Soft Drink Cans	1,530	1,860	2,080	0.7%	0.8%	0.9%
Other Cans	50	40	30	0.0%	0.0%	0.0%
Foil and Closures	360	350	350	0.2%	0.2%	0.1%
Total Aluminum Pkg	1,940	2,250	2,460	0.9%	1.0%	1.0%
Paper & Paperboard Pkg						
Corrugated Boxes	30,160	32,210	35,840	13.9%	14.4%	15.0%
Milk Cartons	460	500	520	0.2%	0.2%	0.2%
Folding Cartons	5,420	5,580	5,740	2.5%	2.5%	2.4%
Other Paperboard Packaging	220	220	220	0.1%	0.1%	0.1%
Bags and Sacks	1,870	1,760	1,620	0.9%	0.8%	0.7%
Wrapping Papers	50	50	40	0.0%	0.0%	0.0%
Other Paper Packaging	1,270	1,370	1,510	0.6%	0.6%	0.6%
Total Paper & Board Pkg	39,450	41,690	45,490	18.2%	18.7%	19.0%
Plastics Packaging						
Soft Drink Bottles	760	770	920	0.4%	0.3%	0.4%
Milk Bottles	670	740	880	0.3%	0.3%	0.4%
Other Containers	1,540	1,650	1,810	0.7%	0.7%	0.8%
Bags and Sacks	1,520	1,570	1,880	0.7%	0.7%	0.8%
Wraps	2,130	2,270	2,670	1.0%	1.0%	1.1%
Other Plastics Packaging	2,810	2,990	3,570	1.3%	1.3%	1.5%
Total Plastics Packaging	9,430	9,990	11,730	4.3%	4.5%	4.9%
Wood Packaging	7,030	8,950	10,180	3.2%	4.0%	4.2%
Other Misc. Packaging	190	180	190	0.1%	0.1%	0.1%
Total Containers & Pkg	71,750	76,500	82,770	33.1%	34.3%	34.6%
*Total Product Wastes****	164,080	174,280	189,410	75.6%	78.1%	79.1%
Other Wastes						
Food Wastes	21,910	22,550	23,480	10.1%	10.1%	9.8%
Yard Trimmings	27,730	23,000	23,000	12.8%	10.3%	9.6%
Miscellaneous Inorganic Wastes	3,250	3,400	3,650	1.5%	1.5%	1.5%
Total Other Wastes	52,890	48,950	50,130	24.4%	21.9%	20.9%
Total MSW Generated	216,970	223,230	239,540	100.0%	100.0%	100.0%
Population (thousands)	267,645	271,237	276,990			

* Generation before materials recovery or combustion.
** Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Figure 31. Historical and projected generation of containers and packaging



Paper and Paperboard. Like other paper and paperboard products, overall generation of paper and paperboard packaging has been increasing rapidly. The increase is mostly in corrugated boxes, which are mainly used for shipping other products. Continued increases in generation of corrugated boxes are projected; tonnage of these boxes is projected to be 32.2 million tons in 2000, (14.4 percent of total MSW generation), and 35.8 million tons (15 percent of total generation) in 2005. Most other paper packaging is also projected to increase in tonnage, but as a percent of total MSW generation, to remain constant. All paper and paperboard packaging is projected to be 45.5 million tons, or 19 percent of total generation, in 2005.

Plastics. Plastics packaging exhibited rapid historical growth from 1960 to 1980, with a slower growth rate experienced during the 1990s. The slower growth rate of the 1990s is projected to continue. Collectively, soft drink bottles, milk bottles, other containers, bags and sacks, wraps, and other plastic packaging are projected to increase less than 3 percent annually through 2005. Generation of all plastics packaging is projected to be 10 million tons and 11.7 million tons in 2000 and 2005, respectively. This will account for 4 to 5 percent of total MSW generation.

SUMMARY

Historical and projected generation of MSW is illustrated in Figure 32. The generation for 2000 and 2005 as projected is somewhat lower than would be predicted by a linear trend analysis. As previous tables and figures have shown, generation of durable goods, nondurable goods, and containers and packaging is projected to be nearly on trend. The effect

Figure 32. Historical and projected generation of MSW

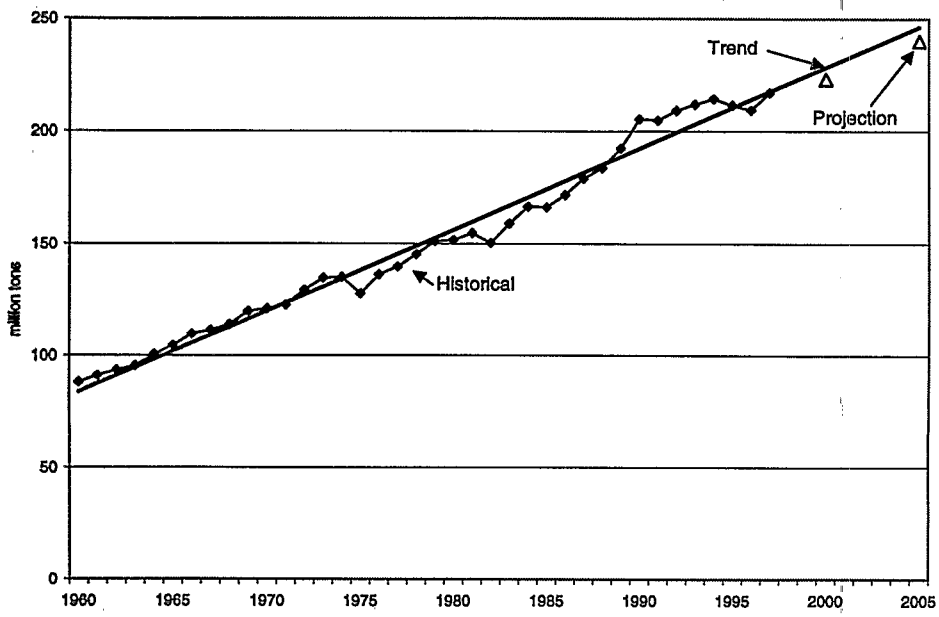
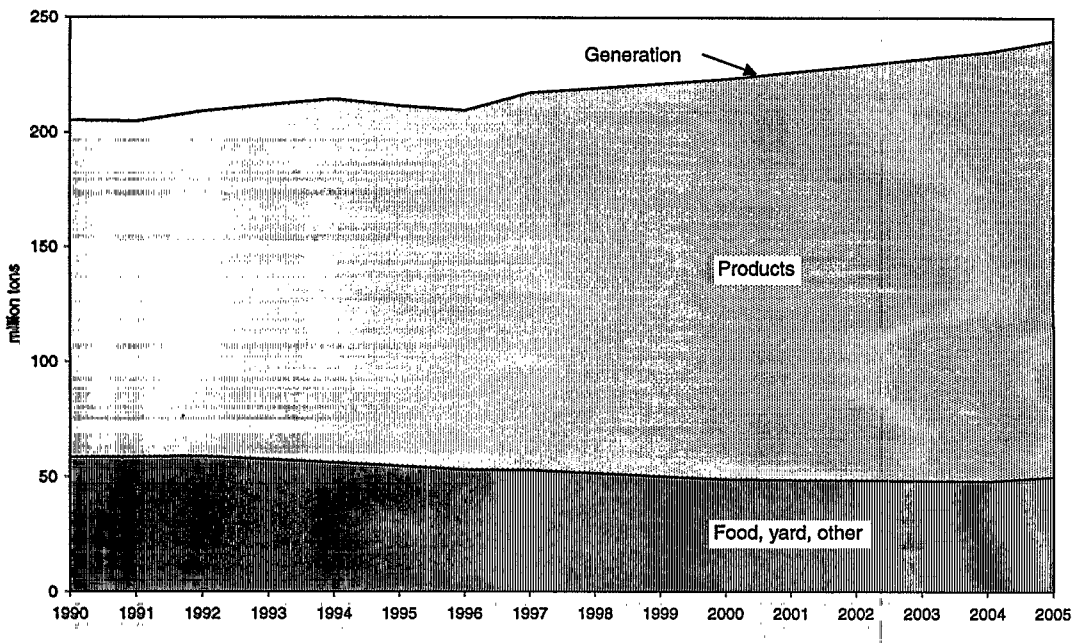


Figure 33. Historical and projected MSW, by category



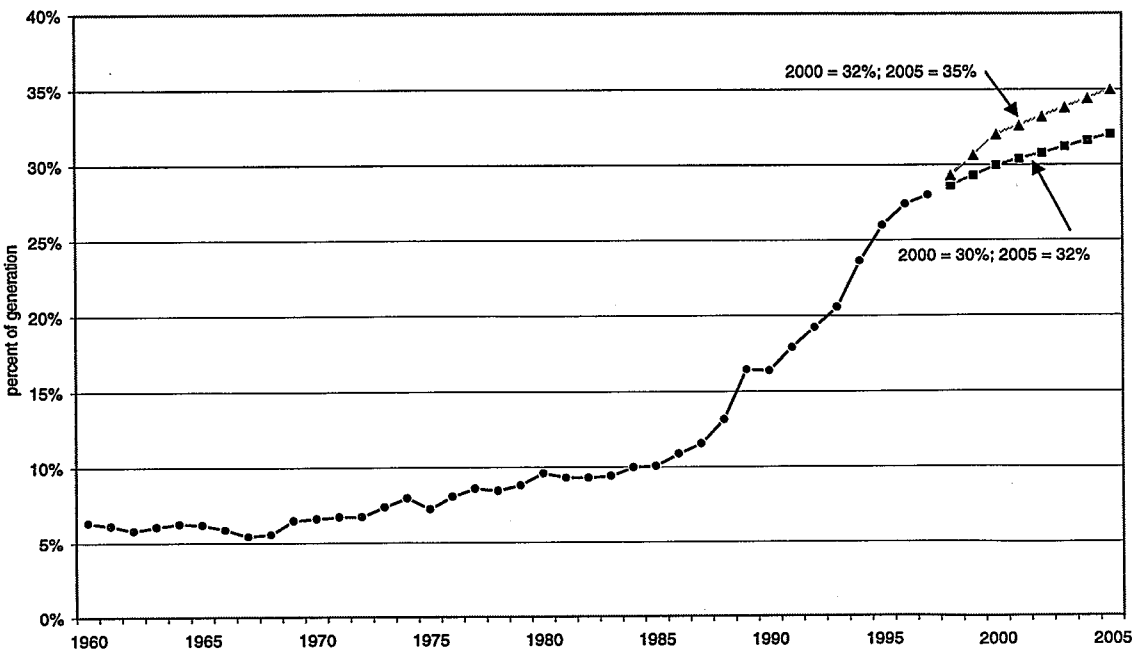
of decreasing generation of yard trimmings accounts for most of the lowered projections. This is illustrated in Figure 33, where generation of products increases almost continually, but food wastes, yard trimmings, and other (in total) have trended downward.

PROJECTIONS OF MSW RECOVERY

In the United States, recovery of materials for recycling and composting experienced rapid growth in the 1990s, increasing from 16 percent of generation in 1990 to 28 percent in 1997. Between 1996 and 1997, however, the rate of increase slowed—increasing only from 27.4 percent in 1996 to 28 percent in 1997 (Figure 34). The dilemma in making projections is this—will recovery rates soon resume a rapid increase, or will we continue to experience a slow rate of growth? The scenarios presented in this section consider both possibilities. The more conservative scenario projects a 30 percent recovery rate in 2000 and a rate of 32 percent in 2005. The more optimistic scenario projects 32 percent recovery in 2000 and 35 percent in 2005.

Reasons to be optimistic include the fact that a recycling infrastructure is already in place. For example, more than half of the U.S. population is served by curbside collection of recyclable materials, there are more than 12,000 drop-off sites for collection of recyclable materials. (However, the number of curbside programs was only slightly higher in 1997 than 1996.)

Figure 34. Historical and projected recovery rates



The most difficult aspect of recycling in 1996 and 1997 has been lack of demand and low prices for collected materials. As demonstrated in the last MSW Characterization Update (EPA 1997), prices received for all major recyclable materials in MSW had dropped markedly from their high points. This situation has not improved. Recent articles in the trade press have highlighted this phenomenon:

- Markets for recovered paper and paperboard have been in decline both for domestic mills and for exports. (Exports are a very important component of recovered paper demand.) Economic problems in Asia have contributed to this situation. (Paper Recycler, June 1998). In addition, the American Forest & Paper Association has recently released its Capacity Survey, reporting a very low rate of increase in paper capacity through 2001, although much of the increase will reflect use of recovered paper (AF&PA 1998).

- Prices for virgin plastic resins have been low, and no improvement seems to be sight for the next year. There is worldwide oversupply of polypropylene, polystyrene, and polyethylene terephthalate (PET). This makes it very difficult for recovered resins to compete. (Plastics November 1998).

- There is worldwide oversupply of aluminum (Container November 1998).

- The market for recovered steel cans is the weakest of the 1990s. A flood of steel imports is coming into the U.S., meaning that there is less demand for domestic steel and less demand for steel scrap (Container November 1998).

- Production of glass containers continues to decline, affecting markets for recovered glass cullet.

The higher recycling scenario presented in this section (32 percent in 2000 and 35 percent in 2005) assumes that the above market difficulties will be corrected in time to stimulate additional recovery. The lower scenario (30 percent in 2000 and 32 percent in 2005) may be more likely (or even optimistic) if markets continue to be depressed.

Discussion of Assumptions

Some general assumptions and principles were used in making the recovery estimates:

- Recovery for recycling includes composting. Recovered materials are assumed to have been removed from the municipal waste stream.

- It was assumed that local, state, and federal agencies will continue to emphasize recycling, including composting, as MSW management alternatives.

- It was assumed that present state deposit laws will remain in place, but that no additional deposit legislation for containers would be enacted.

- It was assumed that affected industries will continue to emphasize recovery and recycling programs, and will make the necessary investments to achieve higher recycling rates.

- It was assumed that the current trend toward diverting certain yard trimmings in landfills will continue to 2000 and beyond, providing stimulus for composting programs and for source reduction of yard trimmings by citizens.
- It was assumed that, for most materials, there will be adequate end-user capacity to utilize all recovered materials that could reasonably be recovered. As discussed above, this may depend upon worldwide economic conditions.
- A majority of U.S. citizens will have access to recovery options before 2000. These options will include curbside collection, drop-off and buy-back centers, and, in some instances, mixed waste processing facilities. Recovery will continue to increase as more recovery systems come on-line.
- In spite of the factors encouraging more recovery as enumerated above, many areas of the U.S. are thinly populated and/or remote from ready markets for recovered materials; many of these areas also have adequate landfill capacity. Therefore, the overall recovery rate for the entire country may not reflect the higher rates achieved in communities where conditions are favorable for recycling, including composting.
- Because of a maturing of the recycling/composting infrastructure and current poor market conditions, the rate of increase in recycling will be slower that that experienced in the earlier 1990s.

Scenarios for 2000

The range of projected recovery rates for materials in MSW under the recovery scenarios (30 and 32 percent) in the year 2000 is shown in Table 36. (Details of the assumptions for individual products in MSW are in Appendix C.)

Continued increases in recovery in every category will be required to reach the scenarios shown. To reach a recovery rate of 30 percent nationwide in 2000, 44 percent of all paper and paperboard, 29 percent of all glass, 42 percent of metals, and 6 percent of all plastics in MSW would be recovered under this scenario. Fifty-two percent of all yard trimmings would be recovered for composting under this scenario (not including backyard composting and other source reduction measures), and 5 percent of food wastes (including some composted paper) would be recovered for composting.

To achieve a recovery rate of 35 percent nationwide in 2000, 46 percent of all paper and paperboard, 33 percent of all glass, 46 percent of all metals, and 54 percent of yard trimmings would need to be recovered. Recovery of rubber and clothing and other textiles would each be about 15 percent of generation. Increased composting of food waste would also be required to reach this level of recovery nationwide.

Table 36

PROJECTED GENERATION AND RANGES OF RECOVERY,* 2000
(In thousands of tons and percent of generation of each material)

Materials	2000 MSW Generation (thous tons)	Recovery: Thousand tons 30%	Recovery: Thousand tons 32%	Recovery: % of generation 30%	Recovery: % of generation 32%	1997 MSW Recovery (%)++
Paper and Paperboard	87,700	38,250	40,300	43.6%	46.0%	41.7%
Glass	11,850	3,400	3,900	28.7%	32.9%	24.3%
Metals						
Steel	12,890	5,330	5,890	41.3%	45.7%	38.4%
Aluminum	3,430	1,280	1,320	37.3%	38.5%	31.2%
Other Nonferrous**	1,300	860	870	66.2%	66.9%	65.4%
Total Metals	17,620	7,470	8,080	42.4%	45.9%	39.1%
Plastics	23,420	1,380	1,570	5.9%	6.7%	5.2%
Rubber & Leather	6,920	1,000	1,100	14.5%	15.9%	11.7%
Clothing, Other Textiles	8,850	1,150	1,300	13.0%	14.7%	12.9%
Wood	13,960	1,200	1,400	8.6%	10.0%	5.1%
Yard Trimmings	23,000	12,000	12,400	52.2%	53.9%	41.4%
Food, Other+	22,550	1,100	1,300	4.9%	5.8%	2.6%
Other Materials‡	7,360	Neg.	Neg.	Neg.	Neg.	Neg.
Totals	223,230	66,950	71,350	30.0%	32.0%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Includes some nonferrous metals other than battery lead.
‡ Miscellaneous inorganic wastes, electrolytes in batteries, other miscellaneous.
\+ Recovery includes paper recovered for composting.
++ From Table 2.
Neg. = Negligible (less than 5,000 tons or 0.05 percent)
Details may not add to totals due to rounding.
Source: Franklin Associates

These overall rates of recovery cannot be achieved without substantial recovery rates of the materials contributing the most tonnage to MSW, e.g., paper and paperboard, glass, metals, and yard trimmings. (Plastics also contribute substantial tonnage, but are often in products such as appliances or furniture where recovery is difficult if not impossible.) As generation of some "heavy" materials such as glass and yard trimmings goes down, there is less material to recover.

Scenarios for 2005

The range of projected recovery rates for materials in MSW under two recovery scenarios (32 and 35 percent) in the year 2005 is shown in Table 37. (Details of the assumptions for individual products in MSW are in Appendix C.) For the 32 percent recovery rate scenario, paper and paperboard would be recovered at a 45 percent rate, glass at a 31 percent rate, metals at a 49 percent rate, and rubber and textiles at rates of 14 to 16 percent. Yard trimmings would be recovered at a 54 percent rate, and food wastes at a 10 percent rate.

To reach the 35 percent recovery scenario nationwide in 2005, 49 percent of all paper and paperboard, 34 percent of all glass, 54 percent of metals, and about 17 percent of rubber and textiles would be recovered. Yard trimmings would be recovered at a 57 percent rate, and 13 percent of food wastes would be recovered for composting.

It should be noted that some intensively recovered products, such as newspapers, corrugated boxes, and steel and aluminum cans, could be reaching their maximum practical recovery rates under the 35 percent scenario. Recovery of yard trimmings and food would also need to be substantially increased.

PROJECTIONS OF MSW DISCARDS AFTER RECOVERY

Discards of municipal solid waste as defined for this report are those wastes remaining after recovery of materials for recycling, including composting of yard trimmings. The remaining discards must be managed by combustion, landfilling, or some other means. The effects of projected recovery rates on the amounts and characteristics of municipal solid waste discards are illustrated in Table 38. (A 30 percent recovery scenario for 2000 and 32 percent recovery scenario for 2005 are shown in this example.)

This projected scenario of discards, which is based on substantial source reduction of yard trimmings and a 30 percent recovery rate for materials and products generated in 2000, shows about the same discards in 2000 as in 1997. Assuming a 32 percent recovery rate for materials and products generated in 2005, discards from 2000 to 2005 would increase 4 percent.

The materials composition of MSW discards is quite different from the materials composition of MSW generation, especially for materials that are recovered at higher rates. For example, paper and paperboard products are projected to comprise 39.3 percent of MSW generation, but 31.6 percent of MSW discards, in 2000. Yard trimmings would decline from 10.3 percent of MSW generation to 7.0 percent of discards under this scenario in 2000. The percentages of other materials discards would likewise increase or decrease, depending upon their projected recovery rates.

Table 37

PROJECTED GENERATION AND RANGES OF RECOVERY,* 2005
(In thousands of tons and percent of generation of each material)

Materials	2005 Generation (thous tons)	Recovery: Thousand tons 32%	Recovery: Thousand tons 35%	Recovery: % of generation 32%	Recovery: % of generation 35%	1997 MSW Recovery (%)+
Paper and Paperboard	94,770	42,820	46,220	45.2%	48.8%	41.7%
Glass	11,200	3,500	3,800	31.3%	33.9%	24.3%
Metals						
Steel	13,590	6,700	7,650	49.3%	56.3%	38.4%
Aluminum	3,780	1,500	1,600	39.7%	42.3%	31.2%
Other Nonferrous**	1,340	900	910	67.2%	67.9%	65.4%
Total Metals	18,710	9,100	10,160	48.6%	54.3%	39.8%
Plastics	26,730	1,820	2,070	6.8%	7.7%	5.2%
Rubber & Leather	7,660	1,200	1,350	15.7%	17.6%	11.7%
Clothing, Other Textiles	10,240	1,400	1,700	13.7%	16.6%	12.9%
Wood	15,810	2,000	2,300	12.7%	14.5%	5.1%
Yard Trimmings	23,000	12,500	13,200	54.3%	57.4%	41.4%
Food, Other+	23,480	2,400	3,100	10.2%	13.2%	2.6%
Other Materials‡	7,940	Neg.	Neg.	Neg.	Neg.	Neg.
Totals	239,540	76,740	83,900	32.0%	35.0%	28.0%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Includes some nonferrous metals other than battery lead.
‡ Miscellaneous inorganic wastes, electrolytes in batteries, other miscellaneous.
\+ Recovery includes paper recovered for composting.
++ From Table 2.
Neg. = Negligible (less than 5,000 tons or 0.05 percent)
Details may not add to totals due to rounding.
Source: Franklin Associates

PROJECTIONS OF MSW COMBUSTION

Making projections of MSW combustion is somewhat difficult because of the many uncertainties affecting the planning and construction of new facilities. Several years are required to site and obtain permits for construction of new MSW combustion facilities. Projections of future waste-to-energy combustion capacity were based on facilities operating or reported under construction or in planning.

Table 38

PROJECTIONS OF MATERIALS DISCARDED* IN MSW: 1997, 2000, AND 2005
(RECOVERY SCENARIOS ASSUMED: 30% IN 2000, 32% IN 2005)
(In thousand of tons and percent of total discards)

	Thousand tons			% of discards		
Materials	**1997**	**2000****	**2005^**	**1997**	**2000****	**2005^**
Paper and Paperboard	48,920	49,450	51,950	31.3%	31.6%	31.9%
Glass	9,090	8,450	7,700	5.8%	5.4%	4.7%
Metals						
Steel	7,600	7,560	6,890	4.9%	4.8%	4.2%
Aluminum	2,070	2,150	2,280	1.3%	1.4%	1.4%
Other Nonferrous	440	440	440	0.3%	0.3%	0.3%
Total Metals	*10,110*	*10,150*	*9,610*	*6.5%*	*6.5%*	*5.9%*
Plastics	20,350	22,040	24,910	13.0%	14.1%	15.3%
Rubber & Leather	5,820	5,920	6,460	3.7%	3.8%	4.0%
Clothing, Other Textiles	7,180	7,700	8,840	4.6%	4.9%	5.4%
Wood	10,980	12,760	13,810	7.0%	8.2%	8.5%
Yard Trimmings	16,240	11,000	10,500	10.4%	7.0%	6.4%
Food, Other+	21,330	21,450	21,080	13.6%	13.7%	12.9%
Other Materials‡	6,250	7,360	7,940	4.0%	4.7%	4.9%
Totals	156,270	156,280	162,800	100.0%	100.0%	100.0%

* Discards after recovery for recycling and composting of yard trimmings.
** 30 percent recovery scenario assumed for 2000 (Table 36).
^ 32 percent recovery scenario assumed for 2005 (Table 37).
+ Recovery includes paper recovered for composting.
‡ Miscellaneous inorganic wastes, electrolytes in batteries, other miscellaneous.
Details may not add to totals due to rounding.
Source: Franklin Associates

Since there is increasing interest in combustion of certain source-separated components of MSW—especially tires, but also wood pallets, paper, and plastics—it was assumed that combustion of these materials would continue to increase.

Based on this analysis, MSW sent to waste-to-energy combustion facilities was projected to be 37.2 million tons and 38.0 million tons for the years 2000 and 2005, respectively.

SUMMARY OF PROJECTED MSW MANAGEMENT

A summary of the projections is presented, with similar figures for 1997 included for contrast, in Table 39. For the summary, a recovery scenario of 30 percent in 2000 and 32 percent in 2005 was used. Graphical illustrations of the long-term trends are shown in Figures 35 and 36.

From 1997 to 2000, generation of MSW is projected to increase by less than one percent per year compared to about 3 percent per year between 1980 and 1990. The generation of MSW is projected to increase by about 1.5 percent per year between 2000 and 2005. As described earlier, source reduction of yard trimmings accounts for much of the decrease from 1997 to 2000 under the selected scenario. Thus, unless new measures are taken to further reduce discards of yard trimmings, renewed growth in MSW generation can be expected.

Table 39

GENERATION, RECOVERY, COMBUSTION, AND DISPOSAL OF MUNICIPAL SOLID WASTE: 1997, 2000, AND 2005 (RECOVERY SCENARIOS ASSUMED: 30% IN 2000, 32% IN 2005)
(In thousands of tons and percent of total generation)

	Thousands of tons			% of generation		
	1997	2000	2005	1997	2000	2005
Generation	216,970	223,230	239,540	100.0%	100.0%	100.0%
Recovery for recycling	48,630	53,850	61,840	22.4%	24.1%	25.8%
Recovery for composting*	12,070	13,100	14,900	5.6%	5.9%	6.2%
Total materials recovery	60,700	66,950	76,740	28.0%	30.0%	32.0%
Discards after recovery	156,270	156,280	162,800	72.0%	70.0%	68.0%
Combustion**	36,700	37,200	38,000	16.9%	16.7%	15.9%
Landfill, other disposal	119,570	119,080	124,800	55.1%	53.3%	52.1%

* Composting of yard trimmings and food wastes. Does not include backyard composting.
** Combustion of MSW in mass burn or refuse derived form, incineration without energy recovery, and combustion with energy recovery of source separated materials in MSW.
Details may not add to totals due to rounding.
Source: Franklin Associates

The effect of assuming this scenario for materials recovery for recycling (including yard trimmings composting) causes discards—as a percent of MSW generation—to decline to 70 percent of MSW generation in 2000 (i.e., 30 percent recovery rate), and 68 percent of MSW generation in 2005 (i.e., 35 percent recovery rate. After deductions for combustion, discards to landfill and other disposal were 119.5 million tons in 1997, with projections of 119.1 million tons and 124.8 million tons in 2000 and 2005, respectively. Based on these projections, the percentage of MSW generation discarded to landfills and other disposal would be 53.3 percent in 2000 and 52.1 percent in 2005.

If recovery for recycling (including composting) could be increased to 35 percent of generation in 2005, MSW landfilled would decrease to 117.6 million tons.

Figure 35. Municipal solid waste management, 1960 to 2005 (Recovery scenarios: 30% in 2000; 32% in 2005)

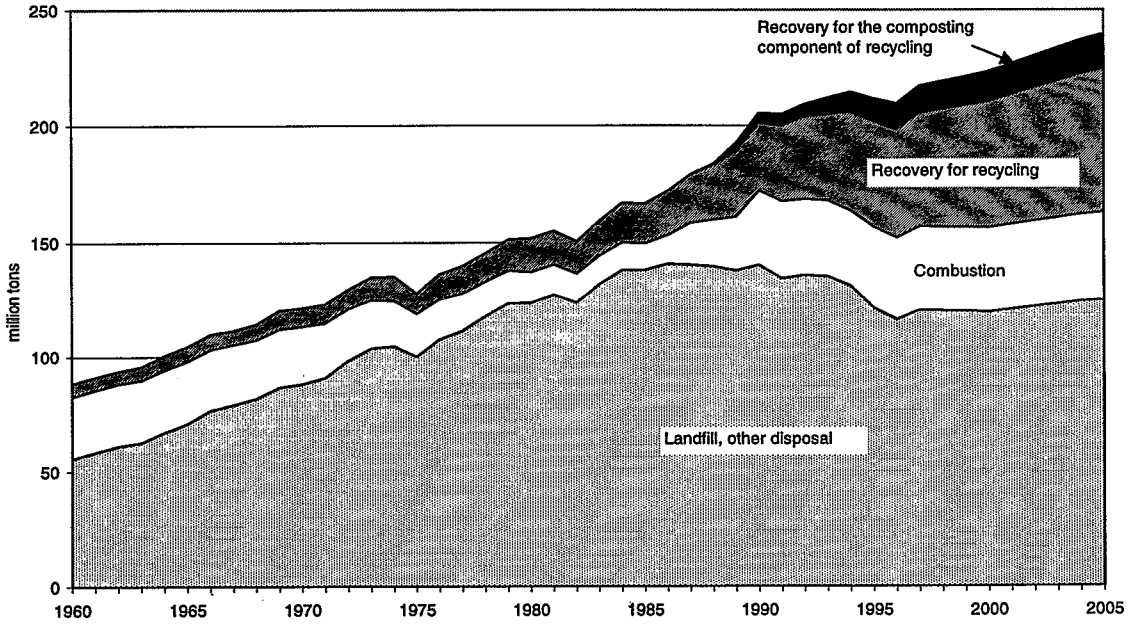
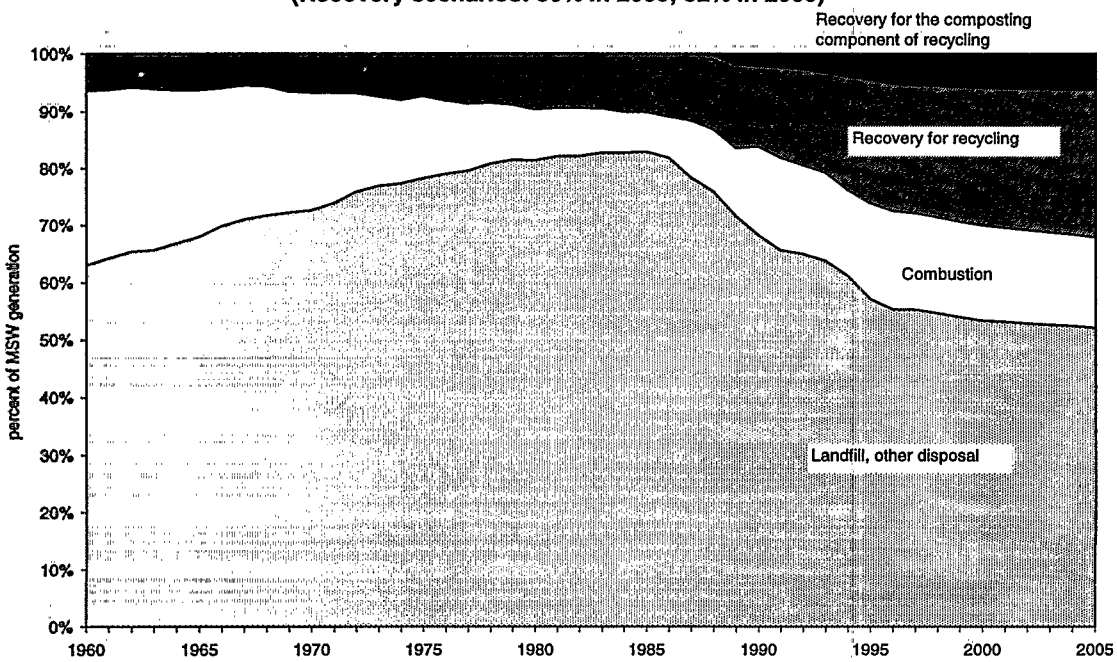


Figure 36. Municipal solid waste management, 1960 to 2005 (Recovery scenarios: 30% in 2000; 32% in 2005)



Chapter 4

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Appendix A

MATERIAL FLOWS METHODOLOGY

The material flows methodology is illustrated in Figures A-1 and A-2. The crucial first step is making estimates of the generation of the materials and products in MSW (Figure A-1).

DOMESTIC PRODUCTION

Data on domestic production of materials and products were compiled using published data series. U.S. Department of Commerce sources were used where available, but in several instances more detailed information on production of goods by end use is available from trade associations. The goal is to obtain a consistent historical data series for each product and/or material.

CONVERTING SCRAP

The domestic production numbers were then adjusted for converting or fabrication scrap generated in the production processes. Examples of these kinds of scrap would be clippings from plants that make boxes from paperboard, glass scrap (cullet) generated in a glass bottle plant, or plastic scrap from a fabricator of plastic consumer products. This scrap typically has a high value because it is clean and readily identifiable, and it is almost always recovered and recycled within the industry that generated it. Thus, converting/fabrication scrap is *not* counted as part of the postconsumer recovery of waste.

ADJUSTMENTS FOR IMPORTS/EXPORTS

In some instances imports and exports of products are a significant part of MSW, and adjustments were made to account for this.

DIVERSION

Various adjustments were made to account for diversions from MSW. Some consumer products are permanently diverted from the municipal waste stream because of the way they are used. For example, some paperboard is used in building materials, which are not counted as MSW. Another example of diversion is toilet tissue, which is disposed in sewer systems rather than becoming MSW.

In other instances, products are temporarily diverted from the municipal waste stream. For example, textiles reused as rags are assumed to enter the waste stream the same year the textiles are initially discarded.

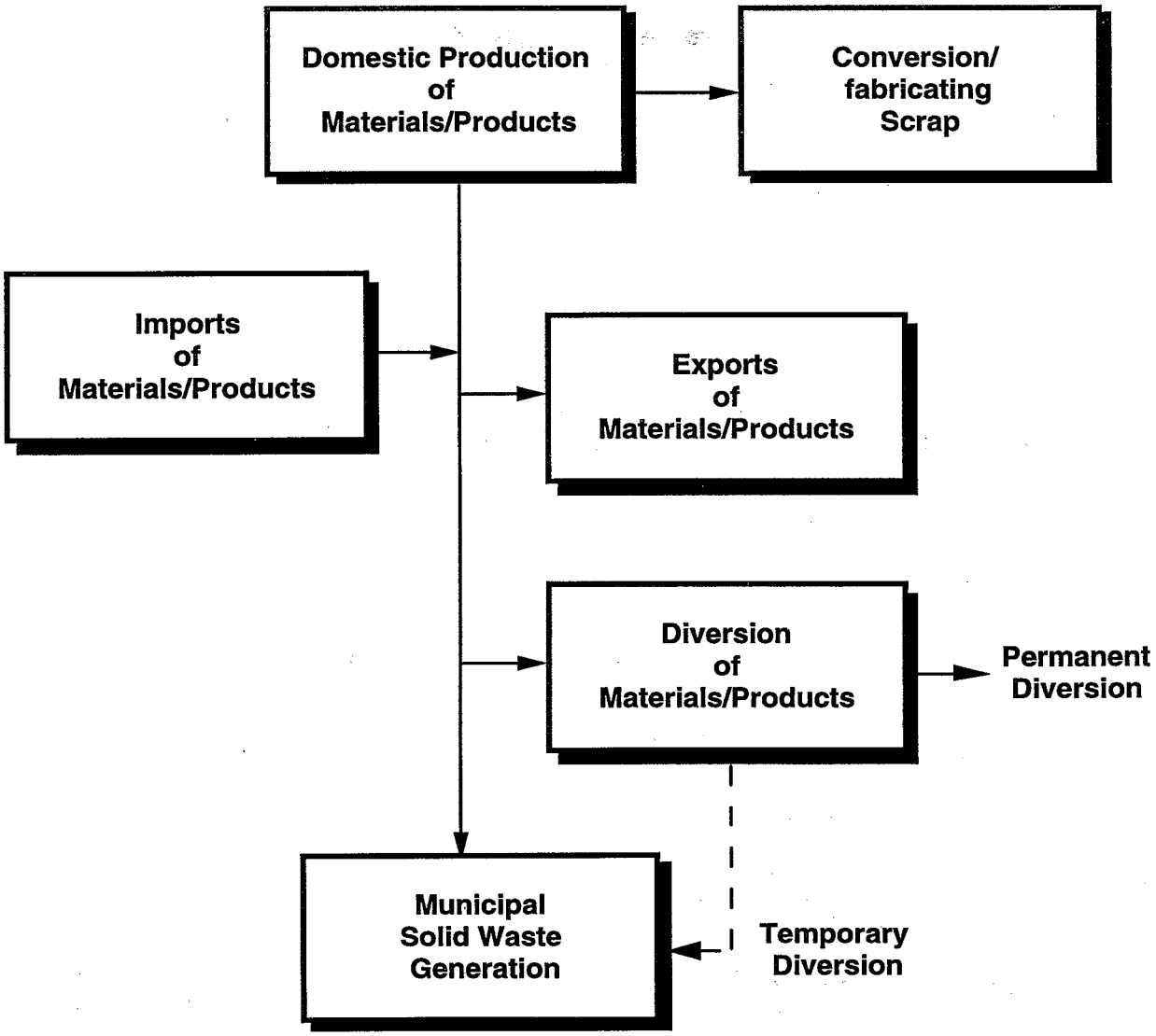

Figure A-1. Material flows methodology for estimating generation of products and materials in municipal solid waste.

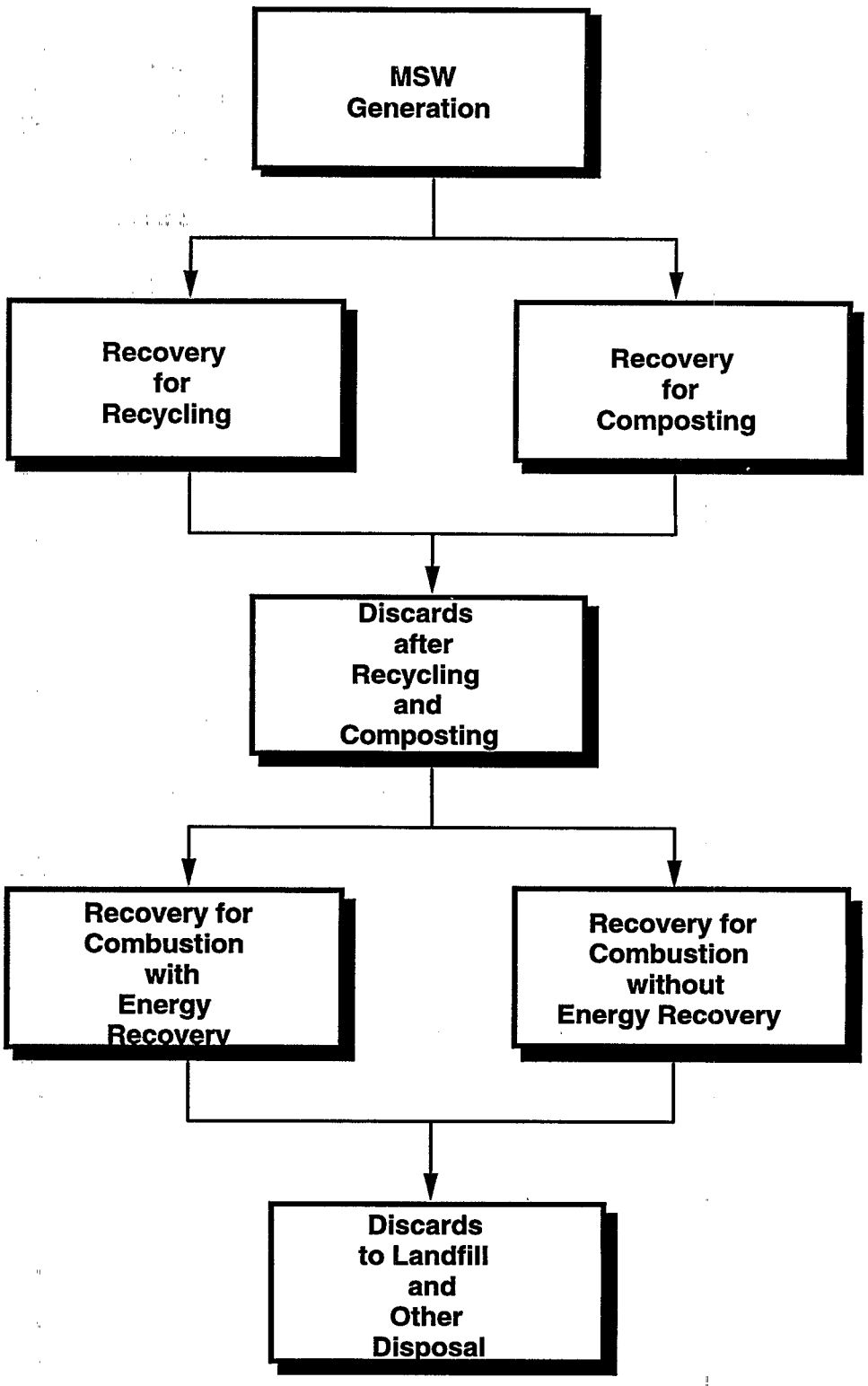

Figure A-2. Material flows methodology for estimating discards of products and materials in municipal solid waste.

ADJUSTMENTS FOR PRODUCT LIFETIME

Some products (e.g., newspapers and packaging) normally have a very short lifetime; these products are assumed to be discarded in the same year they are produced. In other instances (e.g., furniture and appliances), products have relatively long lifetimes. Data on average product lifetimes are used to adjust the data series to account for this.

MUNICIPAL SOLID WASTE GENERATION AND DISCARDS

The result of these estimates and calculations is a material-by-material and product-by-product estimate of MSW generation, recovery, and discards.

Appendix B

ADDITIONAL PERSPECTIVES ON MUNICIPAL SOLID WASTE

In this appendix, the municipal solid waste (MSW) characterization data summarized in previous chapters of the report are presented again from different perspectives. These are:

- Historical and 1997 MSW generation and management on a pounds per person per day basis
- Historical and 1997 MSW generation by material on a pounds per person per day basis
- A classification of 1997 MSW generation into residential and commercial components
- Historical and 1997 discards of MSW classified into organic and inorganic fractions
- A ranking of products and materials in 1997 MSW by tonnage generated, recovered for recycling, and discarded.

Generation and Discards by Individuals

Municipal solid waste planners often think in terms of generation and discards on a per capita (per person) basis. Data on historical and projected MSW generation and management are presented on the basis of pounds per person per day in Table B-1. The top line shows a steady increase in per capita generation of MSW from 1960 to 1990, from 2.7 pounds per person per day in 1960 to 4.5 pounds per person per day in 1990. During the 1990s, however, the per capita generation rate decreased to 4.3 pounds per person per day in 1996, then increased again to 4.4 pounds per person per day in 1997. The primary reason for a decline in growth of MSW generation is a decrease in yard trimmings entering the MSW management system. In 1997, generation of most other materials in MSW increased following declines in 1995 and 1996.

The per capita discards represent the amount remaining after recovery for recycling (including composting). Discards after recovery for recycling grew from 2.5 pounds per person per day in 1960 to 3.8 pounds per person per day in 1990. Between 1990 and 1997, discards declined to 3.2 pounds per person per day due to increased recovery for recycling (including composting).

In 1997, an estimated 0.75 pounds per person per day of discards were managed through combustion, while the remainder—2.45 pounds per person per day—went to landfill or other disposal.

Table B-1

PER CAPITA GENERATION, MATERIALS RECOVERY, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 1997
(In pounds per person per day; population in thousands)

	1960	1970	1980	1990	1994	1995	1996	1997
Generation	2.68	3.25	3.66	4.50	4.50	4.40	4.32	4.44
Recovery for recycling & composting	0.17	0.22	0.35	0.73	1.06	1.14	1.18	1.24
Discards after recovery	2.51	3.04	3.31	3.77	3.44	3.26	3.14	3.20
Combustion	0.82	0.67	0.33	0.70	0.68	0.74	0.75	0.75
Discards to landfill, other disposal	1.69	2.36	2.98	3.07	2.75	2.51	2.39	2.45
Resident Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	265,253	267,645

Details may not add to totals due to rounding.
Population figures from U.S. Bureau of the Census, Current Population Reports.
Source: Franklin Associates

In Table B-2, per capita generation of each material category characterized in this study is shown. The per capita generation rate for paper and paperboard products has nearly doubled from 1960 (0.91 versus 1.72 pounds per person per day). However, since 1990 per capita paper generation has remained relatively steady—between 1.6 and 1.7 pounds per person per day. Plastics has experienced the largest per capita growth rate, increasing to 0.44 pounds per person per day in 1997. After experiencing growth from 1960 to 1990, per capita generation rates for glass products has declined slightly. Per capita generation rates for metals have been consistent at about 0.3 pounds per person per day since 1994. Per capita generation rates for rubber and leather and textile products have increased to 0.13 and 0.17 pounds per person per day, respectively. After growing steadily, the increasing use of reusable pallets in the 1990s has resulted in a decrease in per capita wood generation—to 0.24 pounds per person per day in 1997.

Generation of food wastes has remaining at about 0.45 pounds per person per day during the 1990s (Note: There has been a change in food waste generation methodology reflected in years 1990 through 1997). Generation of yard trimmings on a per capita basis increased over a 30-year period, but then declined because of source reduction efforts. Generation of yard trimmings was 0.57 pounds per person per day in 1997.

Until about 1990, per capita generation of MSW increased in nearly every year. Per capita generation of nonfood products did decline in 1995 and 1996, then increased again in 1997. Declining per capita generation of yard trimmings did not compensate for the increased generation of products in 1997.

Table B-2

PER CAPITA GENERATION* OF MUNICIPAL SOLID WASTE, BY MATERIAL, 1960 TO 1997
(In pounds per person per day)

Materials	1960	1970	1980	1990	1994	1995	1996	1997
Paper and paperboard	0.91	1.19	1.33	1.59	1.70	1.70	1.65	1.72
Glass	0.20	0.34	0.36	0.29	0.28	0.27	0.26	0.25
Metals	0.33	0.37	0.37	0.36	0.34	0.33	0.33	0.34
Plastics	0.01	0.08	0.16	0.38	0.40	0.39	0.41	0.44
Rubber and leather	0.06	0.08	0.10	0.13	0.13	0.13	0.13	0.13
Textiles	0.05	0.05	0.06	0.13	0.15	0.15	0.16	0.17
Wood	0.09	0.10	0.17	0.27	0.24	0.22	0.22	0.24
Other	0.00	0.02	0.06	0.07	0.08	0.08	0.08	0.08
Total Nonfood Products	1.66	2.24	2.63	3.21	3.32	3.26	3.23	3.36
Food wastes	0.37	0.34	0.31	0.46	0.45	0.45	0.45	0.45
Yard trimmings	0.61	0.62	0.66	0.77	0.66	0.62	0.58	0.57
Miscellaneous inorganic wastes	0.04	0.05	0.05	0.06	0.07	0.07	0.07	0.07
Total MSW Generated	2.68	3.25	3.66	4.50	4.50	4.40	4.32	4.44
Resident Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	265,253	267,645

* Generation before materials or energy recovery.
Details may not add to totals due to rounding.
Source: Table 1. Population figures from the Bureau of the Census, Current Population Reports.

Residential and Commercial Generation of MSW

The sources of MSW generation are of considerable interest to management planners. The material flows methodology does not lend itself well to a distinction as to sources of the materials because the data used are national in scope. However, a classification of products and materials by residential and commercial sources was first made for the 1992 update of this series of reports.

For purposes of this classification, residential waste was considered to come from both single family and multi-family residences. This is somewhat contrary to a common practice in MSW management to classify wastes collected from apartment buildings as commercial. The rationale used for this report is that the nature of residential waste is basically the same whether it is generated in a single or multi-family residence. (Yard trimmings are probably the primary exception, and this was taken into account.) Because of this approach, the percentage of residential waste shown here is higher than that often reported by waste haulers.

Commercial wastes for the purpose of this classification include MSW from retail and wholesale establishments; hotels; office buildings; airports and train stations; hospitals, schools, and other institutions; and similar sources. No industrial process wastes are included, but normal MSW such as packaging, cafeteria and washroom wastes, and office wastes from industrial sources are included. As is the case for the data in Chapter 2, construction and demolition wastes, sludges, ashes, automobile bodies, and other non-MSW wastes are not included.

The classification of MSW generation into residential and commercial fractions was made on a product-by-product basis. (See Appendix D for details). The 1997 tonnage generation of each product was allocated to residential or commercial sources on a "best judgement" basis; then the totals were aggregated. These are estimates for the nation as a whole, and should not be taken as representative of any particular region of the country.

Since these allocations were first made for this report in 1994, a few revisions to the methodology have been made based on estimates made in a 1994 report for Keep America Beautiful, which was extensively reviewed by public and private sector experts in municipal solid waste management. Discards of major appliances and rubber tires were reassigned to the commercial sector rather than the residential sector because, while these products may be used in a residential setting, they tend to be collected and managed through the commercial sector.

Table B-3

CLASSIFICATION OF MSW GENERATION INTO RESIDENTIAL AND COMMERCIAL FRACTIONS, 1997
(In thousands of tons and percent of total)

	Thousand tons	Percent of total
Residential Wastes	141,030 – 119,330	55.0% – 65.0%
Commercial Wastes	97,640 – 75,940	35.0% – 45.0%

Estimates are presented as a range because of wide variations across the country.
Source: Franklin Associates (Appendix D)

Based on this analysis, a reasonable range for residential wastes would be 55 to 65 percent of total MSW generation, while commercial wastes range between 35 to 45 percent of total generation (Table B-3).

Organic/Inorganic Fractions of MSW Discards

The composition of MSW in terms of organic and inorganic fractions is of interest to planners of waste management facilities and others working with MSW. This characterization of MSW discards is shown in Table B-4. (Discards were used instead of generation because discards enter the solid waste management system after recovery for recycling, including composting.)

Table B-4

COMPOSITION OF MSW DISCARDS* BY ORGANIC AND INORGANIC FRACTIONS, 1960 TO 1997
(In percent of total discards)

Year	Organics**	Inorganics†
1960	77.3%	22.7%
1970	75.5%	24.5%
1980	77.5%	22.5%
1990	84.9%	15.1%
1997	85.6%	14.4%

* Discards after materials recovery has taken place, and before combustion.
** Includes paper, plastics, rubber and leather, textiles, wood, food wastes, and yard trimmings.
† Includes glass, metals, and miscellaneous inorganics.
Details may not add to totals due to rounding.

Source: Table 3.

The organic fraction of MSW has been increasing steadily since 1970, from 75 percent organics in 1970 to nearly 86 percent in 1997. It is interesting to note, however, that the percentage of MSW that is organic began to "level off" after 1990 because of the decline in yard trimmings discarded.

Ranking of Products in MSW by Weight

About 50 categories of products and materials are characterized as line items in the tables in Chapter 2. It is difficult when examining that set of tables to see in perspective the relative tonnages generated or discarded by the different items. Therefore, Tables B-5, B-6, and B-7 were developed to illustrate this point.

In Table B-5, the various MSW products and materials are arranged in descending order by weight generated in 1997. Subtotals in the right-hand column group components together for further illustration. For example, corrugated boxes, yard trimmings, and food wastes stand at the top of the list, with each generating over 10 percent of total MSW. Together these three items totaled 36.8 percent of MSW generated in 1997. The next six components, each comprising 3 to 6 percent of total MSW generation, accounted for 25.2 percent of generation. Together these nine components accounted for over 62 percent of total MSW generated. The 22 items at the bottom of the list each amounted to one percent or less of generation in 1997; together they amounted to only 11.1 percent of total MSW generation.

Table B-6 ranks products in descending order by weight recovered in 1997. Three products—corrugated boxes, yard trimmings, and newspapers—each account for over 12 percent of total recovery, and collectively account for over 64 percent of MSW recovery. The next three components, each comprising 3 to 6 percent of total MSW recovery, accounted for 12.8 percent of recovery. The bottom 18 items each amounted to one percent or less of recovery in 1997; together they amounted to less than 7.0 percent of total MSW recovery.

A different perspective is provided in Table B-7, which ranks products in MSW by weight discarded after recovery for recycling (including composting). This table illustrates how recovery alters the products' generation rankings. For example, corrugated boxes, which ranked the highest in generation, ranked fourth in discards in 1997.

Food wastes and yard trimmings accounted for about 24 percent of total MSW discards in 1997. Eight components, each representing 3 to 8 percent of total MSW discards, accounted for about 37 percent of discards. These components included; miscellaneous durables, corrugated boxes, furniture and furnishings, wood packaging, newspapers, other commercial printing, clothing and footwear, and paperboard folding cartons. Together these 10 components made up 61 percent of MSW discards in 1997. Twenty-two categories of discards were one percent or less of the total; together these items totaled 11.4 percent of 1997 discards.

Characterization of MSW Discards by Volume

Solid waste is generally characterized by weight, either in pounds or tons. Most statistics are compiled by weight because landfill, combustion, and recycling facilities generally charge fees by weight, and estimates of quantities are stated in tons. Weight can be readily and accurately measured using scales. However, there is no standard methodology for measuring municipal solid waste volume. Results of research into establishing conversion factors from weight to volume were presented in detail in previous updates of this report (i.e., 1990 and 1994 updates).

This section of Appendix B presents estimates of MSW discards by volume for 1997 using density factors previously developed. Table B-8 summarizes these estimated density factors for major categories of landfilled materials.

Table B-5

GENERATION OF MUNICIPAL SOLID WASTE, 1997
ARRANGED IN DESCENDING ORDER BY WEIGHT
(In thousands of tons and percent of MSW generation)

	Thousand Tons	Percent of Total	Cumulative Percent
Corrugated boxes	30,160	13.9%	13.9%
Yard trimmings	27,730	12.8%	26.7%
Food wastes	21,910	10.1%	36.8%
Newspapers	13,490	6.2%	43.0%
Miscellaneous durables	12,910	6.0%	48.9%
Furniture and furnishings	7,510	3.5%	52.4%
Office-type papers	7,040	3.2%	55.7%
Wood packaging	7,030	3.2%	58.9%
Other commercial printing	6,860	3.2%	62.1%
Clothing and footwear	5,760	2.7%	64.7%
Paper folding cartons	5,420	2.5%	67.2%
Glass beer & soft drink bottles	4,960	2.3%	69.5%
Standard (A) mail	4,850	2.2%	71.7%
Other nonpackaging paper	4,270	2.0%	73.7%
Rubber tires	4,260	2.0%	75.7%
Glass food & other bottles	3,830	1.8%	77.4%
Major appliances	3,610	1.7%	79.1%
Miscellaneous nondurables	3,450	1.6%	80.7%
Miscellaneous inorganic wastes	3,250	1.5%	82.2%
Disposable diapers	3,140	1.4%	83.6%
Steel cans and other packaging	3,100	1.4%	85.1%
Tissue paper and towels	3,100	1.4%	86.5%
Other plastic packaging	2,810	1.3%	87.8%
Carpets and rugs	2,330	1.1%	88.9%
Magazines	2,170	1.0%	89.9%
Plastic wraps	2,130	1.0%	90.8%
Aluminum cans and other packaging	1,940	0.9%	91.7%
Paper bags and sacks	1,870	0.9%	92.6%
Glass wine & liquor bottles	1,820	0.8%	93.4%
Lead-acid batteries	1,780	0.8%	94.2%
Plastic other containers	1,540	0.7%	95.0%
Plastic bags and sacks	1,520	0.7%	95.7%
Other paper packaging	1,270	0.6%	96.2%
Books	1,110	0.5%	96.8%
Paper plates and cups	970	0.4%	97.2%
Plastic trash bags	810	0.4%	97.6%
Plastic plates and cups	860	0.4%	98.0%
Small appliances	830	0.4%	98.4%
Plastic soft drink bottles	760	0.4%	98.7%
Towels, sheets, and pillowcases	750	0.3%	99.1%
Plastic milk bottles	670	0.3%	99.4%
Directories	470	0.2%	99.6%
Paper milk cartons	460	0.2%	99.8%
Other paperboard packaging	220	0.1%	99.9%
Other miscellaneous packaging	190	0.1%	100.0%
Paper wraps	50	<0.1%	100.0%
Total MSW Generation	216,970	100.0%	

Source: Chapter 2.

Table B-6

RECOVERY OF MUNICIPAL SOLID WASTE, 1997
ARRANGED IN DESCENDING ORDER BY WEIGHT
(In thousands of tons and percent of MSW recovery)

	Thousand Tons	Percent of Total	Cumulative Percent
Corrugated boxes	20,290	33.4%	33.4%
Yard trimmings	11,490	18.9%	52.4%
Newspapers	7,370	12.1%	64.5%
Office-type papers	3,570	5.9%	70.4%
Major appliances	2,320	3.8%	74.2%
Steel cans and other packaging	1,890	3.1%	77.3%
Lead-acid batteries	1,660	2.7%	80.0%
Glass beer & soft drink bottles	1,550	2.6%	82.6%
Other commercial printing	1,130	1.9%	84.5%
Rubber tires	950	1.6%	86.0%
Standard (A) mail	950	1.6%	87.6%
Aluminum cans and other packaging	940	1.5%	89.1%
Glass food & other bottles	930	1.5%	90.7%
Clothing and footwear	760	1.3%	91.9%
Miscellaneous durables	690	1.1%	93.1%
Wood packaging	590	1.0%	94.0%
Food wastes*	580	1.0%	95.0%
Paper folding cartons	560	0.9%	95.9%
Magazines	500	0.8%	96.7%
Glass wine & liquor bottles	440	0.7%	97.5%
Paper bags and sacks	280	0.5%	97.9%
Plastic soft drink bottles	270	0.4%	98.4%
Plastic milk and other bottles	210	0.3%	98.7%
Plastic other containers	200	0.3%	99.0%
Books	200	0.3%	99.4%
Towels, sheets, and pillowcases	130	0.2%	99.6%
Directories	70	0.1%	99.7%
Plastic wraps	50	0.1%	99.8%
Other plastic packaging	50	0.1%	99.9%
Plastic bags and sacks	40	0.1%	99.9%
Carpets and rugs	20	<0.1%	100.0%
Paper milk cartons	10	<0.1%	100.0%
Small appliances	10	<0.1%	100.0%
Total MSW Recovery	60,700	100.0%	

* Includes some recovery of paper for composting.

Source: Chapter 2.

Table B-7

DISCARDS OF MUNICIPAL SOLID WASTE, 1997
ARRANGED IN DESCENDING ORDER BY WEIGHT
(In thousands of tons and percent of discards)

	Thousand Tons	Percent of Total	Cumulative Percent
Food wastes	21,330	13.6%	13.6%
Yard trimmings	16,240	10.4%	24.0%
Miscellaneous durables	12,220	7.8%	31.9%
Corrugated boxes	9,870	6.3%	38.2%
Furniture and furnishings	7,510	4.8%	43.0%
Wood packaging	6,440	4.1%	47.1%
Newspapers	6,120	3.9%	51.0%
Other commercial printing	5,730	3.7%	54.7%
Clothing and footwear	5,000	3.2%	57.9%
Paper folding cartons	4,860	3.1%	61.0%
Other nonpackaging paper	4,270	2.7%	63.7%
Standard (A) mail	3,900	2.5%	66.2%
Office-type papers	3,470	2.2%	68.4%
Miscellaneous nondurables	3,450	2.2%	70.7%
Glass beer & soft drink bottles	3,410	2.2%	72.8%
Rubber tires	3,310	2.1%	75.0%
Miscellaneous inorganic wastes	3,250	2.1%	77.0%
Disposable diapers	3,140	2.0%	79.0%
Tissue paper and towels	3,100	2.0%	81.0%
Glass food & other bottles	2,900	1.9%	82.9%
Other plastic packaging	2,760	1.8%	84.6%
Carpets and rugs	2,310	1.5%	86.1%
Plastic wraps	2,080	1.3%	87.5%
Magazines	1,670	1.1%	88.5%
Paper bags and sacks	1,590	1.0%	89.5%
Plastic bags and sacks	1,480	0.9%	90.5%
Glass wine & liquor bottles	1,380	0.9%	91.4%
Plastic other containers	1,340	0.9%	92.2%
Major appliances	1,290	0.8%	93.1%
Other paper packaging	1,270	0.8%	93.9%
Steel cans and other packaging	1,210	0.8%	94.6%
Aluminum cans and other packaging	1,000	0.6%	95.3%
Paper plates and cups	970	0.6%	95.9%
Books	910	0.6%	96.5%
Plastic plates and cups	860	0.6%	97.0%
Small appliances	820	0.5%	97.6%
Trash bags	810	0.5%	98.1%
Towels, sheets, and pillowcases	620	0.4%	98.5%
Plastic soft drink bottles	490	0.3%	98.8%
Plastic milk and other bottles	460	0.3%	99.1%
Paper milk cartons	450	0.3%	99.4%
Directories	400	0.3%	99.6%
Other paperboard packaging	220	0.1%	99.8%
Other miscellaneous packaging	190	0.1%	99.9%
Lead-acid batteries	120	0.1%	100.0%
Paper wraps	50	<0.1%	100.0%
Total MSW Discards	156,270	100.0%	

Source: Chapter 2.

Table B-8

SUMMARY OF ESTIMATED DENSITY FACTORS FOR LANDFILLED MATERIALS

	Density (lb/cu yd)
Durable Goods	475
Nondurable Goods	
Nondurable paper	800
Nondurable plastic	315
Disposable diapers	
Diaper materials	795
Urine and feces	1,350
Rubber	345
Textiles	435
Miscellaneous nondurables	390
Containers and Packaging	
Glass containers	
Beer & soft drink bottles	2,800
Other containers	2,800
Steel Containers	
Beer & soft drink cans	560
Food cans	560
Other packaging	560
Aluminum	
Beer & soft drink cans	250
Other packaging	550
Paper and Paperboard	
Corrugated	750
Other paperboard	820
Paper packaging	740
Plastics	
Film	670
Rigid containers	355
Other packaging	185
Wood packaging	800
Other miscellaneous packaging	1,015
Food Wastes	2,000
Yard Trimmings	1,500

Reference: U.S. Environmental Protection Agency. "Characterization of Municipal Solid Waste in the United States: 1994 Update." EPA/530-R-94-042. November 1994.

Table B-9

ESTIMATED VOLUME OF PRODUCTS DISCARDED IN MSW, 1997

	1997 Discards* (thousand tons)	Weight (% of total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of total)
DURABLE GOODS	27,580	17.6%	475	116,126	27.5%
NONDURABLE GOODS					
Newspapers	6,120	3.9%	800	15,300	3.6%
Books	910	0.6%	800	2,275	0.5%
Magazines	1,670	1.1%	800	4,175	1.0%
Office papers	3,470	2.2%	800	8,675	2.1%
Directories	400	0.3%	800	1,000	0.2%
Standard (A) mail	3,900	2.5%	800	9,750	2.3%
Other commercial printing	5,730	3.7%	800	14,325	3.4%
Tissue paper and towels	3,100	2.0%	800	7,750	1.8%
Paper plates and cups	970	0.6%	800	2,425	0.6%
Plastic plates and cups	860	0.6%	355	4,845	1.1%
Trash bags	810	0.5%	670	2,418	0.6%
Disposable diapers	3,140	2.0%	1,150	5,460	1.3%
Other nonpackaging paper	4,270	2.7%	800	10,675	2.5%
Clothing and footwear	5,000	3.2%	435	22,989	5.4%
Towels, sheets & pillowcases	620	0.4%	435	2,851	0.7%
Other misc. nondurables	3,450	2.2%	390	17,692	4.2%
Total Nondurable Goods	44,420	28.4%	699	127,144	30.1%
CONTAINERS AND PACKAGING					
Glass Packaging					
Beer and soft drink	3,410	2.2%	2,800	2,436	0.6%
Wine and liquor	1,380	0.9%	2,800	986	0.2%
Food and other bottles & jars	2,900	1.9%	2,800	2,071	0.5%
Total Glass Packaging	7,690	4.9%	2,800	5,493	1.3%
Steel Packaging					
Food and other cans	1,130	0.7%	560	4,036	1.0%
Other steel packaging	80	0.1%	560	286	0.1%
Total Steel Packaging	1,210	0.8%	560	4,321	1.0%
Aluminum Packaging					
Beer and soft drink cans	620	0.4%	250	4,960	1.2%
Other cans	50	0.0%	250	400	0.1%
Foil and closures	330	0.2%	550	1,200	0.3%
Total Aluminum Pkg	1,000	0.6%	305	6,560	1.6%
Paper & Paperboard Pkg					
Corrugated boxes	9,870	6.3%	750	26,320	6.2%
Milk cartons	450	0.3%	820	1,098	0.3%
Folding cartons	4,860	3.1%	820	11,854	2.8%
Other paperboard packaging	220	0.1%	820	537	0.1%
Bags and sacks	1,590	1.0%	740	4,297	1.0%
Wrapping paper	50	0.0%	800	125	0.0%
Other paper packaging	1,270	0.8%	740	3,432	0.8%
Total Paper & Board Pkg	18,310	11.7%	768	47,663	11.3%

(continued on next page)

Table B-9 (continued)

ESTIMATED VOLUME OF PRODUCTS DISCARDED IN MSW, 1997

	1997 Discards* (thousand tons)	Weight (% of total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of total)
Plastics Packaging					
Soft drink bottles	490	0.3%	355	2,761	0.7%
Milk and other bottles	460	0.3%	355	2,592	0.6%
Other containers	1,340	0.9%	355	7,549	1.8%
Bags and sacks	1,480	0.9%	670	4,418	1.0%
Wraps	2,080	1.3%	670	6,209	1.5%
Other plastics packaging	2,760	1.8%	185	29,838	7.1%
Total Plastics Packaging	8,610	5.5%	323	53,366	12.6%
Wood packaging	6,440	4.1%	800	16,100	3.8%
Other misc. packaging	190	0.1%	1,015	374	0.1%
Total Containers & Packaging	43,450	27.8%	649	133,877	31.7%
Total Product Waste†	115,450	73.9%	612	377,148	89.2%
Other Wastes					
Food wastes	21,330	13.6%	2,000	21,330	5.0%
Yard trimmings	16,240	10.4%	1,500	21,653	5.1%
Miscellaneous inorganics	3,250	2.1%	2,500	2,600	0.6%
Total Other Wastes	40,820	26.1%	1,791	45,583	10.8%
TOTAL MSW DISCARDED	156,270	100%	739 ‡	422,731 ‡	100%

* From Chapter 2. Discards after materials recovery and composting, before combustion and landfilling.

** From Table B-8.

*** This assumes that all waste discards are landfilled, but some are combusted.

† Other than food products.

‡ This density factor and volume are derived by adding the individual factors. Actual landfill density and densities of certain products may be considerably higher than shown (see discussion in text).

Source: Franklin Associates

The estimated volume of MSW discards by product (Table B-9) and material (Table B-10), in cubic yards, was derived from Chapter 2 and Table B-8. (It is necessary to characterize the volume of MSW *discards* rather than generation because discard estimates most closely match the wastes received at a landfill, where the experimental data were derived. Discards include the waste left after materials recovery and composting and before combustion, landfilling, or other disposal.)

The data in Tables B-9 and B-10 are useful in comparing relative volumes of products and materials in a landfill. However, caution is advised when using the data in these tables. The density values in Table B-8 are based on sorted MSW materials. The intermingling of different materials with different characteristics, as occurs in a landfill, results in filling more air space than if the materials were landfilled individually (or apart from each other). For example, mixing one cubic yard of paper with one cubic yard of plastic results in less than two cubic yards of material. At best, the data in the tables may provide an indication of the relative order of densities and volumes of the various waste components in a landfill.

The calculated MSW landfill densities shown in Tables B-9 and B-10 are about 750 pounds per cubic yard, significantly less than what is typically reported in modern landfills. Densities achieved in landfills that accept MSW are reported to vary between 700 and 1,600 pounds per cubic yard. A minimum initial compaction density of 1,000 pounds per cubic yard is sometimes recommended in landfill operator training courses. As landfill depth increases, the density of the waste increases. Higher densities are found in other solid wastes disposed in landfills. The MSW discards density would, therefore, need to be higher than shown here in order to achieve the landfill densities generally reported today.

Table B-10

ESTIMATED VOLUME OF MATERIALS DISCARDED IN MSW, 1997

	1997 Discards* (thousand tons)	Weight (% of MSW total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of MSW total)
Paper & Paperboard	48,920	31.3	795	123,069	29.2
Plastics	20,350	13.0	370	110,000	26.1
Textiles	7,180	4.6	410	35,024	8.3
Rubber & Leather	5,820	3.7	355	32,789	7.8
Ferrous Metals	7,600	4.9	570	26,667	6.3
Wood	10,980	7.0	850	25,835	6.1
Yard Trimmings	16,240	10.4	1,500	21,653	5.1
Food Wastes	21,330	13.6	2,000	21,330	5.1
Aluminum	2,070	1.3	380	10,895	2.6
Glass	9,090	5.8	2,500	7,272	1.7
Other†	6,690	4.3	2,100	6,371	1.5
Totals	156,270	100.0	743 ‡	420,906 ‡	100.0

* From Chapter 2. Discards after materials recovery and composting, before combustion and landfilling.

** Composite material density factors developed by Franklin Associates, Ltd.

*** This assumes that all waste discards are landfilled, but some are combusted.

† Found by difference to obtain total to match products table. Note: Results in this table and Table B-9 are not identical due to rounding differences.

‡ This density factor and volume are derived by adding the individual factors. Actual landfill density and densities of certain materials may be considerably higher than shown (see discussion in text).

Source: Franklin Associates

Appendix C

RECOVERY SCENARIOS FOR 2000 AND 2005

Because of the rapidly changing situation and uncertainty in the available data, projections of materials recovery were made in scenarios that could achieve different rates of recovery in 2000 and 2005. Scenarios were developed for total MSW recovery rates of 30 and 32 percent recovery rates in 2000; and 32 and 35 percent recovery rates in 2005. These scenarios are based on recovery of postconsumer MSW and do not include industrial scrap. Also, estimates for composting of food wastes and yard trimmings are including in these scenarios.

The recovery scenarios developed for this report describe sets of conditions that could achieve the selected range of recovery rates. The scenarios are not intended to predict exact recovery rates for any particular material; there are many ways in which a selected overall recovery rate could be achieved.

Discussion of Assumptions

Some general assumptions and principles were used in making the recovery estimates:

- Recovery for recycling includes composting. Recovered materials are assumed to have been removed from the municipal waste stream.
- It was assumed that local, state, and federal agencies will continue to emphasize recycling, including composting, as MSW management alternatives.
- It was assumed that present state deposit laws will remain in place, but that no additional deposit legislation for containers would be enacted.
- It was assumed that affected industries will continue to emphasize recovery and recycling programs, and will make the necessary investments to achieve higher recycling rates.
- It was assumed that the current trend toward diverting certain yard trimmings in landfills will continue to 2000 and beyond, providing stimulus for composting programs and for source reduction of yard trimmings by citizens.
- It was assumed that, for most materials, there will be adequate end-user capacity to utilize all recovered materials that could reasonably be recovered. As discussed above, this may depend upon worldwide economic conditions.
- A majority of U.S. citizens will have access to recovery options before 2000. These options will include curbside collection, drop-off and buy-back centers, and, in some instances, mixed waste processing facilities. Recovery will continue to increase as more recovery systems come on-line.

- In spite of the factors encouraging more recovery as enumerated above, many areas of the U.S. are thinly populated and/or remote from ready markets for recovered materials; many of these areas also have adequate landfill capacity. Therefore, the overall recovery rate for the entire country may not reflect the higher rates achieved in communities where conditions are favorable for recycling, including composting.

- Because of a maturing of the recycling/composting infrastructure and current poor market conditions, the rate of increase in recycling will be slower that that experienced in the earlier 1990s.

The ranges of projected recovery assumptions for the various materials in MSW are shown for 2000 and 2005 in Table C-1 and Table C-2, respectively. Assumed recovery rates were based on existing recovery rates in 1997, with projected growth that seemed reasonably achievable nationwide for the period of time under consideration. Projections for each product in MSW were made separately, and the results were aggregated, with some minor adjustments to achieve the selected scenarios for each year. It is certainly possible (indeed, probable) that any given material will be recovered at higher or lower rates than those given here, but the scenarios illustrate how the selected recovery rates could be reached.

Table C-1

SCENARIOS FOR RECOVERY OF MSW, 2000

(In thousands of tons and percent of generation)

Products	Generation	30% Recovery		32% Recovery	
		Tons	%	Tons	%
Durable Goods					
Major Appliances (ferrous metals only)	2,720	2,350	86.4%	2,400	88.2%
Rubber Tires	4,270	1,000	23.4%	1,100	25.8%
Batteries, lead acid					
Nonferrous metals	890	860	96.6%	870	97.8%
Plastics	80	75	93.8%	75	93.8%
Misc. Durables (ferrous metals only)	4,380	480	11.0%	600	13.7%
Other Durables	23,250	600	2.6%	800	3.4%
Total Durable Goods	35,590	5,365	15.1%	5,845	16.4%
Nondurable Goods					
Newspapers	13,560	7,800	57.5%	8,200	60.5%
Books	1,190	240	20.2%	280	23.5%
Magazines	2,540	680	26.8%	720	28.3%
Office- type Papers	7,420	3,800	51.2%	4,000	53.9%
Directories	490	80	16.3%	100	20.4%
Standard (A) Mail	5,080	1,100	21.7%	1,300	25.6%
Other Commercial Printing	7,150	1,200	16.8%	1,400	19.6%
Other Nondurable Paper	8,530	50	0.6%	100	1.2%
Textiles, Footwear	6,950	1,150	16.5%	1,300	18.7%
Other Nondurables	9,280	90	1.0%	100	1.1%
Total Nondurable Goods	62,190	16,190	26.0%	17,500	28.1%
Containers and Packaging					
Glass Containers	10,350	3,400	32.9%	3,800	36.7%
Steel Containers & Pkg	3,090	1,900	61.5%	2,090	67.6%
Aluminum Packaging	2,250	1,280	56.9%	1,320	58.7%
Paper & Paperboard Packaging					
Corrugated Containers	32,210	21,800	67.7%	22,500	69.9%
Other Packaging	9,480	1,500	15.8%	1,800	19.0%
Total Paper & Board Pkg	41,690	23,300	55.9%	24,300	58.3%
Plastics Packaging					
Soft Drink Bottles	770	290	37.7%	320	41.6%
Milk Bottles	740	250	33.8%	300	40.5%
Other Containers	1,650	270	16.4%	290	17.6%
Other Plastics Packaging	6,830	400	5.9%	480	7.0%
Total Plastics Packaging	9,990	1,210	12.1%	1,390	13.9%
Wood Packaging	8,950	1,200	13.4%	1,400	15.6%
Other Misc. Packaging	180	0	0.0%	0	0.0%
Total Containers & Packaging	76,500	32,290	42.2%	34,300	44.8%
Total Product Waste*	174,280	53,845	30.9%	57,645	33.1%
Other Wastes					
Yard Trimmings	23,000	12,000	52.2%	12,400	53.9%
Food Wastes	22,550	1,100	4.9%	1,300	5.8%
Other Wastes	3,400	0	0.0%	0	0.0%
TOTAL MSW	223,230	66,945	30.0%	71,345	32.0%

* Other than food products.

Details may not add to totals due to rounding.

Source: Franklin Associates

Table C-2

SCENARIOS FOR RECOVERY OF MSW, 2005

(In thousands of tons and percent of generation)

Products	Generation	32% Recovery		35% Recovery	
		Tons	%	Tons	%
Durable Goods					
Major Appliances (ferrous metals only)	2,620	2,300	87.8%	2,400	91.6%
Rubber Tires	4,610	1,200	26.0%	1,350	29.3%
Batteries, lead acid					
Nonferrous metals	930	900	96.8%	910	97.8%
Plastics	80	75	93.8%	76	95.0%
Misc. Durables (ferrous metals only)	4,760	800	16.8%	900	18.9%
Other Durables	25,960	1,400	5.4%	2,000	7.7%
Total Durable Goods	38,960	6,675	17.1%	7,636	19.6%
Nondurable Goods					
Newspapers	13,750	8,600	62.5%	8,950	65.1%
Books	1,400	280	20.0%	320	22.9%
Magazines	3,050	800	26.2%	1,000	32.8%
Office- type Papers	8,020	4,200	52.4%	4,500	56.1%
Directories	590	90	15.3%	100	16.9%
Standard (A) Mail	5,510	1,300	23.6%	1,500	27.2%
Other Commercial Printing	7,500	1,300	17.3%	1,500	20.0%
Other Nondurable Paper	9,400	100	1.1%	150	1.6%
Textiles, Footwear	8,110	1,400	17.3%	1,700	21.0%
Other Nondurables	10,350	100	1.0%	100	1.0%
Total Nondurable Goods	67,680	18,170	26.8%	19,820	29.3%
Containers and Packaging					
Glass Containers	9,580	3,500	36.5%	3,800	39.7%
Steel Containers & Pkg	3,140	2,200	70.1%	2,350	74.8%
Aluminum Packaging	2,460	1,500	61.0%	1,600	65.0%
Paper & Paperboard Packaging					
Corrugated Containers	35,840	24,400	68.1%	26,000	72.5%
Other Packaging	9,650	1,750	18.1%	2,200	22.8%
Total Paper & Board Pkg	45,490	26,150	57.5%	28,200	62.0%
Plastics Packaging					
Soft Drink Bottles	920	500	54.3%	550	59.8%
Milk Bottles	880	330	37.5%	400	45.5%
Other Containers	1,810	310	17.1%	340	18.8%
Other Plastics Packaging	8,120	500	6.2%	600	7.4%
Total Plastics Packaging	11,730	1,640	14.0%	1,890	16.1%
Wood Packaging	10,180	2,000	19.6%	2,300	22.6%
Other Misc. Packaging	190	0	0.0%	0	0.0%
Total Containers & Packaging	82,770	36,990	44.7%	40,140	48.5%
Total Product Waste	189,410	61,835	32.6%	67,596	35.7%
Other Wastes					
Yard Trimmings	23,000	12,500	54.3%	13,200	57.4%
Food Wastes, other	23,480	2,400	10.2%	3,100	13.2%
Other Wastes	3,650	0	0.0%	0	0.0%
TOTAL MSW	239,540	76,735	32.0%	83,896	35.0%

* Other than food products.

Details may not add to totals due to rounding.

Source: Franklin Associates

Appendix D

ESTIMATES OF RESIDENTIAL/COMMERCIAL WASTES

A classification of products in municipal solid waste into residential and commercial fractions is shown in Table D-1. These allocations were made by Franklin Associates on a "best judgement" basis. The allocations have been reviewed previously in earlier editions of this EPA report and for a 1994 report for Keep American Beautiful, which was extensively reviewed by public and private sector experts in municipal solid waste management.

Residential waste as defined here includes wastes from multi-family dwellings (apartments) because the nature of the wastes is similar to those generated from single-family dwellings. (Yard trimmings would be an exception.) It should be noted, however, that waste haulers typically classify multi-family wastes as "commercial" because these wastes are generally collected by the same vehicles used for other commercial wastes.

Since the first allocation in 1994, major appliances and rubber tires were reallocated primarily to the commercial sector, because that is typically where they enter the solid waste management system. For example, a refrigerator would be used in a private residence, but typically would be picked up by a dealer when a new refrigerator is installed. It then would typically go to a scrap dealer for shredding and recovery of metals.

Based on the analysis, a range of 55 to 65 percent of total generation for residential wastes and 35 to 45 percent for commercial wastes is shown

Table D-1
WORKSHEET FOR ESTIMATES OF
RESIDENTIAL/COMMERCIAL FRACTIONS OF MSW, 1997

	1997 Generation	Residential		Commercial	
	Thousand tons	Percent	Tons	Percent	Tons
Durable Goods					
Major Appliances	3,610	10	361	90	3,249
Small Appliances	830	95	789	5	42
Furniture and Furnishings	7,510	80	6,008	20	1,502
Carpets and Rugs	2,330	80	1,864	20	466
Rubber Tires	4,260	5	213	95	4,047
Batteries, lead acid	1,780	5	89	95	1,691
Miscellaneous Durables	12,910	80	10,328	20	2,582
Total Durable Goods	**33,230**		19,652		13,579
Nondurable Goods					
Newspapers	13,490	85	11,467	15	2,024
Books	1,120	80	896	20	224
Magazines	2,160	65	1,404	35	756
Office Papers	7,000	25	1,750	75	5,250
Directories	470	60	282	40	188
Standard (A) Mail*	4,850	65	3,153	35	1,698
Other Commercial Printing	6,920	65	4,498	35	2,422
Tissue Paper and Towels	3,100	60	1,860	40	1,240
Paper Plates and Cups	970	20	194	80	776
Plastic Plates and Cups	860	20	172	80	688
Trash Bags	810	95	770	5	41
Disposable Diapers	3,140	90	2,826	10	314
Other Nonpackaging Paper	4,250	50	2,125	50	2,125
Clothing and Footwear	5,760	60	3,456	40	2,304
Towels, Sheets and Pillowcases	750	90	675	10	75
Other Miscellaneous Nondurables	3,450	50	1,725	50	1,725
Total Nondurable Goods	**59,100**		37,252		21,849
Containers and Packaging					
Glass Packaging					
Beer and Soft Drink Bottles	4,960	80	3,968	20	992
Wine and Liquor Bottles	1,820	80	1,456	20	364
Food and Other Bottles & Jars	3,830	85	3,256	15	575
Total Glass Packaging	**10,610**		8,680		1,931
Steel Packaging					
Beer and Soft Drink Cans	0	80	0	20	0
Food and Other Cans	2,860	85	2,431	15	429
Other Steel Packaging	240	5	12	95	228
Total Steel Packaging	**3,100**		2,443		657
Aluminum Packaging					
Beer and Soft Drink Cans	1,530	80	1,224	20	306
Other Cans	50	50	25	50	25
Foil and Closures	360	90	324	10	36
Total Aluminum Packaging	**1,940**		1,573		367

(continued on next page)

Table D-1 (continued)
WORKSHEET FOR ESTIMATES OF
RESIDENTIAL/COMMERCIAL FRACTIONS OF MSW, 1997

	1997 Generation	Residential		Commercial	
	Thousand tons	Percent	Tons	Percent	Tons
Paper & Paperboard Pkg					
Corrugated Boxes	30,160	10	3,016	90	27,144
Milk Cartons	460	50	230	50	230
Folding Cartons	5,420	60	3,252	40	2,168
Other Paperboard Packaging	220	50	110	50	110
Bags and Sacks	1,870	90	1,683	10	187
Wrapping Papers	50	90	45	10	5
Other Paper Packaging	1,270	70	889	30	381
Total Paper & Board Pkg	**39,450**		9,225		30,225
Plastics Packaging					
Soft Drink Bottles	750	80	600	20	150
Milk Bottles	670	95	637	5	34
Other Containers	1,540	80	1,232	20	308
Bags and Sacks	1,520	90	1,368	10	152
Wraps	2,130	80	1,704	20	426
Other Plastics Packaging	2,820	80	2,256	20	564
Total Plastics Packaging	**9,430**		7,797		1,634
Wood Packaging	7,030	0	0	100	7,030
Other Misc. Packaging	190	70	133	30	57
Total Containers & Pkg	**71,750**		29,850		41,900
Total Product Wastes	**164,080**		86,753		77,327
Other Wastes					
Food Wastes	21,910	50	10,955	50	10,955
Yard Trimmings	27,730	90	24,957	10	2,773
Miscellaneous Inorganic Wastes	3,250	50	1,625	50	1,625
Total Other Wastes	**52,890**		37,537		15,353
Total MSW Generated	**216,970**	57	**124,290**	43	**92,680**
Range		55 – 65		35 – 45	

* Formerly called Third Class Mail by the U.S. Postal Service.

Source: Franklin Associates

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