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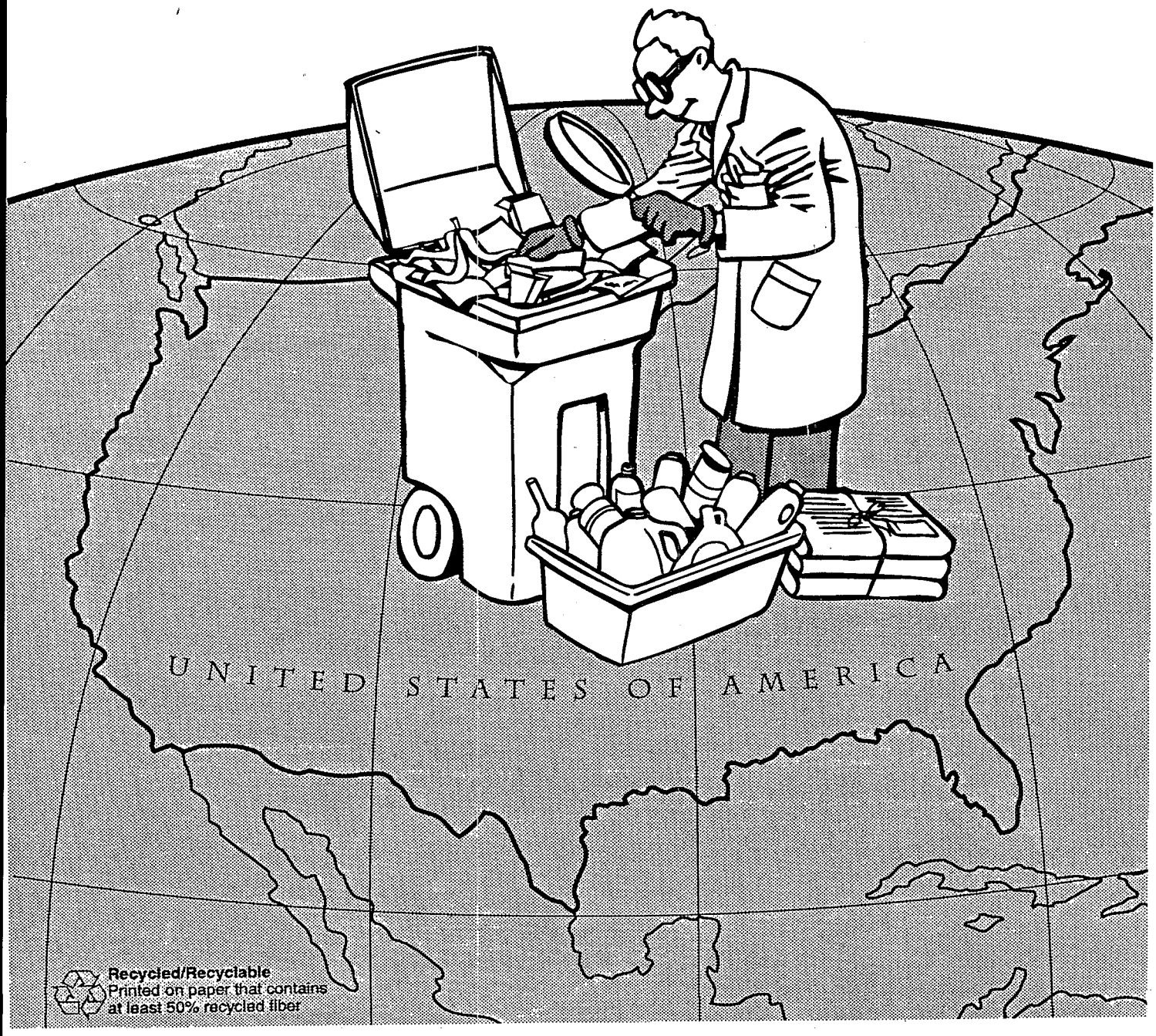
Characterization of Municipal Solid Waste in The United States: 1995 Update

Executive Summary



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CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1995 UPDATE

Executive Summary

FEATURES OF THIS REPORT

This report is the most recent in a series of reports released by the U.S. Environmental Protection Agency (EPA) characterizing municipal solid waste (MSW) in the United States. The report describes the national waste stream based on data collected from 1960 through 1994. This historical perspective is useful for establishing trends and highlighting changes that have occurred over the years, both in types of waste generated and in the ways they are managed. It does not, however, specifically address local and regional variations in the waste stream. Nevertheless, the data in this report can be used to develop approximate (but quick) estimates of MSW generation and composition in a defined area. Due to increased interest in the report over the years and the dynamic nature of the MSW field, EPA plans to provide annual updates of this report as a service to state and local MSW officials and other interested parties.

The report includes information on:

- MSW generation, recovery, and discards from 1960 to 1994
- Per capita generation and discard rates
- Residential/commercial portions of MSW generation
- Trends in MSW management, including recovery for recycling and composting, as well as combustion and landfilling, from 1960 to 1994
- The role of source reduction in MSW management
- Projections for MSW generation and management through 2010, including three scenarios for recovery
- An "Additional Perspectives" Chapter devoted to basic information on the potential climate change implications of various municipal waste management strategies.

REPORT HIGHLIGHTS

While the total amount of MSW generated annually continues to increase, the rate of this growth is slowing. Per capita MSW generation (the amount of MSW generated per person per day) is expected to remain constant at

4.4 pounds per person per day through the year 2000. The primary reason for this steady rate is that, while the per capita generation of the products and packaging component of MSW will continue to rise, efforts to keep yard trimmings out of the waste management system are beginning to have an effect. Recovery rates for recycling and composting continue to grow, and this year, for the first time, composting of food scraps has reached measurable proportions. As MSW generation continues to increase and recycling matures, however, source reduction as a management practice will be increasingly important.

1994 MSW Generation and Management

- A total of 209 million tons of MSW was generated in 1994. This reflects an increase of 3 million tons from 1993, when MSW generation was 206 million tons. This increase in total MSW generation is due largely to an increase in population.

- However, the per capita generation rate remained at 4.4 pounds per person per day, the same rate as 1993.

- The per capita discard rate (after recycling and composting) was 3.4 pounds per person per day in 1994, down from 3.5 pounds per person per day in 1993.

- Recycling and composting recovered 24 percent of MSW in 1994, up from 21 percent in 1993 and up from 17 percent in 1990. As a nation, during 1994 we quickly approached the goal of 25 percent recovery of MSW.

- An estimated 49 million tons of MSW were recovered in 1994, while 44 million tons were recovered in 1993.

- Recovery of paper and paperboard accounted for more than half (nearly 29 million tons) of total MSW recovery. Composting of yard trimmings contributed to the next largest fraction of total recovery at 7 million tons.

- For the first time, composting of food scraps reached measurable proportions at the national level. An estimated 3.4 percent of food scraps was composted (500,000 tons out of 14.1 million tons generated).

- Landfills managed 61 percent of MSW generated (127 million tons), and combustion facilities managed 15 percent of the total MSW generated (32.5 million tons).

Trends in MSW Generation and Management

- Annual MSW generation is expected to increase to 223 million tons in the year 2000 and 262 million tons in 2010. Natural population growth and

sustained long-term growth in the economy account for this projected increase.

- Per capita generation rates are projected to remain constant at 4.4 pounds per person per day to the year 2000. Projected decreases in per capita generation of yard trimmings during this time will be offset by increases in per capita generation associated with the discard of products and packaging.

- After the year 2000, per capita decreases in generation of yard trimmings are expected to plateau, while increases in per capita generation of products and packaging will continue, causing total MSW per capita generation rates to rise to 4.8 pounds per person per day by 2010.

- Achieving a decline in projected overall and per capita waste generation will require continued emphasis on source reduction activities, which prevent waste before it is generated. For example, State and local efforts to keep yard trimmings out of landfills are projected to result in a 25 percent decrease in yard trimmings generation (by the year 2000) from the 1994 estimate of 30.6 million tons. Primarily through the success of grasscycling and backyard composting programs, yard trimmings generation is projected to decrease to 23 million tons by 2000.

- Recovery from recycling and composting continues to show impressive growth. For the year 2000, three recovery scenarios ranging from 25 percent to 35 percent are presented. The range for the year 2010 is 30 percent to 40 percent. Achieving a 40 percent recovery rate nationwide would require recovery rates in the range of 50 percent for many material categories in MSW, including paper and paperboard, yard trimmings, metals, and glass.

- Combustion is expected to remain relatively unchanged through the year 2000.

- While the percentage of MSW being disposed of in landfills is decreasing, the actual tonnage is expected to increase to the year 2000. Landfilling is expected to continue to be the single most predominant MSW management method in future years.

- Preliminary research indicates that source reduction and recycling of MSW have significant potential to reduce greenhouse gas emissions and mitigate climate change.

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 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, composting, landfilling, or combustion takes place.

Recovery of materials means removing MSW from the waste stream for the purpose of recycling or 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 and 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.

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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.

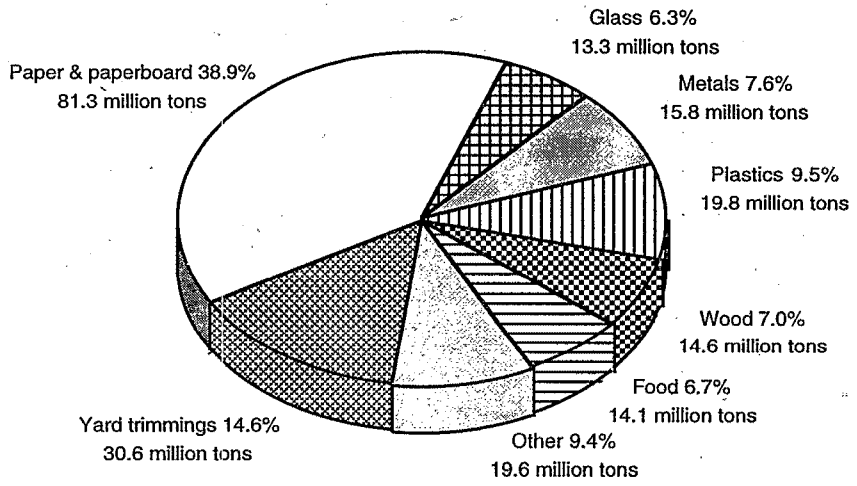
Note that when the report is updated, there are numerical discrepancies in waste generation, recovery, and discards from previous editions. These differences are due to revised estimates from source data (e.g., industry associations and federal agencies) made to the MSW characterization database.

MUNICIPAL SOLID WASTE IN 1994

Materials in MSW

In 1994, MSW generation totaled 209 million tons. Figure ES-1 provides a breakdown by weight of the materials generated in 1994. Paper and paperboard products made up the largest component of MSW generated (39 percent), and yard trimmings were the second largest component (15 percent). Glass, metals, plastics, wood, and food scraps each constituted between 6 and 10 percent of the total MSW generated. Other materials in MSW, such as rubber, leather, textiles, and miscellaneous wastes, made up approximately 9 percent of the MSW generated in 1994.

Figure ES-1. Materials generated in MSW by weight, 1994
(Total weight = 209.1 million tons)



In 1994, a portion of most materials in MSW were recycled or composted, as illustrated in Table ES-1. Each material category (except for food scraps and yard trimmings) is made up of many different products. Because some of these products are not recovered at all, the overall recovery rate for any particular material may be lower than recovery rates for some products within the material category.

Nonferrous metals (other than aluminum) have the highest recovery rate (66 percent), due to high rates of lead recovery from lead-acid batteries. Approximately 38 percent of aluminum is recovered, even though aluminum cans are recovered at rates above 65 percent. Likewise, the overall recovery rate for paper and paperboard is 35 percent, even though corrugated containers are recovered at rates above 55 percent.

Table ES-1

GENERATION AND RECOVERY OF MATERIALS IN MSW, 1994
(In millions of tons and percent of generation of each material)

	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Paper and paperboard	81.3	28.7	35.3%
Glass	13.3	3.1	23.4%
Metals			
Ferrous metals	11.5	3.7	32.3%
Aluminum	3.1	1.2	37.6%
Other nonferrous metals	1.2	0.8	66.1%
Total metals	15.8	5.7	35.9%
Plastics	19.8	0.9	4.7%
Rubber and Leather	6.4	0.5	7.1%
Textiles	6.6	0.8	11.7%
Wood	14.6	1.4	9.8%
Other materials	3.6	0.8	20.9%
Total Materials in Products	161.3	41.8	25.9%
Other Wastes			
Food Wastes	14.1	0.5	3.4%
Yard Trimmings	30.6	7.0	22.9%
Miscellaneous Inorganic Wastes	3.1	Neg.	Neg.
Total Other Wastes	47.8	7.5	15.7%
TOTAL MUNICIPAL SOLID WASTE	209.1	49.3	23.6%

Includes wastes from residential, commercial, and institutional sources.
Neg. = Less than 50,000 tons or 0.05 percent.
Numbers in this table have been rounded to the first decimal place.

Products in MSW

The 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 (Figure ES-2). 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.

Figure ES-2. Products generated in MSW by weight, 1994
(Total weight = 209.1 million tons)

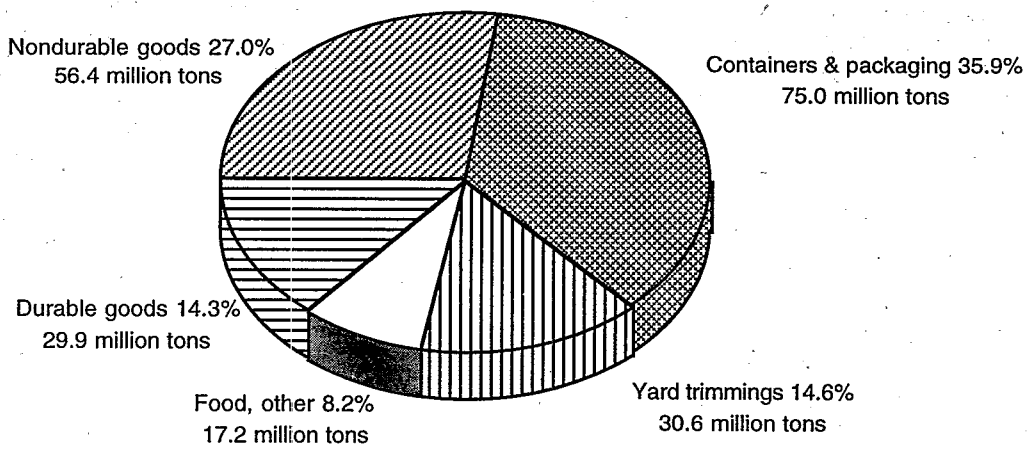


Table ES-2 shows the generation and recovery of the product categories in MSW, broken down by materials within each category. Overall, the materials in **durable goods** were recovered at a rate of approximately 15 percent in 1994. A large portion of non-ferrous metals were recovered from lead-acid batteries. Considerable amounts of ferrous metals were recovered from appliances in the durables category, and some rubber was recovered from tires.

Overall recovery in the **nondurable goods** category was approximately 22 percent in 1994. In this category, large amounts of newspapers, office papers, and some other paper products were recovered.

Recovery from the **containers and packaging** category is the highest of these categories—34 percent of generation. More than 55 percent of aluminum packaging was recovered in 1994 (mostly aluminum beverage cans), while more than 51 percent of steel packaging (mostly cans) was recovered. Paper and paperboard packaging recovery was estimated at 45 percent, with corrugated containers accounting for most of that tonnage. Approximately 26 percent of glass containers were recovered overall, while about 14 percent of wood packaging (mostly pallets) was recovered. About 8 percent of plastic containers and packaging was recovered in 1994, most of which was made up of soft drink, milk, and water bottles.

Table ES-2

GENERATION AND RECOVERY OF PRODUCTS IN MSW
BY MATERIAL, 1994
(In millions of tons and percent of generation of each product)

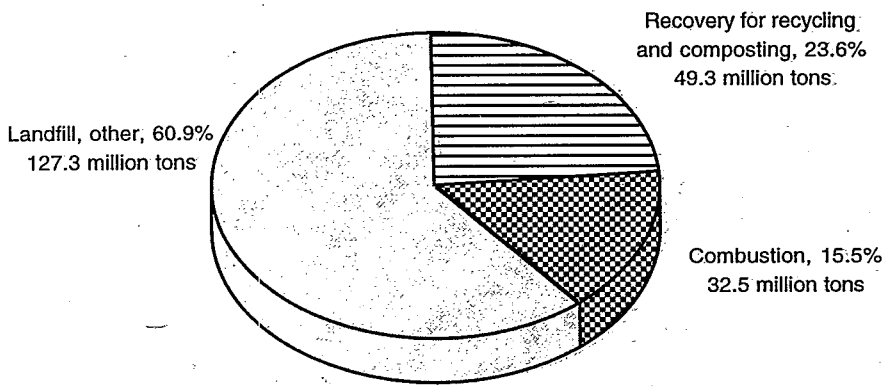
	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Durable goods			
Ferrous metals	8.4	2.1	25.2%
Aluminum	0.8	Neg.	Neg.
Other non-ferrous metals	1.2	0.8	66.1%
Total metals	10.4	2.9	28.0%
Glass	1.2	Neg.	Neg.
Plastics	5.6	0.2	3.6%
Rubber and leather	5.1	0.5	8.9%
Wood	4.4	Neg.	Neg.
Textiles	2.3	0.1	4.4%
Other materials	1.0	0.8	74.3%
Total durable goods	29.9	4.4	14.8%
Nondurable goods			
Paper and paperboard	43.5	11.6	26.8%
Plastics	4.7	Neg.	<1%
Rubber and leather	1.3	Neg.	Neg.
Textiles	4.2	0.7	16.4%
Other materials	2.8	Neg.	Neg.
Total nondurable goods	56.4	12.3	21.9%
Containers and packaging			
Steel	3.1	1.6	51.4%
Aluminum	2.1	1.2	55.0%
Total metals	5.2	2.8	52.9%
Glass	12.1	3.1	25.8%
Paper and paperboard	37.8	17.1	45.2%
Plastics	9.5	0.7	7.5%
Wood	10.2	1.4	14.0%
Other materials	0.2	Neg.	Neg.
Total containers and packaging	75.0	25.1	33.5%
Other wastes			
Food wastes	14.1	0.5	3.4%
Yard trimmings	30.6	7.0	22.9%
Miscellaneous inorganic wastes	3.1	Neg.	Neg.
Total other wastes	47.8	7.5	15.7%
TOTAL MUNICIPAL SOLID WASTE	209.1	49.3	23.6%

Includes wastes from residential, commercial, and institutional sources.
Neg. = less than 50,000 tons or 0.05 percent.
Numbers in this table have been rounded to the first decimal place.

Management of MSW

Figure ES-3 shows how much MSW was recycled, composted, combusted, and landfilled in 1994. Approximately 49 million tons, or 24 percent of MSW, was recycled and composted; an estimated 32 million tons, or 15 percent, was combusted (nearly all with energy recovery); and the remainder, 127 million tons (61 percent), was landfilled (small amounts may have been littered or self-disposed).

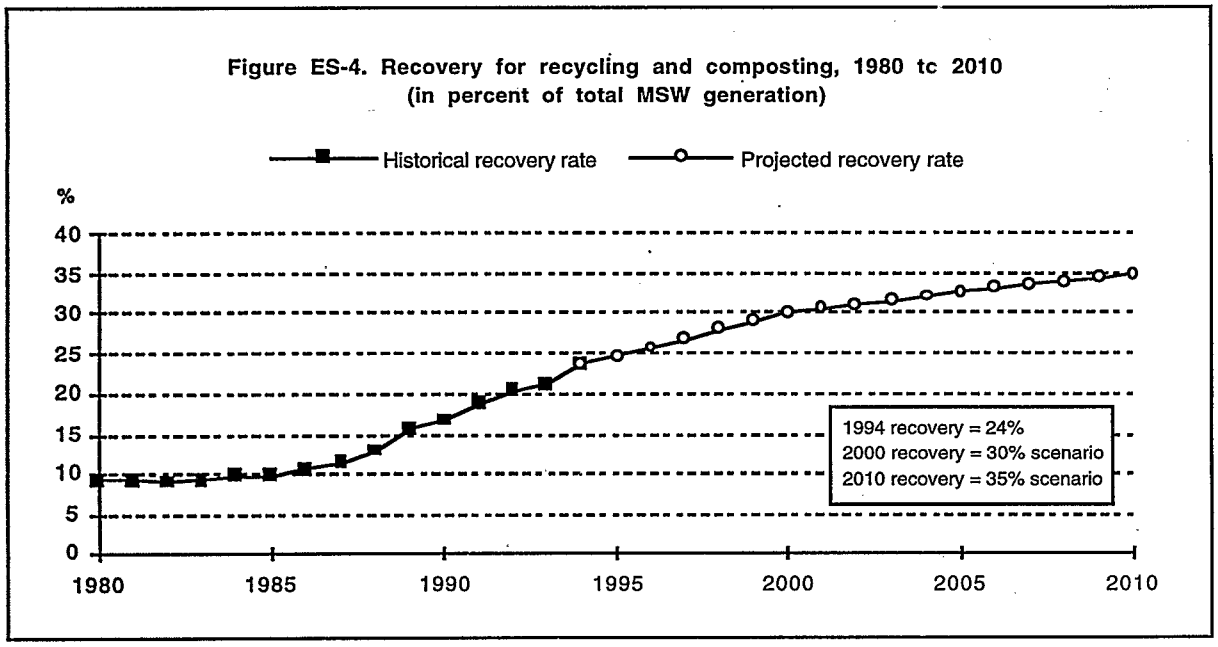
Figure ES-3. Management of MSW in U.S., 1994 (Total weight = 209.1 million tons)



Recovery rates have increased steadily since the 1980s. After remaining constant at 9 to 10 percent in the early to mid-1980s, people nationwide began realizing that new approaches to solid waste management were needed. Recycling and composting rates increased from 13 percent in 1988 to 17 percent in 1990 to 24 percent in 1994 (Figure ES-4). For the year 2000, three recovery scenarios ranging from 25 percent to 35 percent are presented. The range for the year 2010 is 30 percent to 40 percent. Achieving a 40 percent recovery rate nationwide would require recovery rates in the range of 50 percent for many material categories in MSW, including paper and paperboard, yard trimmings, metals, and glass.

Residential and Commercial Sources of MSW

Sources of MSW, as characterized in this report, include both residential and commercial locations (commercial locations include schools, some industrial sites where packaging is generated, and businesses). Identifying sources where MSW is generated is important to developing management techniques, such as collection for disposal, recycling, or composting. Residential wastes



(including wastes from multi-family dwellings) are estimated to be 55 to 65 percent of total generation. Commercial wastes constitute between 35 and 45 percent. Local and regional factors such as climate and level of commercial activity contribute to these variations.

TRENDS IN MSW GENERATION AND MANAGEMENT

Generation of MSW has grown steadily from 88 million tons in 1960 to 209 million tons in 1994. The total amount of MSW generated is projected to be 223 million tons in 2000 and 262 million tons in 2010. Per capita generation of MSW increased from 2.7 pounds per person per day in 1960 to 4.4 pounds per person per day in 1994. This rate is expected to remain constant through the year 2000 based in large part on a projected decrease in the tonnage of yard trimmings entering the MSW management system, along with an increase in generation of consumer products and packaging. After 2000, the amount of yard trimmings diverted from disposal is expected to plateau. Achieving a decline in overall waste generation after 2000 hinges on continued emphasis on source reduction of all MSW.

Source Reduction activities include the design, manufacture, purchase, or use of materials (such as products and packaging) to reduce the amount or toxicity of materials before they enter the MSW management system. Source reduction activities include:

- Designing products or packaging to reduce the quantity of materials or the toxicity of the materials used.

- Reusing products or packaging already manufactured.
- Lengthening the life of products to postpone disposal.
- Managing non-product organic wastes (e.g., food scraps and yard trimmings) through on-site composting or other alternatives to disposal.

While most source reduction activities were not quantified in this report, calculations show that yard trimmings generation could be reduced significantly if current and planned state and local programs to reduce their disposal are implemented. While recycling and composting programs are continuing to decrease the amount of MSW that is disposed of, source reduction can help decrease MSW discards even more, by preventing waste before it is even generated.

Recovery (recycling and composting) has increased from approximately seven percent of MSW in 1960 to 24 percent by 1994. Much of the growth has occurred over the past five or six years. Projected scenarios for recovery are between 25 and 35 percent in 2000, and 30 to 40 percent in 2010. To achieve these recovery rates, some products will have to be recovered at rates of 50 percent or more. In addition, composting of yard trimmings will have to increase substantially.

For this report, EPA examined a range of recovery scenarios from 25 percent to 35 percent nationwide for the year 2000. For the year 2010, EPA examined recovery scenarios ranging from 30 percent to 40 percent. A mid-range projected scenario of 30 percent in the year 2000 and 35 percent in 2010 was used to illustrate the effects of recovery on future MSW management. To achieve this level of recovery, EPA assumed that local, state, and federal agencies would continue to emphasize recycling and composting as a priority; that industries would continue to make the necessary investments in recovery and utilization of materials; that state and local governments would continue to expand programs designed to keep yard trimmings out of landfills; and that most U.S. citizens would have access to some sort of recovery program and that they would be willing to participate.

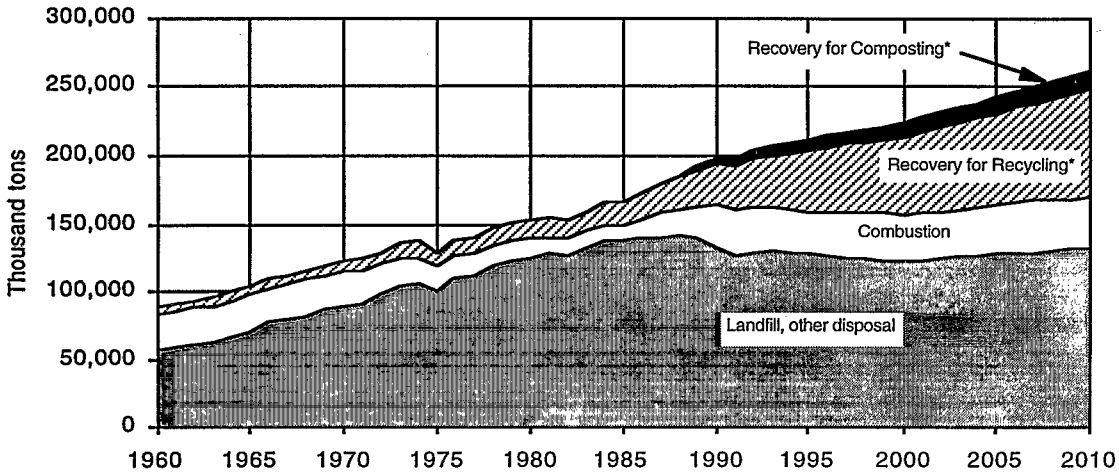
Combustion facilities handled an estimated 30 percent of MSW generated in 1960, mostly through incinerators with no energy recovery and no air pollution controls. In the 1960s and 1970s, combustion dropped steadily as old incinerators were closed, reaching a low of less than 10 percent by 1980. In 1990, approximately 16 percent of MSW was combusted. Between 1990 and 1994, combustion remained between 15 and 16 percent. All major new facilities have energy recovery and are designed to meet air pollution standards.

This report projects that tonnage of MSW combusted will remain relatively unchanged, particularly in terms of percentage of total MSW generation. By the year 2000, the tonnage is expected to increase from about 32 million tons (or 15 percent of total MSW generation) in 1994 to 34 million tons (15 percent of projected 2000 total MSW generation). For 2010, the tonnage of MSW combusted is projected to be 38 million tons (or 14 percent of projected 2010 total MSW generation). Combustion projections are based on an assumption that the current number of facilities will remain the same and that they will operate at around 85 percent of capacity. The projected tonnage increase in combustion is primarily due to an expected rise in the combustion of source-separated materials (e.g., wood and tires).

Landfill use fluctuates with changes in the use of alternative solid waste management methods. For example, when the use of combustion for MSW management declined and recovery rates were low, the amount of waste sent to landfills increased (Figure ES-5). Alternatively, when recovery and combustion of MSW increased, the percentage of MSW discarded in landfills declined. In 1960, approximately 62 percent of MSW was sent to landfills. This increased to 81 percent by 1980 as incineration declined, then decreased to an estimated 61 percent by 1994 due to moderate increases in incineration and dramatic increases in recovery.

Landfill tonnage is expected to decrease from 127 million tons (61 percent of generation) in 1994 to 122 million tons in 2000 (55 percent of generation). Significant diversion of yard trimmings from landfills is the primary reason for

Figure ES-5. Municipal solid waste management, 1960 to 2010



* Recovery scenarios of 30% in 2000 and 35% in 2010 used in this figure. Other scenarios are presented in the report.

this projection. The amount of waste disposed of in landfills is expected to increase in tonnage to 132 million tons by 2010, as diversion of yard trimmings from landfills plateaus and discards from products and packaging increases. However, as a percentage of total MSW generated, discards to landfills are projected to decline to 51 percent by 2010 due to increases in recovery.

ADDITIONAL PERSPECTIVES ON MSW

Global Climate Change

The manufacture and distribution of products and the subsequent management of solid waste can contribute to the formation of excess "greenhouse gases." Carbon dioxide, methane, and other gases form an atmospheric blanket around the planet's surface. These gases regulate the earth's temperature by trapping some of the sun's heat. This natural process is commonly referred to as the "greenhouse effect."

Human activities—in particular, the burning of fossil fuels (e.g., coal, oil, and wood)—and other factors appear to have increased the amount of greenhouse gases in the atmosphere. A buildup of these gases could raise global temperatures, setting off profound changes in the earth's climate and ecosystems, known as "global climate change." There is growing consensus that global climate change is occurring and will cause serious environmental dislocations.

Greenhouse gas emissions can be generated throughout the life cycle of a product, from its manufacture to its disposal. Source reduction and recycling activities can help reduce greenhouse gases because they 1) reduce the need to harvest or extract new raw materials; 2) eliminate the need to manufacture new products; 3) reduce the amount of energy required in manufacturing (through the use of recycled rather than virgin materials); and 4) prevent or divert waste from disposal (greenhouse gas emissions can be released when materials decompose in landfills or burn in combustors). Source reduction and recycling initiatives, as outlined in President Clinton's 1993 Climate Change Action Plan, will make a significant contribution to reducing greenhouse gas emissions.