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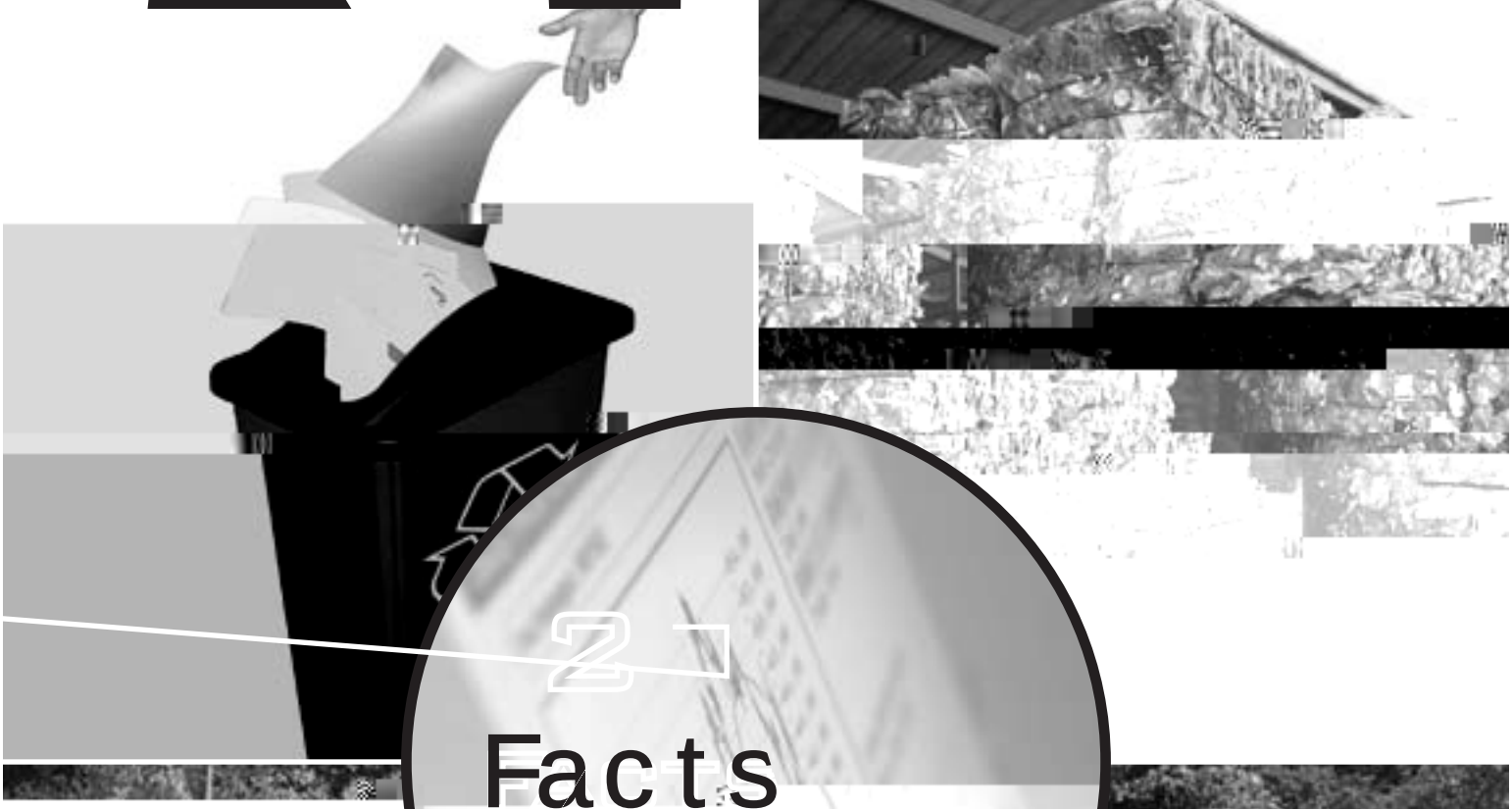

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MUNICIPAL SOLID WASTE IN
THE UNITED STATES:
2005 FACTS AND FIGURES

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Management of Municipal Solid Waste

Materials Flow Methodology

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 2005.

A portion of each material category in MSW was recycled or composted in 2005. The highest rates of recovery were achieved with yard trimmings, paper and paperboard products, and metal products. About 62 percent (19.9 million tons) of yard trimmings was recovered for composting in 2005. This represents nearly a five-fold increase since 1990. Fifty percent (42.0 million tons) of paper and paperboard was recovered for recycling in 2005. Recycling these organic materials alone diverted more than 25 percent of municipal solid waste from landfills and combustion facilities. In addition, about 6.9 million tons, or about 37 percent, of metals were recovered for recycling. Recycling rates for all materials categories in 2005 are listed in Table ES-4.

Figure ES-3: 2005 Total MSW Generation - 246 Million Tons (Before Recycling)

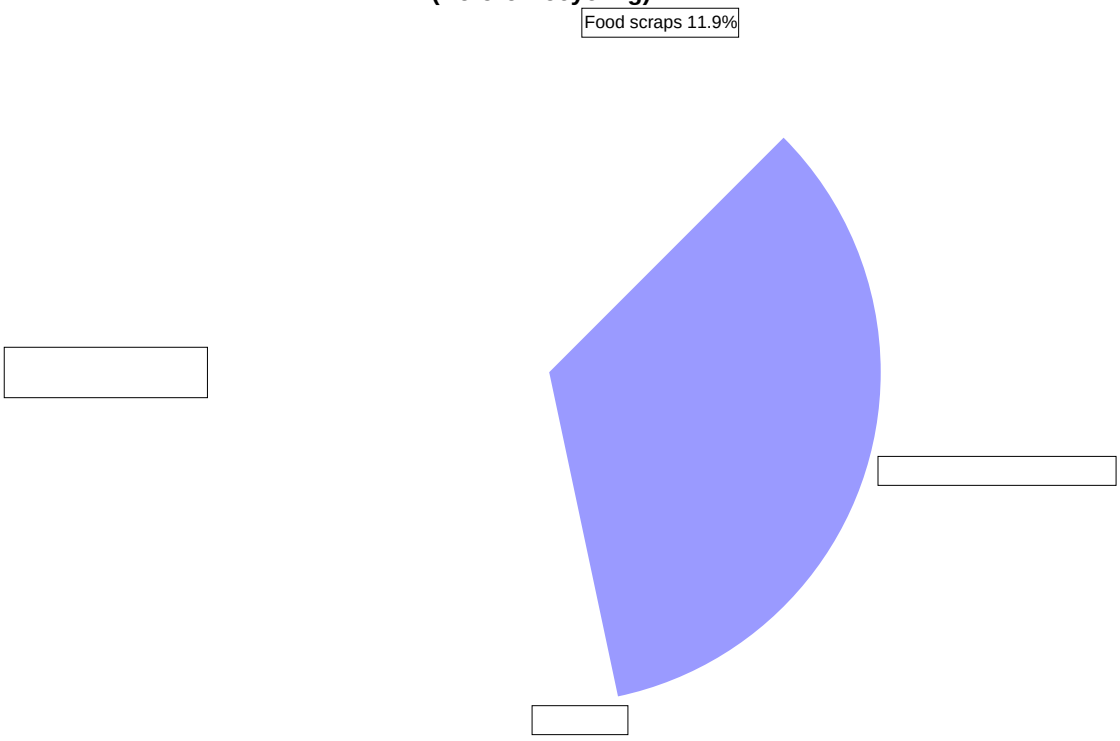
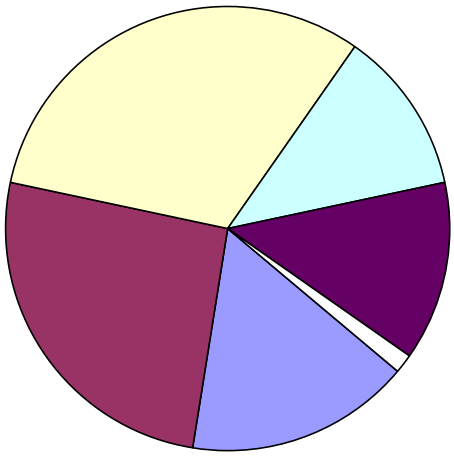


Figure ES-4: Products Generated in MSW, 2005
(Total Weight = 246 million tons)



Overall recovery of *nondurable goods* was at 32.1 percent in 2005. Most of this recovery comes from paper products such as newspapers and high-grade office papers (e.g., white papers). Newspapers constituted the largest portion of this recovery, with 88.9 percent of newspapers generated being recovered for recycling. An estimated 62.6 percent of high-grade office papers and 38.5 percent of magazines was recovered in 2005. Newspaper, high-grade office paper, and magazine recovery increased in percentage between 2004 and 2005.

Recovery percentage of "Other Commercial Printing" stayed about the same at 10.4 percent. The other paper products in the nondurable goods category increased slightly between 2004 and 2005, with Standard mail* recovered at an estimated 35.8 percent, and directories at an estimated 18.2 percent.

The nondurable goods category also includes clothing and other textile products—18 percent of these products were recovered for recycling or export in 2005.

Overall, *durable goods* were recovered at a rate of 18.5 percent in 2005. Nonferrous metals other than aluminum had one of the highest recovery rates, at 72.4 percent, due to the high rate of lead recovery from lead-acid batteries. Recovery of steel in all durable goods was 30.1 percent, with high rates of recovery from appliances and other miscellaneous durable goods.

One of the products with a very high recovery rate was lead-acid batteries, recovered at a rate of 98.8 percent in 2005. Other products with particularly high recovery rates were newspapers (88.9 percent), corrugated boxes (71.5 percent), major appliances (67.0 percent), steel packaging (63.3 percent), and aluminum cans (44.8 percent). About 35 percent of rubber tires were recovered for recycling. (Other tires were retreaded, and shredded rubber tires were made into tire-derived fuel.)

* Standard mail was formerly called Third Class ma

RESIDENTIAL AND COMERCIAL SOURCES OF MSW

Sources of MSW, as characterized in this report, include both residential and commercial locations. We estimated residential waste (including waste from multi-family dwellings) 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) constitutes between 35 and 45 percent of MSW. Local and regional factors, such as climate and level of commercial activity, contribute to these variations.

MANAGEMENT OF MSW

Overview

EPA's integrated waste management hierarchy includes the following four components, listed in order of preference:

- Source reduction (or waste prevention), including reuse of products and on-site (or backyard) composting of yard trimmings
- Recycling, including off-site (or community) composting
- Combustion with energy recovery
- Disposal through landfilling or combustion without energy recovery.

Although we encourage the use of strategies that emphasize the top of the hierarchy whenever possible, all four components remain important within an integrated waste management system.

Source Reduction

When we first established our waste management hierarchy, we emphasized the importance of *reducing* the amount of waste created, reusing whenever possible, and then recycling whatever is left. When municipal solid waste is reduced and reused, this is called "source reduction"—meaning the material never enters the waste stream.

Source reduction, also called waste prevention, includes the design, manufacture, purchase, or use of materials, such as products and packaging, to reduce their amount or toxicity befo

Recycling

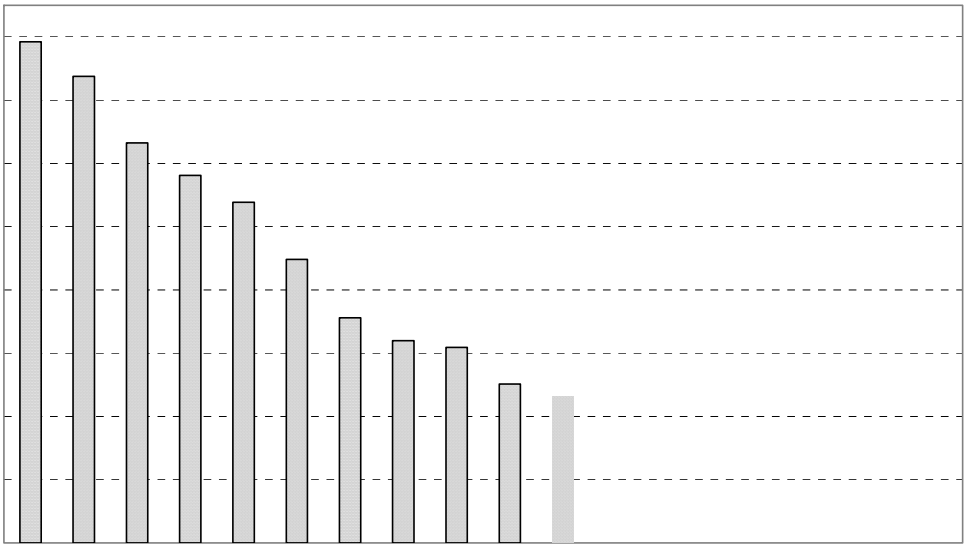
- Recycling (including community composting) recovered 32.1 percent (79 million tons) of MSW in 2005.
- There were about 8,550 curbside recycling programs in the United States in 2005.
- About 3,470 yard trimmings composting programs were reported in 2005.

Combustion with Energy Recovery

An estimated 33.4 million tons (13.6 percent) of MSW was combusted with energy recovery in 2005 (see Tables ES-1 and ES-2), slightly less than the 34.1 million tons estimated in 2004. Combustion with energy recovery increased from 2.7 million tons in 1980 to 29.7 million tons in 1990. Since 1990, the quantity of MSW combusted with energy recovery has increased slightly.

Disposal

During 2005, about 54.3 percent of MSW was landfilled, down somewhat from 54.8 percent in 2004. As shown in Figure ES-5, the number of MSW landfills decreased substantially over the past 18 years, from nearly 8,000 in 1988 to 1,654 in 2005—while average landfill size increased. At the national level, capacity does not appear to be a problem, although regional dislocations sometimes occur.



MSW recovered for recycling (including composting), combusted with energy recovery, and discarded in 2005 is shown in Figure ES-6. In 2005, 79.0 millions tons (32.1 percent) of MSW were recycled, 33.4 million tons (13.6 percent) were combusted with energy recovery, and 133.3 million tons (54.3 percent) were landfilled or otherwise disposed. (Relatively small

CHAPTER 1

INTRODUCTION AND METHODOLOGY

INTRODUCTION

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 45-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 for communities in the 21st century. 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.

This chapter provides background on integrated waste management and this year's characterization report, followed by a brief overview of the methodology. Next is a section on the variety of uses for the information in this report. Then, more detail on the methodology is provided, followed by a description of the contents of the remainder of the report.

BACKGROUND

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 (or waste prevention), including reuse of products and on-site (or backyard) composting of yard trimmings.

- Recycling, including off-site (or community) composting.

- Combustion with energy recovery.

- Disposal through landfilling or combustion without energy recovery.

As done in previous versions of this report, combustion with energy recovery is shown as discards in the Chapter 2 tables and figures.

Overview of the Methodology

Readers should note that this report characterizes the municipal solid waste stream of *the nation as a whole*. Data in this report can be used at the national level. It can also be used to address state, regional, and local situations, where more detailed data are not available or would be too expensive to gather. More detail on uses for this information in this report for both national and local uses is provided later in this chapter.

At the state or local level, recycling rates often are developed by counting and weighing all the recyclables collected, and then aggregating these data to yield a state or local recycling rate. At the national level, we use instead a *materials flow methodology*, which relies heavily on a mass balance approach. Using data gathered from industry associations, key businesses, and similar industry sources, and supported by government data from sources such as the Department of Commerce and the U.S. Census Bureau, we estimate tons of materials and products generated, recycled, or discarded. Other sources of data, such as waste characterizations and surveys performed by governments, industry, or the press, supplement these data.

To estimate MSW generation, production data are adjusted by imports and exports from the United States, where necessary. Allowances are made for the average lifespans of different

products. Information on amounts of disposed MSW managed by combustion comes from industry sources as well. MSW not managed by recycling (including composting) or combustion is assumed to be landfilled.

In any estimation of MSW generation, it is important to define what is and is not included in municipal solid waste. EPA includes those materials that historically have been handled in the municipal solid waste stream–those materials from municipal sources, sent to municipal landfills. In this report, MSW includes wastes such as product packaging, newspapers, office and classroom papers, bottles and cans, boxes, wood pallets, food scraps, grass clippings, clothing, furniture, appliances, automobile tires, consumer electronics, and batteries.

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 debris, biosolids (sewage sludges), industrial process wastes, or a number of other wastes that, in some cases, may go to a municipal waste landfill. These materials, over time, have tended to be handled separately and are not included in the totals in this report. EPA has addressed several of these materials separately, for instance, in *Biosolids Generation, Use, and Disposal in the United States*, EPA530-R-99-009, September 1999, and *Characterization of Building-Related Construction and Demolition Debris in the United States*, EPA530-R-98-010, May 1998. Recycling (including composting) is encouraged for these materials as well.

In addition, the source of municipal solid waste is important. EPA's figures include municipal solid waste from homes, institutions such as schools and prisons, commercial sources such as restaurants and small businesses, and occasional industrial sources. MSW does not include wastes of other types or from other sources, including automobile bodies, municipal sludges, combustion ash, and industrial process wastes that might also be disposed in municipal waste landfills or combustion units.

HOW THIS REPORT CAN BE USED

Nationwide. 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 consistency in methodology and scope aids in the use of the document for reporting over time. The report is, however, of equal or greater value as a solid waste management planning tool for state and local governments and private firms.

Local or state level. 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 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.

Specific reasons for regional differences may include:

- Variations in climate and local waste management practices, which 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.

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

- Variance in the per capita generation of some products, such as newspapers and telephone directories, 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.

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

- Variations in economic activity, which affect waste generation in both the residential and the commercial sectors.
- 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 may have typical 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 local planning to:

- Develop approximate estimates of total MSW generation in an area.
- Check locally developed MSW data for accuracy and consistency.
- Account for trends in total MSW generation and the generation of individual components.
- Help set goals and measure progress in source reduction and recycling (including composting).

national level would require all states to perform these studies, and perform them in a consistent manner conducive to developing a national summary, which so far has not been practical.

Materials

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 sludges, nonhazardous industrial wastes, residue from automobile salvage operations, and construction and demolition debris along with MSW, but these other kinds of wastes are not included in the estim

Figure 1-A: Definition of Terms

The materials flow 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 to be 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). Includes a.o. BT /TT0 1 Tf 0 0 0 rg 0 0 0 RG 1 w 0 J 0 j [] 0 d 1 i 0 g 0 G 0 0 612 792 re W n BT /TT1 1 Tf 10.5 0 0 10.5 72.0 2599.2 Tm 0 0 0 rg 0 0 0 RG 1 w 0 J 0 j [] 0 d 1 i 0 g 0 G 0 0 612 792 re W n BT /TT0 1 Tf 10.5 0 0 10.5 123.0

CHAPTER 1

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CHAPTER 2

CHARACTERIZATION OF MUNICIPAL SOLID WASTE BY WEIGHT

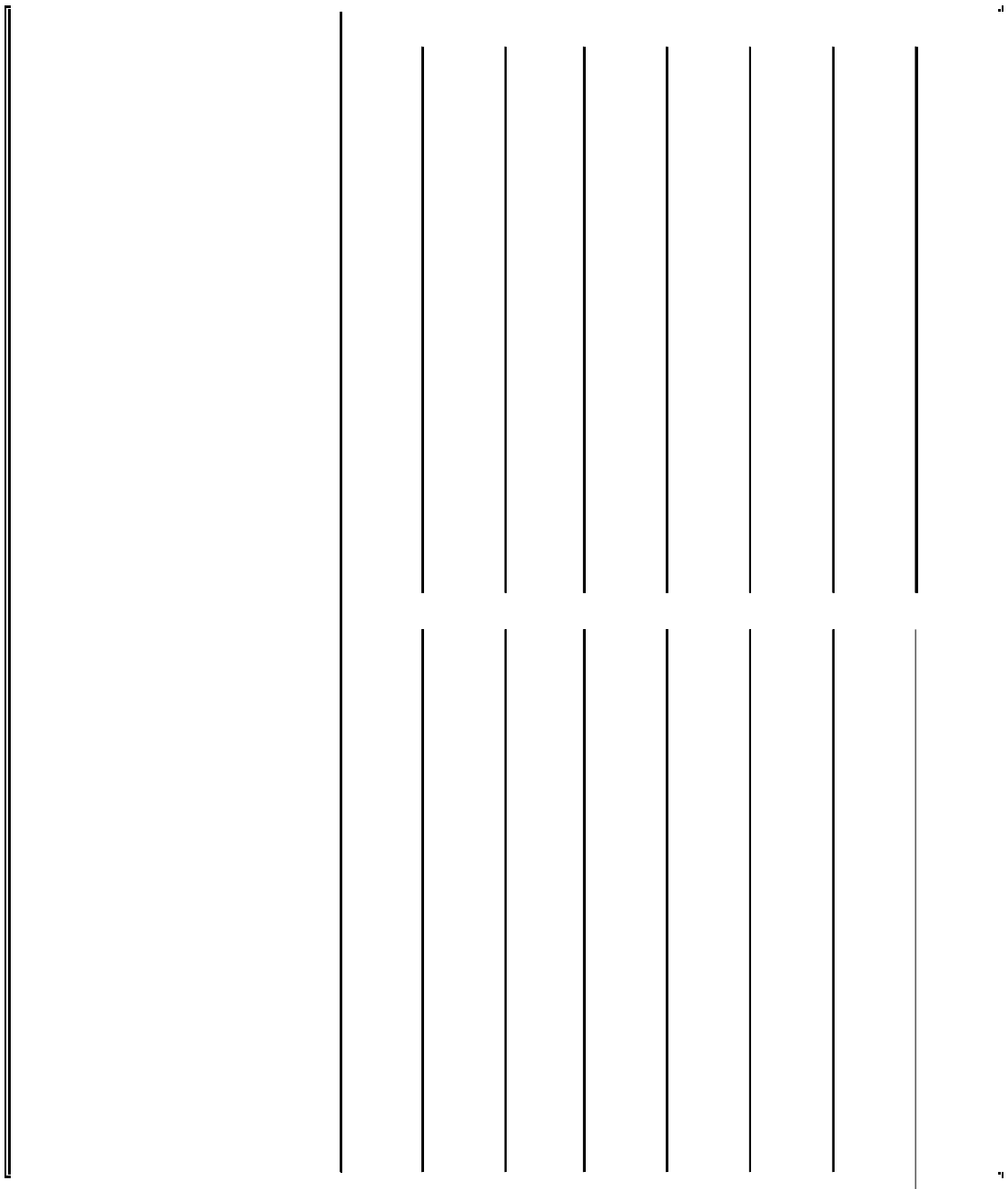
INTRODUCTION

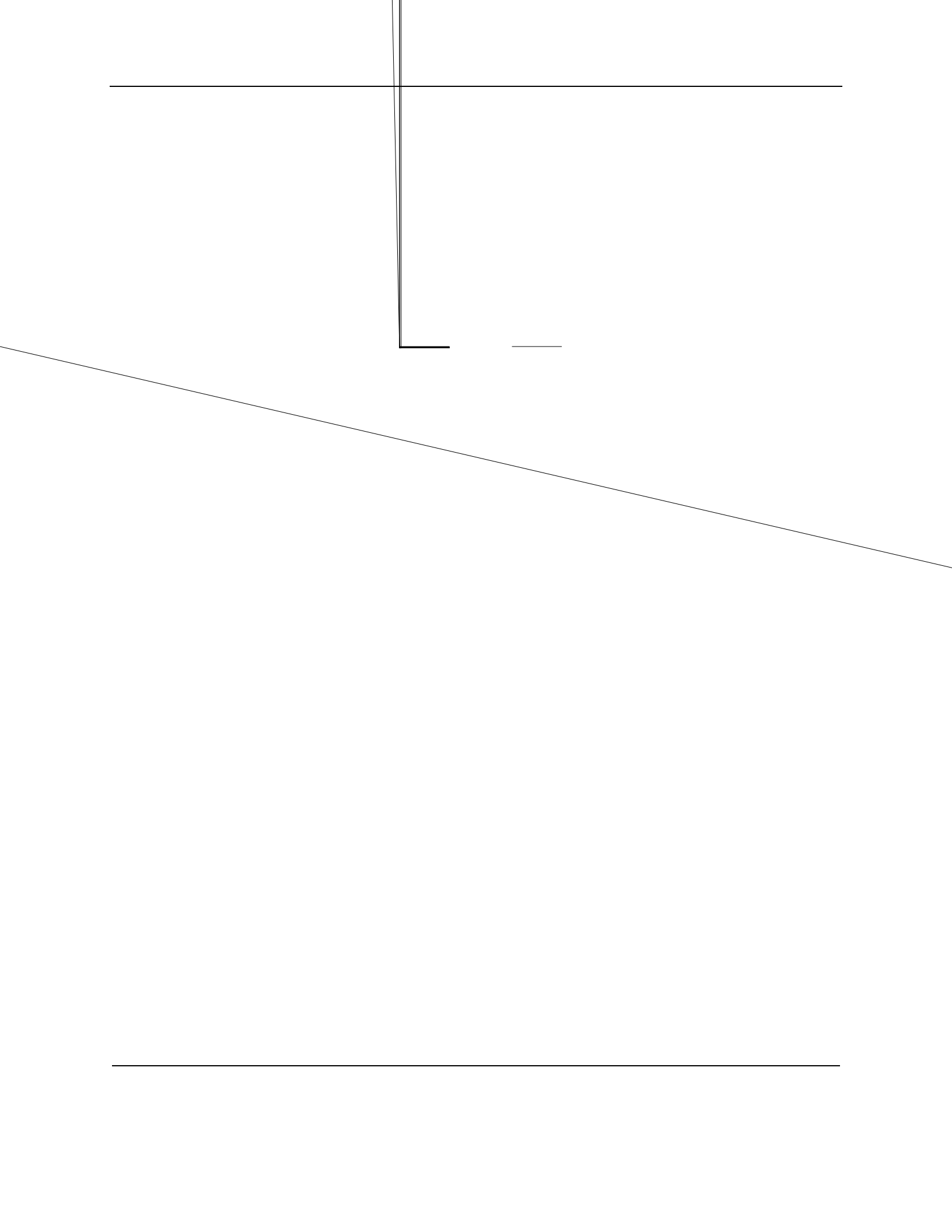
The tables and figures in this chapter present the results of the update of EPA's municipal solid waste characterization report through 2005. The data presented also incorporate some revisions to previously reported data for 2003 and, in some instances, to data for earlier years. The revisions are generally due to revisions and improvements in the data available from data sources used in developing this report.

This chapter discusses how much municipal solid waste (MSW) is generated, recovered, and disposed. First, an overview presents this information for the most recent years, and for selected years back to 1960. This information is summarized in Tables 1 to 3 and Figures 10 to 13. Then, throughout the remainder of the chapter, MSW is characterized in more detail. Findings are presented in two basic ways: the first portion of the chapter presents data by *material type*. Some material types of most use to planners (paper and paperboard, glass, metals, plastics, and rubber and leather) are presented in detail in Tables 4 to 8 and Figures 2 to 9, while data on other materials also is summarized in Figures 12 and 13.

The second portion of the chapter presents data by *product type*. This information is presented in Tables 9 to 23 and Figures 14 to 16. Products are classified into durable goods (e.g., appliances, furniture, tires); nondurable goods (e.g., newspapers, office-type papers, trash bags, clothing); and containers and packaging (e.g., bottles, cans, corrugated boxes). A fourth major category includes other wastes yard trimmings, food scraps, and miscellaneous inorganic wastes. These wastes are not manufactured products, but to provide complete information in each table, they are included in both the product and the material tables.

This chapter provides data on generation, recovery, and discards of MSW. (See Chapter 1 for definitions of these terms.) Recovery, in this report, 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 have been exported from the United States. For yard trimmi





The sensitivity of paper products to economic conditions can be observed in Figure 3. The tonnage of paper generated in 1975

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 or rolls 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 revisions as new data became available. Various deductions also are made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings (classified as construction and demolition debris) or toilet tissue (which goes to wastewater treatment plants).

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 relatively small amount estimated to have been used in other products such as insulation and 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 are deducted from ounts reported by AF&PA. In earlier versions of this EPA report, a simplifying assumption that all converting scrap is recovered was made. For m

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, 71.5 percent of all corrugated boxes were recovered for recycling in 2005; this is up from 67.3 percent in 2000. Newspapers were recovered at a rate of 88.9 percent, and high grade office papers at 62.6 percent, with lesser percentages of other papers being recovered also. Approximately 42 million tons of postconsumer paper were recovered in 2005—50 percent of total paper and paperboard generation. This is up from 42.8 percent in 2000.

Discards After Recovery. After recovery of paper and paperboard for recycling, discards were 42 million tons in 2005, or 25.2 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.

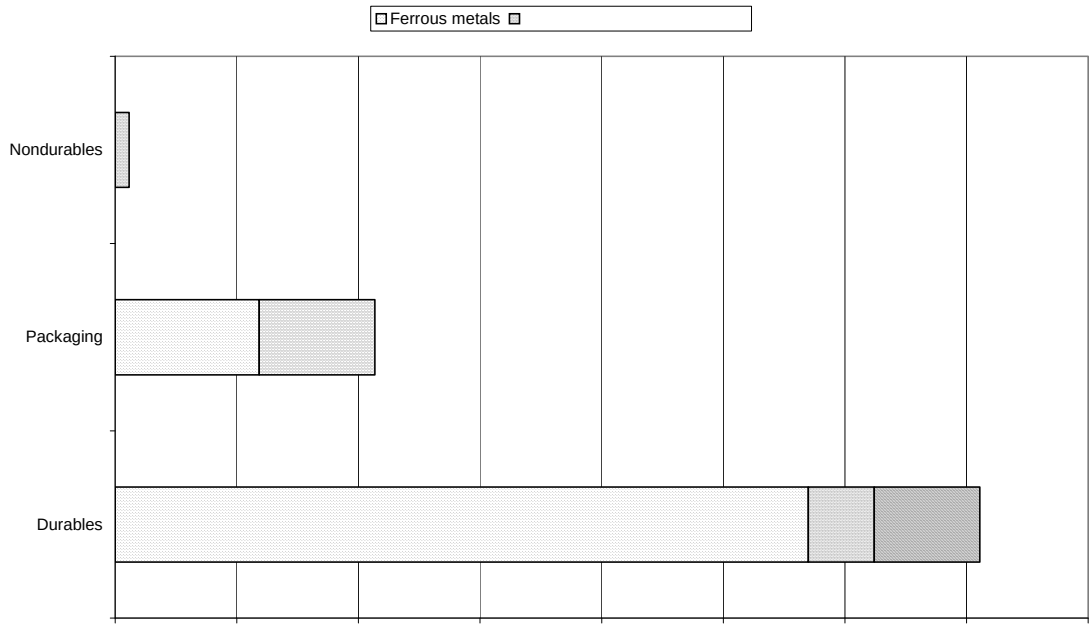
Figure 5. Glass generation and recovery, 1960 to 2005

Table 6

METAL PRODUCTS IN MSW, 2005
(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*	11,400	3,430	30.1%	7,970
Aluminum**	1,080	Neg.	Neg.	1,080
Lead†	1,280	1,260	98.4%	20
Other nonferrouy Tm(o)TjETBT/TT2 1 Tf9.96 0 0 9.9 jE2 1 Tf0.0054 i0.0054 i0.0054r84 TmW9,9Dai0.89.96 0 0 9.96 7				

Figure 6. Metal products generated in MSW, 2005



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 at a rate of 90 percent in 2005. Overall recovery of ferrous metals from durable goods (large and small appliances, furniture, and tires) was estimated to be 30 percent (3.4 million tons) in 2005 (Table 6).

Steel food cans and other cans were estimated to be recovered at a rate of 62.9 percent (1.3 million tons) in 2005. Approximately 160,000 tons of other steel packaging, mostly steel barrels and drums, were estimated to have been recovered for recycling in 2005.

Discards After Recovery. In 2005, discards of ferrous metals after recovery were 8.8 million tons, or 5.3 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 2005, 1.9 million tons of aluminum were generated as containers and packaging, while approximately 1.3 million tons were found in durable and nondurable goods. The total–3.2 million tons–was 1.3 percent of total MSW generation in 2005. 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 44.8 percent of generation (0.7 million tons) in 2005, and 36.3 percent of all aluminum in containers and packaging was recovered for recycling in 2005.

Discards After Recovery. In 2005, about 2.5 million tons of aluminum were discarded in MSW after recovery, which was 1.5 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 1.7 million tons in 2005. Lead in batteries accounted for 1.3 million 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.

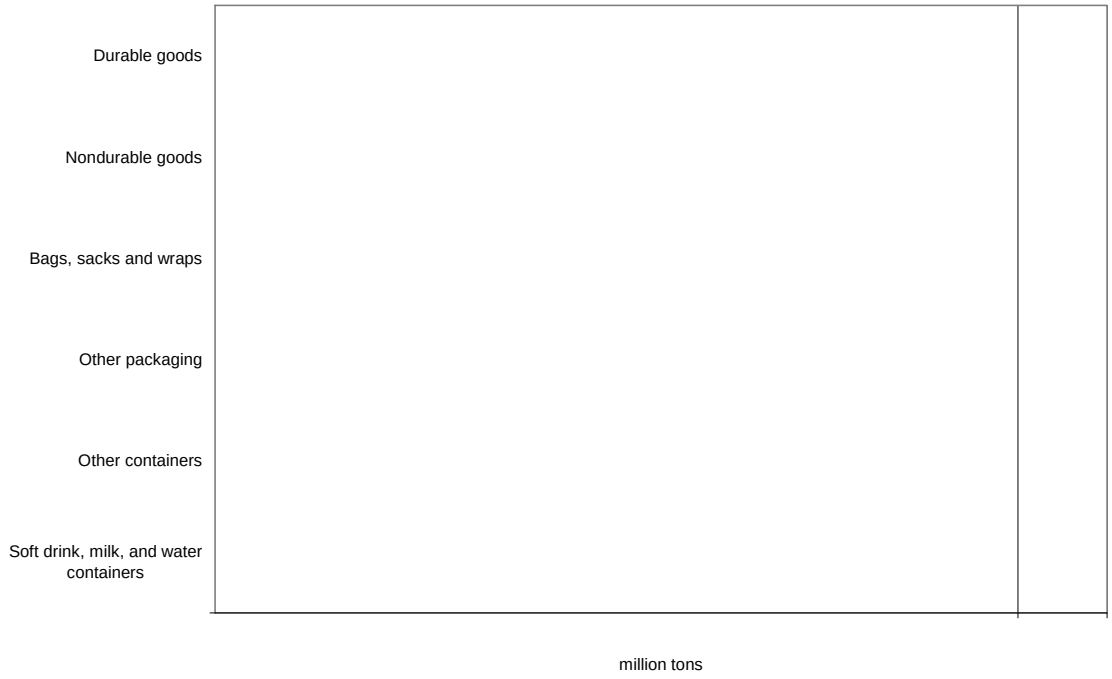
Recovery. Recovery of the other nonferrous metals was 1.3 million tons in 2005, with most of this being lead recovered from batteries. It was estimated that 99 percent of battery lead was recovered in 2005.

Discards After Recovery. In 2005, 480,000 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. While plastics are found in all major MSW categories, the containers and packaging category has the most plastic tonnage (Figure 8 and Table 7).

Figure 8. Plastics products generated in MSW, 2005



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

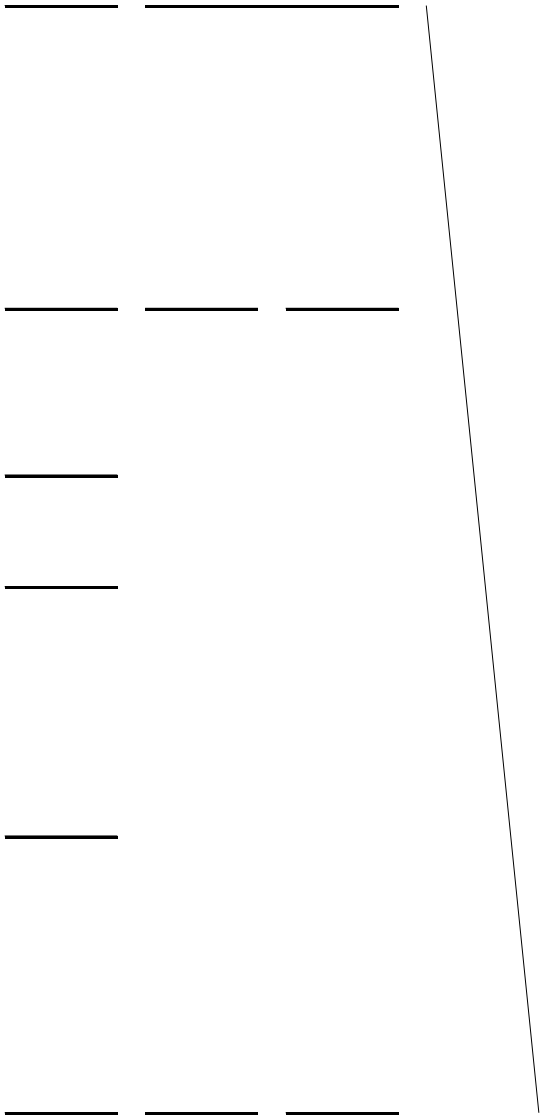


Table 7 (continued)

PLASTICS IN PRODUCTS IN MSW, 2005
(In thousands of tons, and percent of generation by resin)

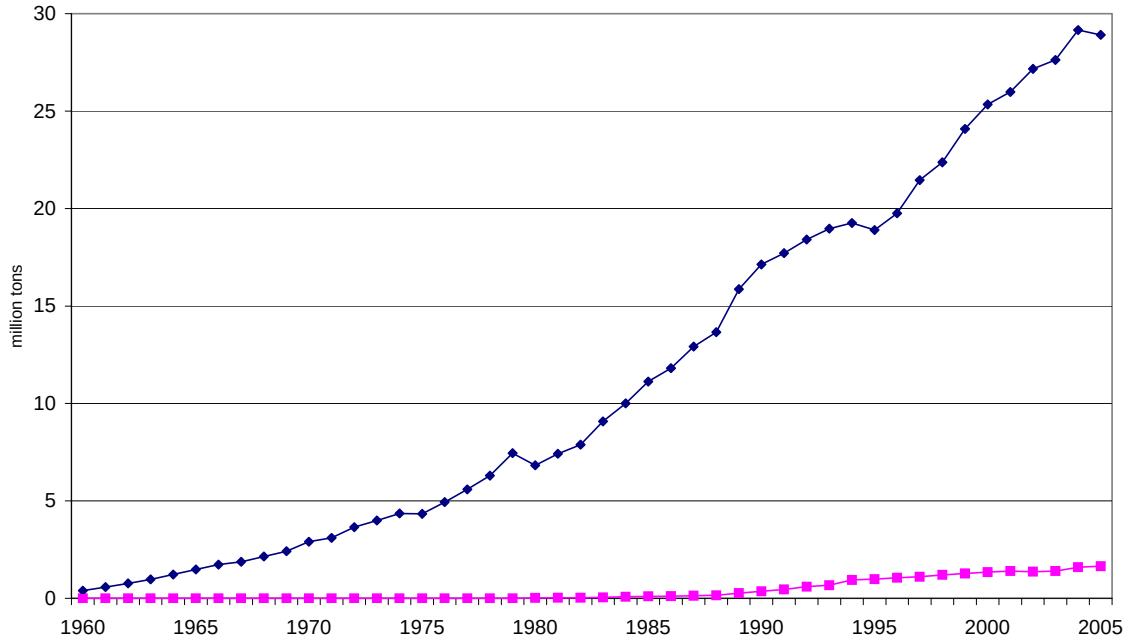
	Generation	Recovery		Discards
	(Thousand	(Thousand	(Percent	(Thous

Plastics are found in such nondurable products as disposable diapers, trash bags, cups, eating utensils, sporting and recreational equipment, medical devices, and household items such as shower curtains. The plastic food service items are generally made of clear or foamed polystyrene, while trash bags are made of high-density polyethylene (HDPE) or low-density polyethylene (LDPE). 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, and lids.

Generation. Production data on plastics resin use in products are taken from the American Plastics Council's annual resin reports. The basic data are adjusted for product service life, fabrication losses, and net imports of plastic products to derive generation of plastics in the

Figure 9. Plastics generation and recovery, 1960 to 2005



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 6.7 million tons in 2005. 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.

Additional data on MSW food scrap composting operations resulted in an estimate of 370,000 tons food scraps composted in 2005.

Another *BioCycle* survey yielded an estimate of approximately 320,000 tons of MSW composted. The total–690,000 tons of food scraps and other organic materials composted in 2005–is shown in the recovery tables.

Yard Trimmings

Yard trimmings[3] include grass, leaves, and tree and brush trimmings from residential, institutional, and commercial sources.

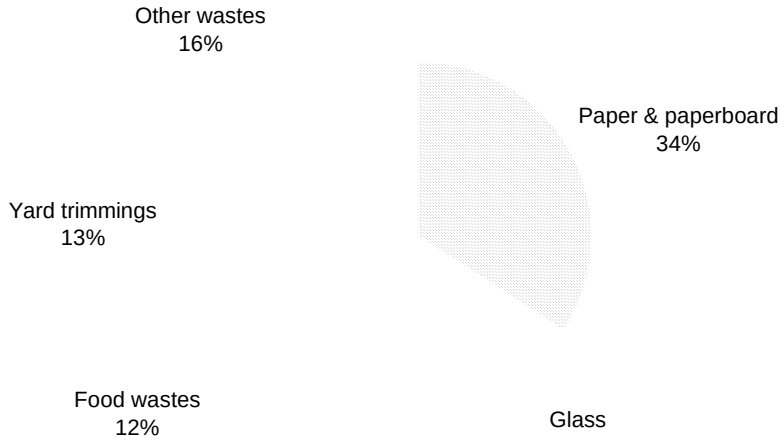
Generation. In earlier versions of this report, generation of yard trimmings was estimated using sampling studies and population data. While in past years generation of yard trimmings had been increasing steadily as population and residential housing grew (i.e., constant generation on a per capita basis), in the 1990s local and state governments started enacting legislation that discouraged 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 more than 28 percent of the nation's population–had legislation in effect that bans or discourages yard trimmings disposal in landfills. The tabulation of current legislation shows 21 states and the District of Columbia, representing about 50 percent of the nation's population, has 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.

[3] Although limited data are 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 estim

Figure 13. Materials generated and discarded* in municipal solid waste, 2005
(In percent of total generation and discards)



The Chapter 2 section above gave a breakdown of municipal solid waste by material. It described how the 245.7 million tons of MSW were generated, recycled (including composted) and disposed of. The following section breaks out the same 245.7 million tons of MSW by product.

PRODUCTS IN MUNICIPAL SOLID WASTE

The purpose of this section is to show how the products that make up municipal solid waste are generated, recycled (including composted) and discarded. For the analysis, products are divided into three basic categories: durable goods, nondurable goods, and containers and packaging. These three categories generally follow the definitions of the U.S. Department of Commerce, one of EPA's data sources. By these definitions, durable goods, (e.g., appliances) are those that last 3 years or more, while nondurable goods (e.g., newspapers and trash bags) last less than 3 years. For this report, containers and packaging are assumed to be discarded the same year the products they contain are purchased.

The following 15 tables (Tables 9 through 23) show generation, recycling (including composting) and discards of municipal solid waste in the three categories–durable goods, nondurable goods, and containers and packaging. Within these three categories, products are listed by type–for instance, carpets and rugs, office paper, or aluminum cans. The material the product is made of may be stated as well (for instance, glass beverage containers or steel cans), or may be obvious (for instance, magazines are made of paper.) Some products, such as tires and appliances, are made of several different material types.

At the bottom of each of these 15 tables (Tables 9 through 23) there is a section titled "Other Wastes." This contains information on food scraps, yard trimmings, and miscellaneous inorganic wastes. These wastes are not products that can be estimated through the materials flow methodology, but they are estimated by other means, as described earlier.

Within Tables 9 through 23, the first three tables–Tables 9 through 11–serve as an index to the other tables. Table 9 shows what tables to consult for detailed information on generation; Table 10 shows what tables to consult for detailed information on recovery; and Table 11 does the same for detailed information on discards. The tables on generation all have the same "bottom line"–245.7 million tons in 2005–with detail provided in different categories–durable goods, nondurable goods, or containers and packaging. For Table 10 and related tables, the "bottom line" is MSW is recovered–79 million tons; and for Table 11 and related tables, the "bottom line" is MSW discarded–166.7 million tons.

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, consumer electronics, and other miscellaneous durable goods (e.g., luggage, sporting goods, miscellaneous household goods) (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 2005, 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 40.3 million tons in 2005 (16.4 percent of total MSW generation). After recovery for recycling, 32.8 million tons of durable goods remained as discards in 2005.

Table 9

CATEGORIES OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 2005
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	36,980	39,440	39,850	40,280
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	64,120	62,300	64,410	63,720
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	76,020	75,360	78,550	76,670
***Total Product** Wastes*	54,620	83,280	108,890	146,510	177,120	177,100	182,810	180,670
Other Wastes								
Food Scraps	12,200	12,800	13,000	20,800	26,480	28,180	29,070	29,230
Yard Trimmings	20,000	23,200	27,500	35,000	30,530	31,470	31,770	32,070
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,620	3,650	3,690
Total Other Wastes	33,500	37,780	42,750	58,700	60,510	63,270	64,490	64,990
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	237,630	240,370	247,300	245,660
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	15.6%	16.4%	16.1%	16.4%
Nondurable Goods *(Detail in Table 15)*	19.7%	20.7%	22.7%	25.4%	27.0%	25.9%	26.0%	25.9%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.0%	31.4%	31.8%	31.2%
***Total Product** Wastes*	62.0%	68.8%	71.8%	71.4%	74.5%	73.7%	73.9%	73.5%
Other Wastes								
Food Scraps	13.8%	10.6%	8.6%	10.1%	11.1%	11.7%	11.8%	11.9%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	12.8%	13.1%	12.8%	13.1%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	25.5%	26.3%	26.1%	26.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before ma

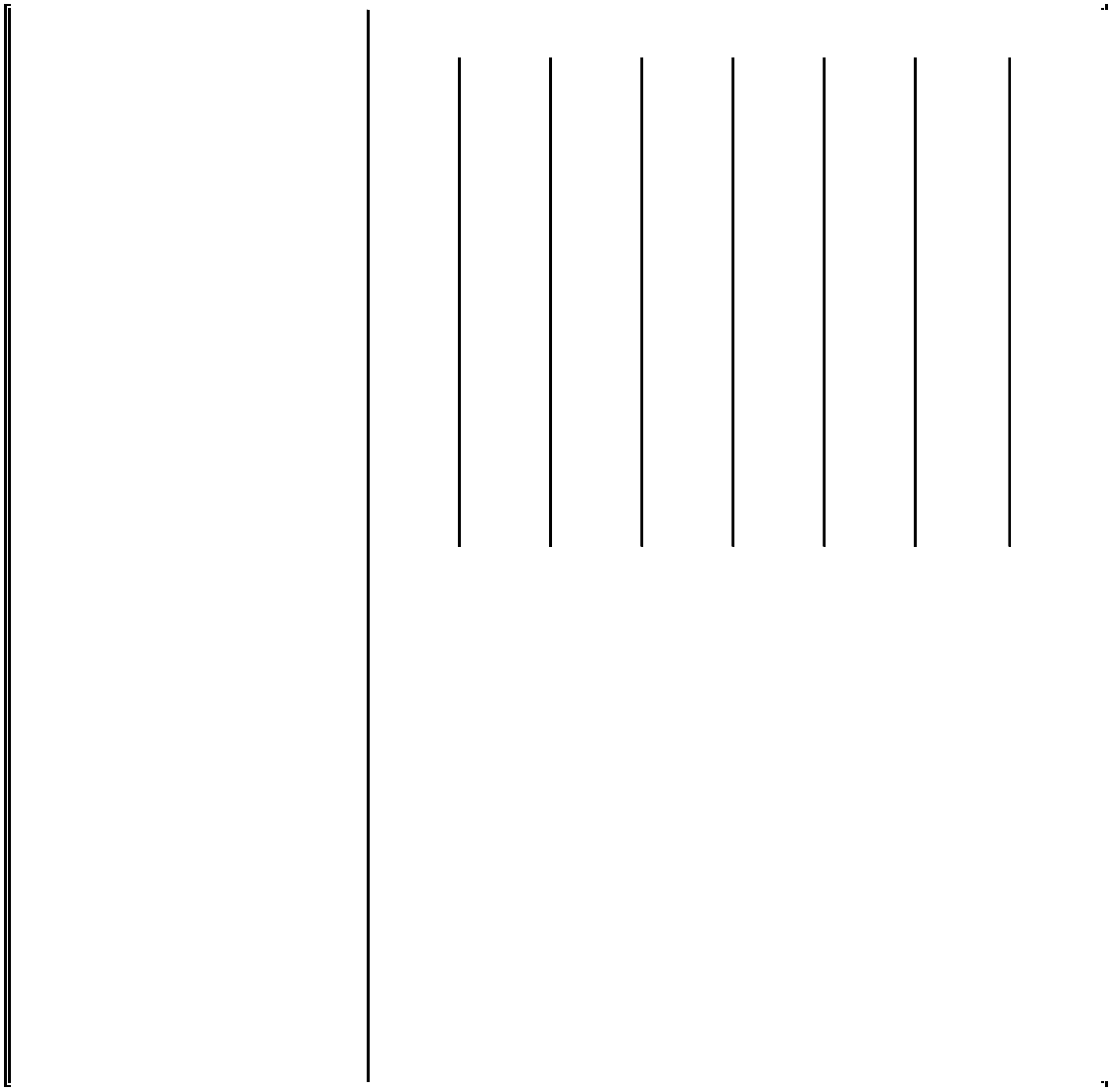


Table 11

CATEGORIES OF PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 2005
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Durable Goods *(Detail in Table 14)*	9,570	13,720	20,440	26,350	30,630	32,280	32,410	32,810
Nondurable Goods *(Detail in Table 17)*	14,940	21,330	29,750	43,370	46,560	43,010	44,450	43,270
Containers and Packaging *(Detail in Table 22)*	24,500	40,210	44,180	47,750	47,280	46,060	48,760	46,190
***Total Product** Wastes*	49,010	75,260	94,370	117,470	124,470	121,350	125,620	122,270
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	25,800	27,430	28,410	28,540
Yard Trimmings	20,000	23,200	27,500	30,800	14,760	13,140	11,960	12,210
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,620	3,650	3,690
Total Other Wastes	33,500	37,780	42,750	54,500	44,060	44,190	44,020	44,440
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	168,530	165,540	169,640	166,710
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Durable Goods *(Detail in Table 14)*	11.6%	12.1%	14.9%	15.3%	18.2%	19.5%	19.1%	19.7%
Nondurable Goods *(Detail in Table 17)*	18.1%	18.9%	21.7%	25.2%	27.6%	26.0%	26.2%	26.0%
Containers and Packaging *(Detail in Table 23)*	29.7%	35.6%	32.2%	27.8%	28.1%	27.8%	28.7%	27.7%
***Total Product** Wastes*	59.4%	66.6%	68.8%	68.3%	73.9%	73.3%	74.1%	73.3%
Other Wastes								
Food Scraps	14.8%	11.3%	9.5%	12.1%	15.3%	16.6%	16.7%	17.1%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	8.8%	7.9%	7.1%	7.3%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.1%	2.2%	2.2%	2.2%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	26.1%	26.7%	25.9%	26.7%
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. In this table, discards include combustion with energy 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, A Division of ERG

Major Appliances. Major appliances in MSW include refrigerators, washing machines,

composition of the appliances. Adjustments are also made for the estimated lifetimes of the appliances, which range up to 20 years.

Generation of major appliances has increased very slowly over the years, and in fact was about constant for the past 5 years. In 2005, generation was 3.6 m

Table 12

PRODUCTS GENERATED* IN THD63U7.5994 0 0 7.5994 9..124 0 0 7.5994 24U.8398 714.1801 Tm(b)TETBT/TT2 1 Tf5.5994 0 0

Table 13

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 2005
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Durable Goods								
Major App								

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 2.6 million tons of lead-acid batteries from automobiles, trucks, and motorcycles were generated in MSW in 2005 (one percent of total generation).

The Battery Council International provided data on recovery of batteries. Recovery of batteries for recycling has fluctuated between 60 percent 99 percent; recovery has increased since 1980 as a growing number of communities have restricted batteries from disposal at landfills or combustion facilities. In 2005, 98.8 percent of the lead in these batteries was estimated to be recovered for recycling as well as substantial quantities of the polypropylene battery casings. Discards after recycling of these batteries were 30,000 tons in 2005. (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, videocassette recorders, and personal computers; luggage; sporting equipment; and the like. An estimated 17.1 million tons of these goods were generated in 2005, amounting to 7.0 percent of MSW generated.

As in recent previous updates of this report, generation of selected consumer electronic products was estimated as a subset of miscellaneous durable goods. In 2005, an estimated 2.6 million tons of these goods were generated. Of this, approximately 330,000 tons of selected consumer electronics were recovered for recycling. Selected consumer electronics include products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones, and computer equipment.

The miscellaneous durable goods category, as a whole, includes ferrous metals as well as plastics, glass, rubber, wood, and other metals. An estimated 620,000 tons of ferrous metals were estimated to have been recovered from this category through pre-combustion and post-combustion magnetic separation at MSW combustion facilities in 2005, bringing total recovery

from this category to 950,000 tons. Discards of miscellaneous durable goods were 16.2 million tons in 2005.

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.

and groundwood[5] 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 2005. Recovery of books is not well documented, but it was estimated that approximately 260,000 tons of books were recovered in 2005. Books are made of both groundwood and chemical pulp.

- Magazines accounted for an estimated 2.5 million tons, or 1.0 percent of total MSW generation, in 2005. Like books, recovery of magazines is not well documented. It was estimated that 970,000 tons of magazines were recovered in 2005. 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. Generation of these office papers was 6.6 million tons, or 2.7 percent of total MSW generation in 2005. 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 4.1 million tons of office-type papers were recovered in 2005.

[5] Groundwood papers, like newsprint, are made primarily from pulp prepared by a mechanical process. The nature of the pulp (groundwood vs. chemical) affects the potential uses for the recovered paper.

- Directories were estimated to generate 660,000 tons (0.3 percent of total MSW) in 2005. These directories are made of groundwood. It was estimated that 120,000 tons of directories were recovered in 2005.

- Standard mail[6] includes catalogs and other direct bulk mailings; these amounted to an estimated 5.8 million tons, or 2.4 percent of MSW generation, in 2005. Both groundwood and chemical pulps are used in these mailings. It was estimated that 2.1 million tons were recovered in 2005. The U.S. Postal Service has implemented a program to increase recovery of bulk mail, and many curbside collection programs also include mail.

- Other commercial printing includes a wide range of paper items, including brochures, reports, menus, and invitations. Both groundwood and chemical pulps are used in these varied items. Generation was estimated at 7.3 million tons, or 3 percent of MSW generation, in 2005, with recovery estimated at 0.8 million tons.

- Tissue paper and towels generation includes facial and sanitary tissues and table 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 3.4 million tons (1.4 percent of total MSW generation) in 2005. No significant recovery of tissue products for recycling was identified, 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 1.0 million tons (0.4 percent of total MSW generation) in 2005. No significant recovery for recycling of these products was identified.

[6] Standard mail was formerly called Third Class mail and Standard (A) mail by the U.S. Postal Service.

- Other nonpackaging papers–including posters, photographic papers, cards, and games–accounted for 4.4 million tons (1.8 percent of total MSW generation) in 2005. No significant recovery for recycling of these papers was identified.

Overall, generation of paper and paperboard products in nondurable goods was 44.9 million tons in 2005 (Table 4). While newspapers were recovered at the highest rate, other paper products, such as books, magazines, and office papers, also were recovered for recycling, and the overall recovery rate for paper in nondurables was 42.4 percent in 2005. Thus 25.9 million tons of paper in nondurables were discarded in 2005.

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

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 2005.

Clothing and Footwear. Generation of clothing and footwear was estimated to be 8.1 million tons in 2005 (3.3 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 products 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 1.3 million tons of textiles in clothing were recovered for export or recycling in 2005. (Reuse is not counted as recycling and is included in the estimates in Chapter 3.)

Towels, Sheets, and Pillowcases. An estim

Containers and Packaging

Containers and packaging make up a major portion of MSW, amounting to 76.7 million tons of generation in 2005 (31.2 percent of total generation). Generation in this category has rema

An estimated 2.8 million tons of glass containers were recovered for recycling, or 25.3 percent of generation, in 2005. Glass container discards were 8.2 million tons in 2005, or 4.9 percent of total MSW discards.

Steel Containers and Packaging. Steel food and other cans, and other steel packaging (e.g., strapping and steel barrels and drums), totaled 2.4 million tons in 2005 (1.0 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.

The Steel Recycling Institute (SRI) provided recovery data for steel containers and packaging. An estimated 1.5 million tons of steel packaging were recovered in 2005, or 63.3 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.

Table 19

Table 22

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 2005
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

In 1996, the Can Manufacturers Institute 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. Total aluminum container and packaging generation in 2005 was 1.9 million tons, or 0.8 percent of total MSW generation.

Aluminum can recovery data are published by the Aluminum Association; this recovery number includes imported used beverage cans (UBC). The imported UBC are subtracted from the tonnage of UBC reported by the Aluminum Association to have been melted by U.S. end-users and recovered for export. Thus, the aluminum can recovery rate reported here is somewhat less than that published by the Aluminum Association.

Recovery of aluminum beverage cans in 2005 was 0.7 million tons, or 44.8 percent of generation. Recovery of all aluminum packaging was estimated to be 36.3 percent of total generation in 2005. After recovery for recycling, 1.2 million tons of aluminum packaging were discarded in 2005.

Paper and Paperboard Containers and Packaging. Corrugated boxes are the largest single product category of MSW at 30.9 million tons generated, or 12.6 percent of total generation, in 2005. Corrugated boxes also represent the largest single category of product recovery, at 22.1 million tons of recovery in 2005 (71.5 percent of boxes generated were recovered). After recovery, 8.8 million tons of corrugated boxes were discarded, or 5.3 percent of MSW discards in 2005.)

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 (primarily set-up boxes such as shoe boxes). Overall, paper and paperboard containers and packaging totaled 39.0 million tons of MSW generation in 2005, or 15.9 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 840,000 tons in 2005). The overall recovery rate for paper and paperboard packaging in 2005 was 58.8 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 and water jugs, film products (including bags and sacks) made of low-density polyethylene (LDPE), and other 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 the American Plastics Council's annual plastics resin 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 13.7 million tons in 2005 (5.6 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 supplemented with additional industry data. Plastic soft drink bottles were estimated to have been recovered at a 34.1 percent rate in 2005 (290,000 tons). Recovery of plastic milk and water bottles was estimated to have been 230,000 tons, or 28.8 percent of generation. Overall, recovery of plastic containers and packaging was estimated to be 1.3 million tons, or 9.4 percent in 2005. Discards of plastic packaging thus were 12.4 million tons in 2005, or 7.4 percent of total MSW generation.

Wood Packaging. Wood packaging includes wood crates and pallets (mostly pallets). Data on production of wood packaging is from the National Wood Pallet and Container Association, and more recently, the USDA Forest Service Southern Research Station and Virginia Polytechnic Institute. In 2005, 8.5 million tons of wood pallets and other wood packaging were estimated to have been generated, or 3.5 percent of total MSW generation.

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 1.3 million tons in 2005.

Accounting for pallet reuse and recovery for recycling, wood packaging discards were

The materials composition of containers and packaging in MSW in 2005 is shown in Figure 16. By weight, paper and paperboard products made up 51 percent of containers and packaging generation; plastics accounted for 18 percent. Glass was 14 percent, wood was 11 percent, and metals were 6 percent.

The percentage of materials discards from

**Figure 15. Nondurable goods generated and discarded*
in mu**

Figure 16. Containers and packaging generated and discarded* in municipal solid waste, 2005
(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 2005 was 245.7 million tons, which was 1.6 million tons less than in 2004, when 247.3 million tons were generated. This compares to 1990, when total generation of MSW was 205.2 million tons.

- Paper and paperboard products made up the largest percentage of all the materials in MSW, at 34.2 percent of total generation. Generation of paper and paperboard products declined from 87.7 million tons in 2000 to 84.0 million tons in 2005. Generation of newspapers has been declining since 1990, and this trend is expected to continue, partly due to decreased page size (source reduction), but also due to increased use of electronic communication of news. Generation of office-type (high grade) papers also has been in decline, due at least partially to increased use of electronic transmission of reports, etc. Paper and paperboard products have ranged between 34 and 35 percent of generation since 2003.

- Yard trimmings comprised the second largest material category, estimated at 32.1 million tons, or 13.1 percent of total generation, in 2005. This compares to 35.0 million tons (17.1 percent of total generation) in 1990. This decline is largely due to state legislation discouraging yard trimmings disposal in landfills, including source reduction measures such as backyard composting and leaving grass trimmings on the yard.

- Containers and packaging recovery increased from 29.8 million tons in 2004 to 30.5 million tons in 2005; percentage recovery increased from 37.9 percent to 39.8 percent. Nondurable goods recovery increased from 20.0 million tons in 2004 to 20.5 million tons in 2005; percentage recovery increased from 31.0 percent to 32.1 percent.

- Measured by tonnage, the most recovered products and materials in 2005 were corrugated boxes (22.1 million tons), yard trimmings (19.9 million tons), newspapers (10.7 million tons), high grade office papers (4.1 million tons), glass containers (2.8 million tons), steel from large appliances (2.4 million tons), rubber tires (1.5 million tons), Standard mail (2.1 million tons), and wood packaging (1.3 million tons). Collectively, these products accounted for about 85 percent of total MSW recovery in 2005.

- Measured by percentage of generation, products with the highest recovery rates in 2005 were lead-acid batteries (98.8 percent), steel in major appliances (90.0 percent), newspapers (88.9 percent), corrugated boxes (71.5 percent), steel packaging (63.3 percent), office-type papers (62.6 percent), yard trimmings (61.9 percent), aluminum cans (44.8 percent), magazines (38.5 percent), Standard mail (35.8 percent), and PET soft drink bottles (34.1 percent).

Long Term Trends

- Generation of MSW has increased (except in recession years), from 88.1 million tons in 1960 to 247.3 million tons in 2004. It decreased somewhat, to 245.7 million tons in 2005.

- Generation of paper and paperboard, the largest material component of MSW, fluctuates from year to year, but has decreased from 87.7 million tons in 2000 to 84.0 million tons in 2005. Generation of yard trimmings, the second largest

component, has increased since 2000. Generation of other material categories also fluctuates from year to year, but overall MSW generation has increased each year since 2000, except for 2005, which saw a decline from 2004 to 2005, primarily due to the decline in paper and paperboard generation between 2004 and 2005.

- 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 (32.1 percent) reflects a rapid increase in the infrastructure for recovery over the last decade.

- Recovery (as a percentage of generation) of most materials in MSW has increased dramatically over the last 35 years. Some examples:

	1970	**1980**	**1990**	**2000**	**2005**
Paper and paperboard	15%	21%	28%	43%	50%
Glass	1%	5%	20%	23%	22%
Metals	4%	8%	24%	36%	37%
Plastics	Neg.	<1%	2%	5%	6%
Yard trimmings	Neg.	Neg.	12%	52%	62%
Rubber in tires	13%	6%	12%	26%	35%
Lead-acid batteries	76%	70%	97%	93%	99%

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

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 (or waste prevention), including reuse of products and on-site (or backyard) composting of yard trimmings.

2. Recycling, including off-site (or community) composting.

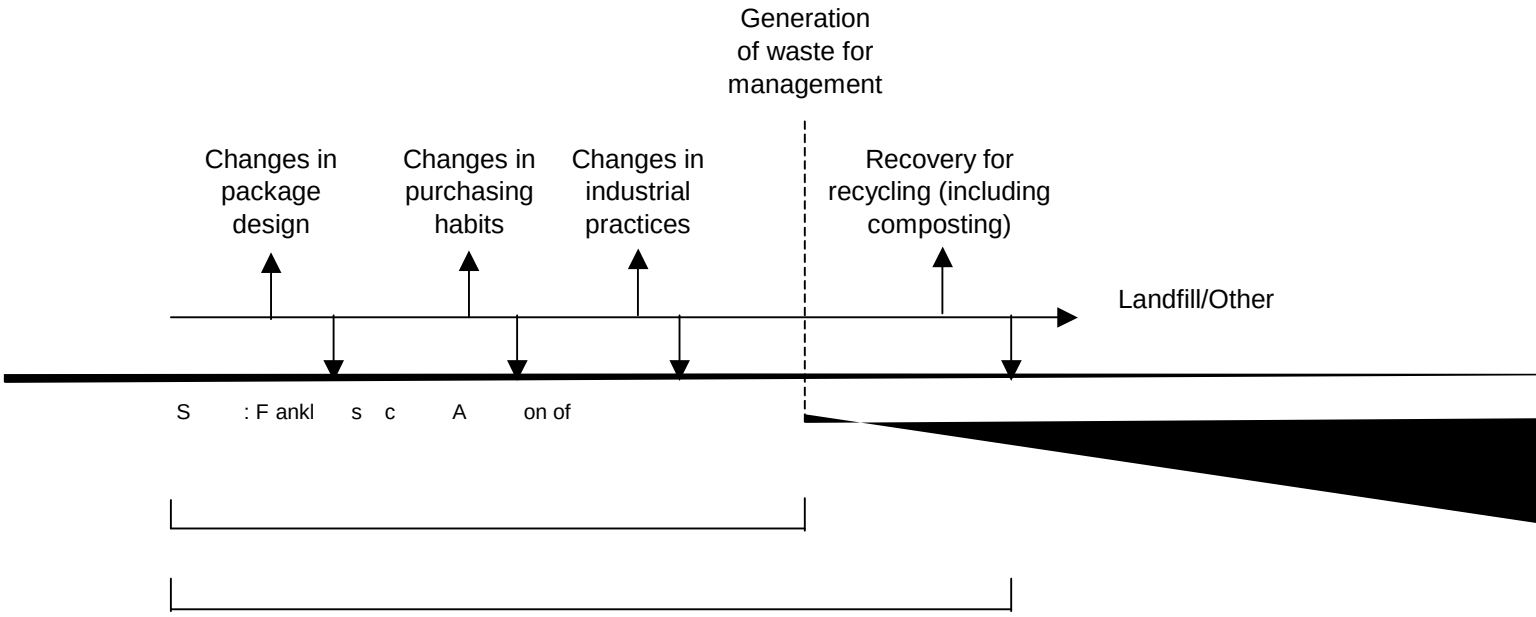
3. Combustion with energy recovery.

4. Disposal through landfilling or combustion without energy recovery.

The four components are put into context in Figure 17.

This chapter addresses the major activities within an integrated waste management system,12 0 0 12 496.2c5n2A.c5n2A.c5n2A.c5N2n.site (or TT2 1 Tf12 0 0 12 316.1166 384.24 8.18612 0 0 12

Figure 17. Diagram of solid waste management



Estimates of the municipal recovery of materials for recycling, including yard trim i

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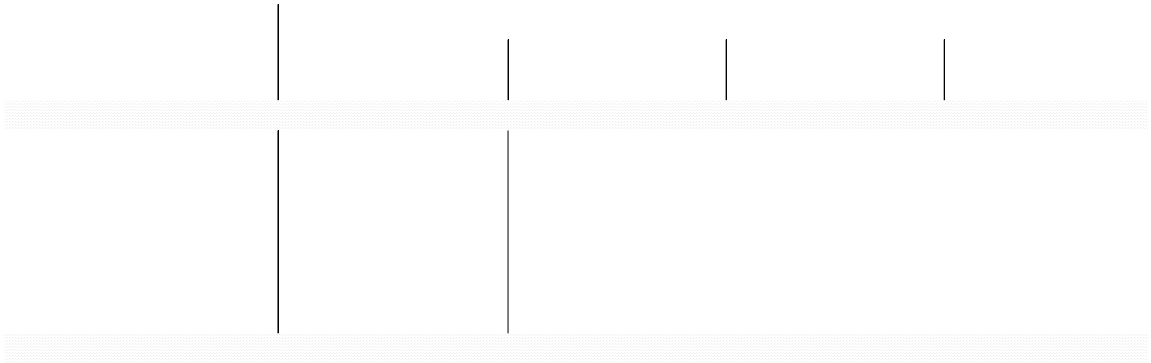


Materials substitution can make a product or package lighter. For example, there has been a continuous trend of substitution of lighter materials such as plastics and aluminum for materials such as glass and steel. The substitution also may involve a flexible package instead of a rigid package. A product 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 product enters the municipal waste stream. The responsibility for lengthening product life lies partly with manufacturers and partly with consumers. Manufacturers can design products 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 also must be willing to care for and repair products.

Modifying Practices to Reduce Materials Use

Businesses and individuals often can 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 also can reduce packaging requirements.

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, and reconditioned printer cartridges.

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 single-use glass bottles, plastic bottles, and aluminum cans have largely replaced these. 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 eight trips (refillings) per bottle.

Another example in this category is the use of refurbished wood pallets for shipping palletized goods. It is estimated that over 10 million tons of wood pallets were refurbished and returned to service in 2005. 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, although this practice can achieve a notable source reduction in packaging. As an 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 packagt7h1m

Management of Organic Materials

Food scraps and yard trimmings combined made up about 25 percent of MSW generation in 2005, so source reduction measures aimed at these products can have an important effect on waste generation. Composting is the usual methodology 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 recycling activity. Estimates for these off-site composting activities are included in this chapter.

There are several types of source reduction that take place at the point of generation (e.g., the yard of a home or business). The backyard composting of yard trimmings and certain food discards is a growing source reduction practice. There also is a trend toward leaving grass clippings on lawns, often through the use of mulching mowers. Other actions contributing to reduced organics disposal are: establishment of variable fees 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 certain legislation such as bans on disposal of yard trimmings in landfills.

Part of the impetus for source reduction and recycling of yard trimmings is the large number of state regulations discouraging landfilling or other disposal of yard trimmings. The Composting Council and other sources reported that in 1992, 12 states (amounting to over 28 percent of the nation's population) had in effect legislation affecting management of yard BT/TT2 1 Tf12 0 0 12

attempts by localities and states often consisted of measuring a single waste stream in a single community. In time, additional research enabled proxy, or estimated values, to be developed for specific waste streams, to use on a state-wide or national level. EPA's *Source Reduction Program Potential Manual* and planning packet, published in 1997 (EPA530-E-97-001) provides an example of this approach. Unlike recycling, where there are actual materials to weigh all through the process, measuring source reduction means trying to measure something that no longer exists.

The November 1999 *National Source Reduction Characterization Report for Municipal Solid Waste in the United States* (EPA 530-R-99-034) provides additional information including an explanation of a methodology that has been used to generate source reduction estimates.

RECOVERY FOR RECYCLING (INCLUDING COMPOSTING)

Recyclables Collection

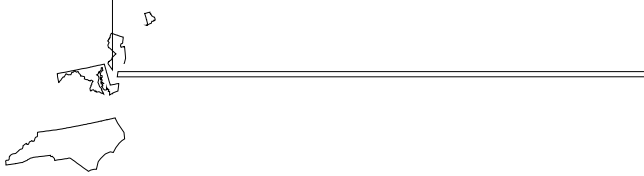
Before recyclable materials can be processed and recycled into new products, they must be collected. Most residential recycling involves curbside recyclables collection, drop-off programs, buy-back operations, and/or container deposit systems. Collection of recyclables from commercial establishments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

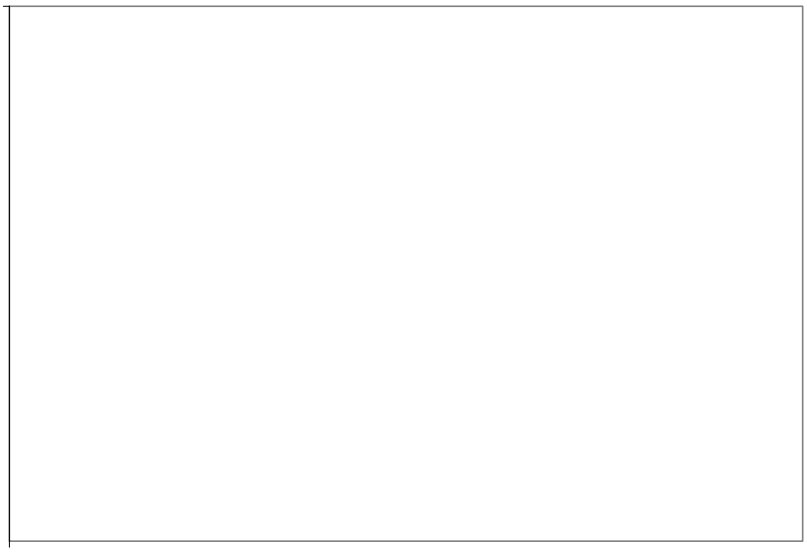
Curbside Recyclables Collection. In 2005, more than 8,500 curbside recyclables collection programs were reported in the United States. As shown in Table 25 and Figure 18, the extent of residential curbside recycling programs varies tremendously by geographic region, with the most extensive curbside collection occurring in the Northeast.

Figure 18. Population served by curbside recycling, 2005

It is difficult to quantify drop-off centers in the United States. It is estimated that there were 12,694 programs in 1997, according to a *BioCycle* survey. In some areas, particularly those with sparse population, drop-off centers may be the only option for collection of recyclable ma

Figure 19. States With Bottle Deposit Rul s





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 scraps and yard trimrd trim

Figure 22. MSW Composting Capacity, 2005
(Capacity in tons per day per million persons)

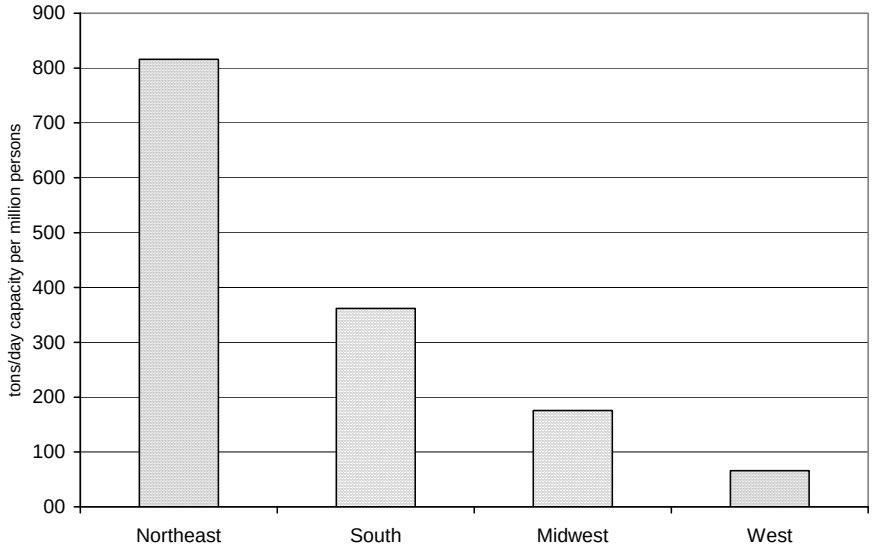
In addition to facilities combusting mixed MSW (processed or unprocessed), there is a small but growing amount of combustion of source-separated MSW. In particular, rubber tires have been used as fuel in cement kilns, utility boilers, pulp and paper mills, industrial boilers, and dedicated scrap tire-to-energy facilities. 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 2.8 million tons of MSW were combusted in this manner in 2005, with tires contributing a majority of the total.

Table 27

MUNICIPAL WASTE-TO-ENERGY PROJECTS, 2005

Region	Number Operational	Design Capacity

Figure 24. Municipal Waste-to-Energy Capacity, 2005
(Capacity in tons per million persons)



Source: U.S. Census Bureau, Integrated Waste Services Association 2004.

RESIDUES FROM WASTE MANAGEMENT FACILITIES

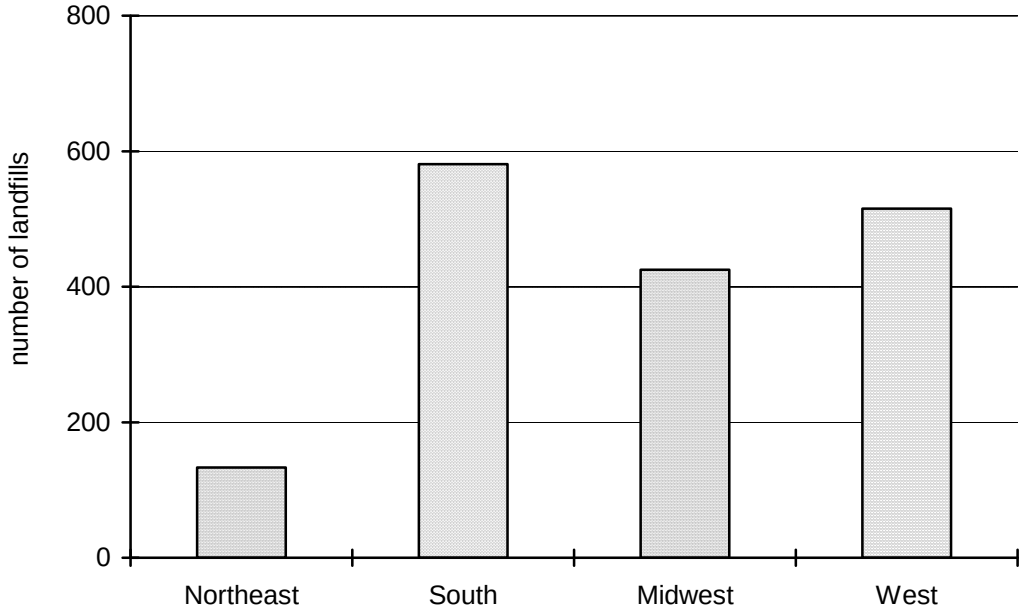
Whenever municipal wastes are processed, residues will remain. For the purposes of this report, it is assumed that most of these residues are landfilled. Materials processing facilities (MRFs) and compost facilities generate some residues when processing various recovered materials. These residues include 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 is managed separately[7]. (There are a number of efforts underway to reuse ash.) As a general "rule of thumb," MSW combustor ash amounts to about 25 percent (by 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.

LANDFILLS
bUni d MSttels

Figure 25. Number of Landfills in the U.S., 2005



Source: BioCycle April 2006.

SUMMARY OF HISTORICAL AND CURRENT MSW MANAGEMENT

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

Figure 26. Municipal soli

CHAPTER 3

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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.

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.

RECOVERY

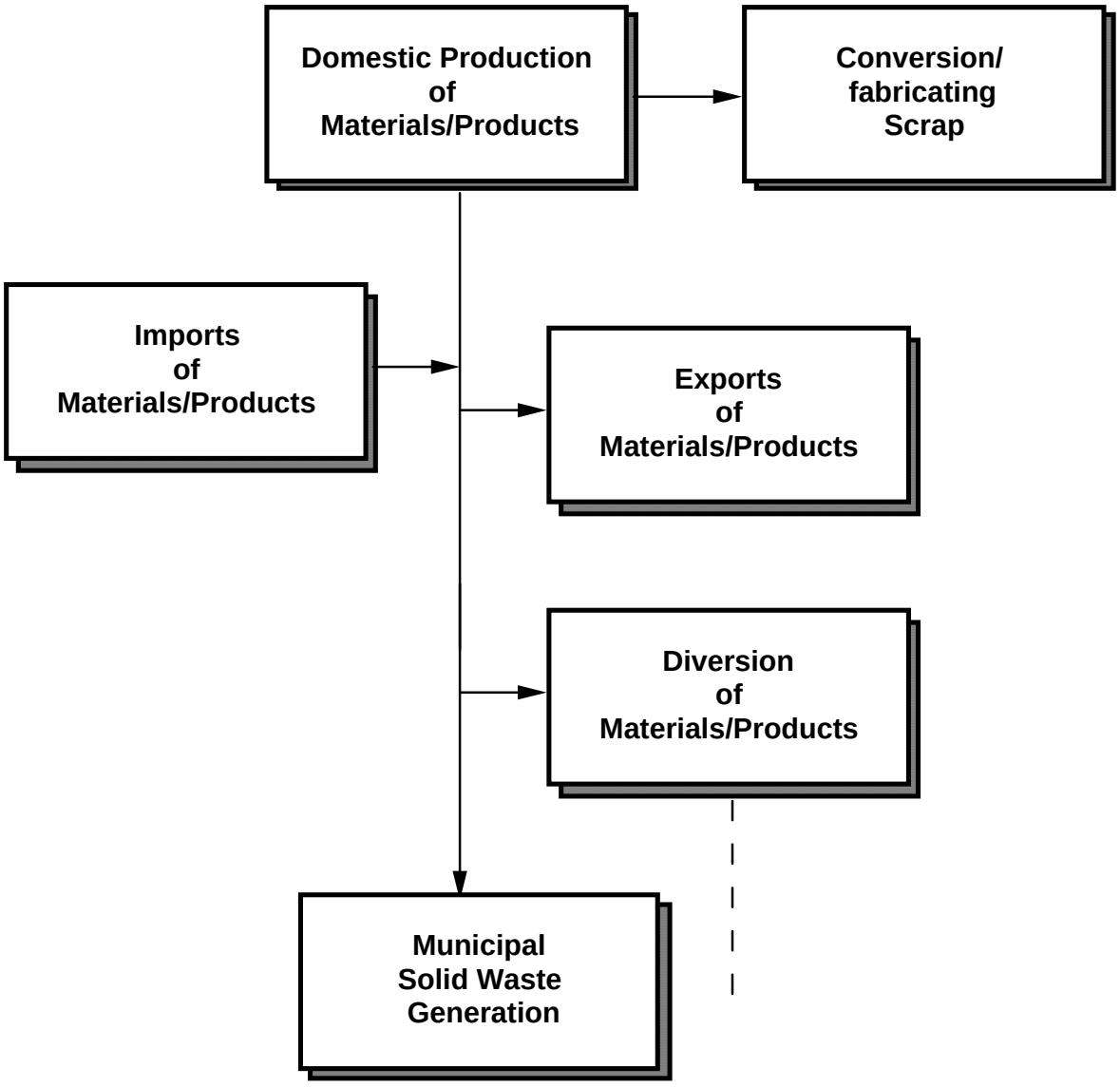
Data on recovery of materials and products for recycling are compiled using industry data adjusted, when appropriate, with U.S. Department of Commerce import/export data. Recovery estimates of yard trimmings or food scraps for composting are developed from data provided by state officials.

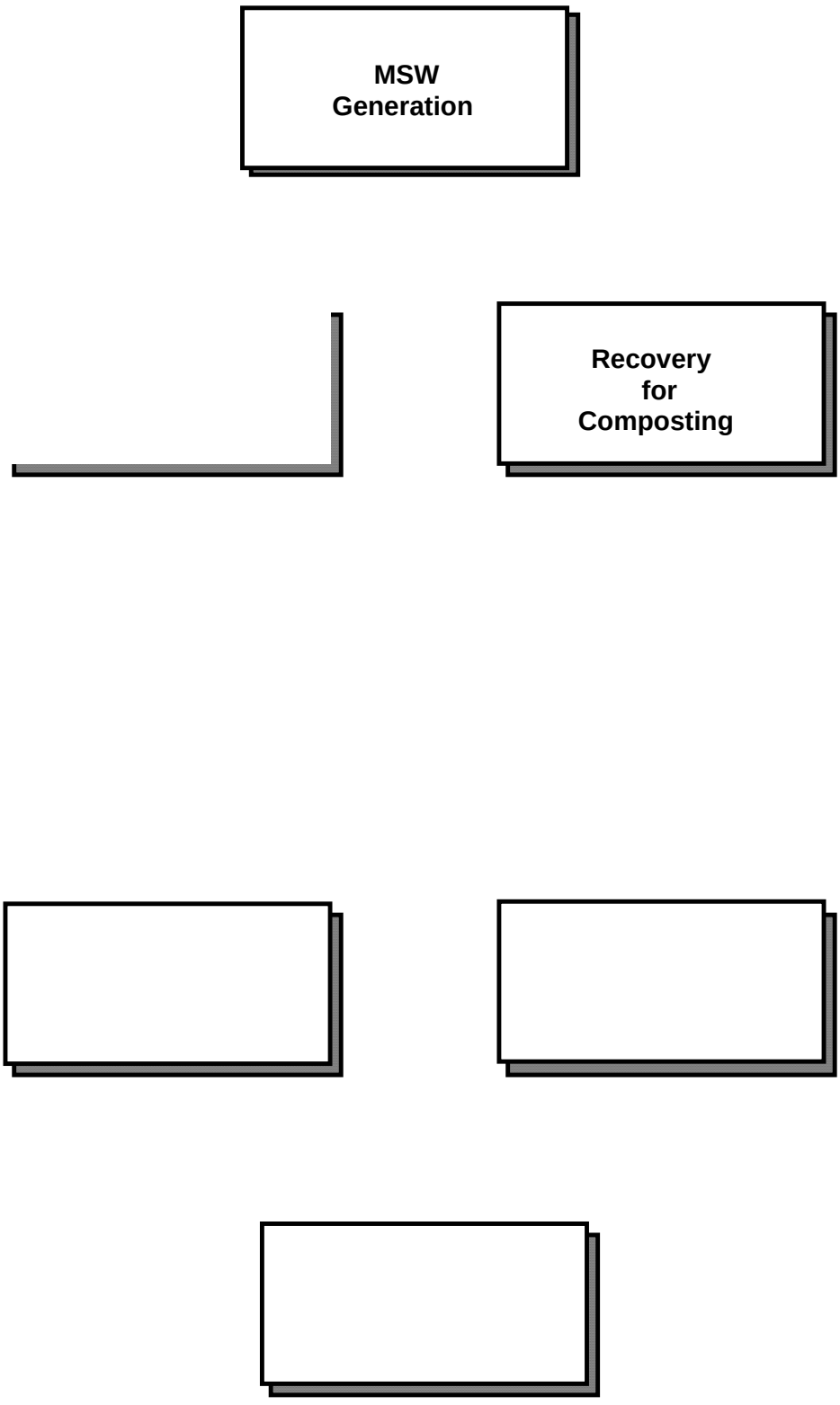
DISCARDS

Mathematically, discards equal that portion of generation remaining after recovery for recycling and composting. Discards can be disposed through combustion with or without energy recovery or landfilling. The amount of MSW consumed at combustion facilities with energy recovery is estimated, and the difference between total discards and the amount sent to combustion for energy recovery is assumed to be landfilled or combusted without energy recovery. (This assumption is not quite accurate, as some MSW is littered or disposed on-site, e.g., by backyard burning. These amounts are believed to be a small fraction of total discards.)

MUNICIPAL SOLID WASTE GENERATION, RECOVERY, 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.


Domestic Production of Materials/Products
Conversion/ fabricating Scrap
Imports of Materials/Products
Exports of Materials/Products
Diversion of Materials/Products
Municipal Solid Waste Generation


MSW
Generation
Recovery
for
Composting

United States Environmental Protection Agency