United States
Environmental Protection
Agency

Solid Waste
and Emergency Response
(5306W)

EPA530-R-99-034
November 1999
www.epa.gov/osw

National Source Reduction Characterization Report

For Municipal Solid Waste in the United States

Source Reduction

ri-dŭk-shən

Waste Prevention

prĭ-vĕn-shən

Sustainable Resource

sə-stān'-ə-bəl rē'-sôrs

Contents

LIST OF TABLES AND FIGURES

Tables

Figures

Chapter 1
INTRODUCTION

source
\'sôrs, 'sôrs\ n. A point of origin.

reduction
\ri-'dək-shən\ n. The amount by which something is lessened or diminished.

1.1 Why Characterize Source Reduction?

In February 1989, the U.S. Environmental Protection Agency's (EPA) *Agenda for Action* called for "a new solid waste management ethic" reflected in what has come to be referred to as the "solid waste management hierarchy." While acknowledging variations in local conditions, the hierarchy established a preferred order to municipal solid waste (MSW) management:

1. Source reduction (including reuse of products, grasscycling, and onsite composting).
2. Recycling (including offsite composting).
3. Waste combustion (preferably with energy recovery) and landfilling.

In its *Agenda for Action*, EPA emphasized a clear preference for source reduction over all other waste management practices. The best way to manage waste is to simply not generate it in the first place, so that it doesn't need to be collected, treated, or disposed of. Furthermore, source reduction's benefits greatly outweigh those of recycling, incineration, and landfilling in terms of reducing energy use, greenhouse gas emissions, and other environmental impacts. Source reduction makes sense—both environmentally and economically.

One of the big challenges with source reduction involves trying to quantify the results of waste prevention efforts. While recycling tonnages and landfill or combustion input can be weighed on a scale, it is very difficult to measure something that has not been generated in the first place.

That is why EPA developed this report. For the first time, a nationwide effort has been made to capture the amount of waste that was *not* created over a certain time period. This report not only estimates the quantity of source reduction nationwide, but also looks at factors that drive waste prevention activities such as changes in design practices, operational changes, policy trends, and new technologies. Source reduction is addressed in terms of the MSW stream as a whole and in major material categories (i.e., paper and paperboard, food scraps and yard trimmings, plastics, metals, wood, glass).

definitions

Source Reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system. Source reduction, also known as waste prevention, occurs before waste generation is measured.

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, such as refillable glass bottles, reusable plastic food storage containers, or refurbished wood pallets.

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. MSW does not include sewage, hazardous wastes, nonhazardous industrial waste, construction and demolition debris, or automobile bodies.

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

Discards refer to the MSW that has not been recycled or composted. These discards are usually combusted or disposed of in landfills, although some MSW is littered, stored, or disposed on site, particularly in rural areas.

Additional terms and definitions can be found in the Glossary of this report.

1.2 How Was Source Reduction Calculated?

In order to quantify and examine source reduction across the country, EPA built this report using MSW data that the Agency has compiled and reported to the public since 1990. For the last decade, EPA has produced a report, *Characterization of Municipal Solid Waste in the United States*, to give overall calculations of MSW generation, recycling, and disposal for all years from 1960 to 1997. MSW generation, recycling, and disposal data are given by material categories (i.e., paper, plastic, metal, wood, glass, food, and yard trimmings), as well as by product categories (i.e., durable goods, nondurable goods, containers and packaging, food scraps, and yard trimmings). This information has proven invaluable for supporting MSW policy decisions and solid waste management practices in the United States.

In order to characterize the waste that was not generated, EPA has developed a methodology for calculating the amount of MSW source reduction occurring in the United States on an annual basis since 1990. This base year coincides with major source reduction policy initiatives embodied in the 1989 *Agenda for Action*, as well as the 1990 Pollution Prevention Act.

This report's basic approach to measuring source reduction involves looking at changes in waste generation, by estimating what the waste generation rate would have been had source reduction *not* taken place. To do this, the methodology focuses on waste generation rates. EPA's methodology takes an important departure from traditional per capita, per day units of measure, by using economic data to understand MSW generation rates. Personal Consumption Expenditures (PCE) are used to evaluate the reduction of waste generation relative to the real growth in consumer spending. PCE, a component of the Gross Domestic Product (GDP), is an economic measure of consumer spending. This approach was chosen because consumer spending data correlates with historical MSW generation. In other words, the more people spend, the more waste they generate. PCE, therefore, can be used to predict what waste generation would have been, had source reduction not occurred. In some cases, individual material waste streams may grow faster than the PCE rate. This is referred to as "source expansion" and is further explained in Chapter 2 of this report.

To further clarify areas where material substitution (e.g., aluminum for glass, paper for plastic, or vice versa) has led to source reduction or expansion, EPA introduced the concept of "functional product groupings." This report examines products in functional categories (e.g., beverage containers used to deliver soft drinks to consumers) so that source reduction may be considered relative to a specific market activity, rather than on a material-specific basis.

Using this overall methodology, which quantifies source reduction by weight, EPA is now able to characterize waste prevention both in the aggregate and by product and material categories. Later efforts may also address material toxicity and volume, which is important when considering the amount of landfill space this waste would have required.

What Is Source Reduction?

Source reduction encompasses a broad range of activities undertaken by private citizens, communities, commercial establishments, institutional agencies, and manufacturers and distributors. In general, source reduction activities include:

- Redesigning products or packages to reduce the quantity or toxicity of the materials used, or substituting lighter materials for heavier ones.
- Lengthening the life of products to postpone their disposal.
- Using packaging that reduces product damage or spoilage.
- Reducing the amount of products or packages used by businesses or consumers.
- Reusing products or packages.
- Managing organic wastes such as food scraps and yard trimmings through grasscycling, backyard composting, or other onsite alternatives to disposal.

1.3 Summary of Results

This report is based directly on tonnage data for MSW provided in the *Characterization of Municipal Solid Waste in the United States*. *Characterization of Municipal Solid Waste in the United States*, *1997 Update* (hereafter referred to as "*1997 Update*") contains waste generation data for 1996; therefore source reduction was calculated for 1996 (relative to the 1990 base year) as this was the most recent data available.

In 1996, a total of more than 23 million tons of MSW were source reduced in the United States. That same year, according to the *1997 Update*, 209.7 million tons of MSW were generated. Had source reduction not taken place, an additional 11 percent of MSW generation would have required recycling, landfilling, or combustion.

By applying the methodology mentioned above, EPA examined which components of MSW were responsible for the 23.3 million tons of source reduction in 1996. Durable goods (e.g., appliances, furniture, tires) represented nearly 2.2 million tons; nondurable goods (e.g., newspapers, clothing) represented nearly 3.6 million tons; containers and packaging represented 4 million tons; and other MSW (e.g., yard trimmings, food scraps) represented 13.5 million tons.

The figures above do not mean that waste generation rates decreased for every product within these broad categories; in fact, within each category, some items had increased waste generation rates, while the rates for other categories were less. The result was a net value of source reduction in the overall category. Chapter 3 provides additional detail regarding areas of source reduction and expansion in various product categories.

EPA also examined source reduction for the years covered in the *1997 Update* (1992, 1994, and 1995), relative to the base year 1990. In 1992, approximately 630,000 tons of MSW were source reduced; in 1994, more than 7.9 million tons of MSW were source reduced; and in 1995, more than 15.8 million tons of MSW were source reduced.

Using this data, the benefits from source reduction can now be assessed more reliably. Product level impacts of source reduction also can be better understood as a critical element of solid waste management planning and policies. This report should ultimately help emphasize the impact of source reduction and capture the attention of policy makers at all levels of government.

This report is an integral part and a natural extension of EPA's ongoing efforts to track and report national developments in MSW generation. EPA intends to add source reduction data as a permanent feature to all future updates of the *Characterization of Municipal Solid Waste in the United States* report, to create a more accurate profile of the nation's efforts to reduce MSW.

1.4 Report Organization

Three chapters follow this introduction. Chapter 2 explains the methodology that was used to generate all of the source reduction estimates presented in this report. Further detail on the chosen methodology, including an explanation of the significance of PCE as a predictor of waste generation, is provided.

Chapter 3 contains the final data on source reduction for the MSW stream as a whole, as well as for its component materials and product categories. It also provides a closer look at several materials and activities that contribute significantly to source reduction on a national level. Data are summarized in figures and tables throughout.

Chapter 4 describes source reduction in action, through a number of case studies. Profiling the source reduction activities of individual organizations helps support the numerical data presented in Chapter 3 with real world examples. The source reduction efforts highlighted include backyard composting, elimination of unnecessary packaging, lightweighting, and material reuse.

A Glossary defines terms used in this report, and the Appendix provides extensive detail on the empirical and statistical analysis undertaken to support the methodology described in Chapter 2.

Chapter 2
METHODOLOGY

waste

\'wāst\ v. To use, consume, or expend carelessly or thoughtlessly.

prevention

\pri-'ven(t)-shən\ n. The act of keeping from happening.

2.1 Introduction

This report represents the first attempt to quantify nationwide source reduction. In developing a methodology for quantifying source reduction at the national level, EPA first began by examining the historical pattern of municipal solid waste (MSW) generation in the United States. It is often assumed that measuring source reduction involves measuring changes in waste generation over a period of time. While changes in waste generation are important indicators of source reduction, they do not take into account the variety of socioeconomic and lifestyle changes that affect the quantity of MSW generated (e.g., changes in packaging, increased consumption of food away from home, changes in lawn and garden care). For this reason, EPA's methodology assumes that, without source reduction, MSW generation would have grown from 1990 to 1996 in proportion to a driving factor such as population or economic activity. A change in the driving factor, thus, would change the amount of waste generated.

The impact of driving factors on MSW generation is measured by analyzing the amount of waste generated over time relative to the driving factor. The rate of waste generation means the amount of waste generated per unit of the driving factor, such as per capita or per dollars spent. Source reduction is then calculated as the difference between the projected amount of MSW generated in 1996, and the actual amount of MSW generated in 1996.

To understand which driving factor best explains waste generation, this report examined several factors to determine which one followed the pattern of waste generation most closely. The following three leading candidates were selected:

- Population: waste generated per capita.
- Gross Domestic Product (GDP): waste generated per million dollars of economic activity.
- Personal Consumption Expenditures (PCE): waste generated per million dollars spent by consumers.

The historical pattern of changes in waste generation was found to be more closely related to changes in consumer spending (PCE) than to changes in GDP or population (or to other possible factors that were tested but not selected). In addition, consumer spending's impact on MSW generation

definitions

Driving Factor refers to macroeconomic developments that cause, or drive, changes in waste generation. Examples include increases or decreases in population, wages, and gross domestic product.

Gross Domestic Product (GDP) refers to the total annual market value of all final goods, services, and structures produced by labor and property located in the United States, regardless of who owns the resources.

Personal Consumption Expenditures (PCE) refers to the amount of spending by consumers on goods and services within the GDP. It is the largest single component of GDP and accounts for two-thirds of its total output. In this report, PCE also is often referred to more generically as "consumer spending."

Additional terms and definitions can be found in the Glossary of this report.

makes intuitive sense, since the products and packaging purchased by consumers are ultimately discarded as MSW.

Source reduction, therefore, was measured as the difference between the amount of waste that would have been generated in 1996, if the relationship between waste generation and consumer spending had remained the same as it was in 1990, and the actual amount of waste generated in 1996.

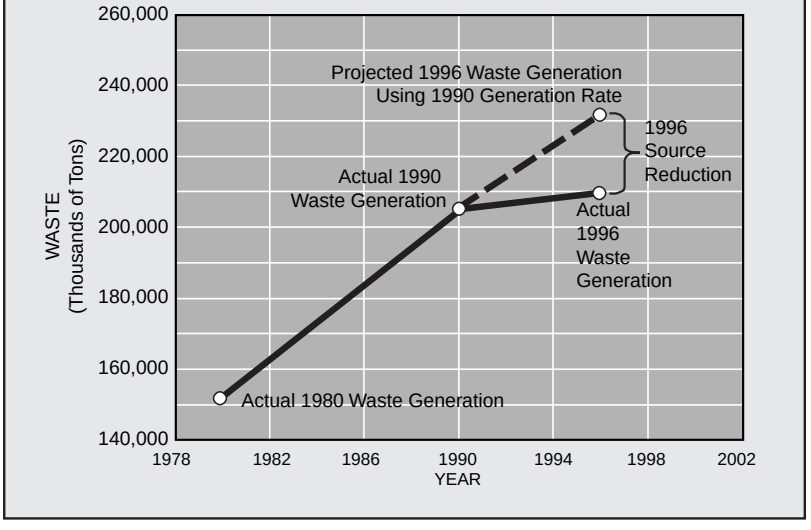
Source Reduction in 1996 = Projected 1996 Waste Generation (Using 1990 Generation Rate) – Actual 1996 Waste Generation

2.2 Overview of the Measurement Approach

Figure 2-1 illustrates the approach to source reduction measurement used in this report. The solid line represents actual waste generation over time, with the values for 1980, 1990, and 1996. The dotted line shows the waste that would have been generated if, beginning in 1990, the rate of waste generation relative to consumer spending remained constant at the 1990 level while consumer spending continued to grow. The waste generation projection for 1996 is greater than the actual amount of waste generated in 1996, reflecting source reduction. If the waste generation rate in 1996 (relative to consumer spending) was greater than the rate in 1990, this would reflect source expansion.

The first step in measuring source reduction at the national level is to examine the historical pattern of MSW generation. Figure 2-2 provides a picture of the percent changes in MSW generation from 1960 to 1996 using data from the *Characterization of Municipal Solid Waste in the United States: 1997 Update* (*1997 Update*). In the *1997 Update*, information is only available for certain years during the period 1960 through 1996. Data for these years are used to develop average annual changes in the generation of MSW. The data show that MSW generation grew steadily from 1960 to 1994. In 1994, however, there was a decisive downturn. It is believed that source reduction is responsible for this downturn. But how much of an impact does source reduction make on MSW generation?

Figure 2-1: Actual vs. Projected MSW Generation (relative to consumer spending)

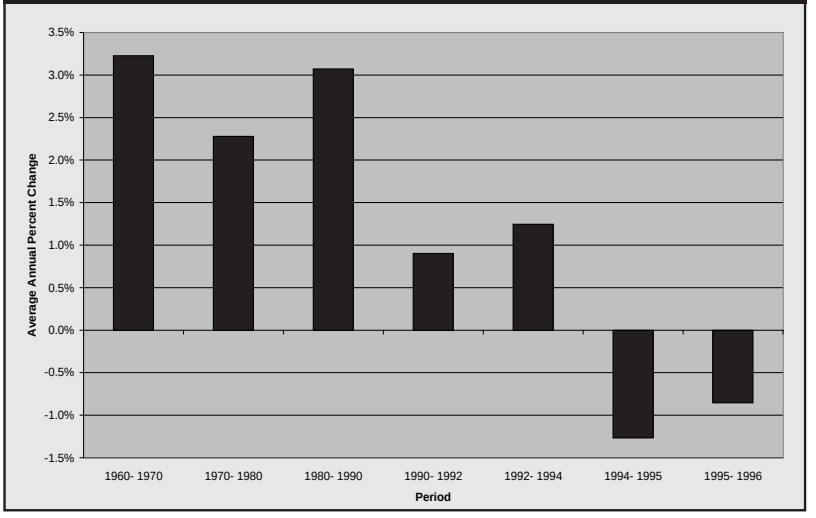


To quantify the amount of waste prevented in a given year (i.e., source reduction), it is necessary to consider the amount of waste that would have been generated if there had been no change in the generation rate. In other words, if people had not practiced source reduction, how much waste would have been generated? Such an approach requires that source reduction in a given year be

measured relative to a base year (1990) and a specified driver (such as PCE). Source reduction is calculated as the difference between the amount of waste that would have been generated in 1996, if the rate of generation (relative to the driving factor) remained the same as it was in 1990, and the actual amount of waste generated in 1996.

It is difficult to measure what would have happened without source reduction, because waste generation is constantly changing as the population and economy change. Modifications in packaging, increased consumption of food away from home, changes in lawn and garden care, and countless other socioeconomic and lifestyle changes impact the quantity of MSW generated. The method used in this report to compute source reduction captures the effects of such changes.

Figure 2-2: Average Annual Percent Change in MSW Generation



2.3 Selecting the Factor Driving Waste Generation

To understand which driving factor impacted waste generation the most, EPA closely examined the top three key driving factors to determine which one followed the pattern of waste generation most closely. The key drivers are: population (waste generated per capita), GDP (waste generated per million dollars of economic activity), and consumer spending or PCE (waste generated per million dollars spent at the retail level).

Using population as the driving factor, a common choice in past studies, assumes that waste generation per capita is relatively stable or predictable. In other words, the number of people drives MSW generation and the actions of those people are generally consistent during the period of time considered. Using GDP, in contrast, assumes that waste generation is proportional to overall economic activity. Similarly, the choice of consumer spending (PCE) assumes that waste generation is driven by the activities and expenditures of consumers. On theoretical grounds, it seems reasonable to expect that one of the two economic measures, rather than population, represents the appropriate driving factor for MSW generation. Per capita generation of MSW is not constant over time; most waste is generated as a result of some type of economic activity.

The link between consumer spending and MSW generation also makes intuitive sense, since consumer spending reflects the goods and products, including food, and their packaging that are purchased, used, and ultimately

discarded as MSW. Consumer spending has generally grown from year to year, reflecting the increasing material well-being of the American population. Consumer spending also is generally linked to yard trimmings waste generation, though not as directly. Material well-being may also be reflected in the purchase of plants, seeds, fertilizer, and water, which ultimately contribute to the generation of yard waste.

For the reasons discussed, EPA's analysis determined that consumer spending (PCE) was the factor that most accurately predicts, or drives, MSW generation. Statistical support for selecting consumer spending as the most appropriate driving factor also is strong. The supporting analysis for this choice can be found in the Appendix.

This report, therefore, measured source reduction as the difference between the projected amount of MSW generated in 1996 and the actual amount of MSW generated in 1996. The projected amount was determined using the 1990 relationship between MSW generation and consumer spending. A complete description of the measurement method used to quantify national source reduction, including a detailed discussion of the statistical analyses undertaken, can be found in the Appendix.

2.4 Calculating Source Reduction for MSW Using Consumer Spending (PCE) as the Driving Factor

With the selection of consumer spending as the driving factor, Figure 2-1 can now be revised to show actual data from the *1997 Update* on MSW generation as well as data on projected waste generation using the 1990 generation rate. Figure 2-3 includes these data and illustrates source reduction in 1996 relative to 1990.

Figure 2-3: Calculation of Source Reduction in 1996

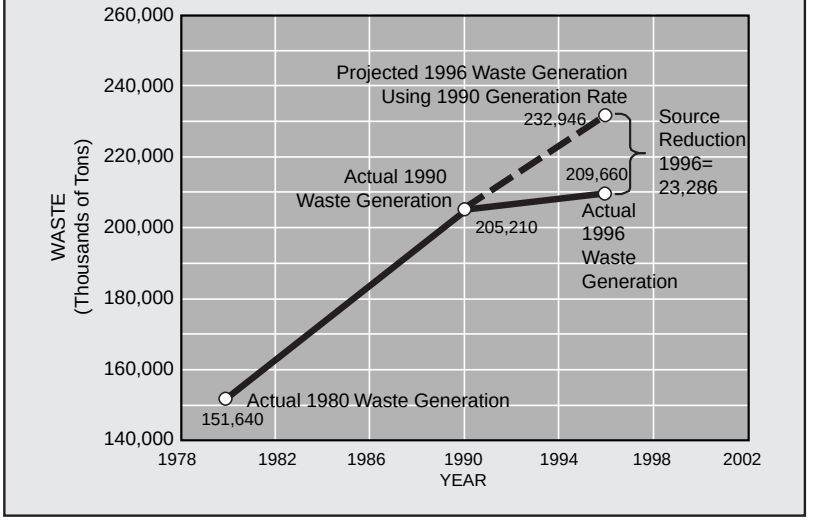


Table 2-1 at right explains the previous figure in more detail, including the main steps involved in calculating source reduction in 1996.

1. The first row of the table contains actual waste generation numbers reported in EPA's annual MSW characterization reports.
2. The second row is the value of real (adjusted for inflation) consumer spending. The data on consumer spending (PCE) was obtained from the *1997 Statistical Abstract of the United States*.
3. The figures shown in the third row are the result of dividing the values for waste generation (the first row) by the values for consumer spending (second row). Specifically, for the 1990 data, 205,210 thousand tons divided by $4,132,200 million yields a waste generation rate of 49.66 tons per million dollars.

Table 2-1: Calculation of Source Reduction in 1996

Source Reduction Equation Components	1990	1996
Waste Stream: Actual Waste Generation (Thousands of Tons)	205,210	209,660
Driving Factor: Consumer Spending (PCE in Millions of Dollars)	4,132,200	4,690,700
Rate: Waste Generation Rate (Tons per Million Dollars)	49.66	44.70
Projected 1996 Waste Generation Using 1990 Generation Rate (Thousands of Tons)	Not Applicable	232,946
Source Reduction in 1996 (Thousands of Tons)	Not Applicable	**23,286**

4. In the fourth row, using the 1990 waste generation rate obtained in step 3, the amount of waste generated in 1996 (assuming no change in behavior since 1990) can be projected. This value—232,946 thousand tons—is simply consumer spending in 1996 ($4,690,700 million) multiplied by the 1990 waste generation rate (49.66 tons per million dollars).
5. Row five subtracts the "Actual 1996 Waste Generation" (209,660 thousand tons) from the "Projected 1996 Waste Generation Using 1990 Generation Rate" (232,946 thousand tons) to compute "Source Reduction in 1996" (23,286 thousand tons). In words, the above calculation can be summarized as follows:

Source Reduction in 1996 = Projected 1996 Waste Generation (Using 1990 Generation Rate) – Actual 1996 Waste Generation

= (232,946 thousand tons) – (209,660 thousand tons)

= 23,286 thousand tons

= 23 million tons

In addition to the calculation of source reduction described in Table 2-1, which EPA preferred because of its simplicity, there is another way to calculate MSW source reduction using the same basic method. This alternative uses statistical rather than nonstatistical analysis. A description of this calculation is outlined in the Appendix.

To isolate which components of MSW were responsible for the 23 million tons of source reduction witnessed in 1996, the average annual changes in the waste generation rate for each product and material included in MSW were examined. Source reduction for each was then calculated using the same method outlined in Table 2-1. Specifically, source reduction for components of MSW was calculated as follows:

Component Source Reduction in 1996 = Projected 1996 Component Waste Generation – Actual 1996 Component Waste

In order to determine "Projected 1996 Component Waste Generation," the following formula was used:

Projected 1996 Component Waste Generation = 1990 Component Waste Generation ÷ 1990 PCE × 1996 PCE

Chapter 3 describes the analysis applied to various product and material categories.

Chapter 3
RESULTS

sustainable

\sə-'stā-nə-bəl\ adj. Able to be kept in existence or maintained.

resource

\'rē-,sôrs\ n. Something that a country, state, etc. has and can use to its advantage.

3.1 Introduction

Measuring of source reduction at the national level provides a useful framework for setting municipal solid waste (MSW) management goals, tracking progress toward those goals, and highlighting opportunities for increased waste prevention.

This report represents the first comprehensive analysis of source reduction at the national level. It provides an estimate of the amount of source reduction that occurred in the United States in 1996, relative to a base year of 1990, the first full year after EPA's adoption of the waste management hierarchy and its emphasis to reduce, reuse, and recycle.

In this chapter, the methodology discussed in Chapter 2 will be applied to various aspects of the waste stream, going from the general to the specific. To recap, the first step is to look at source reduction for the overall annual waste stream and calculate the source reduction for years previous to 1996. The next step is to look at several major categories of products and materials including areas of significant source reduction or source expansion. The conclusion of this chapter includes a list of individual components of MSW that combine to make up the overall waste stream.

3.2 Findings

In 1996, a total of **23 million tons** of MSW were source reduced. This is equivalent to 11 percent of the 209.7 million tons of MSW generated that year.

Using the methodology shown in Table 2.1 of Chapter 2, source reduction achievements in years previous to 1996 (Table 3-1) can now be calculated to provide a "picture" of the year-to-year changes in source reduction over time.

Table 3-1: Source Reduction for Years Prior to 1996

Year	Source Reduction (thousand tons)
1992	630
1994	7,974
1995	15,879
1996	23,286

definitions

Source Reduction (also known as Waste Prevention) refers to any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become MSW. Source reduction also refers to the reuse of products or materials.

Source Expansion refers to increases in the rate of generation of MSW. Source expansion is the opposite of source reduction.

Durable Goods refers to longer lasting goods such as major and small appliances, furniture and furnishings, carpets and rugs, and consumer electronics.

Nondurable Goods refers to items having a lifetime of less than 3 years, such as newspapers, magazines, office paper, telephone directories, paper towels and tissues, paperboard, paper plates and cups, plastic plates and cups, and textiles.

Additional terms and definitions can be found in the Glossary of this report.

Table 3-2: 1996 Source Reduction by Major Material Categories

Waste Stream	Tons Source Reduced in Thousands (Based on consumer spending and change in waste generation rate)
Durable Goods (e.g., appliances, furniture, tires)	2,179
Nondurable Goods (e.g., newspapers and clothing)	3,571
Containers & Packaging (e.g., bottles and boxes)	4,002
Other MSW (e.g., yard trimmings and food scraps)	13,534
Total Source Reduction	**23,286**

Applying the same methodology, the components of MSW that are responsible for the 23 million tons of source reduction in 1996 can be examined. The results are detailed in Table 3-2.

Within the broad categories that make up the MSW stream, some of the individual materials experienced source reduction in 1996, while others experienced source expansion. Source expansion is the opposite of source reduction. As mentioned in Chapter 2, we use this term when there is an increase in the rate of MSW generation rather than a decrease. Table 3-3 provides a summary of the source reduction and source expansion values obtained for the following subcategories of MSW: durable goods, nondurable goods, containers and packaging, and other MSW.

Table 3-3: 1996 Source Reduction and Source Expansion Values for Subcategories of MSW (Thousands of Tons)

Waste Stream	Source Reduction/ (Source Expansion)*	Percent of Overall MSW Source Reduction
Durable Goods		
Source Reduction	2,958	
Source Expansion	(779)	
Net Value	**2,179**	**9.4%**
Nondurable Goods		
Source Reduction	6,314	
Source Expansion	(2,743)	
Net Value	**3,571**	**15.3%**
Containers and Packaging		
Source Reduction	7,161	
Source Expansion	(3,159)	
Net Value	**4,002**	**17.2%**
Other MSW (i.e., yard trimmings, food scraps, miscellaneous inorganics)		
Source Reduction	13,534	
Source Expansion	0	
Net Value	**13,534**	**58.1%**
Total Source Reduction	**29,967**	
Total Source Expansion	**(6,681)**	
Total Net Value	**23,286**	**100%**

* Parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction.

As shown in Table 3-4 on page 14, 10 specific components of MSW contributed significantly to overall source reduction and expansion. Yard trimmings, newspapers, magazines, wood packaging, glass containers, miscellaneous durable goods, and food scraps are each responsible for 1 million tons or more of the total source reduction in the United States in 1996. Yard trimmings represent the largest individual contributor to source reduction, with more than 11.7 million tons being source reduced in 1996.

The source reduction values for the seven significant contributors in Table 3-4 are impacted by the following factors: 1) the amount of yard trimmings in MSW is decreasing due to the use of backyard composting, landfill bans, and mulching lawnmowers for grasscycling; 2) newspaper use has been reduced due to various forms of lightweighting (reductions in the weight of a

Table 3-4: Significant Source Reduction and Source Expansion Within MSW—1996 (Thousands of Tons)

Waste Stream Showing Significant Source Reduction or Expansion	Source Reduction/ (Source Expansion)* (Based on consumer spending and change in waste generation rate)
Significant Source Reduction	
Yard Trimmings	11,731
Newspapers	2,955
Wood Packaging	2,806
Glass Containers	2,389
Miscellaneous Durable Goods	2,145
Food Scraps	1,711
Magazines	1,242
Total	**24,979 ****
Significant Source Expansion	
Corrugated Boxes	(3,481)
Other Commercial Printing	(1,816)
Clothing and Footwear	(1,075)
Total	**(6,371) *****

* Parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction.

** The total source reduction contributed by these six materials is higher than the total net source reduction of 23 million tons due to the offsetting effects of the source expansion experienced by some materials. As shown in Table 3-3, net source reduction is determined by subtracting total source expansion (7 million tons) from total source reduction (30 million tons).

*** Discrepancies in calculations may occur due to rounding.

particular product); 3) source reduction of wood packaging is due to the increasing reuse of wooden pallets in recent years; 4) glass bottles and jars are experiencing significant source reduction as glass is being replaced with plastic and other, lighter packaging materials, particularly in the soft drink industry; 5) the growth of the electronics reuse market during the 1990s and the replacement of larger, heavier computers and telephones with smaller, lighter versions are responsible for the source reduction seen in the miscellaneous durable goods category; and 6) food scraps have experienced source reduction as a result of a variety of activities including backyard composting, donations of edible food, and institutional onsite composting.

Analysis also shows that many products and materials are experiencing source expansion, including several that are experiencing significant source expan-

Table 3-5: Source Reduction/(Expansion) for Functional Categories—1996

Product	Source Reduction/(Expansion)* (Based on consumer spending and change in waste generation rate)
Durable Goods	
Miscellaneous Durables	2,145
Furniture/Furnishings	388
Major Appliances	237
Tires	188
Batteries, Lead Acid	(96)
Small Appliances	(258)
Carpets/Rugs	(426)
Subtotal	**2,179** **
Nondurable Goods	
Publications	4,581
Office Paper	616
Tissue Paper/Towels	380
Miscellaneous Nondurables	351
Other Nonpackaging Paper	289
Towels, Sheets, Pillowcases	56
Trash Bags	25
Disposable Diapers	15
Third Class Mail	(174)
Plates and Cups	(284)
Clothing/Footwear	(788)
Other Commercial Printing	(1,497)
Subtotal	**3,571** **
Containers & Packaging	
Wood Packaging	2,806
Beverage Containers	1,785
Food Containers	878
Bags and Sacks	497
Wrapping	(34)
Miscellaneous Packaging	244
Paper Boxes	(2,174)
Subtotal	**4,002**
Other MSW	
Yard Trimmings	11,731
Food Scraps	1,711
Miscellaneous Inorganics	92
Subtotal	**13,534** **
Grand Total	**23,286** **

* Parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction.

** Discrepancies in calculations may occur due to rounding.

sion, such as corrugated cardboard. This does not necessarily mean that these materials and products are becoming heavier, but, rather, the use of these materials is increasing. Corrugated cardboard boxes, for example, have been and continue to be lightweighted. It is probable, however, that the explosion of catalog, electronic, and Internet commerce has greatly increased the use of corrugated cardboard boxes for transportation packaging to homes and businesses. As a result, the use of those materials or products is outpacing the effects of lightweighting. It also should be noted that in some areas of waste management, the volume of material can be considered as, or more, important than the weight of the material.

Calculating source reduction based on consumer spending and changes in the waste generation rate also can be applied to individual elements of the waste stream. Care must be taken, however, not to focus on a single product or material whose use might be impacted by other products or materials. It might be more instructive, for example, to look at the amount of waste generated from the delivery of soft drinks to consumers via beverage containers, rather than looking at waste from glass, plastic, and aluminum containers individually. EPA refers to the result of looking at multiple related segments of the waste stream as "functional categories." Table 3-5 shows source reduction (or expansion) for these functional categories.

3.3 Analysis of Products and Materials Contributing Significantly to Source Reduction

Table 3-6 below identifies the specific products and materials in MSW which contribute **significant source reduction**—1 million tons or more. For each of the specific products and materials identified, additional evidence supporting the prevalence of source reduction is presented below. This includes measurements of source reduction that take into account lightweighting and materials substitution. **Lightweighting** refers to reductions in the weight of a particular product or material. Aluminum beverage cans, for example, have become significantly lighter over time. **Materials substitution** refers to the replacement of a heavier material with a lighter material. Glass soft drink bottles, for instance, are being more frequently replaced by plastic. The impact of lightweighting and materials substitution on source reduction can be captured through the use of carefully chosen driving factors. The following discussion illustrates those techniques. For selected materials, source reduction values were obtained using driving factors more directly related to the material than consumer spending. In these cases, the alternate driving factors predicted the material's waste generation rate better than consumer spending.

As shown in Table 3-6, **yard trimmings** contribute significantly to overall source reduction. Indeed, yard trimmings are by far the largest individual contributor to source reduction. As explained in the *1997 Update*, the tonnage of yard trimmings in MSW has fallen because the number of states that have banned yard trimmings from landfills has grown, as has the use of backyard composting and mulching lawnmowers.

Grasscycling and Backyard Composting

Montgomery County, Maryland. After imposing a 1994 ban on the disposal of yard trimmings, Montgomery County, Maryland, undertook an aggressive source reduction program targeting grasscycling, backyard composting, and mulching. The initiative resulted in the diversion of 51,000 and 53,000 tons in 1994 and 1995, respectively—nearly 50 percent of the projected total yard trimmings generation. In so doing, the county avoided a $2.5 million expansion of its composting facilities and averted $1 million in annual composting costs.

For more details on this case study and additional case studies on grasscycling and backyard composting see Chapter 4.

Table 3-6: Significant Source Reduction Within MSW—1996 (Thousands of Tons)

Waste Stream	Source Reduction (Based on consumer spending and change in waste generation rate)
Significant Source Reduction	
Yard Trimmings	11,731
Newspapers	2,955
Wood Packaging	2,806
Glass Containers	2,389
Miscellaneous Durable Goods	2,145
Food Scraps	1,711
Magazines	1,242
Total	**24,979***

* The total source reduction contributed by these six products and materials is higher than the total net source reduction of 23 million tons due to the offsetting effects of the source expansion experienced by some materials. As shown previously in Table 3-3, net source reduction is determined by subtracting total source expansion (7 million tons) from total source reduction (30 million tons). Discrepancies in calculations may occur due to rounding.

Lightweighting of Newspapers

The *1996 Update* presents direct evidence of lightweighting of **newspapers.** According to the *1996 Update*, although activities influencing newsprint source reduction vary, for several decades there has been a trend to reduce the "basis weight" of newspapers (the typical thickness of the newsprint, excluding inserts). Prior to 1974, the standard basis weight of newspapers was 32 pounds per 3,000 square feet. In 1995, the standard basis weight was closer to 30 pounds per 3,000 square feet. Other basis weights of 24 pounds per 3,000 square feet or lower were used as well. In addition to this direct evidence, performing a product-specific analysis on newspapers using data on waste generated per page of newspapers read also indicates source reduction. The number of pages read is used as the driving factor rather than consumer spending because this factor is a better indicator of the waste generation rate for newspapers. Table 3-7 mirrors the computation shown in Table 2-1 (page 9) determining overall source reduction, except that the calculation of source reduction is performed using waste generated per million pages read rather than per million dollars spent. While the tonnage reflected is for all newspapers nationwide, the analysis was based on data on "pages per pound" for four large regional newspapers. The table shows a reduction in the waste generation rate (waste generated per million pages) through 1995, revealing significant source reduction between 1990 and 1995. (The *1996 Update* only provides data through 1995; the *1997 Update* does not include data on newspaper lightweighting.)

Table 3-7: Newspaper Lightweighting—1995*

Source Reduction Equation Components	1990	1995
Waste Stream: Actual Newspaper Waste Generation (Thousands of Tons)	13,430	13,140
Driving Factor: Number of Pages (Millions of Pages)	2,605,420	3,101,040
Rate: Waste Generation Rate (Tons per Million Pages)	5.2	4.2
Projected 1995 Waste Generation Using 1990 Generation Rate (Thousands of Tons)	Not Applicable	15,985
Source Reduction in 1995 (Thousands of Tons)	Not Applicable	**2,845**

* Data on newspapers is from the *Characterization of Municipal Solid Waste in the United States: 1996 Update.*

Wooden Pallet Reuse

Pallet Repair, Inc. Pallet Repair, Inc., of Baltimore, Maryland, remanufactures between 8,000 and 10,000 pallets per week for reuse. The company provides services to repair old pallets, manufacture pallets from used pallets, and take apart unusable pallets to grind up for reuse as mulch. At a minimum, Pallet Repair restores approximately 416,000 pallets annually, saving 5.4 million board feet of wood and conserving nearly 60,000 cubic yards of landfill space.

Pallet Resource of North Carolina, Inc. Pallet Resource of North Carolina, Inc., handles a large volume of pallets, managing the collection, repair, and reuse of more than 1.25 million pallets per year. Pallet Resource estimates that by diverting broken pallets from landfills, it saves 16.25 million board feet per year and conserves more than 179,000 cubic yards of landfill space annually.

For more details on these case studies and other examples of wood packaging reduction see Chapter 4.

Wood Packaging Repair and Reuse

Wood packaging is another material that experienced significant source reduction in 1996. This waste consists primarily of wooden pallets, which form a large portion of transportation packaging waste. In the *1997 Update*, the analysis of waste generation for wood packaging was revised to incorporate additional information, reflecting the increasing reuse of wooden pallets. According to the *1997 Update*, this reuse caused the decline in wood waste generation evidenced in 1997. As reuse is a form of source reduction, the increased reuse supports the source reduction found in this report's analysis.

Materials Substitution and Lightweighting of Glass, Plastic, and Aluminum Containers

Materials substitution has played a significant role in the source reduction of **glass bottles and jars.** Glass is being replaced with plastic and other packaging materials that are, on average, much lighter than glass. The result is a significant decline in the packaging weight per unit of product manufactured. This trend is not new; its origins predate the 1980s. Consider, for example, soft drink containers. Using data from the *1997 Update*, Table 3-8 shows that, with a base year of 1980, the tonnage of soft drink containers source reduced is greater than the actual tonnage of soft drink-related waste generated in 1996. Similar to previous tables, this mirrors the same method of computation except that the driving factor for the waste generation rate is more directly related to the product. In this case, beverage consumption is used as the driving factor in place of overall consumer spending.

Table 3-8: Soft Drink Packaging Materials Substitution—1996

Source Reduction Equation Components	1980	1996
Waste Stream: Actual Beverage Packaging Waste Generation (Thousands of Tons)	2,162	1,722
Driving Factor: Beverage Consumption (Thousands of Gallons)	6,315,000	10,295,000
Rate: Waste Generation Rate (Tons per Thousand Gallons)	0.34	0.17
Projected 1996 Waste Generation Using 1980 Generation Rate (Thousand of Tons)	Not Applicable	3,524
Source Reduction in 1996 (Thousands of Tons)	Not Applicable	**1,803***

* Discrepancies in calculations may occur due to rounding.

Table 3-8 focuses on 1980 and 1996 because these are the only 2 years for which the data required to develop the table are available. Because of the difference in base year (1980 in Table 3-8 as opposed to 1990 in Tables 3-5 and 3-9) the source reduction values in Table 3-8 are not directly comparable to those presented in other tables. Data presented in the *1997 Update*, however, do show that glass beverage packaging per person declined nationally between 1990 and 1996. This confirms the source reduction for glass packaging found in this report's analysis.

Reducing Miscellaneous Durable Goods

Miscellaneous durable goods is a heterogeneous category within MSW that includes various types of consumer electronics and a number of other items such as sports equipment. Small appliances, such as toasters and mixers, were included in this category in the past, but since 1990 they have been accounted for separately. In the area of consumer electronics, growth since 1990 has been dominated by personal computers and telephones. Both have experienced weight reductions as a result of portable computers replacing larger desktop models and cellular phones replacing larger and heavier wired units. Perhaps more importantly, during the 1990s, the reuse market for electronics has grown, resulting in significant reuse of these valuable items. Together, these developments confirm the source reduction found in this report's analysis.

Reducing Durable Goods

Monsanto. In March 1997, Monsanto's production facility in Luling, Louisiana, began leasing computer equipment from Dell Computer Corporation in an arrangement that reduces waste for Monsanto and consistently provides them with high-quality personal computer workstations. The leasing program frees Monsanto from having to purchase replacement electronics and provides Dell with a number of remarketing avenues, including spare parts reclamation, sales abroad, and re-leasing to organizations that do not need the latest technology. The waste prevented from this program could be more than 16.5 tons annually, with computers averaging 56 pounds of materials per unit. For more details on this case study and other examples of reducing miscellaneous durable goods see Chapter 4.

Lightweighting Packaging

Clorox Company. Recently, the Clorox Company decided to switch from glass to plastic bottles for both its 18-ounce barbeque sauce and its 16-ounce salad dressing. By redesigning and lightweighting its packaging, Clorox eliminated nearly 15,000 tons of glass waste annually. Clorox also cut its shipping costs by using smaller shipping containers and, consequently, eliminated 1,000 tons of corrugated cardboard annually.

Procter & Gamble Corporation. The Procter & Gamble Corporation (P&G) redesigned the plastic bottles used for its 32- and 48-ounce vegetable oil containers to cut down on the amount of plastic used. P&G changed the containers' geometry to allow a thinner layer of plastic to be used to contain the same amount of oil. The resulting bottles use 30 percent less plastic than before, eliminating about 1,250 tons of plastic per year. In addition, by reducing storage space, the new design requires smaller shipping containers for transportation. This has helped P&G cut its use of corrugated cardboard by about 650 tons annually.

Coca-Cola Company. The Coca-Cola Company has made significant progress in lightweighting its aluminum beverage cans by reducing the amount of raw materials used to manufacture the cans. Coca-Cola has reduced its aluminum usage in the United States by an estimated 20,000 tons per year, primarily by shaving the diameter of the neck on the cans. Furthermore, the total weight of the can itself has been reduced by 41 percent since 1963.

For more details on these case studies and other examples of materials substitution and lightweighting see Chapter 4.

Food Scraps Recovery

Food scraps, including food preparation wastes and uneaten food from households, commercial establishments, institutions, and industries, have experienced source reduction as a result of several types of recovery activities currently occurring across the country. Food scraps recovery methods include donating edible food; processing discards into animal feed; rendering liquid fats and solid meat products into cosmetics, soap, animal food, and other products; and onsite composting, using either aerated windrows or piles, enclosed vessels, or worms (called "vermicomposting").

Food Scraps Recovery

New York State Department of Correctional Services. A 1989 survey found that food scraps comprised 30 percent by weight of the New York State Department of Correctional Services' (DOCS) waste stream. In order to reduce disposal costs, as well as comply with state waste reduction legislation, DOCS initiated a new composting program. Forty-seven of DOCS' 70 correctional facilities collected food preparation discards, leftovers, and scraps for onsite composting in 1997. DOCS' 30 composting facilities accept from 0.5 to 4 tons of food daily, or 6,200 tons annually. Coupled with an additional 700 tons of other organic waste, this represents a 90 percent recovery rate for food and other organic discards, which nets an annual savings of $564,200 for the state in avoided disposal costs.

For more details on this case study and other examples of food scraps recovery see Chapter 4.

3.4 Source Reduction Values for the Individual Components of MSW

The same methodology outlined in Chapter 2 also can be applied to individual elements of the waste stream. Table 3-9 provides a detailed breakdown of source reduction or expansion for individual components of the waste stream. For ease of reference and comparison, these categories mirror the categories established in the *Characterization of Municipal Solid Waste in the United States* report published by EPA. Care must be taken not to draw conclusions about a single product or material whose use might be impacted by other products or materials.

Table 3-9 : Source Reduction/(Expansion) Values for Individual Components of MSW—1996

Waste Stream by Commodity	Source Reduction/(Expansion)* (Based on consumer spending and change in waste generation rate)
Durable Goods	
Miscellaneous Durables	2,145
Furniture/Furnishings	388
Major Appliances	237
Tires	188
Batteries, Lead Acid	(96)
Small Appliances	(258)
Carpets/Rugs	(426)
Source Reduction Subtotal for Durable Goods	*2,958***
Source Expansion Subtotal for Durable Goods	*(779)***
Net Value Subtotal for Durable Goods	***2,179*****
Nondurable Goods	
Newspapers	2,955
Magazines	1,242
Office Paper	616
Tissue Paper/Towels	380
Miscellaneous Nondurables	351
Other Nonpackaging Paper	289
Telephone Directories	222
Books	161
Towels, Sheets, Pillowcases	56
Trash Bags	25
Disposable Diapers	15
Plastic Plates/Cups	(72)
Third-Class Mail	(174)
Paper Plates/Cups	(212)
Clothing/Footwear	(788)
Other Commercial Printing	(1,497)
Source Reduction Subtotal for Nondurable Goods	*6,314 ***
Source Expansion Subtotal for Nondurable Goods	*(2,743)*
Net Value Subtotal for Nondurable Goods	***3,571***
Containers and Packaging	
Wood Packaging	2,806
Glass Beer/Soft Drink Bottles	1,192
Glass Food/Other Bottles & Jars	832
Paper Bags/Sacks	790
Glass Wine/Liquor Bottles	364
Plastic-Other Containers	343
Aluminum Beer/Soft Drink Cans	199
Steel Beer/Soft Drink Cans	170
Milk Cartons	119
Other Paperboard Packaging	99
Wrapping Papers	75
Steel Food/Other Cans	63
Steel-Other Packaging	57
Other Misc. Packaging	20
Plastics-Other Packaging	16
Aluminum-Foils/Closure	15
Aluminum-Other Cans	(17)
Plastic Milk Bottles	(48)
Plastic Wraps	(123)
Other Paper Packaging	(192)
Plastic Soft Drink Bottles	(212)
Plastic Bags/Sacks	(293)
Folding Cartons	(509)
Corrugated Boxes	(1,765)
Source Reduction Subtotal for Containers and Packaging	*7,161***
Source Expansion Subtotal for Packaging	*(3,159)*
Net Value Subtotal for Containers and Packaging	***4,002*****
Other Components of MSW	
Yard Trimmings	11,731
Food Scraps	1,711
Miscellaneous Inorganics	92
Source Reduction Subtotal for Other MSW Components	*13,534*
Source Expansion Subtotal for Other MSW Components	*0*
Net Value Subtotal for Other MSW Components	***13,534***
Source Reduction Total for MSW	*29,967*
Source Expansion Total for MSW	*(6,681)*
Net Value Total for MSW	***23,286***

* Parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction.

** Discrepancies in calculations may occur due to rounding.

Chapter 4
CASE STUDIES

efficiency

\ə-'fish-ən-sē\ n. The ability to produce the desired effect, product, etc. with a minimum of effort, expense, or waste.

This chapter illustrates source reduction in action. Results achieved by the featured source reduction programs support and complement the source reduction values presented in the previous chapter. Case studies profiling the source reduction efforts of businesses and communities across the country are organized into the following sections:

- Reducing Organic Waste
- Reducing Wood and Transport Packaging
- Reducing Primary Packaging
- Working With Suppliers
- Working With Customers

Each section begins with a general introduction and summary of the featured case studies. Following the introduction, the section is divided into subsections focusing on specific source reduction activities. Within each of these subsections, several case studies are then presented. The case studies contain information on the background, goals, implementation, and quantitative results of the source reduction program spotlighted. Many of the companies profiled in this report are participants in the EPA's voluntary *WasteWise* program, which provides assistance to organizations in reducing their solid waste. Additional information on this program and others can be found at the back of this report. The information presented in each case study in this report is current and accurate as of the fall of 1998.

4.1 Reducing Organic Waste

In 1996, organic waste comprised 85.5 percent of the nation's MSW stream, accounting for a total of 179 million tons of the waste generated.[1] A significant portion of the national organic waste stream (e.g., newspaper, office paper, and corrugated cardboard) is already being recovered for recycling. One-quarter of the organic waste stream, however, can be source reduced by one of the methods described below. The source reduction activities described in the following case studies—grasscycling, backyard composting, and food scraps recovery—target yard trimmings and food scraps, which

1 U.S. EPA. 1998. Characterization of Municipal Solid Waste in The United States: 1997 Update. EPA530-R-98-007. Washington, DC. p. 163.1

terminology

Primary Packaging has direct contact with the product it holds. Examples include glass and plastic bottles that contain beverages, steel and aluminum cans that contain food or beverages, bags that hold chips, and paperboard that packages food or consumer goods such as toys.

Secondary packaging allows products to be unitized for handling and distribution, but does not come into direct contact with the product. Examples include a corrugated paperboard tray that holds cans of vegetables, a plastic ring or paperboard box that unitizes beverages cans, and a sealed plastic bag that holds small boxes of candies.

Transport or tertiary packaging unitizes products (usually already in primary and secondary packaging) for shipping or distribution. Examples include external packaging materials including crates, pallets, cartons, skids, wraps, and totes that help contain and protect products during shipping and handling.

Additional terms and definitions can be found in the Glossary of this report.

respectively accounted for 28 million tons and 22 million tons of waste generation in 1996. Nationally, such activities as these contribute to the source reduction of 12.5 million tons of yard trimmings and 1.7 million tons of food scraps each year.

The portion of the national organic waste stream available for grasscycling is 14 million tons, or 50 percent of total yard trimmings generation.[2] Grasscycling is a source reduction strategy that encourages residents and commercial and institutional establishments to leave grass clippings on the lawn after cutting rather than bagging and setting them out for curbside collection.[3] Most grasscycling programs rely heavily on public education efforts such as press releases, brochures, newspaper advertisements, and radio and television spots. Occasionally, financial incentives also are used to either reduce the cost of mulching lawnmowers or the equipment required to retrofit nonmulching mowers or, at times, to discourage the bagging of clippings by charging a per-bag pickup fee.

Backyard composting targets a total of 19 million tons of organic waste—8 million tons of food scraps and 11 million tons of yard trimmings—generated solely by the residential sector.[4] This source reduction activity encourages residents to separate specific organic materials and create their own compost piles using backyard composting bins. Public outreach, bin subsidization, education, and training are the key elements in creating a successful backyard composting program.

The portion of the organic waste stream comprised of commercial and institutional food scraps—11 million tons (50 percent of total food scraps generation)—can be source-reduced via one of several food scraps recovery options. Food discards include food preparation wastes and uneaten food from households, commercial establishments, institutions, and industries. They comprised 10.4 percent by weight of the total 1996 MSW stream, yet only 2.4 percent of discards were recovered that year. According to the U.S. Department of Agriculture Economic Research Service, if just 5 percent of the nation's consumer, retail, and food service discards were recovered, savings from reduced landfill costs alone would be about $50 million annually.[5] Food scraps recovery methods include donating edible food; processing discards into animal feed; rendering liquid fats and solid meat products into cosmetics, soap, animal food, and other products; and composting.

While composting can be done either on site or off site, there is an important distinction. Onsite composting is a type of source reduction, through the use of either aerated windrows or piles, enclosed vessels, or worms (called "vermi-

2 Ibid., p. 44.

3 U.S. EPA. 1998. Organic Materials Management Strategies. EPA530-R-97-003. Washington, DC. p. 13.

4 Ibid., pp. 15, 17.

5 U.S. EPA. 1998. Don't Throw Away That Food. Strategies for Record-Setting Waste Reduction. EPA530-F-98-002. Washington, DC. p. 1.

composting"). This method enables the business or institution to take advantage of the final, nutrient-rich compost. Offsite composting is considered recycling, *not* source reduction, since it does not prevent organic material from entering the municipal waste collection system. Typically it involves a contracted hauler who transports the materials to a public or private composting facility, from where the final product is ultimately sold for profit to other end users.

The following case studies describe a wide range of source reduction programs for grass clippings, yard trimmings, and food scraps. The programs highlighted vary in scale, materials of focus, and people and behaviors targeted for change. Montgomery County, Maryland, represents a model program for the comprehensive reduction of all three types of materials. The case study on Pinellas County, Florida, illustrates its success in source reducing many tons by simply leaving grass clippings on the lawn. The Commonwealth of Massachusetts provides an example of a backyard composting program endeavoring to reach residents statewide. Finally, food scraps recovery operations are profiled at sites ranging from state facilities to local fairgrounds to private corporations. Recovery methods span onsite composting, donation, and conversion to animal feed.

4.1.1 Implementing Comprehensive Source Reduction

Montgomery County, Maryland[6]

Montgomery County, Maryland's comprehensive source reduction program for organics illustrates the benefits source reduction can render. In 1994, waste composition analyses indicated that yard trimmings constituted approximately 18 percent of the county's MSW stream. To conserve landfill space, Montgomery County's Department of Environmental Protection (DEP) imposed a ban on the disposal of yard trimmings and initiated weekly curbside collection to compost the material instead. The county's compost facility can only handle 60,000 to 70,000 tons annually, however, which left a 35,000-ton surplus. Having a clear need to cut the yard trimmings collected by one-third, the county undertook an aggressive source reduction program targeting grasscycling, backyard composting, and mulching. In so doing, Montgomery County avoided a $2.5 million expansion of its composting facilities.

The Montgomery County DEP launched its yard trimmings source reduction program over a 2-year period (1994 to 1995), during which it targeted 180,000 single family homes, 250 landscape and lawn service companies, 30,000 multifamily and commercial property managers, conservation groups, homeowner associations, garden clubs, nature centers, public gardens, and nurseries. Startup costs for the county's grasscycling campaign were $360,000 for the program's first year, when there was an intensive push to produce outreach materials, videos, public service announcements (PSAs), and six direct mail pieces. (Each mailing cost the county $30,000 in postage alone!) In its

[6] Personal communication with Joseph Keyser, environmental specialist, Montgomery County Department of Environmental Protection. July 28, 1998. Eastern Research Group. Arlington, VA.

second year, the composting and mulching initiative cost just $230,000. This 36 percent cost reduction was due to the outreach portion of the campaign becoming relatively self-sufficient by the second year. In addition, followup surveys at the end of the first year indicated the county already made great progress toward its reduction goals, relieving some pressure in the second year.

As an affluent community, Montgomery County faced an added challenge in convincing residents to grasscycle. Seventeen percent of households hire some form of lawncare service rather than doing their own mowing. Aware that this could be an obstacle, the county disseminated information to registered lawncare operations to make them aware of the potential for saving 40 percent of their time by not bagging, while simultaneously eliminating their tipping fees and allowing them to take on more clients with no added costs. The Montgomery County DEP also provided materials for the lawncare services to give their clients to educate them about the benefits of mulching in terms of the health of the lawn and the reduced need for fertilizer.

In total, Montgomery County's grasscycling campaign diverts approximately 27,000 tons of grass clippings per year. This figure is even more impressive when coupled with the 72,000 tons of carboniferous bulking materials, such as brush, the county would have to compost along with the grass in order to maintain a 2:1 ratio of carbon to nitrogen. Having eliminated the need to compost yard brush, the county instead is able to collect brush separately, grind it up, and give it away at local shopping center depots as a crude ground cover for landscaping. According to an environmental specialist with the Montgomery County DEP, "Residents loved the program! They couldn't get enough of the mulch." As a result of this highly successful brush diversion program, approximately 12,000 tons of mulch ended up in garden beds around the community rather than filling up the county's facility in 1995.

The major thrust of the backyard composting campaign was to educate and train residents in proper composting methods for yard trimmings via regularly scheduled workshops held at locations across the county. In partnership with the Audubon Naturalist Society, regional government service centers, libraries, and numerous garden centers and home improvement centers, Montgomery County sponsored more than 350 workshops, attended by 14,000 county residents, between 1994 and 1995. A strong indication of the success of the workshops is that more than 7,000 compost bins (more than one bin for every two participants) were sold at workshops that year. Two years later, more than 90 percent of those bins were still in use. In fact, Montgomery County won the National Association of Counties' 1998 Composting Award for having sold 24,000 compost bins to residents, indicating that more than 1 in 10 households have changed their behavior to adopt backyard composting as a home source reduction measure. Overall, documented waste diversion indicates that as many as 60 percent of people in the county participate in backyard composting.

In addition to yard trimmings diversion, the composting campaign also separately targeted food scraps recovery. VermiLab, the county's school vermicomposting program, encouraged the use of worms for onsite composting of cafeteria scraps. VermiLab provided worm boxes, which were set up in the central courtyards of 12 schools and more than 100 public and private elementary, middle, and high schools; trained faculty in more than 150 classrooms; developed a composting curriculum for grades K through 12; and created the Digger the Worm cartoon character and 7-foot-tall mascot to appeal to the interests of young students. Volunteer students recorded the weight of food scraps collected each day before adding them to the worm boxes. In total, students recorded 3 tons of vermicomposted cafeteria scraps across the county. Additionally, by educating 10,000 students per year about vermicomposting, the VermiLab program has inspired 1,000 households in the county to set up worm boxes for their own food scraps.

Montgomery County's combined outreach efforts to promote grasscycling, mulching, backyard composting, and vermicomposting amounted to impressive source reduction results. Quarterly waste composition samplings conducted before, during, and after program implementation indicated that 51,000 tons and 53,000 tons—nearly 50 percent of the projected total yard trimmings generation—were grasscycled or backyard composted in 1994 and 1995, respectively. By source reducing approximately 50,000 tons of compostable materials annually, Montgomery County saves almost $1 million in processing costs. Pre- and postsurvey data also indicated program success, with an increase from 59 percent to 70 percent in the grasscycling rate and from 43 percent to 60 percent in the residential composting of yard trimmings.

By reducing yard trimmings and food scraps at the source, Montgomery County's grasscycling and composting initiatives successfully eliminated the need to expand the county composting facility as a result of the landfill ban. This accomplishment saved $2.5 million in building expenses and $1 million in averted annual composting costs. The source reduction program also had a dramatically lower dollars-per-ton cost than that of recycling or disposal.

Montgomery County's environmental specialist in charge of source reduction shared his recommendations for implementing a successful source reduction program. First, he emphasized it is extremely useful to conduct a baseline survey to find out what people's current practices and motivations are in order to hone your message appropriately as you develop your campaign strategy. Followup surveys both during and after the campaign also are helpful in determining how effective different outreach tactics are and have been. Finally, he advised building partnerships with local nonprofit organizations, utility companies, newspapers, garden and retail centers, and other interested factions. In doing so, you can disseminate your message to more people and can greatly reduce the costs of outreach efforts.

4.1.2 Grasscycling

Pinellas County, Florida

In a study conducted from 1990 to 1993, Pinellas County, Florida's Department of Solid Waste Management documented the benefits and waste diversion capacity of grasscycling based on the participation of 200 volunteer residents each year. In return, participants received T-shirts and free fertilizer. Surveys completed after the project's close indicated that residents who grasscycled felt their lawns looked healthier, spent less time mowing, and actually used less fertilizer.[7] To promote grasscycling in the community, Pinellas County gave out bumper stickers and lawn signs to establishments that left grass clippings on their lawns. In addition, the county distributed brochures to nurseries and landscaping companies and produced two 30-minute video programs that aired on the University of Florida's public access channel.[8] An annual telephone survey, which polls 500 randomly selected households that have resided in the county for at least 1 year, revealed in 1993 that 61 percent of residents engaged in grasscycling—a 41 percent increase from 1990. Based on an average yard size of 5,000 square feet and an average generation of roughly 1,500 pounds of grass clippings per yard per year, the 1997 telephone survey found that 51,227 tons of clippings were diverted through grasscycling that year by approximately 70,000 participating households.[9]

4.1.3 Backyard Composting

Commonwealth of Massachusetts[10]

Massachusetts imposed landfill disposal bans on yard trimmings and grass clippings in addition to the municipal leaf and grass composting programs it already had in place. To encourage residents to source reduce by using backyard composting, rather than send yard trimmings for offsite composting at a municipal facility, the Massachusetts Department of Environmental Protection (MADEP) has conducted home composting coordinator training programs since 1991. Workshops are held each year in the spring and fall to educate the general public and to enlist volunteer home composting coordinators. A core of more than 300 trained coordinators present workshops in their communities, set up demonstration sites with materials supplied by MADEP, distribute compost bins, and serve as local sources of composting information.

MADEP has provided home composting bins and educational materials to 225 communities since 1994 through a state-subsidized grant program. An estimated 78,000 bins were distributed by 1997, reducing disposal by approximately 30,000 tons per year. MADEP also sponsors the "Don't Trash Grass" program that encourages residents to grasscycle. The program is supported

[7] Center for Policy Alternatives. 1996. Source Reduction Roundtable II. Tools for State and Local Programs. Washington, DC. pp. 32-33.

[8] U.S. EPA. 1998. Organic Materials Management Strategies. EPA530-R-97-003. Washington, DC. p. 13.

[9] Personal communication with Rebecca Stone, recycling coordinator, Pinellas County Department of Solid Waste Management. August 10, 1998. Eastern Research Group. Arlington, VA.

[10] U.S. EPA. 1998. State Source Reduction Report. Appendix C: State Source Reduction Fact Sheets. Washington, DC.

by workshops and the dissemination of printed materials, videos, and print and radio PSAs.

4.1.4 Food Scraps Recovery[11]

New York State Department of Correctional Services

A 1989 survey found that food scraps comprised 30 percent by weight of the New York State Department of Correctional Services' (DOCS) waste stream. In order to reduce disposal costs, as well as comply with state waste reduction legislation, the department initiated a new composting program. Forty-seven of DOCS' 70 correctional facilities collected food scraps for onsite composting in 1997. These participating facilities prepare approximately 125,000 meals a day for an average of 1,000 inmates per facility. Kitchen workers put food preparation discards in unlined plastic containers and inmates deposit leftovers in collection containers in dining halls. Full containers are refrigerated until inmates transport them to DOCS' onsite composting facilities three or four times a week. At the composting sites, the food scraps are mixed with bulking material and composted in windrows. Staff at each site train inmates in composting procedures; well-trained staff and inmates who are invested in the program keep contamination to a minimum. DOCS' 30 composting facilities accept from 0.5 to 4 tons of food daily, or 6,200 tons annually. Coupled with an additional 700 tons of other organic waste, this represents a 90 percent recovery rate for food and other organic discards, which nets an annual savings of $564,200 for the state in avoided disposal costs. In addition, kitchen staff separately collect large bones and liquid fat in 30- to 50-gallon barrels provided by a rendering company that retrieves them every 2 weeks free of charge and then processes the materials for manufacture into cosmetics and soaps.

Frost Valley YMCA

The Frost Valley YMCA, a 6,000-acre residential educational and recreational facility in the Catskill Mountains (Claryville, New York), has achieved total onsite composting of the food discards from its kitchen and dining room. When a waste assessment in the late 1980s found food to be the greatest component of the waste stream, Frost Valley began to take steps to implement a static aerobic composting system. Since 1990, the camp's kitchen staff have been collecting all of their food preparation scraps, meat, bones, and paper towels, while guests deposit their leftovers in an unlined can in the dining room. Staff stationed in the dining room during meals educate guests and assist them with proper food recovery procedures. Eventually, the collected food discards are added to a standard feed mixer along with Frost Valley's other organic waste (including yard trimmings and horse manure), mixed with an equal amount of wood chips (which act as a bulking agent), and finally windrow-composted on site after the materials have begun to break down. Frost Valley uses the finished compost in landscaping and gardening projects

[11] U.S. EPA. 1998. Don't Throw Away That Food. Strategies for Record-Setting Waste Reduction. EPA530-F-98-002. Washington, DC.

and in its onsite greenhouse, which demonstrates the benefits of composting to the thousands of visitors that participate in the YMCA's waste reduction education program every year. In 1997, the facility recovered an estimated 80 tons of food and other organic discards—100 percent of its estimated generation! Frost Valley realizes a net savings of $5,200 annually as a result.

Del Mar Fairgrounds

Since January 1997, this California fairgrounds has vermicomposted fruit and vegetable scraps from the facility's kitchen on site. When scraps are a few days old, staff feed the partially decayed food to worms in a framed wooden box. The finished worm compost, or castings, is used as fertilizer on Del Mar Fairgrounds. In total, the worms processed more than 6 tons of food discards in 1997. Every ton composted saves the fairgrounds $40 to $47 in avoided disposal costs. Startup costs were under $500, including the cost of purchasing 25 pounds of worms. In 1998, Del Mar Fairgrounds expanded the scale of its vermicomposting operation with the purchase of two more worm boxes.

New College/University of South Florida at Sarasota

New College reported composting more than 2 tons of food scraps on site in 1997. While conducting a cafeteria waste audit prior to implementation of the composting program, the college's resource conservation coordinator "was amazed to see how much perfectly good food [was thrown] away each day."[12] Since then, the college has forged a partnership with the Salvation Army, whose food service director collects roughly 10 gallons of prepared food every afternoon, feeding approximately 100 people. This amounts to 10 tons of food donated instead of disposed of every year.[13]

3M[14]

This St. Paul, Minnesota, diversified manufacturing company prepares thousands of meals daily for 12,000 employees at its headquarters' food services operation. Disposal of the food preparation waste was a messy and costly endeavor, however, so the company began to explore creative disposal solutions. An environmental consultant helped 3M locate a family farming operation experienced in collecting and converting reclaimed food to animal feed. To increase understanding between the groups, farm employees toured 3M's food services operation, and 3M employees visited the farm. This exchange proved key in preventing contamination because food service employees recognized the importance of keeping paper, glass, and metal from mixing with the food scraps. In the program's first 2 years, 3M diverted 45 tons of food scraps and edible oils and saved more than $30,000.

[12] U.S. EPA. 1997. WasteWise Update: Donation Programs—Turning Trash into Treasure. EPA530-N-97-005. Washington, DC. p. 8.

[13] U.S. EPA. 1993. Business Guide for Reducing Solid Waste. Appendix D. EPA530-K-92-004. Washington, DC. p. 36.

[14] U.S. EPA WasteWise. 1996. Managing Food Scraps as Animal Feed. Washington, DC. p. 4.

4.2 Reducing Wood and Transport Packaging

Single-use wooden pallets and other transport packaging can contribute significantly to the amount of waste businesses generate. Transport packaging includes cartons, crates, pallets, skids, wraps, and totes used to ship products and materials to the marketplace, customers, and between facilities. Businesses can reduce costs, improve efficiency, conserve resources, and eliminate waste by implementing programs to reduce or reuse their transport packaging. Specific strategies to preserve wooden pallets and other transport packaging include remanufacture and repair of wooden pallets or switching to reusable transport packaging.

In 1996, wood packaging was source reduced by more than 3.3 million tons, making it one of the major components of MSW experiencing source reduction. Wood transport packaging includes both wooden crates and pallets, although pallets represent the majority of this category. In 1997, it is estimated that 18.87 million tons of wood pallets and other wood packaging were generated, or 9 percent of total MSW generation. Pallet reuse and pallet and container retrieval and recovery systems are the fastest growing segment of the transport packaging industry. According to a 1995 Virginia Tech study, nearly 171.1 million pallets—representing more than 3 million tons of wood packaging—were estimated to be refurbished and returned to service.[15] The study estimates that, annually, fewer than 1.5 million (less than 1 percent of the total) of the pallets recovered by the pallet remanufacturing industry are sent to landfills.

The *1997 Modern Materials Handling Pallet User Survey* conducted by the National Wooden Pallet and Container Association (NWPCA) indicates that 1 out of every 5 pallet users took advantage of reuse and recovery systems compared to only 1 out of every 14 pallet users just 2 years earlier. The survey also indicates that nearly 80 percent of pallet users reuse their pallets more than one time, and 25 percent might use pallets more than 20 times.

Switching to reusable transport packaging is another excellent source reduction strategy that results in significant cost savings. By reusing a durable container or pallet, businesses avoid the cost of purchasing single-use transport packaging.

The following case studies represent a range of source reduction programs focusing on wood and transport packaging reductions. The first set of case studies on Pallet Repair, Inc., Pallet Resource of North Carolina, and Pennsylvania Power and Light highlight examples of pallet remanufacturing or repair operations and partnerships. The second set of case studies demonstrate how three companies, Alpine Windows, Home Depot, and Schlegel Systems, Inc., successfully reduced significant amounts of transport packaging waste by switching to reusable packaging.

[15] Virginia Tech. 1995. Recycling in the U.S. Pallet Industry: 1995. Blacksburg, VA.

4.2.1 Remanufacturing or Repairing Wooden Pallets

Pallet Repair, Inc.[16]

Pallet Repair, Inc., is a medium-sized wooden pallet repair company located in Baltimore, Maryland, that provides approximately 25 jobs. The business remanufactures between 8,000 and 10,000 pallets per week for reuse. At a minimum, Pallet Repair repairs approximately 416,000 pallets annually, saving 5.4 million board feet of wood and conserving nearly 60,000 cubic yards of landfill space.[17] The company provides services to repair old pallets, manufacture pallets from used pallets, and takes apart unusable pallets to grind up for reuse as mulch. Pallet Repair strives to be a "closed-loop" business by selling many of its rebuilt pallets to customers that supply it with used pallets. In addition, Pallet Repair does not landfill any of the used pallets it purchases on the open market or receives from its customers.

Pallet Repair believes the voluntary programs to encourage waste reduction and the cost savings attributed to the reuse of pallets helped its business flourish. In 1989, Pallet Repair operated out of a 15,000-square-foot warehouse equipped with only two loading docks. Pallet Repair relocated several times to expand its storage and operations both internally and externally. The company currently occupies 5 acres with a 25,000-square-foot warehouse, enough storage space for more than 100,000 pallets at one time. The expansion helped sales increase by approximately 30 percent annually.

Pallet Repair initiated a closed-loop business after building up a strong customer base of large companies with needs for both a supplier of large volumes of pallets and a reclamation method once they were used. Pallet Repair encouraged its customers to participate in its closed-loop process by offering to pick up used pallets free of charge if the customer committed to purchasing the remanufactured pallets from the company. Pallet Repair also guaranteed that no pallets would ever be sent to the landfill; pallets that cannot be remanufactured, or approximately 15 percent of all used pallets, are sent to a contractor for mulching. Pallet Repair contracts primarily with large manufacturers including companies such as Lever Brothers, McCormick Spice, Beverage Capital, and Chesapeake Fiber, Inc. For these customers, Pallet Repair provides onsite trailers to load and store wooden pallets until they can be picked up for remanufacturing. Pallet Repair acknowledges it must still purchase some pallets from the open market to support business demand, but the services it provides to major customers help contribute to the success of its closed-loop business. In addition, Pallet Repair believes its guarantee of high-quality service to its customers and entering the market at a time when remanufactured pallets were becoming increasingly popular helped the business expand throughout the region.

[16] Personal communication with a Pallet Repair representative. June 30, 1998. Eastern Research Group. Arlington, VA.

[17] Calculations obtained from Mr. Phil Araman, U.S. Forest Service.

1 pallet = 13 board feet; 416,000 pallets x 13 board feet/pallet = 5,408,000 board feet

7 pallets = 1 yd^3; 416,000 pallets/ 7 pallets/yd^3 = 59,428 yd^3

A major barrier to the success of pallet remanufacturing is the perception that remanufactured pallets are not as good as new ones. Used pallets appear gray and some customers perceive that they are of lower quality. Other companies demand pallets that meet specific quality standards in order to be capable of transporting products. Pallet Repair affiliates with NWPCA, which constantly strives to resolve these issues by setting quality standards that help increase the reliability and success of the pallet remanufacturing industry. Pallet Repair strongly believes that through the influence of NWPCA, pallet reuse will continue to grow and significantly contribute to the source reduction of wood waste and keep pallets completely out of the landfill.

Pallet Resource of North Carolina, Inc.[18]

Pallet Resource of North Carolina is a major operation serving more than 250 industrial customers and bringing in annual revenues of more than $6 million. Pallet Resource handles a large volume of pallets, managing the collection, repair, and reuse of more than 1.25 million pallets per year. The reason it is able to manage such a large volume is because it accommodates virtually any need the customer might have for managing their used pallets and will accept all pallet sizes and types. Pallet Resource accepts all broken or used wooden pallets, with nearly 65 percent of the pallets received able to be repaired for reuse. The remaining unusable pallets are either disassembled for reusable components or pulverized into wood fiber for end use as animal bedding, mulch, or playground cushion materials. No pallets are sent to landfills for disposal. Pallet Resource estimates that by diverting broken pallets from landfills, it saves 16.25 million board feet of wood per year and conserves more than 179,000 cubic yards of landfill space.[19]

Pallet Resource started its operation in 1985 and its facilities occupy 21 acres of land, including six buildings with more than 50,000 square feet of storage and operation space. Its incoming pallets are manually sorted by size and condition. Repairable pallets are fixed and returned to the customer. Pallets that cannot be repaired are disassembled to obtain reusable components. Salvaged boards are cut to acceptable lengths and later utilized to create customized pallets that are not readily available in other markets. Customized pallets have a twofold benefit—they reduce costs for buyers and save virgin resources. Pallets that cannot be reused are pulverized in a hammermill to produce wood fiber that is reused as a different commodity such as animal bedding or mulch.

Depending upon their quality, Pallet Resource might purchase used pallets from businesses for repair and remanufacturing purposes. If pallets are in

[18] Institute for Local Self-Reliance. 1997. Sustaining Businesses & Jobs Through Pallet Repair & Reuse. Washington, DC.

[19] Calculations obtained from Mr. Phil Araman, U.S. Forest Service.

1 pallet = 13 board feet; 1,250,000 pallets x 13 board feet/pallet = 16,250,000 board feet

7 pallets = 1 yd^3; 1,250,000 pallets/ 7 pallets/yd^3 = 178,570 yd^3

poor condition, however, Pallet Resource can charge a significant handling fee, depending on the quantity of pallets it transports to its location. Pallet Resource obtains its pallets from retail food and grocery distribution centers, retail home improvement centers, and bulk mail and packaging distribution centers, primarily located within central North Carolina. Pallet Resource's fleet of 110 flat and van type trailers backhaul pallets, which are collected as refurbished pallets are dropped off. Others are purchased from smaller businesses that deliver the pallets to Pallet Resource.

Pallet Resource's marketing strategy helps their business grow. By providing full service pallet collection, repair, and reuse, they continue to obtain and retain more customers every year. In addition, both the increased remanufacturing of pallets and the rising raw material prices to create new pallets help guarantee a strong market. Pallet Resource noted that although more pallets are currently remanufactured, the percentage of pallets that can be repaired and resold has declined recently. Since pallets are repaired more times, the pallets received are often in worse overall condition, making it more difficult to remanufacture them for reuse. A greater percentage of pallets are disassembled for components or sent for mulching. Pallet Resource views this as a positive change, however, because it still continues to reduce the demand for new lumber to be used in the pallet manufacturing industry.

Pennsylvania Power and Light Company, Inc. (PP&L)

PP&L, Inc. provides electrical delivery throughout a 10,000-square-mile area, supplying electricity to more than 1.2 million customers. One of PP&L, Inc.'s corporate objectives is to achieve at least $1 million in savings annually through waste prevention activities. To help achieve this goal, PP&L, Inc. implemented initiatives to reduce pallet purchases by nearly 100 tons.

PP&L, Inc. achieved reductions in its use of wooden pallets by working with vendors on the quality of their pallets to improve the potential for internally reusing them. PP&L, Inc., for example, had not previously been purchasing standard sizes that could be remanufactured easily. It began requesting standard sizes for purchase and also bought pallets made of hardwood materials to increase their longevity. It discouraged its purchasing department from acquiring specialty or one-time use pallets. PP&L, Inc. attempts to reuse pallets wherever feasible and allows employees to take home excess pallets to create compost bins and for other personal uses. It publishes a list of pallet refurbishers and mulching facilities to avoid sending these materials to the landfill.

PP&L, Inc.'s successful reuse program for wooden pallets can be attributed to its strong commitment to the environment, both from management and the effort of its employees. PP&L, Inc.'s Corporate Environmental Policy Committee consists of management representatives that review their compa-

[20] U.S. EPA. 1997. Waste Reduction Activities of Selected WasteWise Partners: Electric Power Industry. EPA530-R-97-017. Washington, DC.

ny's environmental direction and set policy. The committee's goal is to develop a cultural attitude for environmental responsibility equivalent to that of safety, quality, and productivity. PP&L, Inc. also has launched a "Taking Care of the Future Today" campaign with the message that good corporate environmental performance comes from the actions and decisions made each day by employees.

4.2.2 Substituting Materials for Transport Packaging

Alpine Windows[21]

Established in 1973, Alpine Windows is located in Bothell, Washington, and employs approximately 400 people, making it one of the largest window manufacturers in the Northwest. Alpine manufactures vinyl windows for contractors, manufactured home builders, and home owners. To reduce its packaging waste and improve packaging and handling efficiency, Alpine Windows modified its process for shipping window glass by switching from wood crates to "glass packs," a process that uses only a special truck, slings, and tarps. The switch to glass packs saves the company more than $265,000 annually and eliminates the need for wooden crates.

The opportunity to eliminate crates became apparent when Alpine adopted new technology for feeding individual sheets of glass into the glass cutter. Previously, whole crates were removed from the flatbed truck by forklift and placed on a cart for transport to the production area, where the crate was opened and sheets were picked up one at a time by suction cups and placed on the feeder.

The new feeder method permits the glass supplier to load uncrated packs of glass against an A-frame structure on a flatbed truck, covering the packs with tarps and securing the load with tie-downs. At Alpine, these uncrated packs are unloaded by a forklift rigged with a boom and nylon web slings. Packs are placed on a trolley rigged with an A-frame and moved to the production area, where individual sheets of glass are peeled from the pack and fall onto the feeder table. Under this "free-fall" system, air pressure slows the fall rate of the glass, preventing it from breaking.

The slings for the new system cost $250 each, but are reusable for more than a year. Alpine also invested about $400,000 in the new free-fall system, but it has a service life of 20 years. Previously, Alpine purchased 12 to 24 wooden crates daily at a cost of 50 dollars each. Now Alpine avoids their use and disposal completely, eliminating the need for thousands of crates and saving $230,000 annually. Since the company now receives uncrated packs of glass, they are able to obtain 50 percent more sheets of glass than the same number of crated packs. Restock time is thus cut by a very significant amount. Alpine estimates the annual labor savings is an additional $35,000.

Both employees and customers responded enthusiastically to the switch to glass packs for shipping. Employees noted the improvement in operational

[21] Indiana Institute on Recycling. 1996. Case Study 9606. Indiana University, Terre Haute, IN.

efficiency because loading glass onto the cutting tables was much easier with the new method and made the cutting process about 10 to 15 percent faster. Customers responded to Alpine's competitive prices, which are a reflection of the reduced costs and increased efficiency of the packaging and handling changes. Clearly, Alpine's strategic switch has been beneficial not only for the competitiveness of the company, but also to conserve precious raw materials and protect the environment.

Home Depot[22]

Home Depot opened its doors for business in 1978. Now, with more than 700 stores, the company is the largest home improvement retailer in the United States. In early 1995, Home Depot sent letters to its vendors introducing the option to ship products to their stores using slip sheets weighing 3 pounds instead of wooden pallets weighing 40 pounds. A slip sheet is a solid sheet of fiberboard, corrugated board, or high-density plastic upon which freight is placed and stabilized with stretch wrap, glue, or tape. Slip sheets have short panels extending beyond one or more sides that are used for handling and moving the freight.

Before Home Depot began accepting shipments using slip sheets, more than 40 percent of the company's incoming shipments were delivered on wood pallets. The Home Depot distribution network favored switching materials, because the company does not have a system to return pallets to vendors. Slip sheets did not work for all vendors because their products were too heavy or awkward, but the company's logistics department estimated that about 55 percent of Home Depot's shipments could be handled with slip sheets. Home Depot saved an estimated $2 million and eliminated 36,000 tons of wood from its waste stream during the first year the program was implemented.

Before implementing this new program, Home Depot conducted a cost analysis of slip sheets versus pallets for an average vendor. Slip sheets averaged $3.70 per unit compared to pallets at $6.00 per unit. By making the switch, Home Depot eliminated the need for more than 1.8 million pallets (36,000 tons) in retail operations, saving more than $660,000 in disposal and handling costs for the wood. They also avoided freight costs of $2.4 million, including savings to vendors that reduced the weight of their shipments or had the ability to ship additional products on each trailer. In addition, Home Depot either reuses the slip sheets internally or sends them back to be reground and recycled into new slip sheets, so the disposal impact of the slip sheets is negligible.

Home Depot leases about $2 million worth of equipment from Cascade, a firm that manufactures push/pull attachments for slip sheet handling that fit onto a forklift. This cost, however, is not entirely attributable to slip sheets; the attachments can be used for handling wood pallets as well. Each distribu-

[22] National Recycling Coalition. 1997. Case Studies in Source-Reduced and Reusable Transport Packaging. Alexandria, VA.

tion center and Home Depot retail store needs at least one push/pull attachment. Home Depot must also still manage a great number of wood pallets. At most locations, the retailer has found a pallet reuse and repair business to remove the pallets. The reduction in pallet storage requirements, however, has helped Home Depot increase its warehouse product storage capacity by 10 percent. Home Depot's use of slip sheets has also led to improved transport efficiency due to less weight and more efficient use of truck space.

Schlegel Systems, Inc.[23]

Schlegel Systems, Inc. switched from corrugated and wooden gaylord shipping containers to reusable plastic folding gaylord containers as part of a cost savings project with one of its plastic resin suppliers. The switch eliminated approximately 30,000 pounds of corrugated and wood packaging annually. In addition, the supplier saved money on packaging and passed that savings along to Schlegel in the form of a raw material price reduction. Since the plastic containers fold for easy storage, Schlegel also conserves valuable warehouse space.

Schlegel also uses folding returnable plastic containers as part of an ongoing source reduction project with Xerox. The company had been using corrugated boxes to ship parts to Xerox. By switching to reusable containers, the amount of corrugated used has been reduced by thousands of pounds. Schlegel's changes have not only been beneficial for their company but also for their supplier, their customers, and the environment.

4.3 Reducing Primary Packaging

According to the *1997 Update*, the many products made or packaged with paper and paperboard comprise the largest component of MSW. Total generation of paper and paperboard in MSW has grown steadily from 30 million tons in 1960 to 79.9 million tons in 1997. The percentage has varied over time, but increased to 38.1 percent of total MSW generation in 1997. The following case studies examine source reduction activities that focus on primary packaging, which includes all packaging that directly covers or protects a product and is not specifically used for transporting the product. Primary packaging, for example, includes cans, bottles, and boxes, but excludes corrugated boxes and wood packaging generally used to contain and transport products already packaged. Approximately 3.1 million tons of packaging materials (excluding corrugated boxes and wood packaging) were source reduced in 1996.

Long-held production and marketing practices often specify the use of more primary packaging than is actually needed to protect and preserve a product. Recognizing this, many organizations are taking a second look at the product packaging they generate. By establishing in-house teams and working with

[23] Schlegel Systems, Inc. WasteWise Awards Application. 1997.

suppliers, organizations can eliminate unnecessary packaging, switch to reusable packaging, or examine methods to lightweight, redesign, or substitute packaging without sacrificing product safety or quality.

Plastics are a small but visible portion of the waste stream often used as primary packaging materials. As a percentage of MSW generation, plastics constituted less than 1 percent by weight in 1960, increasing to 9.4 percent in 1997. A common materials substitution practice involves using plastic to replace glass in beverage packaging. Plastic resins are now used for a variety of beverage containers such as soft drink bottles and milk and water jugs. This increased use of plastic bottles to replace glass bottles, however, is one of the underlying factors behind the source expansion occurring for plastic soft drink and milk bottles. The waste streams for plastic soft drink bottles and plastic milk bottles increased by 209,000 and 56,000 tons, respectively, in 1996. Other types of plastic packaging, including bags, sacks, and wraps, also experienced source expansion in 1996—309,000 tons for bags and sacks and 4,000 tons for wraps. The following case studies, however, provide evidence of specific cases where source reduction is occurring for these materials.

Another common beverage container, the aluminum can, has undergone significant redesign and lightweighting to reduce the amount of aluminum required for packaging. According to the Can Manufacturers Institute, nearly 80 percent of all single-serving beverages are packaged in aluminum cans today. In 1996, there were 99 billion cans sold to the beverage industry. The Can Manufacturers Institute also reports that consumption per person of these beverages has grown from 76 gallons per year to 96 gallons per year, or 28 percent, since 1980. Since consumers show a strong preference for aluminum cans, the beverage industry has continuously analyzed ways to lightweight cans and reduce the cost of packaging its products. In fact, even though consumption of beverages has increased, packaging of beverages on a per person basis has actually decreased from 101 pounds per year to 93 pounds per year, or 7.5 percent since 1980.

The following case studies represent a range of source reduction programs focusing on packaging reductions. Businesses and governments alike have successfully reduced significant amounts of waste using these strategies. The Clorox Company, the Coca-Cola Company, Federal Express Corporation, and Procter & Gamble Corporation prevented waste by lightweighting or redesigning packaging. Warner-Lambert Corporation eliminated unnecessary packaging for its products. Dunn County, Wisconsin, switched to reusable packaging in order to eliminate waste and save money.

4.3.1 Lightweighting and/or Redesigning Primary Packaging

The Clorox Company[24]

While Clorox is most known for its laundry additives and cleaning products, it also manufactures such merchandise as automotive protective products, cat litter, dressings and sauces, and water filtration products. With such a large and varied operation, Clorox continually seeks ways to eliminate extraneous costs by cutting waste wherever possible. Recently, Clorox decided to switch from glass to plastic bottles for both its 18-ounce barbeque sauce and its 16-ounce salad dressing. By redesigning and lightweighting its packaging, Clorox eliminated nearly 15,000 tons of glass waste annually. The new polyethylene terephthalate (PET) bottles weigh 85 percent less than the old glass bottles.

Initially, Clorox began considering the switch from glass to plastic in order to reduce production costs and increase resource efficiency. Clorox had already converted its larger size barbeque sauce and salad dressing bottles to plastic containers. Larger containers have less surface area in contact with the products so it is easier to use more permeable plastic material to package them and still maintain product quality. Clorox needed to ensure that when plastic containers were used, they would still provide an acceptable shelf life for the product. In addition, Clorox had to fine-tune its filling lines and make other manufacturing changes for plastic containers to be used. Ultimately, Clorox modified its entire manufacturing and shipment process. The switch from glass to plastic produced substantial cost savings including cutting shipping costs by using smaller shipping containers and consequently eliminating 1,000 tons of corrugated cardboard annually.

Clorox discovered another immediate benefit of its switch—consumers showed a stronger preference for the product when packaged in plastic rather than glass. Clorox's products became a better value to the customer because its source reduction initiative not only cut waste but also reduced the cost of shipping, which ultimately avoids price increases to the customer. Although sales figures are not released, Clorox notes that it significantly increased its market share. Clorox is satisfied with the major switch made for its salad dressings and barbeque sauces but also finds that there will be fewer opportunities to reduce packaging in the future. Most packaging will be source reduced 1 gram at a time, but Clorox considers it worthwhile because so many products are sold that the amount of waste reduced is significant.

The Coca-Cola Company[25]

Through the years, the Coca-Cola Company has significantly reduced the amount of raw materials needed to produce its packaging through lightweighting and redesign initiatives. The glass bottles, aluminum cans, and plastic bottles used by the company today have been reduced from their origi-

[24] Personal communication with a Clorox Company representative. July 15, 1998. Eastern Research Group. Arlington, VA.

[25] Personal communication with a Coca-Cola Company representative. July 17, 1998. Eastern Research Group. Arlington, VA.

nal weights by 43 percent, 41 percent, and 21 percent, respectively. This means it takes fewer raw materials to make these packages and less energy to transport them.

To better understand Coca-Cola's source reduction initiatives, it is helpful to look at the company's experience with the aluminum can. Since the aluminum can was first introduced for soft drink applications in 1963, the total weight of the can has been reduced from approximately 55 pounds per 1,000 cans to approximately 30 pounds per 1,000 cans—a 41 percent total source reduction. This accomplishment has been achieved by reducing the body weight and sidewall thickness of cans. In 1993, for example, the company shaved more than 4 millimeters off the necks of its aluminum cans, reducing its aluminum usage in the United States alone by an estimated 20,000 tons per year. The weight of this narrower can end is more than 2 pounds lighter per 1,000 cans than the previous can end used.

Along with these achievements, the Coca-Cola Company continues to search for new ways to reduce its use of raw materials in packaging.

Federal Express Corporation[26]

Since 1981, Federal Express has continuously reduced the thickness of the paperboard used to manufacture its 9-1/2 by 12-1/2 FedEx Letter envelope. The envelope has been lightweighted by 40 percent, and the combined savings from this source reduction activity and the redesign of other paper, paperboard, and polyethylene shipping containers totals more than $20 million annually for the company.

Federal Express picks up, sorts, and delivers more than 3 million letters and packages every day. In volume alone, Federal Express is a world leader in overnight express delivery, with 1997 sales of $15 billion. As part of its service, Federal Express provides shipping envelopes and boxes to its customers. Annual outlays for such supplies total approximately $200 million. To control this significant cost of business, Federal Express continuously examines its various containers and related shipping items to identify ways to reduce their size and weight without compromising their integrity and appearance.

Federal Express supplies more than 300 million FedEx Letters to customers every year, so the payback in supply costs is virtually immediate when a lighter weight stock is adopted. Originally, the FedEx Letter was manufactured from a 20-point stock, the lightest stock available to meet the company's requirements for envelope strength and printability. The paper industry currently produces an acceptable 12-point stock, reducing paper requirements for the FedEx Letter.

Since 1986, Federal Express also has reduced the FedEx Pak from 26-pound to 14-pound material. The FedEx Pak is made from DuPont Tyvek®, a spun-

[26] Indiana Institute on Recycling. 1995. Case Study 9504. Indiana University, Terre Haute, IN.

bonded high-density polyethylene. Federal Express works closely with DuPont to incorporate postconsumer material (plastic milk jugs and water bottles) into the FedEx Pak. The Pak currently contains 25 percent postconsumer material.

Federal Express continues to work closely with its suppliers to improve the quality and cost of materials it purchases. Federal Express notes that if the company can improve its supplier's internal costs, the supplier can pass the savings on.

The Procter & Gamble Corporation[27]

For companies that ship millions of products every year, even small design changes can result in significant waste reductions. The Procter & Gamble Corporation (P&G) wanted to redesign the plastic bottles used for its 32- and 48-ounce vegetable oil bottles to reduce the amount of plastic used. The company also wanted to find a way to increase shipping capacity. It turned out that both goals could be met by replacing the traditional cylindrical shape of the oil bottle with a rectangular design. Changing the bottle's geometry allowed a thinner layer of plastic to be used to provide the same strength as a thicker bottle. The resulting bottle uses 30 percent less plastic than before, eliminating about 1,250 tons of plastic per year. In addition, the bottle's new design requires smaller shipping containers for transportation and increases the number of products in each shipment. This has helped P&G cut its use of corrugated cardboard by about 650 tons annually.

When P&G sought a design change in the 32- and 48-ounce bottles, it had to meet certain quality standards including bottle strength, supplier's ability to manufacture a new design, and customer appeal of the new package. P&G also anticipated process changes and transport packaging changes that would potentially occur with a new packaging design. During 4 years of development, test marketing, and careful analysis of cost, P&G partnered with its bottle supplier, Continental PET Technologies, to produce the new bottle design. In addition to the source reduction already discussed, the new design realized the following benefits:

- Better space utilization resulted with the rectangular bottom as compared to the cylindrical bottom, as it reduced unused space from 22 percent to 12 percent.
- The rectangular design permitted more bottles to be shipped per cubic foot and per truck, saving shipping space and energy.
- Faster label assembly occurred since one label replaced the two that were previously used.[28]

[27] U.S. EPA. 1995. WasteWise Update: A Fresh Look at Packaging. EPA530-N-95-004. Washington, DC.

[28] Indiana Institute on Recycling. 1996. Case Study 9632. Indiana University, Terre Haute, IN.

P&G saw a 25 to 30 percent rate of return on its investment, and it completely recovered its costs in approximately 3 years. P&G notes that when the competition copies you, you know you have a winner. P&G concluded that this cost-effective reduction in packaging was integrated quite successfully into product manufacturing and delivery systems. Subsequently, P&G applied the same design to its 64- and 128-ounce vegetable oil bottles, manufactured by Continental Plastic Container. This saves an additional 600 tons of plastic and 800 tons of corrugated cardboard annually.

4.3.2 Eliminating Unnecessary Packaging

Warner-Lambert Company[29]

Warner-Lambert, a manufacturer of health care and consumer products, has focused on minimizing the amount of packaging used for its products. Recently, the company removed the outer paperboard cartons on a line of cold formula remedies, leaving only the shrink-wrapped bottle. This step alone eliminates the generation of 33 tons of paperboard each year.

The old outer carton packaging prevented scuffing of the bottle, sufficiently satisfied tamper resistance and safety concerns, provided ample space for advertising, and held good shelf presence. In 1993, with less than a month of paperboard carton inventory remaining, Warner-Lambert initiated a major packaging change—elimination of the outer carton. By making the switch, Warner-Lambert was able to increase the number of bottles displayed in the same shelf space. To counter potential tampering problems, the dispensing cup was tightly shrink-wrapped to the cap of the bottle, completely closing the top. The decision was approached carefully by a multidisciplinary team including technical packaging, product manufacturing, marketing, and environmental staff. They considered the marketing, cost savings, consumer acceptance, and waste reduction impacts of removing the paperboard carton before finally deciding to eliminate it.

Consumer complaints to Warner-Lambert about unnecessary packaging led the company to examine the feasibility of eliminating some of it. In response, Warner-Lambert reduced the weight and amount of packaging for its mouthwash product line, switching from a glass bottle with corrugated and paper overwrap to just a plastic bottle. This one change eliminated more than 9,500 tons of packaging per year, a 52 percent reduction. The company considered various factors, including development of a child-resistant cap, shelf-life testing, consumer acceptance, the safety of reduced packaging, the purchase of new machinery to produce it, a strategy for distribution and transportation of the products, and the overall cost savings resulting from this change. By analyzing every part of its manufacturing process, Warner-Lambert was able to effectively identify methods to address these issues and sell the mouthwash in a plastic bottle with no additional packaging. Both of these source reduction

[29] Indiana Institute on Recycling. 1996. Case Study 9644 and 9645. Indiana University, Terre Haute, IN.

initiatives allowed the company to successfully reduce waste, save money, and increase consumer satisfaction with its products.

4.3.3 Switching to Reusable Packaging

Dunn County, Wisconsin[30]

Dunn County, a rural area located in west central Wisconsin, received a state grant to implement a demonstration program designed to elevate awareness of source reduction and motivate changes in behavior to reduce its waste generation rates. The county initiated an in-house source reduction pilot project for all its offices and operations to establish a baseline and quantify the decrease in waste generation by keeping track of source reduction initiatives at its facilities. One of its participating facilities, the County Health Care Center, made several minor packaging changes that saved significant resources. The center switched to reusable steel food tray covers, saving $3,000 per year on aluminum foil and plastic film wrap. The center prevented 1.5 tons of container waste annually by using a juice machine instead of purchasing juices in disposable containers. The center also eliminated more than 5,460 milk containers by using returnable containers.

As a result of the efforts made by the center and other county offices, Dunn County kicked off an extensive public education campaign to communicate the benefits of source reduction, including quantifying local results, to the rest of the county's waste generators. Positive coverage by the press helped educate a broader audience and led other communities around the state to establish similar programs. The program also helped set general operating procedures to reduce waste in county facilities, which will encourage source reduction activities in the future. Internally, the county designated employees to take charge of source reduction ideas and activities, which helped guarantee continued support and effort once the grant activities were completed. A Dunn County representative noted that, "Implementing a program is only half the challenge. In order to achieve success, you need to continue to motivate people and develop new ideas. Repetition makes for a successful program."

4.4 Working With Suppliers

Businesses, institutions, and government agencies that implement source reduction often focus on the waste produced by their own office buildings, stores, and factories or on the packaging waste passed on to their customers. Some innovative organizations also are reducing the waste *entering* their facilities by forming cooperative relationships with their vendors and suppliers. These organizations recognize they are paying their suppliers and waste disposal contractors for every pound of excess packaging and every mile of unnecessary transportation resulting from wasteful supply chains.

[30] National Recycling Coalition. 1998. Making Source Reduction and Reuse Work in Your Community. Alexandria, VA.

Supplier relationships play a key role in reducing the waste generated from a variety of products. Supplier relationships, for example, significantly contribute to the 4.3 million tons of packaging material source reduction that takes place each year in the United States. Supplier relationships impact several specific products within packaging materials, including paper, corrugated, plastic, and wood packaging. In addition, interactions with suppliers impact office paper usage through invoices, purchase orders, and other forms. Efforts to streamline purchasing practices contributed to the 655,000 tons of office paper source reduced in 1996.

Not all of these individual materials, however, are experiencing source reduction on a national level. Wood packaging experienced significant source reduction (3.3 million tons), while corrugated boxes experienced significant source expansion (2.1 million tons). It is important to remember, however, that these values reflect activity in the aggregate at the national level; for many individual companies, supplier relationships have led to the source reduction of significant quantities of corrugated boxes. Several case studies included in this section illustrate this activity.

Organizations form supplier relationships by drafting procedural memoranda, holding meetings, conducting plant tours, revising purchasing policies, and stipulating waste reduction activity in vendor and supplier contracts. Source reduction activities involving suppliers include product design changes, packaging changes, new distribution systems, take-back programs targeted toward reuse, and the purchase of more durable products.

The following case studies provide an overview of supplier relationships formed by organizations to reduce municipal solid waste. A case study from Target Stores illustrates source reduction through the elimination of unnecessary supplier packaging. Case studies from Maytag Corporation's Galesburg Refrigeration Products facility and Herman Miller, Inc., profile how working with suppliers to establish reusable and returnable packaging programs produces significant source reduction results. The final two case studies, from Silicon Graphics and Commonwealth Edison, demonstrate the benefits of working with suppliers to streamline purchasing practices.

4.4.1 Eliminating Unnecessary Packaging From Suppliers

Target Stores

Target Stores is a national chain of more than 850 retail stores headquartered in Minneapolis, Minnesota. Since 1993, the company has eliminated approximately 2,250 tons of waste per year (the majority of which was low-density polyethylene) and saved an estimated $4.5 million by initiating a packaging reduction program for its "softlines" merchandise, which includes such items as clothing and shoes. In addition, its suppliers saved an estimated $3 million by reducing the packaging material used in shipments.[31]

[31] U.S. EPA. 1995. WasteWise Update: A Fresh Look at Packaging. EPA530-N-95-004. Washington, DC.

By developing a team and carefully evaluating its packaging needs, Target realized that much of the packaging used by its vendors was unnecessary and costly. When the Target team approached vendors about reducing excess packaging, it was surprised to learn that vendor packaging choices were based upon the vendors' perceptions of Target's needs. This began a very constructive dialogue in which Target and its vendors worked together to design specifications to eliminate excess packaging.

Suspecting that much of the merchandise shipped to Target included excess packaging, senior management chartered a team of about 20 employees to study the packaging of the softlines merchandise. The team came from several different areas within the company, including the Environmental, Quality Assurance, Distribution, Operations, and Special Projects departments. Team members spent many hours in the stockrooms of several stores in the Minneapolis metropolitan area going through shipments to examine how the merchandise was packaged. They observed both the amount of waste from packaging and the time workers spent opening and unwrapping shipments.

The team found that a great deal of labor was expended tearing apart packaging for the softlines merchandise. One typical clothing shipment, for example, contained 24 individually wrapped sweaters. Each of the sweaters had to be unwrapped before they could be displayed in the store. The team ultimately determined that an entire shipment of 24 sweaters could be safely shipped using just one outside wrapper.

"Old paradigms die hard," according to a quality assurance director at Target. Many vendors and buyers doubted the packaging changes would be effective. They felt that the clothing would arrive wrinkled because of the reduced packaging and make the merchandise unpresentable. To see whether the merchandise would arrive at the store in good condition, the Target team asked its vendors to test its packaging reduction idea. After several shipments of clothing arrived unwrinkled and presentable, the team decided to change Target's vendor packaging specifications.

"We proved the skeptics wrong by doing several test runs. There has been no loss of sales due to presentation," explains the director. The team had to convince management these test runs were important, as management wanted to implement the team's suggestions more quickly. "We wanted to make sure the job was done right."

The resulting specifications, drawn up by Target and its vendors, exclude not only individually wrapped items but also tissue paper, cardboard inserts, pins, collar inserts, tape, and clips. Target initiated a series of noncompliance penalties to be assessed if merchandise does not arrive according to the specifications. "If these sweaters arrive individually wrapped, we will charge the vendor for the additional labor it takes us to remove the excess packaging," explains a Target environmental manager.

Target's current goal is "to ship floor-ready apparel and minimize excess packaging." "Floor-ready" means that the merchandise requires minimal preparation before being displayed on the sales floor. Target chose this goal because it would reduce labor and disposal costs for both Target and the manufacturer while providing significant environmental benefits. Target's goal to become "trashless" includes eliminating all unnecessary packaging as well as reusing the necessary packaging.

Target's advice for other companies considering initiating this type of program is to begin studying packaging needs immediately. Companies should ask themselves two questions: Is each packaging component necessary for shipping? Does each component help significantly in the presentation or protection of the product? If the answer to either of these questions is no, then eliminate or reduce the packaging. Another hint on how companies can reduce their packaging is to work collaboratively with vendors—communicate precisely what kinds of packaging your company needs and does not need. Vendors might think all the packaging they are delivering is required, even though this might not be the case. Target found that having vendors as partners was a key to its success.

4.4.2 Switching to Reusable and Returnable Packaging With Suppliers

Maytag Corporation's Galesburg Refrigeration Products Facility

Maytag Corporation's Galesburg Refrigeration Products facility produces refrigerators for worldwide distribution. The Galesburg, Illinois, facility has been working with suppliers to implement new returnable packaging systems since 1989. At that time, only one or two of Galesburg's suppliers were using returnable packaging to ship goods to the facility, and Galesburg was sending virtually all of its waste to the landfill (9,711 tons in 1989). By 1995, Galesburg was sending only 1,593 tons of waste to the landfill, nearly an 84 percent decrease since 1989. The reduction in part was a result of Galesburg's returnable packaging and recycling programs. Currently, the company reduces an estimated 900 tons of waste each year.[32]

Galesburg's early waste reduction efforts focused on finding markets for and recycling wood skids and corrugated waste. These measures alone contributed $600,000 to the company in the form of revenues generated from the sale of the materials and cost savings from avoided disposal fees.[33] The facility soon began to look beyond recycling, however. Galesburg realized there were opportunities for eliminating large amounts of packaging waste if the plant was willing to work with its suppliers.

The Galesburg facility most often notified parts suppliers of its returnable packaging proposals during contract renegotiations. Vendors were told that the new packaging systems would have to submit to certain durability,

[32] Personal communication with a Maytag environmental specialist. June 11, 1998. Eastern Research Group. Arlington, VA.

[33] Ibid.

ergonomic, and safety tests and that the two companies would share any savings resulting from the packaging change. Most suppliers enthusiastically embraced the proposals when they realized the packaging changes could ultimately reduce their disposal costs. The timing of the packaging change proposals, accompanied by an appeal to increased profit, were critical negotiation tools.

The new packaging systems developed by Galesburg and its suppliers generally consisted of heavyweight corrugated and extruded plastic containers, both of which generally replaced lightweight corrugated containers. On average, these new materials extended the number of trips the containers could sustain from 5 to 100. The changes also improved work processes. The facility began using larger, "walk-in" boxes, for example, with side panels that unlock and partially detach for easier packing.

Galesburg used the new reusable container systems to ship plastic refrigerator components with cosmetic finishes, such as air deflectors and control covers. These components must sustain a great deal of handling without damage. In addition to reducing the facility's waste output, the durable returnable packaging systems helped provide extra protection for these cosmetic components. The number of damaged components arriving at the Galesburg facility dropped considerably after the introduction of reusable packaging. One vendor's switch to returnable packaging reduced the number of damaged components arriving from the vendor by 18 percent.[34] Furthermore, the new container systems allowed Galesburg's suppliers to use truck trailer space more efficiently. Returnable containers eliminated bulky excess packaging and enabled double stacking. For shipments of refrigerator shelves, for example, Galesburg introduced wire baskets that collapse from 40 to 6 inches in height when emptied. These baskets allowed for easier unpacking and saved space when they were shipped back to the supplier for reuse. Efficient use of truck trailer space reduced the freight costs passed on to the Galesburg plant. One packaging change that enabled double stacking, for instance, reduced shipping costs for one refrigerator component by 50 percent.[35]

Galesburg has approximately 100 suppliers for its products. Twenty-eight percent of Galesburg's suppliers have converted to returnable packaging, and the plant's waste reduction team hopes to eventually create a 100 percent returnable packaging delivery system. As Galesburg adjusts its fire protection system to account for the handling and storage of new types of packaging, the returnable container requirements will become mandatory for all "preferred" Galesburg suppliers.

[34] Personal communication with a Maytag environmental specialist. July 31, 1998. Eastern Research Group. Arlington, VA.

[35] Ibid.

Herman Miller, Inc.

Herman Miller, Inc., also has implemented a variety of returnable and reusable packaging systems with their suppliers. In 1990, Herman Miller's Holland Chair Plant underwent a 6-month switchover from a waste-intensive corrugated box and filler system for shipping shells for its Equa chairs to a reusable plastic tray system.

Under the original packaging system, the company shipped about 300,000 shells per year in heavy corrugated boxes, which fit 28 shells each.[36] Employees wrapped the shells in polyethylene bags and added polyethylene fillers to the boxes for added protection. All packaging was recycled after each 30 mile, one-way trip. The new system replaced the corrugated carton and polyethylene material with two plastic trays capped on top of each other and wrapped in a corrugated sleeve. Under the new system, the materials are reused after each trip. The corrugated sleeves can be used for 3 to 4 years (approximately 50 to 100 round trips).

The new packaging system cost the company approximately $500,000 and paid for itself in less than a year. The company has saved at least $1.4 million since the packaging change. The change itself resulted in a 70 percent packaging material reduction and a 94 percent decrease in damage claims.[37] It also resulted in substantial additional truck trailer and warehouse space.

Royal Crest Dairy

Royal Crest Dairy has served as a role model for the dairy industry through its demonstrated commitment to waste reduction for more than 30 years. In 1965, this family-owned, independent, home-delivery dairy became one of the first dairies in the country to offer reusable, recyclable, high-density polyethylene (HDPE) milk containers. Royal Crest collects, cleans, and reuses these containers up to 100 times before recycling them. Today, the company prevents more than 40 tons of waste per year through this reuse process.[38]

The milk bottle reuse program is extremely successful; however, the chemical process of cleaning the bottles created a new waste stream for Royal Crest. The cleaning chemicals came in large HDPE barrels that, once used, piled up quickly and took up more storage space than Royal Crest had to spare. According to a Royal Crest risk manager, company managers—finding themselves "waist deep in 55-gallon barrels"—provided the impetus to pursue a less wasteful disposal method. The company first examined the possibility of locating a recycler who was willing to pick up the chemical barrels. Unfortunately, the awkward size of and the chemical residue in the barrels made the drums difficult, if not impossible, to recycle.

[36] Indiana Institute on Recycling. 1995. Case Study 9627. Indiana University, Terre Haute, IN.

[37] Ibid.

[38] U.S. EPA. 1998. WasteWise Update: Building Supplier Partnerships. EPA530-N-98-003. Washington, DC.

Royal Crest turned to its chemical supplier to see if the company would collect the used barrels for reuse. The supplier responded with a flat rejection: it did not have the resources to clean or recycle the barrels and one small customer was not worth the investment. Not discouraged, plant managers began arranging for a new supplier who would pick up the used barrels. One plant manager knew of a company who provided pickup service, which expedited the entire process. Even so, managers were pleasantly surprised to find they were able to identify and arrange for a new supplier within 1 week.

Pleased to discover there is usually someone out there who is willing to accommodate the special needs of even a small company, the Royal Crest risk manager encourages other small companies to persevere. "Don't stop at your first rejection," he recommends. Companies should keep switching vendors, be they product suppliers or recyclable haulers, until they find one who will meet their waste reduction needs.

4.4.3 Streamlining Purchasing Practices

Silicon Graphics

By developing a Web-based purchasing system, Silicon Graphics, a leading computer manufacturer, conserved more than 2.5 tons of paper forms in just 1 year. Now, the company's 11,000 employees order products and services electronically without leaving a costly paper trail.

Early in 1994, Silicon Graphics began investigating opportunities to streamline its purchasing process and cut costs. The company, based in Mountain View, California, noticed that during the previous 2 years the number of purchasing transactions increased by 90 percent, reaching 19,000 transactions.[39] The purchasing manager realized he either needed to hire additional people to handle the growing paperwork or reengineer the purchasing process to become more efficient. He chose to research electronic commerce opportunities and put these technologies to work for the company.

By replacing the multipart paper forms with electronic forms, Silicon Graphics conserved approximately 500,000 sheets of paper in just 1 year (60 to 70 percent of the paper is unrecyclable carbon paper). Using a Web-based system, Silicon Graphics' Purchasing Group reduced the number of purchasing steps from 15 to 3.[40] "That's not all," the purchasing manager adds. "Now employees can receive their purchases more quickly, too. Employee orders can often be filled within 24 hours instead of 3 weeks."

Under Silicon Graphics' new purchasing system, employees browse supplier catalogs electronically linked to the system and fill out an electronic form. The system sends the form via e-mail to the appropriate manager for approval. If the manager approves the request, the purchase order is transmit-

[39] U.S. EPA. 1996. WasteWise Update: Going Paperless With Technology. EPA530-N-96-007. Washington, DC.

[40] Ibid.

ted to the supplier via electronic data interchange (EDI). In the future, the system will allow digital signatures to acknowledge receipt of materials and electronic invoices and payments. Employees also will be able to track the status of an order at any point throughout the process.

In the first year, the project saved an estimated $200,000 for Silicon Graphics. Initial costs were high because they included all of the efforts to research, design, develop, pilot, and implement the system as well as efforts to work with and educate employees and suppliers.[41] With the infrastructure in place, however, Silicon Graphics could expand its use of the electronic forms into other company groups.

Silicon Graphics' new system made life easier for everyone involved, including suppliers. Managers are excited about the savings in time and money. Employees receive their orders faster and do not get frustrated because the order slip has been misplaced. Suppliers are paid promptly and now have the infrastructure in place to work electronically with their other customers.

Commonwealth Edison

While bulk purchasing can help reduce waste for some organizations, others receive more supplies than they can use on a regular basis. For generating stations at Commonwealth Edison (ComEd), an electric utility company in northern Illinois, these problems created hefty disposal costs and increased administrative burdens. ComEd established a "just-in-time" policy through a single supplier that enabled the company to obtain supplies as needed and reduce waste from materials that exceeded their shelf life. This policy, along with other streamlining processes, has saved the company more than $500,000 since the project began.[42]

Before ComEd adopted its just-in-time policy with a single laboratory supplier, the company faced many difficulties in managing the supply chain. Formerly, it ordered materials from six suppliers, each of which required a separate invoice for every order. With ComEd's 16 facilities placing orders for several items each day, the cost for processing the invoices and paper flow alone became a significant expense. In addition, bulk orders produced waste from leftover supplies whose shelf life had expired.

A pilot program with one of the suppliers was developed to alleviate ComEd's burden. ComEd negotiated with the supplier to designate several new methods to order supplies by phone, fax, and the Internet. The supplier created a Web site that contained an online catalog, a complete list of stock, and online order forms. This system provided real-time data on the availability of particular items so ComEd employees could determine when they would receive the supplies. The supplier also agreed to fill the orders for next-day delivery as needed and send only one billing statement monthly to each facility.

[41] Ibid.

[42] U.S. EPA. 1998. WasteWise Update: Building Supplier Partnerships. EPA530-N-98-003. Washington, DC.

The most important part of the contract, however, was establishing a third-party buying system so ComEd need only order through a single supplier. By establishing a third-party buying system, the supplier became responsible for ordering materials and supplies from other companies and charging ComEd for its services. This policy relieved ComEd from its dependence on six different suppliers with separate invoicing and delivery systems. The supplier also agreed to adhere to a buy-back policy so surplus materials would not be thrown away.

ComEd expanded the pilot study to all 15 generating stations and the central lab facility. In order to make it a complete success, it was especially important for the supplier to commit to a firm price for a long-term contract. ComEd selected the supplier based on its willingness to meet ComEd's needs and its strong performance on consistent pricing and delivery. ComEd's procurement specialist states, "It's not only great for cutting waste and improving our bottom line, it ultimately reduces the end cost for our customers too."

4.5 Working With Customers

Manufacturers can reduce waste in the design and manufacturing of products, but once those products are shipped out, source reduction is often up to the customer. Companies can make it easier for customers to reduce waste by facilitating the reuse, service, or repair of their products. Customers and manufacturers often cooperate to reduce the waste generated by a range of products including durable goods (e.g., longer lasting goods such as computers, appliances, furniture, and carpets), nondurable goods (e.g., office paper and disposable plates), and containers and packaging.

Durable goods made up 15.1 percent of the 1996 U.S. MSW stream. This component of the waste stream has been growing both in sheer tonnage and as a percentage of the total waste stream for the last several decades. Nondurable goods accounted for 26.5 percent of the waste generated in 1996.[43] Source reduction for durable and nondurable goods, each currently at 2.4 million tons per year, slows the growth of product waste.

Product reuse is one important source reduction strategy for durable and nondurable goods. Product manufacturers are often in the best position to reuse or remanufacture their own goods due to design knowledge, materials compatibility, and economies of scale. In order to ensure effective reuse and remanufacturing, businesses develop efficient means of recovering used products from their customers. The remanufacturing industry has experienced significant growth in recent years. Recent figures estimate sales from the industry at $53 billion with nearly 500,000 people employed.[44]

[43] U.S. EPA. 1998. Characterization of Municipal Solid Waste in the United States: 1997 Update. EPA530-R-98-007. Washington, DC.

[44] Lund, Robert T. 1996. The Remanufacturing Industry: Hidden Giant. Boston, MA.

Extending product life is an important source reduction strategy for durable goods. Manufacturers can extend the usable life of their goods by signing agreements with customers to provide product service and repair over many years. When customers know they can have an expensive product repaired at minimal cost, there is little motivation to discard the item and purchase a new one. By delaying the end of a product's life, customers, manufacturers, and service organizations reduce the amount of durable goods in the waste stream.

Opportunities for businesses to work with customers do not stop with durable and nondurable goods, however. Companies can also work with their customers to reduce waste from containers and packaging. One example is in-store reuse programs for grocery bags. In 1996, Americans discarded approximately 2 million tons of bags and sacks (nearly 1 percent of the U.S. waste stream).[45] During that same time, nearly 515,000 tons of bags and sacks were source reduced.

The following case studies represent a range of source reduction programs involving a business-to-customer relationship or interaction. Case studies of Xerox Corporation, Eastman Kodak Company, and The Laser Link, Inc. profile product take-back and remanufacturing programs. Xerox's take-back program is supported by product design policies that facilitate recovery, reuse, and remanufacturing. Two case studies, Monsanto and the city of San Diego, examine how lease agreements can prevent waste. Lease agreements facilitate product recovery and, when they include service provisions, extend product life. The final case study, an example of businesses working with customers to reduce packaging waste, details a program that provides an incentive for customers to return grocery bags to supermarkets for reuse.

4.5.1 Product Take-Back and Remanufacturing Programs

Xerox Corporation

Many companies are beginning to recover their products from customers to prevent these items from going to waste and to cut raw material costs by substituting recovered material for virgin material. Recovery is easier when engineers build reusability and recyclability into the products they design. This is one aspect of Design for the Environment (DfE)—identifying cost-effective alternatives to existing products and processes that reduce risks to the environment. Xerox Corporation's DfE program and product take-back operation, known as the Asset Recycle Management program, treats used products as assets, rather than waste.

In 1997, Xerox remanufactured equipment from more than 30,000 tons of returned machines. The programs also have saved Xerox a substantial amount of money. Xerox estimates that annual savings in raw material, labor, and disposal as a result of design changes and product take-back programs are on the order of several hundred million dollars.[46] These impressive cost savings justi-

[45] U.S. EPA. 1998. Characterization of Municipal Solid Waste in the United States: 1997 Update. EPA530-R-98-007. Washington, DC.

[46] Personal communication with Xerox environmental specialist. July 22, 1998. Eastern Research Group. Arlington, VA.

fy the programs internally. According to Xerox, the company's asset recycling and DfE programs merge environmentalism with good business sense.

Xerox encourages customers to return machines to the company. Employees log, disassemble, and sort parts from returned machines that meet internal criteria for remanufacturing. Xerox incorporates reprocessed parts into new products. Parts that do not meet remanufacturing criteria and cannot be repaired are often ground, melted, or otherwise converted into basic raw materials. The company integrates remanufacturing into the same assembly lines that produce new products. The aim of the asset recycling program is to prevent Xerox product assembly and disassembly from producing landfill waste (see Figure 4-1 on page 54).

Although the asset recycling program saved Xerox approximately $50 million in its first 12 months of operation, it was difficult to work with equipment not initially designed to be remanufactured or recycled.[47] With this in mind, Xerox developed its DfE program to incorporate environmental considerations, such as recycling and remanufacturing, into product design. Xerox's DfE program includes the following criteria:

- Satisfaction of all regulatory requirements.
- Satisfaction of criteria defined by major environmental labeling programs such as EPA's ENERGY STAR® and Germany's Blue Angel.[48]
- Satisfaction of customer environmental requirements.
- Satisfaction of internal requirements for remanufacturing and environmental protection.

Xerox began training engineers in DfE principles in 1993. Soon afterward, the company began producing removable copier cartridges designed specifically for parts reuse. Xerox later applied DfE principles to entire copiers and printers. DfE requires product designers to develop an environmental plan for each product, focusing on environmental impacts and incorporating features to minimize the cost of recycling or reusing components.

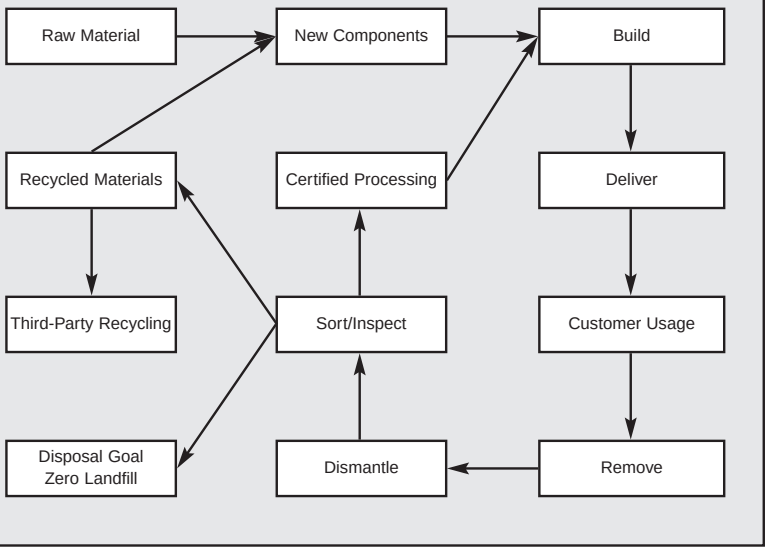
DfE principles encourage Xerox designers to limit production materials to recycled and recyclable plastics and metals. Xerox now uses fewer types of plastics than it did before DfE was introduced. Xerox's ultimate goal is to use only easily recyclable thermoplastics in the future. Paper labels, which contaminate recycled plastic, are avoided, and all components are marked with recycling symbols to identify their materials.

DfE principles also led engineers to design products for easier maintenance, disassembly, cleaning, and testing, which extended the life of product compo-

[47] Murray, Fiona. 1994. Xerox: Design for the Environment. Harvard Business School. N9-794-022. January 7. p. 9.

[48] ENERGY STAR® is a U.S. registered trademark.

Figure 4-1: Xerox Product "Closed Loop" Lifecycle Management



Source: Xerox Environment, Health and Safety Department Web site <www.xerox.com/ehs/1995/prodstew.html>

nents. Engineers design many parts to snap together, for example, facilitating parts service and replacement.

Xerox engineers use a variety of other DfE concepts in product design and manufacturing. One diagnostic tool, known as signature analysis, uses a sophisticated methodology to help Xerox engineers determine the remaining lifespan and performance potential of recovered products. Additionally, a financial model helps determine how design changes that influence a product's manufacturing cost also affect the lifecycle cost of the product, which includes remanufacturing return on investment and disposal costs. Product designers can then examine the tradeoffs between product costs and lifecycle costs.

Xerox promotes the achievements of these programs to shareholders and the public. Besides providing information for journal articles and case studies, such as one published by the *Harvard Business Review* in 1994, Xerox produces an annual environmental, health, and safety progress report and posts a copy on its corporate Web site. Xerox managers also conduct lectures and programs at universities, including a 3-day course for environmental executives at the University of Michigan.

Eastman Kodak Company

Kodak achieved an 85 percent reuse and recycling rate for its single-use FunSaver Camera line through an innovative take-back program. In order to reuse the parts, Kodak offers incentives to photo processors to ensure the cameras are returned to the company. Since the start of the program, Kodak has reused parts from more than 160 million returned cameras. This process has prevented more than 7,500 tons of waste.[49]

Customers purchase one-time use cameras because of their cost and convenience. They use the FunSaver camera just as they would any other camera, except they take the entire camera, rather than just the film, to a photo processor for developing. What many of these consumers do not realize is that the photo processor sends the camera back to Kodak after removing and developing the film. Initially, photo processors returned approximately 40

[49] Personal communication with an Eastman Kodak Company environmental specialist. February 27, 1998. Eastern Research Group. Arlington, VA.

percent of the cameras for disassembly and reuse or recycling. Kodak then initiated an incentive program to the photo processors to increase the return rate of the cameras. The incentive program includes offering deposits, free collection and shipping containers, a list of preferred carriers, and recycling signs and posters. This incentive program, along with a partnership agreement with its competitor Fuji to exchange mistakenly delivered cameras, boosted the return rate to 70 percent.

When the photo processor returns the FunSaver camera to Kodak, the valuable parts from the camera, such as the shutter, viewfinder, and circuit board are removed from the camera. Kodak reuses these parts to manufacture "new" cameras. Other parts that cannot be reused are then recycled.

The Laser Link, Inc.

The Laser Link, Inc., established in October 1992, is a seven-employee toner cartridge remanufacturer located in Boyertown, Pennsylvania. The motto of the company is "Renewing Our Resources With Quality Products." By accepting, disassembling, cleaning, testing, refilling, and reselling printer, copier, and fax machine toner cartridges, the cartridge remanufacturing industry prevents more than 37,000 tons of empty toner cartridges (mostly consisting of HDPE) from entering the U.S. waste stream each year. In Pennsylvania alone, there are more than 200 cartridge remanufacturers producing more than 68,900 cartridges per month.[50]

Laser Link remanufactures approximately 9,600 cartridges annually, diverting more than 19 tons of waste from landfills and waste combustors. Of the cartridges sold to Laser Link's customers, 90 percent are exchanged for empty toner cartridges.[51] For each empty toner cartridge returned, customers receive a $10 discount on each remanufactured toner cartridge they purchase. This exchange program ensures Laser Link a steady stream of empty toner cartridges for remanufacturing.

Laser Link picks up empty toner cartridges from its customers while delivering new cartridges. The company also encourages customers to return all cartridge packing materials, which include corrugated, polystyrene, paper, and aluminum. Laser Link either reuses or recycles these materials.

[50] Judge, Tricia. 1998. Make My Day. *Recharger Magazine*. January. Vol. 9, No. 5. pp. 74-75.

[51] Laser Link, Inc. internal company document.

4.5.2 Leasing Programs

Monsanto and Dell Computer Corporation

Escaping the trap of computer obsolescence has preoccupied many information technology (IT) professionals in recent years. Together, Monsanto and Dell Computer Corporation found a way to do just that. In March 1997, Monsanto's production facility in Luling, Louisiana, began leasing computer equipment from Dell in an arrangement that reduces waste for Monsanto and consistently provides them with high-quality personal computer (PC) workstations. Leased PCs are covered by a 3-year warranty, freeing Monsanto from having to purchase replacement electronics and from having to find disposal solutions for the unusable parts. The waste prevented from this program could be more than 16.5 tons annually, with PCs averaging 56 pounds of materials per unit.[52]

According to a Monsanto IT team leader, "An examination of Monsanto's total cost of PC ownership showed there were some compelling business reasons to move to a computer leasing model." When asked about some of the practical benefits of a leasing program, the team leader noted that the new program "eliminated a number of ongoing problems including PC disposal, routine PC upgrades, and IT resource demands."

Problems began to mount as Monsanto's PC network grew older and seemingly slower in a world where microprocessor speeds continually increased. Monsanto noticed its PC network had become obsolete far ahead of its depreciation schedule. Additionally, the age-old practice of PC hand-me-downs was causing a torrent of IT service demands. As Monsanto purchased new systems and transferred the old machines internally, IT team members scurried to update and reconfigure systems for their new owners. "With more than 600 PCs at Luling alone, we had a major problem on our hands," the IT team leader admitted.

To help solve this problem, Monsanto brainstormed and examined the finances for a leasing program. In late 1994 and early 1995, Monsanto identified the leasing model as the most cost-effective solution to its growing problem. By 1997, the Luling facility was one of a few test sites where Monsanto began leasing PCs.

Monsanto leases high-end computer workstations on a 24- or 36-month program that ultimately returns the used systems to Dell for reuse. Returned PCs often carry substantial value after the lease ends. According to a Dell leasing division official, "For many years, Dell products have been designed for easy serviceability, a key feature that helps the leasing program function effectively. The Dell direct model (leased PC) provides the company with a number of remarketing avenues including spare parts reclamation, sales abroad, and re-leasing to organizations that don't need the latest technology."

[52] Personal communication with a Monsanto IT specialist. May 29, 1998. Eastern Research Group. Arlington, VA.

Dell does not design leased PCs differently than other units. All Dell PCs use a modular chassis, which provides flexibility in product specification, and PC component consistency. This design is beneficial for a leasing program because the company does not have to guess what type of components come back with each returned system.

The City of San Diego and Interface, Inc.

In 1996, the city of San Diego entered into an innovative carpeting lease agreement with Interface, an Atlanta-based carpet manufacturer. By leasing the carpet from Interface, San Diego will never have to dispose of massive amounts of worn or damaged carpet. At 10 pounds per yard, the leasing project will save San Diego from disposing of 125 tons of carpet waste.[53]

The leased Interface carpet is different from ordinary carpet. Interface carpet is laid down in easily replaceable tiles or squares. The tiles are not individually glued to the floor. A porous, rubbery carpet backing grips the floor like a suction cup, and glue strips are only necessary every 6 feet, reducing consumption and exposure to potentially hazardous adhesives. As part of the lease, Interface agreed to rotate the carpet squares to prevent excessive wear in high traffic areas and replace the squares with new pieces in the case of damage.

According to San Diego's sustainable building coordinator, "The quality and durability, as well as the 12 percent recycled content, of the carpet were the main reasons for going with Interface." There were no capital outlays for the materials and, at the end of the carpet life, the manufacturer will remove the carpet and recycle the fibers and backing into new product.

The carpet lease was an integral part of the San Diego Green Building Project. In 1994, the city purchased a 3-story, 73,000 square foot building and spent the better part of 2 years on a "green renovation." The Environmental Services Department moved in upon completion in April 1996. Leasing a carpet square system was one of the many environmental innovations San Diego included in the Green Building Project so they could lead by example.

When asked about the carpet's performance 2 years after installation, the sustainable building coordinator noted that it is holding up well. The carpet is under a 5-year lease contract, but is backed by a 15-year warranty and San Diego is pleased with the performance.

[53] Personal communication with a San Diego environmental specialist. May 1, 1998. Eastern Research Group. Arlington, VA.

4.5.3 Packaging Reuse by Customers

Wakefern Food Corporation

Wakefern Food Corporation is the largest retailer-owned food wholesaler in the United States. The company operates more than 190 ShopRite supermarkets in Connecticut, Delaware, New Jersey, New York, and Pennsylvania.

In 1991, Wakefern instituted a $.05 customer rebate for each paper grocery bag or plastic bag returned to ShopRite stores for reuse, regardless of whether bags originated in a ShopRite store. To promote the program to customers, Wakefern posted window signs, distributed point-of-purchase materials and take-home brochures, and broadcasted store announcements. One of the promotional brochures informed customers that "All bags should be reused if possible." ShopRite stores also occasionally promoted the in-store sale of reusable cloth bags. Cloth bags can be reused more than paper or plastic bags, resulting in even greater waste reductions.

The rebate program and promotional materials helped conserve large quantities of paper and plastic and generated significant cost savings. In the first year of the program, ShopRite stores reused more than 5.2 million bags. By the fourth year of the program, ShopRite was reusing more than 8 million bags annually. Approximately 53 million of the nearly 56 million bags reused since the program's inception are paper grocery bags. These 53 million paper bags translate into 3,430 tons of paper waste diverted from landfills and waste combustion facilities.[54]

Through rebates, ShopRite stores passed along savings from avoided labor, transportation, and purchasing costs to their customers. These savings amounted to more than $100,000 in 1991 and nearly $200,000 in 1997.

[54] Wakefern Food Corporation internal company document.

Glossary

Backyard Composting refers to a method of source reduction whereby food scraps and yard trimmings are diverted from the waste stream through controlled decomposition in open piles, pits, windrows, or bins. This is considered a form of source reduction since the waste material is handled "onsite" and never enters the waste stream.

Dependent Variable refers to the variable on the left side of the equality sign in an equation. Its value is determined by, or dependent on, the values of the independent variables on the right side.

Discards include the MSW remaining after recovery for recycling (including offsite composting). These discards would presumably be combusted or landfilled.

Drivers (also known as Driving Factors) refer to macroeconomic developments that cause, or drive, changes in waste generation. Examples include population, wages, and gross domestic product.

Durable Goods refers to longer lasting goods (3 or more years) such as major and small appliances, furniture and furnishings, carpets and rugs, tires, lead-acid batteries, and consumer electronics.

Food Scraps Recovery refers to a method of source reduction whereby food is kept out of the waste stream through donations to community groups, onsite composting, processing discards into animal feed, or rendering.

Grasscycling refers to a method of source reduction whereby grass clippings are left on the lawn rather than bagged and set out for collection. This is considered a form of source reduction since the waste material is handled "onsite" and never enters the waste stream.

Gross Domestic Product (GDP) refers to the total annual market value of all final goods, services, and structures produced by labor and property located in the United States, regardless of who owns the resources.

Independent Variable refers to the variable on the right side of the equality sign in an equation. Its value is determined independently of, or outside, the equation.

Lightweighting refers to reductions in the weight of material used to make packaging (i.e., less plastic in a food container or less aluminum in a beverage can) per unit of material contained in the package.

Glossary

Linear Regression refers to the study of quantitative relationships between two measurable variables. Data are collected on a number of units or cases within the variables and then analyzed to determine the relationship.

Materials Flow Waste (MFW) refers to waste from the 47 products and packaging materials within the broader categories of durable goods, nondurable goods, and containers and packaging.

Materials Substitution refers to a method of source reduction in which one material is replaced with another. Shrink wrapping a bottle of cough syrup previously packaged in a paperboard box is an example of materials substitution as is replacing a metal appliance cover with a lighter plastic one.

Municipal Solid Waste (MSW) refers to 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. MSW does not include sewage, hazardous wastes, nonhazardous industrial wastes, construction and demolition debris, or automobile bodies.

Nominal refers to the measurement of an economic variable in current prices. The opposite of nominal is real.

Nondurable Goods refers to items having a lifetime of less than 3 years, such as newspaper, books, magazines, office paper, telephone directories, paper towels and tissues, paperboard, paper plates and cups, plastic plates and cups, rubber, leather, and textiles.

Other Waste (OW) refers to waste from yard trimmings, food scraps, and miscellaneous inorganic materials.

Personal Consumption Expenditures (PCE) refers to the amount of spending by consumers on goods and services. It is the largest single component of the GDP and accounts for two-thirds of its magnitude.

Primary Packaging refers to all packaging that directly covers or protects a product and is not specifically used for transporting the product. Primary packaging also serves to promote products.

R-Squared (R^2) Value refers to a standard measurement associated with linear regression that indicates how well the regression equation explains the underlying data used for the regression. The higher the R^2 value, the better the equation explains the data.

Rate of Waste Generation refers to the amount of waste generated in a given year (W) divided by the value of a particular driver (D), or R = W/D.

Real refers to economic data that has been adjusted for inflation.

Remanufacturing refers to the restoration of durable products to serve their original function by replacing worn or damaged parts.

Rendering refers to a type of food scraps recovery in which liquid fats and solid meat products can be used as raw materials in an industrial process, which converts them into animal food, cosmetics, soap, and other products.

Reuse refers to a type of 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.

Source Expansion refers to the results of source reduction calculations in which the rate of generation of municipal solid waste increases after the base year. Source expansion is the opposite of source reduction, in which the rate decreases.

Source Reduction (also known as Waste Prevention) refers to any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become municipal solid waste. Source reduction also refers to the reuse of products or materials.

Transport Packaging refers to external packaging materials, including crates, pallets, cartons, skids, wraps, and totes, that help contain and protect products during shipping and handling.

Vermicomposting refers to a type of composting in which worms (usually red worms) break down organic materials into high-quality compost (worm castings). Animal products or grease cannot be composted in this manner.

Waste Generation refers to the amount (weight or volume) of materials and products that enter the waste stream before recycling (including off-site composting), landfilling, or combustion take place. Waste generation occurs after source reduction.

Yard Trimmings refers to leaves, branches, and other organic debris generated from yards, parks, and public places.

Appendix

A.1 Overview of the Appendix

This appendix provides more detail on the statistical analysis undertaken to support the results described in Chapters 2 and 3. It is not intended to be a stand-alone section; it refers back to sections, figures, and tables from Chapters 2 and 3 without repeating them explicitly.[1]

A.2 Definition of Source Reduction

As shown in Figures 2-1 and 2-3 (see pages 6 and 8), source reduction quantified in this report reflects changes in waste generation from 1990 to 1996. The year 1990 is referred to as the **base year.** The objective of the methodology is to define source reduction for a specific waste stream (W) using data on the tonnage in 1990 (W90) and in 1996 (W96). In addition to the waste stream tonnage, source reduction measurement requires the introduction of the concept of a **driving factor** (D) such as population or consumer spending. The term "driving factor" captures the idea that D causes some of the observed changes in W. Using the driving factor and the waste stream tonnage, the **rate of waste generation** (R) is defined as follows:

$$(1)\quad R = W/D$$

Using the driving factor and the rate of waste generation, source reduction in 1996 relative to a 1990 base year (SR96) is defined by the following equation:

$$(2)\quad SR96 = (R90 \times D96) - W96$$

This equation corresponds to the definition of source reduction illustrated earlier in Figures 2-1 and 2-3.

In equation (2), R90 is simply the rate of waste generation in 1990, measured as W90 divided by D90. The term R90 x D96 is 1996 waste generation without source reduction, or the waste one would expect if the rate of waste generation in 1996 remained the same as in 1990. W96 is actual 1996 waste generation.

Equation (2) can be rewritten in a simpler form. Using equation (1), W96 = R96 x D96. Equation (2), therefore, can be rewritten as follows:

$$(3)\quad SR96 = (R90 - R96) \times D96$$

In other words, equation (3) states that the **total source reduction in 1996 is the product of the reduction in the rate of waste generation between 1990 and 1996 and the level of a specified driving factor in 1996.** Equation (3) highlights a crucial aspect of source reduction. Source reduction depends only on changes in the rate of waste generation. **SR96 will be positive, indicating source reduction in 1996 relative to 1990, if, and only if, waste generation in 1996 is less than waste generation in 1990.**

[1] The statistical and analytical methods described in this Appendix were conducted in coordination with the Tellus Institute and in accordance with similar research conducted by Tellus on behalf of the Organization for Economic Cooperation and Development (OECD).

A.3 Empirical Analysis of Waste Generation From 1960 to 1996

Chapter 2 discussed source reduction results for the municipal solid waste (MSW) stream as a whole. This report also examined individual component streams within MSW. The most important of these component streams, for the purposes of this report, are the following:

- **Materials Flow Waste (MFW).** This stream consists of waste from 47 specific products and packaging materials, which the *Characterization of Municipal Solid Waste in the United States: 1997 Update (1997 Update)* groups into durable goods, nondurable goods, and containers and packaging. In the *1997 Update*, waste from each of the specific products and packaging materials is accounted for separately using a materials flow methodology, which tracks each product or material from its introduction into the economy to the point at which it becomes part of the waste stream.
- **Other Waste (OW).** This stream consists primarily of yard trimmings: leaves, branches, and other organic debris generated from yards, parks, and public places. In addition, OW includes food scraps and miscellaneous inorganic waste. The components of OW are neither analyzed using the materials flow methodology, nor subdivided into specific products and materials.

Figure A-1 below shows the relationships among the various components of MSW discussed above, as well as the 1996 tonnage for each component. As shown below, MSW is the sum of MFW and OW.

Figure A-1: The Structure of MSW and its Components (1996 Generation in Millions of Tons)

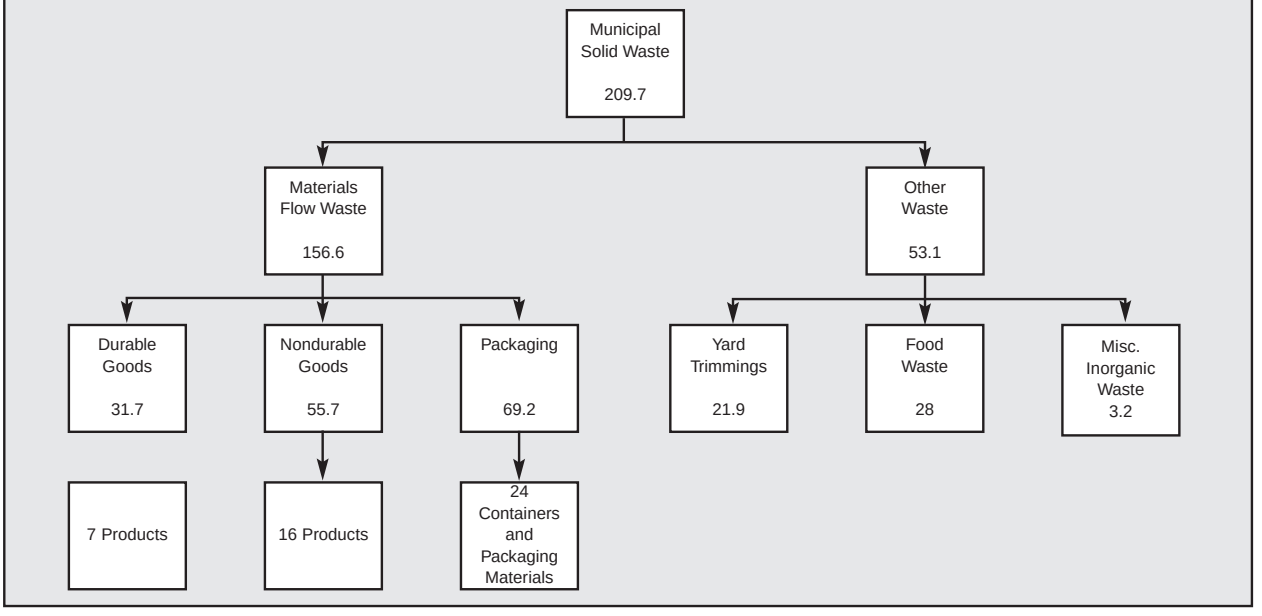
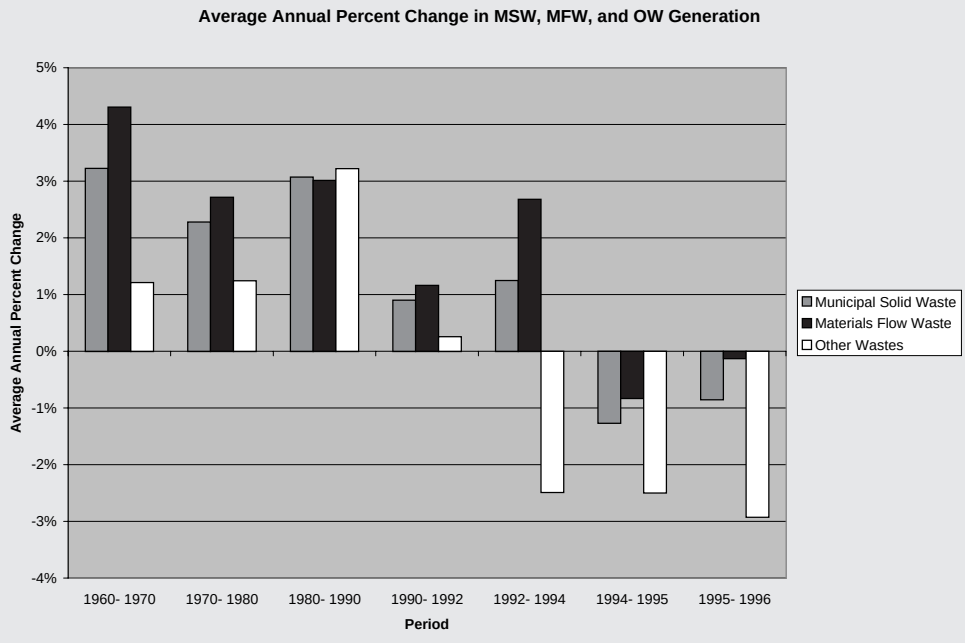


Figure A-2 below expands on the information presented in Figure 2-2 (see page 7)—in addition to MSW, data for selected years are used to develop average annual percent changes in the generation of MFW and OW. This provides a picture of the growth that has taken place in these waste streams since 1990. Notice that for MSW and MFW, growth occurred through 1994. In 1994, there is a serious downturn leading to subsequent reductions. For OW, there is a different pattern—growth was strong through 1990, at which point a downturn began to occur.

Figure A-2: Average Annual Percent Change in MSW, MFW, and OW Generation



A.4 Statistical Analysis Approach to Measuring Source Reduction

As described in Chapter 2, it is generally accepted that changes in driving factors, such as consumer spending, gross domestic product (GDP), or population, can cause changes in the MSW stream. It is less clear, however, which factor most affects source reduction. Linear regression can help address this question. Further, linear regression allows the rate term in the formula for source reduction, R90 - R96 in equation (3) on page 63, to be replaced by a formula that reflects all of the waste rate data for the period 1990 to 1996. To address these points, a three-step statistical approach was applied:

Step 1: A range of driving factors were regressed against waste generation to see which best explained the historical generation pattern. Driving factors were tested individually, rather than in groups; because the driving factors were sufficiently collinear, multilinear analyses were problematic. Testing single driving factors also allowed for a simple evaluation of the regression results: the best driving factor was selected by comparing R^2 values from the regressions.

For each waste stream analyzed, two types of regression equations were considered as part of the driving factor selection process. **Trend equations** were developed by regressing waste generation against driving factors. **Change equations** were developed by regressing year-to-year changes in waste generation against year-to-year changes in driving factors. For the best driving factor, both the trend and change equations should have R^2 values near 1. Particular attention was paid to the R^2 value for the change equation, since a driving factor's ability to explain year-to-year variation in waste generation provides a strong argument that the driving factor is, in fact, related directly to waste generation for the stream under study.

Step 2: Based on the resulting R^2 values, the preferred driving factor (D) was then used to calculate the rate of waste generation (R) defined in equation (1) as W divided by D. The resulting annual data for R were then regressed against time (T), producing a rate equation of the following form:

$$\textbf{(4)}\quad R = aT + b$$

As a final step in the driving factor selection, the regression results from equation (4) were examined. An R^2 value near 1 provides additional evidence, beyond the results from the trend and change equations, that waste generation and the driving factor selected are highly correlated.

Step 3: Using equation (4), the waste generation rates in 1990 and 1996, R90 and R96, were then calculated. R90 was obtained by setting T = 0 since 1990 is the base year. R96 was obtained by setting T = 6 since 1996 - 1990 equals 6 years. Next, R90 - R96 was calculated

(R90 - R96 = -6a). As shown in equation (2), SR96 = (R90 - R96) x D96. Replacing R90 - R96 with -6a yielded the following equation:

(5) SR96 = -6a x D96

-6a is one example of a regression-based formula for changes in rate. A variety of such formulas were developed. A potential advantage of such formulas is that they reflect the rate of waste generation for all years from 1990 to 1996, whereas R90 - R96 reflected the rates for only 1990 and 1996.

This three-step approach was used to analyze the MSW stream as a whole, its major component streams, and specific products and materials within MSW, as described in the following section.

A.5 Support for Selection of Consumer Spending as the Driving Factor

In measuring source reduction for MSW and its component waste streams, the following driving factors were considered: population, wages, real and nominal GDP, and real and nominal personal consumption expenditures (PCE).[2] Nominal data are the actual, annual values for GDP and PCE. Real data are the nominal data adjusted to remove the effects of inflation. While real data for GDP and PCE correspond better to the actual products and materials that end up in the MSW stream, nominal data were included for thoroughness. These driving factors were selected for the reasons discussed in Chapter 2 and also based on the following observations:

- In the United States and elsewhere, MSW generation has traditionally been analyzed on a per-capita basis. Both the *1997 Update* and the Organization for Economic Cooperation and Development's *Towards Sustainable Development: Environmental Indicators* analyze MSW generation in this fashion.
- Wages and PCE are the components of GDP that correspond most closely to the products and materials which, when purchased and discarded, form the MSW stream.

Analysis began with data on the tonnage of MSW, MFW, and OW generated for the period 1960 through 1996. Using each driving factor, the **average annual change in the rate of waste generation** for both 1960 to 1990 and 1990 to 1996 was developed. The results of this analysis for MSW are shown in Table A-1 on page 68. The average annual changes in rate were computed as indicated by the headings. In the column headed "1960 - 1990," for example, the rate in 1990 was subtracted from the rate in 1960, and the result divided by 30 years. The average annual change in rate was calculated in this

[2] Note: Throughout this report, the term "consumer spending (PCE)" is used to refer to the value of real or inflation-adjusted PCE. For this section on driving factor selection, however, where it is important to distinguish between the real and nominal values of PCE, the terms real and nominal PCE are used. The values for "consumer spending (PCE)" used in this report are non-product specific and an aggregate of overall consumer spending as reported in the *1997 Statistical Abstract of the United States*.

fashion so the resulting data would conform with the source reduction equation. As shown in equation (3) on page 63, source reduction for the period 1990 to 1996 depends on the value of R90 - R96, the rate of waste generation in 1990 minus the rate of waste generation in 1996.

In order for source reduction to occur, the rate of waste generation must decline. In Table A1, **positive** entries in the columns headed "Average Annual Change" indicate declines in rate, or source reduction. The results in Table A-1 show the following:

Table A-1: Possible Drivers of Waste Generation Rates for MSW

Driving Factor	Rate			Average Annual Change	
	1960	1990	1996	1960 - 1990	1990 - 1996
Population (tons per capita)	0.49	0.82	0.79	(0.01)*	0.01
Wages (tons per million dollars)	323.02	74.42	57.76	8.29	2.78
Nominal GDP (tons per million dollars)	167.34	35.73	27.67	4.39	1.34
Real GDP (tons per million dollars)	38.94	33.44	30.36	0.18	0.51
Nominal PCE (tons per million dollars)	265.26	53.45	40.70	7.06	2.13
Real PCE (tons per million dollars)	61.51	49.66	44.70	0.39	0.83

* Throughout the tables in this report, parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction.

- For the 1990 to 1996 period, source reduction occurs for all of the driving factors considered.
- For the period 1960 to 1990, source reduction occurs for all driving factors except population.
- For the real economic driving factors, reductions in rate are greater in the 1990 to 1996 period than in the 1960 to 1990 period; for wages and the other nominal data, the opposite is true.

The first two points confirm that source reduction has occurred during the specified time periods. The choice of driving factor, however, significantly affects the magnitude of the reduction. The third point illuminates an issue in the use of the nominal data as driving factors. From 1960 to 1990, nominal GDP and its components, including PCE, increased greatly due to inflation. From 1990 to 1996, inflation was very low. For the nominal data, it is inflation that causes the waste generation rate to drop faster before, rather than after, 1990. In order to avoid effects due to inflation, the use of real data is, therefore, preferable when analyzing source reduction.

Analyses similar to those summarized in Table A-1 were conducted for MFW, OW, and their individual components. Results of these additional analyses

generally support the points made above for MSW. Selection of the best driving factor(s) for MFW, OW, and their components also was based on the use of linear regression. The following analyses were undertaken:

- Data for the periods 1960 to 1990 and 1960 to 1994 were considered.
- For each time period, all six driving factors were used to analyze each waste stream.
- For each time period and each driving factor, two regressions were performed. The trend and change equations defined as part of the three-step approach were produced, and their R^2 values were recorded. (The rate equation was used for another purpose as described later in this appendix.)

The analyses required to develop all the necessary linear regressions were data-intensive. Thousands of individual regressions needed to be performed and analyzed. These regressions were not performed one equation at a time, but processed in batches using a spreadsheet model. Batch processing allowed all the linear regressions for each time period (e.g., 1960 to 1990, 1960 to 1994) to be performed in a single operation. Table A-2 presents the R^2 values for the three sets of regressions performed for MSW for the period 1960 to 1994.

As shown in Table A-2, for the trend equation, the R^2 values for all six driving factors were above 0.96, and it was difficult to distinguish which one was the best driving factor. The change equation was then used as a second level of analysis. The change equation, which explains year-to-year fluctuations, offers a more refined method of capturing the underlying movement of MSW generation. Using the change equation, only R^2 values for two of the six driving factors—real PCE and real GDP—rose above 0.90, and real PCE produced a higher R2 than real GDP. **Real PCE, therefore, was selected as the most appropriate driving factor to use when calculating source reduction.**

Similar analyses were performed for MFW for the period 1960 to 1994 using total PCE. OW was analyzed in a similar fashion, but using 1960 to 1990 data rather than 1990 to 1994 data because, as shown in Figure A-2 on page 65, the break in OW's average annual growth pattern is in 1990, not 1994. That is to say that 1990 is the year in which growth in OW generation began to decrease. As with MSW, real PCE and real GDP were the best driving factors for MFW and OW based on R^2 values. For both, the R^2 values also suggest real PCE is a better driving factor than real GDP. The major components of MFW

Table A-2: R^2 Values for MSW-Related Regressions for 1960 to 1994

Driving Factor	R^2 By Type of Equation	
	Trend	Change
Population	0.987	0.769
Wages	0.975	0.708
Nominal GDP	0.969	0.657
Real GDP	0.996	0.938
Nominal PCE	0.964	0.632
Real PCE	0.998	0.969

(i.e., durable goods, nondurable goods, and containers and packaging) and OW (i.e., yard trimmings, food scraps, and miscellaneous inorganic waste) also were analyzed, leading generally to the same conclusions.

In order to fully explore the impact of driving factor choice on the measurement of source reduction, however, analyses were initially conducted using all of the driving factors shown in Table A-2. Table A-3 below summarizes the results obtained for MSW. For each driving factor, two values for source reduction were computed: a value based on the change in the rate of waste generation, as in equation (3), and a regression-based value developed using equation (5) from Section A.4 above.

As shown in Table A-3, based on the choice of driving factor and measurement technique, values for source reduction range from about 7.5 million tons to 65.7 million tons. In addition to the analyses shown in Table A-3, analyses of source reduction for MSW were made that took into account the change in waste generation growth occurring in 1994. To do this, regressions covering 1990 to 1994 and 1994 to 1996 were used. These methods obtained essentially the same values for source reduction as those developed using the regression covering 1990 to 1996 as a whole.

Table A-3: Source Reduction Values for MSW (Thousands of Tons)

Driving Factor	Source Reduction	
	Using Change in Rate of Waste Generation Method	Using 1990 to 1996 Regression Method
Population	8,621	7,495
Wages	60,488	59,451
Nominal GDP	61,013	61,117
Real GDP	21,317	21,423
Nominal PCE	65,682	65,537
Real PCE	23,286	23,434

The range of source reduction values discussed in Chapter 2 is taken from the "Change in Rate of Waste Generation" column of Table A-3, which shows a range of 8.6 million tons to 65.7 million tons. Since the results from both the regression-based and nonregression-based analyses yielded similar source reduction values using real PCE, Chapter 2 presents only the nonregression-based findings. The following section presents the results from both the regression-based and nonregression-based approaches.

A.6 Additional Analysis of Source Reduction and Source Expansion

The bulk of the analyses of source reduction conducted for this report were more specific than those presented in Table A-3. Source reduction was quantified using the following techniques and assumptions:

- **Waste Streams.** The MSW stream, as well as its two major components, MFW and OW, were considered in the aggregate. Each of the 47 products included in MFW, as well as the three components of OW (i.e., yard trimmings, food scraps, miscellaneous inorganic waste) also were considered individually. (Analyses also were conducted for the material components of MSW—paper and paperboard, glass packaging, etc. These did not, however, prove particularly useful.)
- **Measurement Techniques.** Source reduction was computed based on the change in the waste generation rate between 1990 and 1996 and by using linear regression.

The resulting source reduction values produced for MSW, MFW, and OW, using consumer spending (real PCE) as the driving factor, are shown in Table A-4 below.[3]

The results in Table A-4 reveal that source reduction "adds up" in a logical fashion: source reduction for MSW is equal to source reduction for MFW plus source reduction for OW. (Small differences are due to rounding.) This is true whenever the same driving factor is used for all components of a waste stream, even if some components experience source expansion.

Table A-4: Source Reduction Values for MSW, MFW, and OW (Thousands of Tons)

Waste Stream	Source Reduction Based on Consumer Spending	
	Using Change in Rate of Waste Generation Method	Using 1990 to 1996 Regression Method
Materials Flow Waste (MFW)	9,752	9,123
Other Waste (OW)	13,534	14,311
Municipal Solid Waste (MSW = MFW + OW)	23,286	23,434

Waste generation data for the individual products and materials in both MFW and OW were then analyzed. Table A-5 on pages 72-75 presents the source reduction values calculated for each component of the MFW and OW streams, using consumer spending as the driving factor for the two types of analyses performed: change in the rate of waste generation and 1990 to 1996 regression. The values for "change in rate of waste generation" correspond to those values found in Table 3-8 (see page 18) of Chapter 3.

[3] It should be noted that an annual value of PCE for total U.S. expenditures is used consistently throughout all analyses in this report including the analysis of individual products and materials. This is done so that the reduction and expansion effects can be counted from the occurrence of both material specific lightweighting as well as material substitution of interchangeable materials within the same functional categories. Furthermore, while values of PCE for specific consumer expenditures do exist, as in cases like food and clothing, such expenditure-specific PCE values are not easily correlated with, or available for, all of the materials found in MSW. Consequently, this report does not utilize expenditure-specific PCE values when calculating source reduction (expansion) estimates for individual materials nor for functional product categories.

Table A-5: Source Reduction Values for the Individual Components of MSW* (Thousands of Tons)

Waste Stream	Source Reduction Based on Consumer Spending	
	Change in Rate of Waste Generation**	1990 to 1996 Regression**
Components of MFW		
Durable Goods		
Major Appliances	237	273
Small Appliances	(258)	(263)
Furniture/Furnishings	388	473
Carpets/Rugs	(426)	(454)
Tires	188	165
Lead-Acid Batteries	(96)	(189)
Miscellaneous Durable Goods	2,145	2,441
Source Reduction Subtotal for Durable Goods	*2,958*	*3,352*
Source Expansion Subtotal for Durable Goods	*(779)*	*(905)*
Net Value Subtotal for Durable Goods	***2,179***	***2,447***
Nondurable Goods		
Newspapers	2,955	2,447
Books	161	31
Magazines	1,242	1,015
Office Paper	616	655
Telephone Directories	222	282
Third-Class Mail	(174)	(462)
Other Commercial Printing	(1,497)	(1,605)
Tissue Paper/Towels	380	333
Paper Plates/Cups	(212)	(269)
Plastic Plates/Cups	(72)	(85)

* MFW + OW = MSW

**Discrepancies in calculations may occur due to rounding.

Table A-5: Source Reduction Values for the Individual Components of MSW* (Thousands of Tons) *(continued)*

Waste Stream	Source Reduction Based on Consumer Spending	
	Change in Rate of Waste Generation**	1990 to 1996 Regression**
Trash Bags	25	55
Disposable Diapers	15	38
Other Nonpackaging Paper	289	217
Clothing/Footwear	(788)	(759)
Towels, Sheets, Pillowcases	56	58
Other Misc. Nondurables	351	425
Source Reduction Subtotal for Nondurable Goods	*6,314*	*5,557*
Source Expansion Subtotal for Nondurable Goods	*(2,743)*	*(3,181)*
Net Value Subtotal for Nondurable Goods	***3,571***	***2,376***
Containers and Packaging		
Glass Beer/Soft Drink Bottles	*1,192*	1,307
Glass Wine/Liquor Bottles	*364*	447
Glass Food/Other Bottles & Jars	832	515
Steel Beer/Soft Drink Cans	170	180
Steel Food/Other Cans	63	111
Other Steel Packaging	57	29
Aluminum Beer/Soft Drink Cans	199	186
Other Aluminum Cans	(17)	(18)
Aluminum Foils/Closures	15	16
Corrugated Boxes	(1,765)	(2,115)
Milk Cartons	119	92
Folding Cartons	(509)	(574)
Other Paperboard Packaging	99	88

* MFW + OW = MSW

**Discrepancies in calculations may occur due to rounding.

Table A-5: Source Reduction Values for the Individual Components of MSW* (Thousands of Tons) *(continued)*

Waste Stream	Source Reduction Based on Consumer Spending	
	Change in Rate of Waste Generation**	1990 to 1996 Regression**
Paper Bags/Sacks	790	824
Wrapping Papers	75	66
Other Paper Packaging	(192)	(101)
Plastic Soft Drink Bottles	(212)	(209)
Plastic Milk Bottles	(48)	(56)
Other Plastic Containers	343	462
Plastic Bags/Sacks	(293)	(309)
Plastic Wraps	(123)	(4)
Other Plastic Packaging	16	52
Wood Packaging	2,806	3,289
Other Misc. Packaging	20	24
Source Reduction Subtotal for Containers and Packaging	*7,161*	7,687
Source Expansion Subtotal for Packaging	*(3,159)*	(3,387)
Net Value Subtotal for Containers and Packaging	***4,002***	4,300
Source Reduction Subtotal for MFW	*16,434*	*16,596*
Source Expansion Subtotal for MFW	*(6,682)*	*(7,473)*
Net Value Subtotal for MFW	***9,752***	***9,123***

* MFW + OW = MSW
**Discrepancies in calculations may occur due to rounding.

Table A-5: Source Reduction Values for the Individual Components of MSW* (Thousands of Tons) *(continued)*

Waste Stream	Source Reduction Based on Consumer Spending	
	Change in Rate of Waste Generation**	1990 to 1996 Regression**
Components of OW		
Yard Trimmings	11,731	12,455
Food Scraps	1,711	1,746
Miscellaneous Inorganics	92	110
Source Reduction Subtotal for OW	*13,534*	*14,311*
Source Expansion Subtotal for OW	*0*	*0*
Net Value Subtotal for OW	***13,534***	***14,311***
Source Reduction Total for MSW	*29,967*	*30,907*
Source Expansion Total for MSW	*(6,681)*	*(7,473)*
Net Value Total for MSW	***23,286***	***23,434***

* MFW + OW = MSW

**Discrepancies in calculations may occur due to rounding.

As Table A-5 shows, both of the analyses using consumer spending as the driving factor (i.e., change in the rate of waste generation and 1990 to 1996 regression) support the computation of 23 million tons as the value for MSW source reduction in 1996, relative to the base year of 1990.

Additional Source Reduction Resources

EPA MSW Source Reduction Programs

EPA promotes source reduction through a variety of programs, including the following:

- **Pay-As-You-Throw Programs.** EPA provides technical and outreach assistance to encourage communities to implement pay-as-you-throw programs for solid waste. Under pay-as-you-throw, residents are charged for MSW services based on the amount of trash they discard, creating an incentive to generate less trash and increase recycling. On average, communities with pay-as-you-throw achieve waste reductions of 14 to 27 percent. For more information about these programs, access EPA's Pay-As-You-Throw Web site at <www.epa.gov/payt> or call 888 EPA-PAYT (372-7298).
- **WasteWise.** WasteWise is a voluntary partnership between EPA and U.S. businesses, institutions, nonprofit organizations, and government agencies to prevent waste, recycle, and buy and manufacture recycled-content products. By eliminating more than 1.8 million tons of waste through source reduction in the first 4 years of the program, WasteWise partners prevented the emission of 1.1 million metric tons of carbon equivalent (the basic unit of measure for greenhouse gases) into the atmosphere. More than 750 organizations participated in the WasteWise program in 1998. For more information about the program, access EPA's WasteWise Web site at <www.epa.gov/wastewise> or call 800 EPA-WISE (372-9473).

Information Available From Other EPA Programs

The following publications are available on EPA's Public Access Server at <www.epa.gov/epaoswer/osw>. They also are available through the RCRA Hotline. To order a document, call 800 424-9346 (or 800 553-7672 for the hearing impaired) and request the document number listed below in parentheses. In Washington, DC, the number is 703 412-9810 or TDD 703 412-3323. The RCRA Hotline is open from Monday through Friday, 9 a.m. to 6 p.m., e.s.t.

EPA's Climate Change and Waste Web Site
www.epa.gov/mswclimate

EPA's Office of Solid Waste
www.epa.gov/osw

EPA's Composting www.epa.gov/compost

The Consumer's Handbook for Reducing Solid Waste
(EPA530-K-92-003)

Business Guide for Reducing Solid Waste
(EPA530-K-92-004)

Environmental Fact Sheet: Recycling Grass Clippings
(EPA530-F-92-012) t

Environmental Fact Sheet: Yard Waste Composting
(EPA530-SW-91-009)

Enviroene
www.epa.gov/envirosense

Pay-As-You-Throw: Throw Away Less and Save
(EPA530-F-96-028)

Waste Prevention, Recycling, and Composting Options: Lessons From 30 Communities
(EPA530-R-92-015)

Other Selected Sources of Information

Some of the publications listed below might require an ordering fee.

Reuse It, Repair It, Rent It, Donate It—But Don't Throw It Away!
To order, contact:
New York City Department of Sanitation
Phone: 212 219-8090

Making Source Reduction and Reuse Work in Your Community
To order, contact:
National Recycling Coalition, Inc.
1727 King Street
Suite 105
Alexandria, VA 22314-2720
Phone: 703 683-9025

Making Less Garbage: A Planning Guide for Communities
Making Less Garbage on Campus: A Hands-On Guide
Reducing Office Paper Waste
To order, contact:
Inform, Inc.
120 Wall Street
New York, NY 10005-4001
Phone: 212 361-2400, Ext. 240

Source Reduction Now
How to implement a source reduction program at an organization.
To order, contact:
Minnesota Office of
Environmental Assistance
520 Lafayette Road
St. Paul, MN 55155
Phone: 651 215-0232

Weaving Textile Reuse into Waste Reduction
To order, contact:
Institute for Local Self-Reliance
2425 18th Street, NW.
Washington, DC 20009-2096
Phone: 202 232-4108

Selected Internet Resources

California Integrated Waste Management Board (CIWMB)
www.ciwmb.ca.gov

Indiana Institute on Recycling (IIR)
web.indstate.edu:80/recycle

INFORM
www.informinc.org/

National Pollution Prevention Roundtable
www.p2.org

National Waste Prevention Coalition (NWPC)
www.metrokc.gov/nwpc

Privacy Rights Clearinghouse's Reducing Junk Mail Fact Sheet
www.privacyrights.org/fs/fs4-junk.htm

The Solid Waste Association of North America (SWANA)
www.swana.org

National Reuse Organizations

Reuse organizations are points of contact for organizations interested in buying, selling, or donating excess material that would otherwise go to waste. Contact your state recycling agency for information about local and regional reuse organizations.

Reuse Development Organization, Inc.
P.O. Box 441363
Indianapolis, IN 46244
Phone: 317 631-5396
E-mail: info@redo.org
Internet: www.redo.org

Chicago Board of Trade Recyclables Exchange
141 West Jackson Boulevard
Chicago, IL 60604-2994
Phone: 312 435-7223
Internet: www.cbot-recycle.com

National Association for the Exchange of Industrial Resources
560 McClure Street
Galesburg, IL 61401
Phone: 800 562-0955
E-mail: donor.naier@misslink.net
Internet: www.freegoods.com/

ri-yōōz´

Reuse

Efficiency

ə-fish´ən-sē

Printed on paper that contains at least 30 percent postconsumer fiber.