Integrated Solid Waste Management of Scottsdale, Arizona

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A national laboratory of the U.S. Department of Energy
Managed by the Midwest Research Institute
for the U.S. Department of Energy
Under Contract No. DE-AC36-83CH10093

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Abstract

The subject document reports the results of an in-depth investigation of the fiscal year 1992 cost of the city of Scottsdale, Arizona, integrated municipal solid waste management (IMSWM) system, the energy consumed to operate the system, and the environmental performance requirements for each of the system's waste-processing and disposal facilities.

The document reports actual data from records kept by participants. Every effort was made to minimize the use of assumptions, and no attempt is made to interpret the data reported. Analytical approaches are documented so that interested analysts may perform manipulation or further analysis of the data. As such, the report is a reference document for municipal solid waste (MSW) management professionals who are interested in the actual costs and energy consumption, for a 1-year period, of an operating IMSWM system.

The report is organized into two main parts. The first part is the executive summary and case study portion of the report. The executive summary provides a basic description of the study area and selected economic and energy information. Within the case study are detailed descriptions of each component operating during the study period; the quantities of solid waste collected, processed, and marketed within the study boundaries; the cost of MSW in Scottsdale; an energy usage analysis; a review of federal, state, and local environmental requirement compliance; a reference section; and a glossary of terms.

The second part of the report focuses on a more detailed discourse on the above topics. In addition, the methodology used to determine the economic costs and energy consumption of the system components is found in the second portion of this report. The methodology created for this project will be helpful for those professionals who wish to break out the costs of their own integrated systems.

Other reports in the series include a synopsis of results and methodologies that presents the principal findings from the case studies and case studies of each of the six IMSWM systems evaluated in this program. In addition to the city of Scottsdale, Arizona, the following systems participated in the evaluation: Minneapolis/Hennepin County, Minnesota; Palm Beach County, Florida; Seattle, Washington; Sevierville, Tennessee; and Springfield, Massachusetts.

Key Words

Case study
Composting
Cost analysis
Energy analysis
Energy recovery
Environmental requirements: solid waste management
Integrated municipal solid waste management
Landfilling
Materials recovery
Municipal solid waste
Recycling
Resource recovery
Scottsdale, Arizona
Solid waste
SWANA
Waste-to-energy

Foreword

This case study report is one of six developed for the following integrated municipal solid waste management systems:

- Minneapolis (Hennepin County), Minnesota; NREL/TP430-20473
- Palm Beach County, Florida; NREL/TP430-8131
- Scottsdale, Arizona; NREL/TP430-7977
- Seattle, Washington; NREL/TP430-8129
- Sevierville, Tennessee; NREL/TP430-8136
- Springfield, Massachusetts; NREL/TP430-8137

All the reports, including a summary report (NREL/TP430-20471), are available through the National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado, 80401, or call (303)275-4363.

The authors are extremely grateful for the support and cooperation of the six systems managers and participants in those six systems. Without their assistance, this effort would not have been possible.

Funding for the conduct of the case studies and the development of the six reports was provided by the American Plastics Council and the United States Department of Energy's National Renewable Energy Laboratory.

In conducting the studies, the authors experienced considerable difficulty in gathering economic and energy information. In municipal solid waste management, no standard accounting methods exist. Further, local governments by tradition and practice maintain their financial records in a variety of ways to serve their own specific needs. The lack of a standard accounting procedure in the United States, and of standard definitions of solid waste, made the collection and analysis of the economic data a challenge. The methods for developing the cost information for this effort will be helpful to those with responsibilities for planning and implementing integrated municipal solid waste management systems. Also, the six sets of cost data will be useful for guiding other systems managers in their planning, cost accounting, and measuring of performance.

The development of the energy information represents a major step forward in analyzing integrated municipal solid waste management systems. The information in the six studies and the analytical methodology will be extremely useful to integrated municipal solid waste management systems planners, decision makers, and managers in the future.

Finally, as might be expected, the environmental regulatory information is limited. Although landfill and combustion facilities are under well-defined regulations, other portions of integrated municipal solid waste systems are not. The end result of these limitations is that the information presented on conformance with environmental requirements is sketchy for systems that do not include combustion.

A final caution to the readers of these reports is to not attempt to try to compare one system against the other. The authors **deliberately** did not do so for the very sound reason that it is ill-advised to attempt to compare systems that:

- are geographically different,
- are politically different,
- are structurally different in providing municipal solid waste services,

- are at different stages of development, and
- face different regulatory requirements.

Rather, readers of these reports are encouraged to examine and analyze (using the techniques and analytical methods of the six studies) their own geographical, political, structure, stage of development, and regulatory status and then assess those findings against six other sets of data to see how they can best make the best decisions for their systems.

ACKNOWLEDGEMENTS

SWANA is especially grateful for the assistance and support of many individuals and organizations who contributed information for this Scottsdale Case Study. From the City of Scottsdale: Pete Chavez, Sanitation Director; Rick Pence, Sanitation Manager; Rudy Martinez, Fleet Management Director; Randy Grant, Chief Environmental Officer; Daryl Everhart, Municipal Services Operations Assistant; Barbara Gatlin, Loss Control Manager; and Nancy Swick, Judy Frost, and Terry Sassone. In addition, John Shufflebean, Director, Solid Waste Management Department, Maricopa County; and Michael Greenslade, Arizona Department of Environmental Quality. Also, individuals from EMCO Recycling (Barry Fleet), Disposal Control Services, Inc. (Michael Gingerella), and Copper State Metals, Inc.

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Executive Summary

This executive summary provides a short review of the key findings of the Scottsdale case study. Readers are advised to read the *condensed* Scottsdale case study to fully understand how the economic, energy, and environmental results were developed. In addition, all data collected and analyzed during this study are available in the *in-depth* Scottsdale case study, with Appendices A through D.

Each integrated municipal solid waste management (MSWM) system is unique due to geography, climate, customs, politics, and time. However, readers may benefit from the findings of this study *and* the study techniques and methodology to develop actual economic, energy, and environmental facts about their own MSWM systems. Because each system is unique, readers are cautioned not to compare the findings of this particular study with other systems.

Background

Scottsdale, Arizona (the "city"), is located in Maricopa County just east of Phoenix, the state capital, and north of Tempe. The mid-1992 population is estimated at 137,590. There were approximately 72,330 housing units in Scottsdale, of which approximately 42,470 were single-family homes.

Scottsdale encompasses an area of approximately 185 square miles; 18% is residential, 4% is industrial or commercial, and 78% is undeveloped/agricultural. Most of the undeveloped land lies in the northern two-thirds of the city, and the population is concentrated in the lower third of the land area.

During fiscal year (FY) 1992, which extended from July 1, 1991, through June 30, 1992, about 115,000 tons of municipal solid waste (MSW) were managed by the city's Sanitation Division or delivered directly to the Tri-City Landfill by residents of Scottsdale.

Overview of the Scottsdale MSWM System

The city's FY 1992 MSWM system consisted of the following integrated system components:

- Separate collection of garbage, brush/bulky waste, white goods, and move-in boxes by the city
- A city-sponsored, privately run annual household hazardous waste collection day
- A city-operated mobile trailer drop-off recycling program
- A stationary container drop-off program
- A city office paper recycling program
- Two privately owned and operated landfills, and one landfill owned and operated by the county.

The city's Sanitation Division collected MSW from approximately 41,750 homes in FY 1992, using primarily automated, side-loading collection vehicles. The Sanitation Division also provides, on a contract basis, commercial garbage collection services to multifamily homes, apartment houses, and businesses. The city competes for this business with private haulers.

Household hazardous waste (HHW) can be dropped off at the Corporation Yard, site of the city services offices. During FY 1992, the city contracted with Disposal Control Services, Inc., to manage and dispose of the HHW delivered to the site.

The city managed nine sites for its Mobile Recycling Program in FY 1992. There were more than 14,250 participants in the program that year. The city also places several dozen stationary containers for old newspaper and aluminum cans either on city-owned property or at apartment buildings and condominiums.

In FY 1992, most of the MSW collected by the city was delivered to and disposed of at the Tri-City Landfill, owned and operated by the Salt River Pima-Maricopa Indian Community.

Definitions

MSW is categorized in this case study as garbage, brush and bulky waste, recyclables, and HHW.

ANALYZED MSW—That portion of the total MSW stream for which the associated management net costs are known, or at a minimum, can be reasonably estimated. The reason for limiting the types of MSW included in Analyzed MSW is that only that portion of MSW should be included for which sufficient data were available to draw defensible conclusions regarding the allocation of cost to the tons of MSW managed. Consequently, the types of MSW included in Analyzed MSW will vary between IMSWM systems.

GARBAGE—Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.

BRUSH—In Scottsdale, brush is defined as leaves, twigs, palm skins and weed cuttings, tree limbs and shrubbery clippings not exceeding 3 feet in length.

RECYCLABLES—Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm, and can, therefore, be reused or recycled for the same or other purposes.

PROGRAM INCREMENTAL COSTS (OR SAVINGS)—Determined for MSW management components (or programs) of each IMSWM system by calculating the system cost of MSW management, first with the inclusion of a specific program, and then calculating the cost of MSW management without that program. Landfilling is considered the basic program that is not optional. Therefore, the Program Incremental Cost is the difference between the cost of managing MSW with the inclusion of a particular program and the cost of managing MSW without that program.

Key Findings

Discussion of Costs

Of the approximately 115,000 tons of solid waste managed within the city, about 112,000 tons were analyzed ("Analyzed MSW") to determine the cost of Scottsdale's IMSWM system. *The cost to manage the remaining 3000 tons of MSW is excluded because that MSW was self-hauled to one of the landfills.*

Overall Program Costs

The total FY 1992 cost to manage 112,000 tons of Analyzed MSW was \$6.6 million, or about \$59 per ton. This total cost breaks down to, in rounded numbers:

Table ES-1. Cost of Program Elements

Category	Tonnage	Total Cost	Total Cost Per Ton
Residential Garbage	58,600	\$3.71 million	\$63
Commercial Garbage	44,800	\$1.86 million	\$41
Brush and Bulky Waste	7,970	\$0.86 million	\$108
Recyclables	820	\$0.15 million	\$182
TOTAL	112,190	\$6.61 million	\$59

Collection accounts for 62% of the total cost of the Scottsdale system, general and administrative (G&A) expense is 25%, and landfill is 14% of the total cost.

Program Incremental Costs

The incremental cost for each of the resource recovery programs, i.e., the cost (or savings) associated with *adding* the resource recovery program to the IMSWM system, is the difference between the cost of managing all the MSW with the inclusion of a particular program and the cost of managing all the MSW without that program. The program incremental cost (or savings) is, therefore, a measure of the impact of any particular program on the cost of managing all MSW. A major objective of this case study was to clarify the differences between the average cost per ton and the actual incremental cost. The methodology for calculating incremental costs is described in the in-depth Scottsdale case study and Appendices.

The FY 1992 program incremental cost (or savings) of each of the resource recovery programs was, in rounded numbers:

Table ES-2. Incremental Cost of Program Elements

Program	Tonnage	Incremental Cost (Savings)	
		Dollars	\$ Per Ton
Mobile Trailer	401	\$69,400	\$173
Move-In Box	58	\$500	\$9
White Goods	55	\$500	\$9
Stationary Container	279	\$2,400	\$9
Office Wastepaper	30	(\$900)	(\$30)

These numbers exclude the state of Arizona's landfill/recycling fee (\$0.25 per ton), which would skew the results by overstating the cost contribution of each program. In addition to the incremental cost or savings that can be attributed to each of the resource recovery programs, each of them contributes materials to the economy and reduces the use of available landfill space.

Energy Usage Analysis

The primary forms of energy used within Scottsdale's IMSWM system are transportation fuels for collection, haul to market, and facility vehicles. Energy consumed in the use of recovered materials to make new products is excluded because it is beyond the IMSWM boundary. However, because many manufacturing processes that use recovered materials use less energy than do virgin material processes (especially aluminum recycling), this exclusion may understate the overall energy efficiency of recycling. This case study did not attempt to consider all aspects of the life cycle of products in the MSW stream; other studies may take these aspects into consideration.

Data on energy consumption for the Scottsdale IMSWM system were analyzed, yielding estimates for the equivalent diesel gallons per ton shown in Table 3.

Environmental Regulatory Framework

Environmental regulations for the elements of an IMSWM system are directed primarily at the facilities that serve such a system. For the most part, these facilities will be one or more of the following:

- Transfer station
- Materials recovery facility
- Compost facility
- Waste-to-energy facility
- Sanitary landfill.

Table ES-3. Energy Consumed to Manage Garbage, Brush, and Recyclables
(equivalent gallons/ton)

Activity	Residential Garbage	Commercial Garbage	Brush	Recyclables
Sanitation Collection Vehicles	2.1	1.3	2.2	2.9
Individuals' Cars and Trucks				4.2
Container Repair & Misc. Fleet	<0.1	<0.1	<0.1	<0.1
Landfills	0.4	0.4	0.4	
Total Fuel Equivalent (gallons/ton)	2.5	1.8	2.7	7.2
Total Fuel Equivalent (Btu/ton)	370,000	256,500	390,200	1,049,600

Notes:

1. Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.
2. Btu content of diesel fuel is 146,390 Btu per gallon.
3. Based on 58,568 tons of residential garbage, 44,775 tons of commercial garbage, 7,868 tons of brush, and 793 tons of recyclables.

In the state of Arizona, the authority for regulating solid waste management and protecting against negative environmental consequences of such management activities is granted within the Arizona Solid Waste Management Law (Arizona Revised Statutes, Title 49, Chapter 4, as amended). The law is administered by the Department of Environmental Quality (DEQ). The law authorizes DEQ to "define and prescribe reasonably necessary rules regarding storage, collection, transportation, disposal, and reclamation of garbage, trash, rubbish, manure, and objectionable wastes." The rules and regulations for the management of MSW are provided in the Arizona Administrative Code. The Tri-City Landfill, located on Indian land, is regulated by the federal government.

The law delegates responsibility for solid waste management to counties, cities, and towns and authorizes these local jurisdictions to collect MSW and to own or operate MSW management facilities, or contract for such services. Municipalities with populations of more than 60,000 cannot prohibit private firms from providing solid waste management services to commercial and industrial establishments, but can prescribe local regulations for such activities. The city has enacted regulations for the licensing of commercial or industrial solid waste and recycling services.

Landfill Disposal Regulations

Because of Arizona's arid climate, the state's relatively lax landfill regulations, and the age of the landfills used by the city in FY 1992, none of the landfills used was constructed with liners, and no routine groundwater or methane gas monitoring was required. There was no requirement to plan and provide financial security for the closure of landfills or any postclosure maintenance. Generally, the only environmental control requirement imposed on the landfills was for daily cover.

However, Arizona has recently modified its solid waste regulatory requirements, generally incorporating RCRA Subtitle D regulations. These requirements did not, however, apply in FY 1992 to the landfills used by the city.

Recycling Regulations

There are no specific regulatory requirements for processing and marketing of recyclables. State law requires residential and commercial garbage containing putrescible materials to be collected at least twice a week. A special exemption can be obtained if a community wishes to substitute one residential collection for a recyclables collection.

The Arizona Solid Waste Recycling Act of 1990 (Recycling Act) prescribes a statewide program to support recycling. The Recycling Act requires that all counties, cities, and towns provide "residents with an opportunity to engage in recycling and waste reduction." The recycling programs implemented by the city comply with this requirement. Proceeds from a \$0.25-per-ton landfill disposal fee are deposited in a Recycling Fund, and proceeds from the fund are used for statewide programs in support of recycling and source reduction.

Introduction to Condensed Report

Scottsdale, Arizona (the "city"), is located in Maricopa County just east of Phoenix, the state capital, and north of Tempe, as shown in Figures 1 and 2. The city was incorporated in June 1951. The Scottsdale population grew from 2032 people in 1950 to 130,069 in 1990. The mid-1992 population was estimated to have been about 137,590 people. This population is projected to grow at about a 5% annual rate from 1992 to 1997. As of June 1992, there were about 72,330 housing units in Scottsdale, of which approximately 42,470 were single-family homes.

Scottsdale encompasses an area of approximately 185.2 square miles. Of this area, 17.9% is residential, 3.8% is industrial or commercial, and 78.3% is undeveloped/agricultural. Because most of this undeveloped/agricultural land lies in the northern two-thirds of the city, the population is concentrated in the lower third of the land area.

During fiscal year (FY) 1992, which extended from July 1, 1991, through June 30, 1992, about 115,000 tons of municipal solid waste (MSW) were managed by the city's Sanitation Division or delivered directly to the Tri-City Landfill by residents of Scottsdale.

The City's Integrated MSW Management System

System Overview

The city's FY 1992 integrated municipal solid waste management (IMSWM) system consisted of the following system components:

- Separate collection of garbage, brush/bulky waste, white goods, and move-in boxes by the city
- A city-sponsored, privately run annual household hazardous waste (HHW) collection day
- A city-operated mobile trailer drop-off recycling program
- A stationary container drop-off program
- A city office paper recycling program
- Two privately owned and operated landfills, and one county-owned and operated landfill.

MSW is categorized in this report to include garbage, brush and bulky waste, recyclables, and HHW.

FIGURE 1 MAP OF ARIZONA

Figure 1. Map of Arizona

FIGURE -2: MAP OF SCOTTSDALE, ARIZONA

Figure 2. Map of Scottsdale, Arizona

City Of Scottsdale
 Scottsdale, Arizona
 and neighboring communities

System Component Summary Descriptions

Collection

The city's Sanitation Division is responsible for collecting garbage from all single-family homes. An average of 41,750 homes was served during FY 1992. Collection of garbage from most single-family homes is accomplished with automated, side-loading collection vehicles. Each vehicle is equipped with a barrel snatcher and operated by a single driver.

In FY 1992, about 68% of Scottsdale residents placed their garbage into 80-gallon, rollout, plastic containers and received automated street pickup collection. Homeowners living in many of the city's older neighborhoods, where service alleys separate individual blocks of homes, share 300-gallon plastic containers. About 27% of single-family homes use these 300-gallon containers, with an average 3.2 homes sharing each container. The balance, or about 5%, of homeowners live in areas that are not readily accessible by the automated collection vehicles, thus necessitating manual collection using single-person crews. In these areas homeowners place their garbage into typical garbage containers or plastic bags.

The city also collects brush and bulky waste from all single-family homes, using rear-loading packer trucks. Each truck has a two-person crew. Households receive brush/bulky waste collection service once every four weeks.

Once a week a brush-collection vehicle and crew are used to collect "move-in" boxes (i.e., corrugated cardboard boxes used for moving into new homes), which are then recycled. Similarly, a brush-collection vehicle and crew are used about every other week to collect white goods for recycling.

The Sanitation Division also provides, on a contract basis, commercial garbage collection services to multifamily homes, apartment houses, and businesses. The city must compete for this business with private haulers. The city supplies 2- to 8-yard containers or 20- to 40-yard roll-offs, depending on the service requested. Collection can occur from 1 to 6 days a week. Multifamily homes and apartments, restaurants, and other commercial accounts that dispose of putrescible waste must receive at least twice-a-week collection, in accordance with state health regulations.

All of the 80- and 300-gallon containers used in the automated collection program are owned by the city. When the program began, the city purchased the containers and distributed them to the existing homes. Developers of new homes are responsible for "purchasing" a container from the city with each home they sell; however, ownership of these containers is vested in the city and remains with the house. The city repairs and maintains the containers and provides replacement containers when necessary. Similarly, the city owns and maintains all of the containers and roll-offs used to collect commercial garbage.

Household Hazardous Waste

The Corporation Yard, the site of the city services offices, including the Sanitation Division and its vehicle storage yard and maintenance shop, is the drop-off site for HHW because it is permitted for the storage and handling of certain hazardous or specially managed wastes (e.g., used oil, antifreeze). The materials collected are classified as waste oil, antifreeze, flammable liquid, flammable aerosol, flammable poisons, flammable solids, mercury metallic, paint related, corrosive liquid, corrosive solid, oxidizer solid, poison liquid, poison solid, and non-RCRA hazardous. In FY 1992, the city entered into a 1-year contract with Disposal Control Services, Inc., a subsidiary of Laidlaw, to handle the HHW delivered to the site and arrange for its disposition. The city is responsible for promoting the program and overseeing its operation.

Mobile Recycling Program

The city instituted its Mobile Recycling Trailer Program (Mobile Recycling) in October 1989 with a single trailer to collect aluminum cans, newspaper (no magazines or phone books), and glass jars and bottles from Scottsdale residents. In September 1990, a second trailer was added. Each mobile unit consists of a truck and trailer. Each trailer has three 4-cubic-yard containers and is equipped with a roof and a retractable canopy. One of the containers is divided into two sections—one section for brown glass, the other for green glass. The other two containers are used to store clear glass and aluminum, respectively. One trailer is towed by a dump truck and the other by a boom truck. Newspapers are loaded directly into the dump truck or into two 8-cubic-yard containers placed on the boom truck.

The nine sites used for the Mobile Recycling Program in FY 1992 are shown in Figure 3. Each mobile unit visits one site on Saturday and another on Sunday; thus, four sites are covered each weekend. Sites with higher participation rates are covered more frequently than others. Residents bring recyclables to these sites between 8 a.m. and 3 p.m. Each load is inspected, weighed, and sorted by a Sanitation Division employee, thus ensuring that high-quality materials are collected. At the end of the day, each site is cleaned, and the materials collected are delivered to the city's Corporation Yard, where they are unloaded and prepared for shipment to markets. After each weekend, the collected newspaper and aluminum are shipped to recycling dealers. Glass is transferred to other containers and stored at the Corporation Yard. Once a truckload has been collected, it is shipped to markets and recycling dealers.

In FY 1992, there were more than 14,250 participants¹ in the Mobile Recycling Program. This represents an increase of almost 75% over the number of participants in FY 1991. To encourage participation, the city has instituted an incentive program whereby residents can win U.S. Savings Bonds. On a monthly basis, the individual who brings in the most weight of each of the three materials collected (i.e., aluminum cans, newspaper, and glass) is awarded a \$100 savings bond. The individual who brings in the most combined weight of all three materials is awarded a \$200 savings bond. On an annual basis, the individual who brings in the most combined weight of all three materials wins a \$1,000 savings bond.

Other Recycling Programs

In addition to the Mobile Recycling Program, the city also collects newspaper and aluminum cans through its stationary container program. Separate containers are used for newspaper and aluminum cans. In FY 1992, there were 59 300-gallon and 13 80-gallon stationary containers located on city-owned property or at apartment buildings and condominiums. The use of stationary containers for recyclables at apartment and condominium complexes is included in the commercial service provided to these establishments.

Every Friday an automated residential truck picks up the recyclables and delivers them to local recycling dealers—newspapers to Sunbelt Recycling, Inc., and aluminum to Empire Metal Limited. Both recycling dealers are located in Tempe.

In FY 1992, the city also had an office wastepaper recycling program in four city buildings. White paper, computer paper, and colored paper were collected in separate, centrally located containers within each office building. The material collected was picked up by the Friedman Recycling Company on an on-call basis.

¹ A participant is an individual who delivers recyclables to any site on a given day. If the same individual delivers materials on another day, he or she is counted again.

FIGURE 3: LOCATION OF MOBILE RECYCLING DROP-OFF SITES IN FY92

1. Cactus Park, Cactus/Scottsdale Road
2. Chaparral Park, Hayden/Jackrabbit
3. Eldorado Park, Miller/Oak
4. McCormick Railroad Park, Indian Bend/Scottsdale Road
5. Mountain View Park, Mountain View/85th Street
6. Pinnacle Peak General Store, Pina/Pinnacle Peak
7. Price Club, Hayden/83rd Place
8. Scottsdale Ranch, 102/Via Linda
9. Thunderbird Park, Thunderbird/92nd Street

City of Scottsdale
Scottsdale, Arizona

Figure 3. Location of mobile recycling drop-off sites in FY 1992

Landfill Disposal

In FY 1992, most of the garbage, brush, and bulky waste collected by the city was delivered to and disposed of at the Tri-City Landfill, which is owned and operated by the Salt River Pima-Maricopa Indian Community. Small quantities of garbage, brush, and bulky waste were disposed of at Maricopa County's Cave Creek Landfill. In addition, some brush and bulky waste were disposed of at Sanifill's Lone Cactus brush landfill. Residents of Scottsdale could also deliver MSW directly to the Tri-City Landfill. The cost of disposal of such self-hauled MSW was paid for by the city. The locations of these and other solid waste management facilities located in the Phoenix metropolitan area are provided in Figure 4.

MSW Collected, Processed, and/or Disposed of in Scottsdale

Of the approximately 115,000 tons of MSW processed or disposed of by the city in FY 1992, about 92.4% was garbage, 6.8% was brush and bulky waste, 0.7% was recyclables, and less than 0.1% was HHW. Table 1 summarizes the tonnage collected, processed, and/or disposed of by the city during FY 1992. This tonnage does not include garbage, brush, bulky waste, and recyclables collected from apartment houses, condominiums, and business establishments that contracted with private haulers to collect, process, and/or dispose of their MSW. A waste flow and resource recovery diagram of the waste stream processed through the city's IMSWM System in FY 1992 is depicted in Figure 5.

Garbage Collection and Disposal

A total of 106,315 tons of garbage was collected and/or disposed of in FY 1992. About 97% of this garbage, or 103,343 tons, was collected by the city. The balance, 2,972 tons, was delivered to the Tri-City Landfill by residents.

Of the garbage collected by the city, 57,285 tons of single-family residential garbage were collected using automated collection vehicles, and 1283 tons were collected using manual equipment. The city also collected 44,775 tons of commercial garbage from apartment houses, condominiums, and business establishments. Almost 86% of this commercial garbage was collected using 2- to 8-cubic-yard containers and front-end loaders. The balance was collected in roll-off containers.

Collection and Disposal of Brush and Bulky Waste

In FY 1992, the city collected 7868 tons of brush and bulky waste. No accounting was made to determine the mix of brush and bulky waste collected. About 93.2% of this brush and bulky waste was delivered to the Tri-City Landfill for disposal. The balance, 6.8%, was disposed of at the Sanifill Landfill.

Collection and Disposition of Recyclables

The city collected approximately 823 tons of recyclables from four different programs: the Mobile Recycling Trailer Program, the white goods and move-in box collection program, the stationary container program, and the city high-grade office paper program.

FIGURE 4 : LOCATION OF MUNICIPAL SOLID WASTE MANAGEMENT FACILITIES

Figure 4. Location of municipal solid waste management facilities

Table 1. MSW Collected, Processed, and/or Disposed of in Scottsdale in FY 1992*

Waste Type	Percent	Tons
Garbage		
Residential-Automated Collection	49.8	57,285
Residential-Manual Collection	1.1	1,283
Commercial	38.9	44,775
Self-Haul to Landfill	<u>2.6</u>	<u>2,972</u>
Subtotal Garbage	92.4	106,315
Brush and Bulky Waste	6.8	7,868
Recyclables		
Mobile Recycling Trailers	0.3	401
White Goods & Move-In Boxes	0.1	113
Stationary Containers	0.2	279
City Office Papers	<u>0.0</u>	<u>30</u>
Subtotal Recyclables	0.7	823
Household Hazardous Waste	0.0	11
Totals	100.0	115,017

*This table does not include all of the garbage, brush, and recyclables collected, processed, and disposed of by commercial and business establishments. Therefore, the data in this table do not provide a complete account of MSW generation and recycling activities.

**FIGURE 5: WASTE FLOW AND RESOURCE RECOVERY DIAGRAM -
SCOTTSDALE, ARIZONA (FY92 Tons)**

Figure 5. Waste flow and resource recovery diagram—Scottsdale, Arizona (FY 1992 Tons)

In FY 1992, the Mobile Recycling Program collected 401 tons of recyclables. Of this, 204 tons (51%) were newspaper, 185 tons (46%) were glass, and 12 tons (3%) were aluminum. More than 55 tons of white goods and 58 tons of move-in boxes were collected by the city. An additional 279 tons of newspaper and aluminum cans were collected from the stationary container program. The majority of this material was collected from apartment buildings and condominiums that asked to participate in the city's recycling program. The city also recovered about 30 tons of high-grade office paper, computer paper, and colored paper from the four city office buildings.

The breakdown of revenues earned in FY 1992 from each of these materials in each of these four programs is shown in Figure 6. The markets for these materials, their locations, and their end-uses are provided in Table 2.

Collection and Disposition of HHW

The types and amounts of HHW materials collected, and their disposition, are provided in Table 3. Almost 35% of the material collected was paint related, and another 34% was flammable liquids (27.4% nonpoisonous and 6.2% poisonous), including paint thinners and solvents. Non-Resource Conservation and Recovery Act (RCRA) hazardous waste materials and used oil made up another 11% and 5.3%, respectively, of the material collected. In total, these four classes of materials represented almost 85% of the HHW collected.

FIGURE 6: REVENUES RECEIVED FOR RECOVERED MATERIALS IN FY92

Recycling Program

Figure 6. Revenues received for recovered materials in FY 1992

Newspaper, Glass, and Aluminum Collected in Mobile Recycling Program
Newspaper and Aluminum Collected in Stationary Recycling Program

Table 2. Markets for Recovered Materials Sold in FY 1992

Recovered Materials	Tonnage Sold	Vendor/ Location	Distance to Remanufacturer*	Mode of Transport	Remanufacture Use	Comments
Aluminum	17	Emco Recycling (formerly Empire Metal) (Phoenix, AZ)	300-1000	Transfer truck	Can sheet Window frames Automotive parts	
Glass						
Flint	47	Todd & Assoc. (Yorba Linda, CA)	500 (ultimate destination: West Coast and Mexico)	Transfer trailer	Furnace-ready cullet Fiberglass bldg. material Glassphalt	Out of business- unable to contact
Amber	<u>7</u>	Sunbelt Recycling				
Subtotal	54					
Paper						
Corrugated (move-in boxes)	58	Sunbelt Recycling	360 (ultimate destination: California and China/Korea)	Transfer trailer/rail	Writing paper (white) Facial and toilet tissue (colored)	Out of business
Newspaper	437	Sunbelt Recycling				
Office Paper (white and colored)	<u>30</u>	Friedman Recycling (Phoenix, AZ)				
Subtotal	525					
White Goods	55					
Total	651					

*Because of requests not to specify remanufacturers, vendor's estimates of distances traveled cannot be verified. Distances given are for intra-U.S. travel only.

Table 3. Collection and Disposition of HHW in FY 1992

Types of HHW	Size of Containers (gallons)	Number of Containers	Tons	Percent	Disposition
Corrosive Liquid—Acid (Lab Pack)	55	1	0.11	1.0	Treated
Corrosive Liquid—Alkaline (Lab Pack)	55	2	0.22	2.0	Treated
Corrosive Solid—Acid (Lab Pack)	55	1	0.11	1.0	Treated
Corrosive Solid—Alkaline (Lab Pack)	55	1	<u>0.11</u>	<u>1.0</u>	Treated
Subtotal			0.55	5.1	
Non-RCRA Hazardous Waste Material	55	11	1.21	11.2	Landfilled
Flammable Liquid—Aerosol	55	3	0.41	3.8	Incinerated
Flammable Liquid—Poisonous Aerosol	14	1	0.05	0.5	Incinerated
Flammable Liquid—Poisonous (Lab Pack)	30	9	0.68	6.3	Incinerated
Oxidizer Solid (Lab Pack)	55	1	0.11	1.0	Incinerated
Poison B Liquid (Lab Pack)	5	1	0.01	0.1	Incinerated
Poison B Solid (Lab Pack)	30	2	<u>0.15</u>	<u>1.4</u>	
Subtotal			1.41	13.0	
Antifreeze	-	35 gallons	0.14	1.3	Recycled
Flammable Liquid (Lab Pack)	55	27	2.97	27.4	Recycled
Flammable Solid (Lab Pack)	55	2	0.22	2.0	Recycled
Mercury Metallic	5	1	0.01	0.1	Recycled
Paint-Related Material	264	3	3.75	34.6	Recycled
Used Oil	-	155 gallons	<u>0.58</u>	<u>5.4</u>	Recycled
Subtotal			7.67	70.8	
Totals			10.84	100.0	

SOURCE: Letter from Daniel Degrade to Pete Chavez, Disposal Control Services, Inc., December 4, 1991, and telephone conversation with Mike Ginerella, Disposal Control Services, Inc.

COST OF MSW MANAGEMENT IN SCOTTSDALE

Summary Of Results

The expenses incurred and revenues received by the MSW management enterprise fund of the city's Sanitation Division (including adjustments made as part of this study) resulted in a net cost of approximately \$6.7 million in FY 1992. This was the net cost incurred in managing about 115,000 tons of MSW. The elements of this cost are shown in Table 4.

Overall Program Costs to Manage Analyzed MSW

Of the approximately 115,000 tons of MSW managed within the city, about 112,000 tons were analyzed (Analyzed MSW) to determine the cost of Scottsdale's IMWSM System. The cost to manage the remaining MSW is excluded, because that MSW was self-hauled to one of the landfills. The cost to manage the HHW is treated separately.

The total FY 1992 net cost to manage the approximately 112,000 tons of Analyzed MSW was about \$6.6 million, or \$59 per ton. This net cost breaks down to, in rounded numbers:

CATEGORY	TONNAGE (tons)	NET COST (\$ millions)	NET COST PER TON
Residential Garbage	58,600	\$3.71	\$63
Commercial Garbage	44,800	\$1.86	\$41
Brush and Bulky Waste	7,970	\$0.86	\$109
Recyclables	820	\$0.18	\$182
TOTAL/AVERAGE	112,190	\$6.61	\$59

Figures 7a through 7c depict these results graphically. The primary factor contributing to the differences among the per-ton costs is the cost of collection relative to the other key cost elements (i.e., G&A expenses, landfill fees, and promotional expenses).

The cost of managing the 11 tons of HHW, which was analyzed separately from the other components of the MSW stream, was about \$53,300, or more than \$4,800 per ton.

As shown in Figure 8, collection costs are the most significant factor in the total of the Scottsdale IMWSM System, accounting for about 62% of the total cost. Figure 9 shows the allocation of costs to each of the key functional areas (i.e., collection, G&A, landfill, and promotion) for each of the program areas. Note that, in all cases, collection costs account for well over half of the total costs. The cost allocation for managing recyclables is presented without the inclusion of the \$0.25/ton state-imposed landfill fee, which is used to support recycling. Without this fee, collection costs account for about 70% of the total net costs of the recycling program, compared to an average of about 60% for managing residential and commercial garbage.

Table 4. Statement of Expenses
Year Ending June 30, 1992

Category	Reported Costs	Adjusted Costs
<u>Sanitation Expenses</u>		
Salary and Wages	\$1,881,031	\$1,881,031
Landfill Expenses	933,970	933,970
HHW Contract Services	33,329	33,329
Other Contractual Services	<u>41,143</u>	<u>41,623</u>
Subtotal	1,008,442	1,008,922
Fleet Services	1,901,460	1,917,327
Property & Liability Insurance	<u>137,544</u>	<u>137,544</u>
Subtotal	2,039,004	2,054,871
Supplies & Equipment	200,906	76,245
Capital Outlays (Sanitation Only)	45,201	0
Capital Costs (Sanitation Only)	<u> </u>	<u>343,611</u>
Total Sanitation	5,174,584	5,364,680
<u>Other Indirect Expenses</u>		
City General & Administration	1,019,497	1,138,849
Customer Services	<u>193,204</u>	<u>187,297</u>
Subtotal	1,212,701	1,326,146
Recyclables Drop-Off (Gas and Oil)	<u>0</u>	<u>6,880</u>
Total Other Costs	1,212,701	1,333,026
Total Cost in FY 1992	\$6,387,285	\$6,697,706

SOURCES: City of Scottsdale, "Budget Worksheet," Computer Printout, March 18, 1993, and City of Scottsdale, "1963-1994 Budget Summary and City of Scottsdale, "Sanitation Fund Summary 1993-1994."

FIGURE 7a
PROGRAM COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(tons)

Figure 7a. Program costs for the IMSWM system (analyzed MSW)
(tons)

FIGURE 7b
PROGRAMS COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(\$ millions)

Figure 7b. Program costs for the IMSWM system (analyzed MSW)
(\$ millions)

FIGURE 7c
PROGRAM COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(\$/ton)

Figure 7c. Program costs for the IMSWM system (analyzed MSW)
(\$/ton)

Gross Cost is \$6,620,000

Total Revenue is \$13,500

Figure 8. Allocation of total costs for IMSWM system in FY 1992

Allocation by Functional Area
(Cost to Manage 112,000 Tons of Analyzed MSW)

FIGURE 9 **ALLOCATION OF THE COSTS TO MANAGE MSW IN SCOTTSDALE** **(Allocation by Function Area)**

RESIDENTIAL GARBAGE

COMMERCIAL GARBAGE

RECYCLABLES (Without Landfill Fee)

BRUSH

HHW

TOTAL MSW

Figure 9. Allocation of the costs to manage MSW in Scottsdale
 (Allocation by Function Area)

Program Incremental Costs

Scottsdale's IMSWM System recycling program is comprised of mobile trailer, office wastepaper, move-in-box, white goods, and stationary container recycling programs. Together, these programs generated about \$13,500 in revenues in FY 1992 from the sale of recovered recyclables. The breakdown of these revenues was, in order of contribution:

- Mobile Recycling \$8,688
- Stationary Containers \$2,099
- Move-In Boxes \$1,129
- Office Wastepaper \$ 728
- White Goods \$ 329

This breakdown of the revenues from the recycling programs is depicted graphically in Figure 10.

The incremental cost for each recycling program, i.e., the cost (or savings) associated with adding the program to the IMSWM System, is the difference between the cost of managing all of the MSW with the inclusion of a particular program and the cost of managing all of the MSW without that program. The Program Incremental Cost (or Savings) is, therefore, an appropriate measure of the impact of any particular program on the cost of managing MSW. The FY 1992 Program Incremental Cost (or Savings) for each of the city's recycling programs was, in rounded numbers:

Program	Tonnage of Recyclables	Incremental Cost (Savings)	
		Dollars	\$ Per Ton
Mobile Trailer	401	69,400	173
Office Wastepaper	30	(900)	(30)
Move-In Box	58	500	9
White Goods	55	500	9
Stationary Container	279	2,400	9

These numbers exclude the State of Arizona's landfill/recycling fee, which would skew the results by overstating the cost contribution of each program.

In addition to the incremental cost or savings that can be attributed to each of the recycling programs, each of them contributes materials to the economy and reduces the use of available landfill space. These attributes are summarized in Table 5.

FIGURE 10: REVENUES RECEIVED FOR RECOVERED MATERIALS IN FY92

Figure 10. Revenues received for recovered materials in FY 1992

Newspaper, Glass, and Aluminum Collected in Mobile Recycling Program
Newspaper and Aluminum Collected in Stationary Recycling Program

Table 5. Incremental Cost and Resource Contribution of Resource Recovery Programs in Scottsdale, AZ (FY 1992)

Resource Recovery Program	Tons Managed	Total Incremental Cost (Savings)	Average Incremental Cost (Savings)	Resource Conservation	
				Materials Recovered (tons)	Landfill Volume Reduction (cubic yards)
Mobile Drop-Off Recycling	401	\$69,400	\$173/Ton \$93/Cu Yd	204 Paper	469
				185 Glass	236
				<u>12 Alum.</u>	<u>42</u>
				401	748
Office Paper Recycling	30	(\$900)	(\$30)/Ton (\$13)/Cu Yd	30 Office Paper	69
Move-in-Box Recycling	58	\$500	\$9/Ton \$4/Cu Yd	58 Corrugated cardboard	133
White Goods Recycling	47	\$500	\$11/Ton \$8/Cu Yd	47 Metal/Plastic	64
Multi-family Household Stationary Container Drop-Off Recycling	279	\$2,400	\$9/Ton \$4/Cu Yd	279 Paper & Aluminum	575

ENERGY USAGE ANALYSIS

The primary forms of energy used within Scottsdale's IMSWM System are the fuels (gasoline and diesel) consumed by the collection vehicles. Fuel is also consumed by the heavy equipment at the landfills, container repair vehicles, and fleet automobiles and trucks. In addition, gasoline is consumed by the vehicles of individuals transporting their recyclables to the mobile drop-off sites.

Summary of Results

In FY 1992, the Scottsdale IMSWM System configuration resulted in the consumption of the equivalent of more than 201,000 gallons of diesel fuel. About 97% of this energy consumption was for the collection of residential and commercial garbage, and brush and bulky waste, which together account for about 99.3% of the MSW managed. As shown in Table 6, there was a significant difference between the per-ton energy consumption for garbage and brush collection (about 2 gallons per ton) and the per-ton consumption for collecting and delivering recyclables (about 7 gallons per ton). This difference is primarily caused by the fuel consumed by individuals who delivered their recyclables to the mobile drop-off trailers.

The contribution of each of Scottsdale's recycling programs to energy consumption within the IMSWM System is presented in Table 7. These data clearly show that the energy consumed by the vehicles of participants in the mobile recycling program is the largest single contributor to the comparatively high amounts of energy consumed for recycling in Scottsdale.

Environmental Regulations and Permitting Requirements

The costs of compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this case study. As of FY 1992, none of the components of Scottsdale's IMSWM System were out of compliance with any federal, state, or local environmental or safety laws or regulations.

Overview of Relevant Federal Environmental Legislation and Regulations

Embodied in many federal environmental laws that apply to solid waste management is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions, including toxic air pollutants. The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution. The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants. The Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992, is the main piece of federal legislation addressing landfill disposal regulation.

In that Scottsdale's IMSWM system does not include MSW combustion, the Clean Air Act did not apply to the facilities comprising the System.

Table 6. Energy Consumed to Managed Garbage, Brush, and Recyclables
(equivalent gallons/ton)

Activity	Residential Garbage	Commercial Garbage	Brush	Recyclables
Sanitation Collection Vehicles	2.1	1.3	2.2	2.9
Individual's Cars and Trucks				4.2
Container Repair & Misc. Fleet	<.1	<.1	<.1	<.1
Landfills	0.4	0.4	0.4	
Total Fuel Equivalent (gallons/ton)	2.5	1.8	2.7	7.2
Total Fuel Equivalent (Btu/ton)	370,000	256,500	390,200	1,049,600

NOTES:

1. Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.
2. Btu content of diesel fuel is 146,390 Btu per gallon.
3. Based on 58,568 tons of residential garbage, 44,775 tons of commercial garbage, 7,868 tons of brush, and 793 tons of recyclables.

Table 7. Energy Consumption for Recycling Programs in Scottsdale (FY 1992)

Recycling Program	Eq. gal	Tons	Gal/Ton
Mobile Recycling			
Sanitation Tractors & Trailers	1,088	401	2.7
Participant Vehicles	3,335	401	8.3
Total	4,423	802	11.0
Stationary Containers	711	279	2.5
Move-In Boxes	357	58	6.2
White Goods	179	55	3.3

NOTE: Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits—"best practicable control technology" and "best available technology."

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements and develop adequate procedures for enforcement.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment. The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater.

Subtitle D of RCRA primarily addresses nonhazardous waste. In October 1991, the Environmental Protection Agency promulgated revised Subtitle D regulations applicable to municipal solid waste landfills, with an effective date of October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.²

²On October 1, 1993, the federal criteria for municipal solid waste (MSW) landfills under subtitle D of RCRA were amended to extend the date of compliance for small landfills to April 9, 1994. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for 2 years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. (*Federal Register*, "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," Vol. 58, No. 189, pages 51536-51548, 1993.)

Overview of State and Local Environmental Regulations

Municipal solid waste management is regulated in accordance with the Arizona Solid Waste Management Law (Arizona Revised Statutes, Title 49, Chapter 4, as amended). This law is administered by the Department of Environmental Quality (DEQ). The state's Solid Waste Management Law authorizes the DEQ to "define and prescribe reasonably necessary rules regarding storage, collection, transportation, disposal and reclamation of garbage, trash, rubbish, manure and objectionable wastes." The rules and regulations for the management of MSW are provided in the Arizona Administrative Code. The Tri-City landfill, located on Indian land, is regulated by the federal government.

The state's Solid Waste Management Law delegates the responsibility for solid waste management to counties, cities, and towns and authorizes these local jurisdictions to collect MSW and to own or operate MSW management facilities, or to contract for such services. Municipalities with populations greater than 60,000 cannot prohibit private firms from providing solid waste management services to commercial and industrial establishments but can prescribe local regulations for such activities. The city has enacted regulations for the licensing of commercial or industrial solid waste and recycling services.

Landfill Disposal Regulations

Because of Arizona's arid climate, the state's relatively lax landfill regulations, and the age of the landfills used by the city in FY 1992, none of the landfills used was constructed with liners, and no routine groundwater or methane gas monitoring was required. Furthermore, the state did not require landfill operators to plan and provide financial security for the closure of landfills, or any postclosure maintenance. Generally, the only environmental control requirement imposed on the landfills was for daily cover.

Arizona has recently modified its solid waste regulatory requirements. In the future, all landfills in the state must obtain an Aquifer Protection Permit and incorporate Best Available Demonstrated Control Technology (BADCT). The BADCT evaluation requires a review of liner and monitoring options, leachate collection and control options, and closure and postclosure monitoring requirements. The BADCT requirements are site specific and are determined through negotiations between the landfill owner and the DEQ. In general, Arizona's new regulations incorporate the RCRA Subtitle D regulations. These requirements did not, however, apply in FY 1992 to the landfills used by the city.

Recycling Regulations

There are no specific regulatory requirements for the processing and marketing of recyclables. Arizona law does require residential and commercial garbage containing putrescible materials to be collected at least twice a week. A special exemption, however, to this requirement can be obtained if a community wishes to substitute one residential collection for a recyclables collection.

The Arizona Solid Waste Recycling Act of 1990 (Recycling Act) prescribes a statewide program to support recycling. The Recycling Act, among other provisions, provides for a 5% preference in awarding certain state contracts to bidders offering recycled material, prescribes specifications that do not discriminate against the use of recycled materials, provides for a public education program, provides for the identification and development of markets for recovered materials, prescribes standards for newsprint quality, and establishes a landfill disposal fee.

The Recycling Act requires that all counties, cities, and towns must provide "its residents with an opportunity to engage in recycling and waste reduction." The recycling programs implemented by the city comply with this requirement.

The proceeds from the \$0.25-per-ton landfill disposal fee are deposited in a Recycling Fund. Proceeds from the fund are used for statewide programs in support of recycling and source reduction.

HHW Collection Day Regulations

A special permit was required for the collection and storage of HHW at the city's Corporation Yard. Because the city already had a permit for the use and storage of potentially hazardous materials (e.g., gasoline and oil used for fleet vehicles) at the Corporation Yard, the process of obtaining authorization for the HHW program was relatively simple. All of the material collected from the HHW program had to be manifested.

Appendix A

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Appendix B

Glossary of Terms

ALLOCATED COST (\$/year):	That portion of the total cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
ANALYZED MSW:	That portion of the Municipal Solid Waste (MSW) stream for which the cost of collecting, transferring, hauling, processing, combusting, marketing, and/or disposing of such waste is known or can be reasonably estimated.
AVERAGE COST	(\$/ton): Total or allocated cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
AVERAGE PROGRAM INCREMENTAL COST (SAVINGS) (\$/ton):	The program incremental cost divided by the number of tons of materials diverted from the landfill by the program.
BRUSH	In Scottsdale, brush is defined as leaves, twigs, palm skins and weed cuttings, tree limbs and shrubbery clippings not exceeding 3 feet in length (see yard waste).
BULKY WASTE:	Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.
COMMERCIAL MSW:	MSW that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry), institutions (e.g., schools and government establishments), and public areas (e.g., train stations, airports, and litter from roadside).

GARBAGE:

Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.

HAZARDOUS WASTE:

Waste which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed *and* is defined as hazardous in accordance with federal and state laws. Does not include Household Hazardous Waste.

HOUSEHOLD HAZARDOUS WASTE (HHW):

Materials that are separated from Residential MSW as household hazardous waste for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.

INTEGRATED SOLID WASTE MANAGEMENT:

A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the MSW stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.

MARGINAL COST (SAVINGS) (\$/ton):

The cost (savings) of managing *an additional* ton of MSW, garbage, trash, recyclables, or yard waste.

MARGINAL COST (SAVINGS) OF SUBSTITUTION (\$/ton):

The net cost (savings) of managing an additional ton of recyclables or yard waste less the savings (cost) of managing one less ton of garbage.

MATERIALS RECOVERY:

A term describing the extraction and use of materials from a waste stream.

MUNICIPAL SOLID WASTE (MSW):

Nonhazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes, construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.

PROGRAM INCREMENTAL COST
(SAVINGS) (\$/year):

The difference between the cost of managing MSW with the inclusion of a particular program and the cost of managing MSW without that program (e.g., curbside collection, processing, and marketing of recyclables).

RECOVERED MATERIALS:

Recyclable materials that are recovered from MSW and may also include some contamination.

RECYCLABLE MATERIALS OR
RECYCLABLES:

Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.

RECYCLE:

To convert discarded materials into useful products through reuse and remanufacturing.

RESIDENTIAL MSW:

MSW that is generated by households.

RESIDUE:

That portion of processed MSW that is ultimately disposed of in a landfill.

RESOURCE RECOVERY:

A term describing the extraction and use of energy or materials from a waste stream.

SECONDARY MATERIAL:

A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."

SELF-HAUL:

The delivery of MSW or other wastes to an integrated MSW management system by a private firm or individual that is not under contract to a municipality, authority, utility, or other public entity responsible for MSW management to make such deliveries.

TOTAL NET COST OR TOTAL COST (\$/year):

The aggregate of all expenditures incurred to manage MSW, inclusive of general and administrative, planning, capital, collection, processing, transfer and haul, marketing, promotion and education, and disposal costs, less any revenues derived from resource recovery activities.

YARD WASTE:

Vegetative material that is segregated from the MSW stream for separate collection and/or processing, including grass, prunings, plants, and small tree limbs, but excluding tree stumps, land-clearing debris, and other large vegetative matter (see Brush).

WHITE GOODS:

That portion of bulky waste which consists of large appliances, such as refrigerators, stoves, washing machines, and dryers.

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1. Introduction

Scottsdale, Arizona ("the City"), which calls itself "the west's most western town," is located in Maricopa County just east of Phoenix, the state capital, and north of Tempe, the home of Arizona State University, as shown in Figures 1-1 and 1-2. Prior to being founded in 1888 by retired U.S. Army Chaplain Winfield Scott, the area was strictly desert except for about 1,300 miles of canals created by the Hohokam Indians about 2,000 years ago. Scottsdale averages 314 days of sunshine and about 7.7 inches of rain per year. The average minimum and maximum temperatures range from 55.7 to 84.6 degrees. Tourism is the City's most important industry.

The City was incorporated in June 1951, and its current charter was adopted in November 1961. In accordance with this charter, Scottsdale operates as a council-manager form of government. The Mayor and six City Council members are elected at large for four-year terms. The City Manager is appointed by the Council, and in turn appoints City employees and department general managers.

As reported by the U.S. Bureau of the Census, the Scottsdale population grew from 2,032 people in 1950 to 130,069 in 1990. This reflects an average annual growth rate over these four decades of about 11 percent. The mid-1992 population was estimated to have been about 137,590 people. This population is projected to grow at about a 5-percent annual rate from 1992 to 1997.¹ As of June 1992 there were about 72,330 housing units in Scottsdale, of which approximately 42,470 were single-family homes.²

Scottsdale encompasses an area of approximately 185.2 square miles. Of this area, 17.9 percent is residential, 3.8 percent is industrial or commercial, and 78.3 percent is undeveloped/agricultural. Most of this undeveloped/agricultural land lies in the northern two-thirds of the City, which was annexed in the early 1980s and consists of scenic desert and mountainland. Therefore, the population is concentrated in the lower third of the City.

During fiscal year 1992, which extended from July 1, 1991, through June 30, 1992 (FY 1992), about 115,000 tons of municipal solid waste (MSW) were managed by the City's Sanitation Division or delivered to the Tri-City Landfill directly by residents of Scottsdale.

¹ City of Scottsdale, "Five Year Forecast Premise Statistics," Fiscal Years 1992-93 through 1996-97, Planning and Community Development Department.

² City of Scottsdale, "Solid Waste Information Package," Sanitation, June 1992, page S-7.

FIGURE 1-1: MAP OF ARIZONA

FIGURE 1-2: MAP OF SCOTTSDALE, ARIZONA

City Of Scottsdale
 Scottsdale, Arizona
 and neighboring communities

2. The City's Integrated Municipal Solid Waste Management System

2.1 System Overview

The City's 1992 Integrated Municipal Solid Waste Management (IMSWM) System consisted of the following integrated system components:

- separate collection of garbage, brush/bulky waste, white goods, and move-in boxes by the City;
- a City-sponsored, privately run annual household hazardous waste collection day;
- a City-operated mobile trailer drop-off recycling program;
- a stationary container drop-off program;
- a City office paper recycling program; and
- two privately owned and operated landfills, and one County-owned and operated landfill.

Municipal solid waste is categorized in this report as comprising garbage, brush and bulky wastes, recyclables, and household hazardous wastes (HHW). Figure 2-1 is a graphical representation of these components of MSW. The reader is advised to peruse the Glossary of Terms in Appendix A for a more detailed definition of these and other terms used in this document.

A description of each of the individual components of the City's IMSWM System follows.

2.2 System Component Descriptions

2.21 Collection

The City's Sanitation Division is responsible for collecting garbage from all single-family homes. The number of single-family homes served in FY 1992 grew from 41,040 in July 1991 to 42,473 in June 1992. An average 41,753 homes were served each month during FY 1992. Collection of garbage from most single-family homes is accomplished with automated, side-loading collection vehicles. Each vehicle is operated by a single driver.

The City began providing household garbage collection in March 1964.³ At that time, a "train" method of collection was utilized. "The train consisted of a pick-up truck with a removable bed which pulled four five-yard, open-box trailers." When the box trailers were filled, they were removed from

³The following account of the history of the development of automated collection in Scottsdale and the associated quotations were taken from "Revolutionizing an Industry - The Story of Mechanized Residential Refuse Collection in the City of Scottsdale, Arizona," by Rick Pence.

FIGURE 2-1: MSW: DEFINED CONSTITUENTS

the train. A front-end-loading packer truck would then empty the trailers, which were subsequently re-hooked to the train. The packer truck would unload four trainloads prior to proceeding to the landfill.

In 1965 the City began to explore ways to mechanize garbage collection. One of the "first ideas was one in which the City would supply plastic bags to homeowners who would, when filled, hang them on a pole in front of their houses; then the refuse truck would drive down the street and snag the bags from the poles." Many other ideas came and went until the City developed the "barrel snatcher" concept. The City applied for and received a grant from the U.S. Department of Health, Education and Welfare, Office of Solid Waste Management, to demonstrate the technical, social, and economic feasibility of the barrel snatcher for automated collection. The demonstration grant period extended from March 1969 through June 1972. The barrel snatcher consisted of an arm extending from the right front of a front-end-loading collection vehicle with a mechanical grabber for securing garbage containers. The arm would extend in front of the truck, grab a garbage container, lift it over the top front of the vehicle to discharge its contents into the truck's hopper, place the empty container back into its original position, and then release the container. The advantage of the barrel snatcher was its ability to be operated by the driver from within the truck's cab. In addition to the design of the vehicle, the City also had to develop, with the assistance of container manufacturers, the proper container size, shape, and composition. Cone-shaped container sizes of 80⁴, 160, and 300 gallons manufactured with various grades of polyethylene plastic were tested.

The first automated container pickup was made on August 1, 1969, using a 1964 International front-end-loader that was retrofitted with a barrel snatcher. The truck was nicknamed "Godzilla." During its maiden run, Godzilla successfully reached for and grabbed a container, picked it up, and proceeded to deposit its contents, along with the container, into the truck hopper. Shortly thereafter, while testing an electronic system presumably designed to fully automate the collection process with just the push of a button, Godzilla's arm swung back and forth, damaging the fences on both sides of the alley. These and other problems were solved, and numerous improvements were made during the initial six-month test period and the City's subsequent two decades of experience with automated collection. For example, the dump cycle time has been reduced from 30 seconds during the initial test period to about seven seconds today.

Following the end of the initial test period "it was determined that the 80-gallon containers serviced twice a week for street pick-ups, and the 300-gallon containers used by [up to] four families and serviced twice a week for alley use were the most effective combinations...." These collection service frequencies and container sizes are still used today.

In FY 1992, about 68 percent of Scottsdale residents placed their garbage into 80-gallon, roll-out, plastic containers and received automated street pick-up collection. Homeowners living in many of the City's older neighborhoods, where service alleys separate individual blocks of homes, share 300-gallon plastic containers. About 27 percent of single-family homes use these 300-gallon containers, with an average 3.2 homes sharing each container.⁵ The balance, or about 5 percent, of homeowners live in

⁴Although these containers are referred to by the City as "80-gallon" containers, they are actually 90-gallon containers (Rick Pence, Scottsdale Sanitation Division, 1994).

⁵ In June 1992 a reported 11,412 homeowners were using 3,582 300-gallon containers. City of Scottsdale, "Solid Waste Information Package," Sanitation, June 1992, pages S-9 and S-19.

areas that are not readily accessible by the automated collection vehicles, thus necessitating manual collection using single-person crews. In these areas homeowners place their garbage into typical garbage containers or plastic bags.

The City also collects brush and bulky waste from all single-family homes, using rear-loading packer trucks. Each truck has a two-person crew. Households receive brush/bulky waste collection service once every four weeks. Bulky waste items include garbage that cannot be placed into the 80- and 300-gallon containers used for automated collection.

Once a week a brush-collection vehicle and crew are used to collect "move-in" boxes (i.e., corrugated cardboard boxes used for moving into new homes), which are then recycled. In FY 1992 an average of 80 move-in box pickups were made each month, or a total of 965 pickups during the year. Similarly, a brush-collection vehicle and crew are used about every other week to collect white goods for recycling. In FY 1992 an average of 75 white-good pickups were made each month, or a total of 901 pickups during the year.⁶ Homeowners are responsible for the removal and legal disposal of freon from the white goods.

The Sanitation Division also provides commercial garbage collection services to multi-family homes, apartment houses, and businesses.⁷ The City must compete for this business with private haulers. The City supplies two- to eight-yard containers or 20- to 40-yard roll-offs, depending on the service requested. Collection can occur from one to six days a week. Multi-family homes and apartments, restaurants, and other commercial accounts that dispose of putrescible waste must receive at least twice-a-week collection, in accordance with state health regulations.

All of the 80- and 300-gallon containers used in the automated collection program are owned by the City. When the program began, the City purchased the containers and distributed them to the existing homes. Developers of new homes are responsible for "purchasing" a container from the City with each home they sell; however, ownership of these containers is vested in the City and remains with the house. The City repairs and maintains the containers and provides replacement containers when necessary. Similarly, the City owns and maintains all of the containers and roll-offs used to collect commercial garbage.

2.2.2 Household Hazardous Waste

On Saturday, November 16, 1991, the City held its third annual HHW collection day. Just over 300 vehicles dropped off some materials at the City's Corporation Yard. The Corporation Yard, the site of the City services offices, including the Sanitation Division and its vehicle storage yard and maintenance shop, was chosen as the drop-off site because it was already permitted for the storage and handling of certain hazardous or specially managed wastes (e.g., used oil, antifreeze). The materials collected were classified as waste oil, antifreeze, flammable liquid, flammable aerosol, flammable poisons, flammable solids, mercury metallic, paint related, corrosive liquid, corrosive solid, oxidizer

⁶ City of Scottsdale, "Monthly Recycling Statistics," Sanitation, unpublished worksheets, 1993.

⁷ A five-percent discount given to commercial customers that signed contracts with the City. Others may receive service without a written contract.

solid, poison liquid, poison solid, and non-RCRA hazardous.⁸

In FY 1992, the City entered into a one-year contract with Disposal Control Services, Inc., a subsidiary of Laidlaw, to: (1) manage and provide all labor necessary to accept and handle the HHW delivered to the site; (2) identify and categorize the HHW received; (3) prepare for transportation and transport the HHW to authorized treatment (including recycling) or disposal sites; (4) properly manifest all HHW transported from the site; (5) arrange for or treat and dispose of all HHW received at the site; and (6) provide a Certificate of Disposal and Destruction for all materials and/or shipments related the HHW collection program. The City was responsible for: (1) obtaining a U.S. Environmental Protection Agency provisional hazardous waste generator identification number; (2) advertising and promoting the HHW collection program; (3) helping Disposal Control Services set up the site; (4) providing fire protection and police personnel to control traffic; (5) greeting participants and accepting or rejecting material brought to the site; and (6) determining which non-hazardous wastes (e.g., latex paint) were to be reused by the City and which wastes were to be transported off-site by Disposal Control Services.⁹

2.2.3 Mobile Recycling Program

The City instituted its Mobile Recycling Trailer Program (Mobile Recycling) in October 1989 with a single trailer to collect aluminum cans, newspaper (no magazines or phone books), and glass jars and bottles from Scottsdale residents. In September 1990, the City added a second trailer. Each mobile unit consists of a truck and trailer. Each trailer has three 4-cubic-yard containers and is equipped with a roof and retractable canopy. One of the containers is divided into two sections: one section for brown glass, the other for green glass. The other two containers are used to store clear glass and aluminum, respectively. One trailer is towed by a dump truck and the other by a boom truck. Newspapers are loaded directly into the dump truck or into two 8-cubic-yard containers placed on the boom truck.

The nine sites used for the Mobile Recycling Program in FY 1992 are shown in Figure 2-2.¹⁰ Each mobile unit visits one site on Saturday and another on Sunday; thus, four sites are covered each weekend. Sites with higher participation rates are covered more frequently than others. For example, a mobile unit is located at Eldorado Park and Chaparral Park every weekend, while Pinnacle Peak General Store and Thunderbird Park are used about once a month. Residents bring recyclables to these sites between 8 a.m. and 3 p.m. Each load is inspected, weighed, and sorted by a Sanitation Division employee, thus ensuring that high-quality materials are collected. At the end of the day, each site is cleaned and the materials collected are delivered to the City's Corporation Yard, where they are unloaded and prepared for shipment to markets. After each weekend, the collected newspaper and aluminum is shipped to recycling dealers. Glass is transferred to other containers and stored at the Corporation Yard. Once a truckload has been collected, it is shipped to market and recycling dealers.

⁸ Memo to Dick Bowers, City Manager, from Pete Chavez, Sanitation Director, January 7, 1992.

⁹ "Agreement for Hazardous Waste Removal & Disposal Services By and Between the City of Scottsdale, Arizona and Disposal Control Services, Inc.," as amended on April 15, 1991, pages 2-6.

¹⁰ A tenth site, Smitty's, was added to the program after FY92.

FIGURE 2-2: LOCATION OF MOBILE RECYCLING DROP-OFF
SITES IN FY92

1. Cactus Park, Cactus/Scottsdale Road
2. Chaparral Park, Hayden/Jackrabbit
3. Eldorado Park, Miller/Oak
4. McCormick Railroad Park, Indian Bend/Scottsdale Road
5. Mountain View Park, Mountain View/85th Street
6. Pinnacle Peak General Store, Pima/Pinnacle Peak
7. Price Club, Hayden/83rd Place
8. Scottsdale Ranch, 102/Via Linda
9. Thunderbird Park, Thunderbird/92nd Street

City Of Scottsdale
Scottsdale, Arizona
and neiahorina communities

In FY 1992 there were over 14,250 participants¹¹ in the Mobile Recycling Program. This represents an increase of almost 75 percent over the number of participants in FY91.¹² To encourage participation, the City has instituted an incentive program whereby residents can win U.S. Savings Bonds. On a monthly basis, the individual who brings in the most weight of each of the three materials collected (i.e., aluminum cans, newspaper, and glass) is awarded a \$100 savings bond. The individual who brings in the most combined weight of all three materials is awarded a \$200 savings bond. On an annual basis, the individual who brings in the most combined weight of all three materials wins a \$1000 savings bond.¹³ Although no groups or organizations are allowed to participate in the incentive program, the incentive program may prompt some individuals to collect materials in their neighborhoods prior to delivering them to the mobile units. Therefore, the number of households participating in the program may be higher than those that actually deliver material to the sites.

2.2.4 Other Recycling Programs

In addition to the Mobile Recycling Program, the City also collects newspaper and aluminum cans through its stationary container program. Separate containers are used for newspaper and aluminum cans. In FY 1992 there were 59 300-gallon and 13 80-gallon stationary containers located on City-owned property or at apartment buildings and condominiums. Nine containers were placed for general public use, and the remaining containers were used at apartment and other complexes requesting the service. The use of stationary containers for recyclables at apartment and condominium complexes is included in the commercial service provided to these establishments.

Every Friday an automated residential truck picks up the recyclables and delivers them to local recycling dealers: newspapers to Sunbelt Recycling, Inc., and aluminum to Empire Metal Limited. Both recycling dealers are located in Tempe, Arizona.

In FY 1992, the City also had an office wastepaper recycling program in four City buildings. White paper, computer paper, and colored paper were collected in separate, centrally located containers within each office building. The material collected was picked up by the Friedman Recycling Company on an on-call basis. The materials would be collected within three days of the City's call.

2.2.5 Landfill Disposal

In FY 1992 most of the garbage, brush, and bulky waste collected by the City was delivered to and disposed of at the Tri-City Landfill, which is owned and operated by the Salt River Pima-Maricopa Indian Community (SRPMIC). Small quantities of garbage, brush, and bulky waste were disposed of at Maricopa County's Cave Creek Landfill. In addition, some brush and bulky wastes were disposed of at Sanifill's Lone Cactus brush landfill. Residents of Scottsdale could also deliver MSW directly to

¹¹ A participant is an individual who delivers recyclables to any site on a given day. If the same individual delivers materials on another day, he or she is counted again.

¹² "Year-to-Date Figures/Recycling Program," Sanitation, 1993.

¹³ City of Scottsdale, "Mobile Recycling Program Incentive Program Rules," Sanitation.

the Tri-City Landfill. The cost of disposal of such self-hauled MSW was paid for by the City.¹⁴ The locations of these and other solid waste management facilities located in the Phoenix metropolitan area are provided in Figure 2-3.

2.2.6 Changes Since FY 1992

Since the end of FY 1992 there have been a number of changes in Scottsdale's IMSWM System. Due to a partial washout of the Tri-City Landfill, the City ceased using this landfill in FY93. The Tri-City Landfill was permanently closed in October 1993. The City currently disposes of most of its garbage, brush, and bulky waste at Maricopa County's Cave Creek Landfill. This has significantly increased the distance traveled by the collection vehicles to the landfill site. The City is planning to construct its first transfer station, to be located in the west central portion of the City. The proposed location for this transfer station is shown in Figure 2-3.

In FY 1993 the City instituted a pilot curbside recycling collection program. Two sections of the City participate in the program. In total only about 2,000, or about 5 percent, of the approximately 42,500 single-family households participate in the program -- half on a voluntary basis whereby they still receive two garbage pick-ups per week, and half on a mandatory basis, whereby one garbage pick-up is substituted for a recyclable pick-up. Only newspaper, tin cans, and aluminum cans are collected in the voluntary program, whereas these materials as well as number 1 and 2 plastics and corrugated cardboard are collected as part of the mandatory program.

¹⁴ "Waste Disposal Facility Agreement Between the Salt River Pima-Maricopa Indian Community and the Cities of Mesa, Scottsdale, and Tempe," page 2.

FIGURE 2-3: LOCATION OF MUNICIPAL SOLID WASTE
MANAGEMENT FACILITIES

FIGURE 2-3: LOCATION OF MUNICIPAL SOLID WASTE
MANAGEMENT FACILITIES (CONTINUED)

LEGEND

1.	Northwest Regional Landfill	6.	Cave Creek Landfill
2.	New River Landfill	7.	Waste Management Transfer Station
3.	Lone Cactus Landfill	8.	Butterfield - Waste Management Landfill
4.	Tri-City Landfill	9.	City of Phoenix Transfer Station and MRF
5.	New Salt River Landfill	10.	City of Phoenix - Skunkcreek Landfill
		11.	Proposed Scottsdale Transfer Site

3. MSW Collected, Processed, and/or Disposed of in Scottsdale

A total of approximately 115,000 tons of MSW was processed or disposed of by the City in FY 1992. Of this amount, about 92.4 percent was garbage, 6.8 percent was brush and bulky waste, 0.7 percent was recyclables, and less than 0.1 percent was HHW. Table 3-1 summarizes the tonnage collected, processed, and/or disposed of by the City during FY 1992. This tonnage does not include garbage, brush, bulky waste, and recyclables collected from apartment houses, condominiums, and business establishments that contracted with private haulers to collect, process, and/or dispose of their MSW. A waste flow and resource recovery diagram of the waste stream processed through the City's IMSWM System in FY 1992 is depicted in Figure 3-1.

In the following Sections 3.1 through 3.4, the types and quantities of MSW collected, processed, and/or disposed of by the City during FY 1992 are presented in more detail.

3.1 Garbage Collection and Disposal

A total of 106,315 tons of garbage was collected and/or disposed of in FY 1992. About 97 percent of this garbage, or 103,343 tons, was collected by the City. The balance, 2,972 tons, was delivered to the Tri-City Landfill by residents.¹⁵

Of the garbage collected by the City, 57,285 tons of single-family residential garbage were collected using automated collection vehicles, and 1,283 tons were collected using manual equipment. About 69 percent of the 57,285 tons collected with automated equipment was collected in 80-gallon containers, while 31 percent was collected in 300-gallon containers.

The City also collected 44,775 tons of commercial garbage from apartment houses, condominiums, and business establishments. Almost 86 percent of this commercial garbage was collected using 2- to 8-cubic-yard containers and front-end loaders. The balance was collected in roll-off containers. Of the 103,343 tons of garbage collected by the City, 100,918 tons (97.7 percent) were delivered to the Tri-City Landfill; 1,878 tons (1.8 percent) were delivered to Maricopa County's Cave Creek Landfill; and 547 tons (0.5 percent) were delivered to Sanifill's Lone Cactus Landfill.¹⁶ The City began using the Sanifill Landfill in April 1992. The 547 tons of garbage delivered to Sanifill in FY 1992 were collected in roll-off containers. The Sanifill Landfill is only permitted to accept brush, fill, C&D waste, and other non-prutrescible wastes.

3.2 Collection and Disposal of Brush and Bulky Wastes

In FY 1992 the City collected 7,868 tons of brush and bulky wastes. No accounting was made to determine the mix of brush and bulky waste collected. About 93.2 percent of this brush and bulky waste was delivered to the Tri-City Landfill for disposal. The balance, 6.8 percent, was disposed of at the Sanifill Landfill. As stated above, the City only began use of the Sanifill landfill in April 1992.

¹⁵ "Monthly Landfill Logs," Sanitation, July 1991 through June 1992.

¹⁶ "Monthly Landfill Logs," Sanitation, July 1991 through June 1992.

**TABLE 3-1: MSW COLLECTED, PROCESSED,
AND/OR DISPOSED OF IN SCOTTSDALE IN FY92**

WASTE TYPE	PERCENT	TONS
GARBAGE		
Residential-Automated Collection	49.8%	57,285
Residential-Manual Collection	1.1%	1,283
Commercial	38.9%	44,775
Self Haul to Landfill	2.6%	2,972
Subtotal Garbage	92.4%	106,315
BRUSH AND BULKY WASTE	6.8%	7,868
RECYCLABLES		
Mobile Recycling Trailers	0.3%	401
White Goods & Move-in Boxes	0.1%	113
Stationary Containers	0.2%	279
City Office Papers	0.0%	30
Subtotal Recyclables	0.7%	823
HOUSEHOLD HAZARDOUS WASTE	0.0%	11
TOTALS	100.0%	115,017

NOTE: This table does not include all of the garbage, brush, and recyclables collected, processed, and disposed of from commercial and business establishments. Therefore, the data in this table does not provide a complete account of MSW generation and recycling activities in Scottsdale.

**FIGURE 3.1: WASTE FLOW AND RESOURCE RECOVERY DIAGRAM -
SCOTTSDALE, ARIZONA (FY92)**

3.3 Collection and Disposition of Recyclables

The City collected approximately 823 tons of recyclables from four different programs: the Mobile Recycling Trailer Program; the white goods and move-in box collection program; the stationary container program; and the City high-grade office paper program.

In FY 1992 the Mobile Recycling Program collected 401 tons of recyclables. Of this, 204 tons (51 percent) were newspaper, 185 tons (46 percent) were glass, and 12 tons (3 percent) were aluminum. Over 55 tons of white goods and 58 tons of move-in boxes were collected by the City in FY 1992. An additional 279 tons of newspaper and aluminum cans were collected from the stationary container program. The majority of this material was collected from apartment buildings and condominiums that asked to participate in the City's recycling program. The City also recovered about 30 tons of high-grade office paper, computer paper, and colored paper from four City office buildings. These materials were picked up and marketed by the Friedman Recycling Company. The City paid Friedman Recycling a hauling fee for collecting the material and in turn received revenues for the materials collected.

The breakdown of revenues earned in FY 1992 from each of these materials in each of these four programs are shown in Figure 3-2. The markets for these materials, their locations, and their end-uses are provided in Table 3-2.

In FY 1992, 823 tons of the recyclable materials recovered in the City were sold to various outlets. A telephone survey was conducted to track these materials to their remanufacturing points. Vendors (brokers) were contacted to determine: the end use of the material; the distance traveled from the City's Corporation Yard to the processing or remanufacturing destination; and the mode of transport used. Only 651 tons of the materials sold could be accounted for through the survey. Table 3-2 presents the survey results.

Recovered aluminum (17 tons) was sold to EMCO Recycling (formerly Empire Metal), of Phoenix. The aluminum was shipped via transfer trucks to markets where it was remanufactured into can sheet, window frames, and automotive parts.

Recovered clear (flint) glass (47 tons) was marketed to Todd and Associates, of Yorba Linda, California. The glass was transported via transfer-trailer trucks to brokers and processors both on the West Coast and in Mexico. The glass was processed into furnace-ready cullet for use in building materials (fiberglass) and glassphalt. Amber, green, and mixed glass (7 tons) was sold to Sunbelt Recycling; however, this company is no longer in business and therefore no disposition details are known.

Corrugated paper (move-in boxes) (58 tons) and newspaper (437 tons) were also sold to Sunbelt Recycling, and again no details are known. Recovered office paper (30 tons) was picked up at four City office locations by Friedman Recycling, of Phoenix. Friedman transported the loose paper to its processing facility in Phoenix, where the paper was sorted and prepared for shipment via transfer-trailer trucks and rail cars to remanufacturing outlets. The white paper was shipped to mills in California for processing into pulp as feedstock for writing materials. The colored paper found markets in California and the Pacific Rim (China and Korea), where it was manufactured into facial tissue and toilet paper.

FIGURE 3-2: REVENUES RECEIVED FOR RECOVERED MATERIALS IN FY92

Newspaper, Glass, and Aluminum Collected in Mobile Recycling Program
Newspaper and Aluminum Collected in Stationary Recycling Program

TABLE 3-2: MARKETS FOR RECOVERED MATERIALS SOLD IN FY92

RECOVERED MATERIALS	TONNAGE SOLD	VENDOR/ LOCATION	DISTANCE TO REMANUFACTURER*	MODE OF TRANSPORT	REMANUFACTURE USE	COMMENTS
ALUMINUM	17	Emco Recycling (formerly Empire Metal) (Phoenix, AZ)	300-1,000	Transfer truck	Can sheet Window frames Automotive parts	
GLASS						
Flint	47	Todd & Assoc. (Yorba Linda, CA)	500 (ultimate destination: West Coast and Mexico)	Transfer trailer	Furnace-ready cullet Fiberglass bldg. material Glassphalt	Out of Business - unable to contact
Amber	7	Sunbelt Recycling				
Green						
Mixed						
Subtotal	54					
PAPER						
Corrugated (move- in boxes)	58	Sunbelt Recycling	360 (ultimate destination: California and China/Korea)	Transfer trailer/rail	Writing paper (white) Facial and toilet tissue (colored)	Out of Business
Newspaper	437	Sunbelt Recycling				
Office Paper (white and colored)	30	Friedman Recycling (Phoenix, AZ)				
Subtotal	525					
WHITE GOODS	55					
TOTAL	651					

* Because of requests not to specify remanufacturers, vendor's estimates of distances traveled cannot be verified. Distances given are for intra-U.S. travel only.

3.4 Collection and Disposition of HHW¹⁷

Disposal Control Services, Inc. managed the material generated from the City-sponsored HHW day on November 16, 1991. A total of about 10.8 tons of material was collected. The types and amounts of materials collected, and their disposition, are provided in Table 3-3. Almost 35 percent of the material collected was paint related, and another 34 percent was flammable liquids (27.4 percent non-poisonous and 6.2 percent poisonous), including paint thinners and solvents. Non-RCRA hazardous waste materials and used oil made up another 11 and 5.3 percent, respectively, of the material collected. In total, these four classes of materials represented almost 85 percent of the HHW collected.

A total of about 3.2 tons of HHW was disposed of through treatment, landfilling, or incineration. About five percent of the HHW, specifically 0.55 tons of corrosive liquids and solids, were disposed of via "treatment". Treatment involves neutralization, often by combining alkaline and acidic material together, and then processing the neutralized material through a commercial wastewater treatment facility. About 11 percent of the HHW, i.e., 1.2 tons of non-RCRA hazardous waste material, was landfilled. The balance of the HHW disposed of, 1.4 tons, was incinerated. About 7.7 tons, or about 71 percent, of the HHW collected were classified as being recyclable.¹⁸ Ninety-five percent of this recyclable material was paint related, flammable liquids, and used oil.

The City kept 404 gallons of latex paint material for its own use. The oil-based paint was classified as being reusable, hardened, or junk. Reusable paints are mixed together to create large enough batches for use or sale. Some communities use recycled oil-based paints to paint over graffiti in public areas or buildings. Hardened oil-based paint is tested to determine whether it can be ground and used as a fuel. If not, it is either landfilled or incinerated. Junk oil-based paint products are still in a liquid form, but have broken down and cannot be used as paint. Junk products are mixed together and reused as fuel.

Flammable liquids that are recyclable are mixed, as appropriate, and used or sold as a fuel. Similarly, flammable solids can be ground and used as a fuel. Waste oil, depending on its condition, can also be used as a fuel or can be reprocessed to make grease. Used antifreeze can be cleaned, reprocessed, and made back into antifreeze. Materials containing mercury are processed to extract and reuse the mercury.

¹⁷ Tonnages and use of material obtained from letter to Mr. Pete Chavez, Sanitation Director, City of Scottsdale from Mr. Daniel DeGracie, Chemist, Disposal Control Service, Inc., dated December 4, 1991, and telephone discussion between Mr. Mike Gingerella, Disposal Control Service, Inc. and Dr. Alan Cohen, February 4, 1994.

¹⁸ Not all of this material was actually recycled. For example, the weight of "mercury metallic" includes non-mercury and non-recyclable materials that house the mercury, e.g., thermometers. Furthermore, some of the unusable paint material may have been eventually landfilled or incinerated.

TABLE 3-3: COLLECTION AND DISPOSITION OF HHW IN FY 1992

TYPES OF HHW	SIZE OF CONTAINERS (Gallons)	NUMBER OF CONTAINERS	TONS	PERCENT	DISPOSITION
Corrosive Liquid - Acid (Lab Pack)	55	1	0.11	1.0	Treated
Corrosive Liquid - Alkaline (Lab Pack)	55	2	0.22	2.0	Treated
Corrosive Solid - Acid (Lab Pack)	55	1	0.11	1.0	Treated
Corrosive Solid - Alkaline (Lab Pack)	55	1	0.11	1.0	Treated
Subtotal			0.55	5.1	
Non RCRA Hazardous Waste Material	55	11	1.21	11.2	Landfilled
Flammable Liquid - Aerosol	55	3	0.41	3.8	Incinerated
Flammable Liquid - Poisonous Aerosol	14	1	0.05	0.5	Incinerated
Flammable Liquid - Poisonous (Lab Pac)	30	9	0.68	6.3	Incinerated
Oxidizer Solid (Lab Pack)	55	1	0.11	1.0	Incinerated
Poison B Liquid (Lab Pack)	5	1	0.01	0.1	Incinerated
Poison B Solid (Lab Pack)	30	2	0.15	1.4	
Subtotal			1.41	13.0	
Antifreeze	-	35 gallons	0.14	1.3	Recycled
Flammable Liquid (Lab Pack)	55	27	2.97	27.4	Recycled
Flammable Solid (Lab Pack)	55	2	0.22	2.0	Recycled
Mercury Metallic	5	1	0.01	0.1	Recycled
Paint-Related Material	264	3	3.75	34.6	Recycled
Used Oil	-	155 gallons	0.58	5.4	Recycled
Subtotal			7.67	70.8	
Totals			10.84	100.0	

SOURCE: Letter from Daniel DeGrade to Pete Chavez, Disposal Control Services, Inc., December 4, 1991 and telephone conversation with Mike Ginerella, Disposal Control Services, Inc.

4. Cost of MSW Management in Scottsdale

4.1 Summary of Results

Of the approximately 115,000 tons of MSW managed within the City, about 112,000 tons were analyzed (Analyzed MSW) to determine the cost of Scottsdale's IMWSM System. The cost to manage the remaining MSW is excluded because that MSW was self-hauled to one of the landfills. The cost to manage the HHW is treated separately.

4.1.1 Overall Program Costs

The total FY 1992 net cost to manage the approximately 112,000 tons of Analyzed MSW was about \$6.6 million, or \$59 per ton. This net cost breaks down to, in rounded numbers:

CATEGORY	TONNAGE (tons)	NET COST (\$ millions)	NET COST PER TON
Residential Garbage	58,600	\$3.71	\$63
Commercial Garbage	44,800	\$1.86	\$41
Brush and Bulky Waste	7,970	\$0.86	\$109
Recyclables	820	\$0.18	\$182
TOTAL/AVERAGE	112,190	\$6.61	\$59

Figure 4-1 depicts these results graphically. The primary factor contributing to the differences among the per-ton costs is the cost of collection relative to the other key cost elements (G&A expenses, landfill fees, and promotional expenses).

The cost of managing the 11 tons of HHW, which was analyzed separately from the other components of the MSW stream, was about \$53,300, or over \$4,800 per ton.

As shown in Figure 4-2, collection costs are the most significant factor in the total cost of the Scottsdale IMSWM System, accounting for about 62 percent of the total outlays. Figure 4-3 shows the allocation of costs to each of the key functional areas (i.e., collection, G&A, landfill, and promotion) for each of the program areas. Note that, in all cases, collection costs account for well over half of the total costs. The cost allocation for managing recyclables is presented without the inclusion of the \$0.25/ton state-imposed landfill fee, which is used to support recycling. Without this fee, collection costs account for about 70 percent of the total net costs of the recycling program, compared to an average of about 60 percent for managing residential and commercial garbage.

4.1.2 Program Incremental Costs

Scottsdale's IMSWM System recycling program is comprised of mobile trailer, office wastepaper, move-in-box, white good, and stationary container recycling programs. Together, these programs generated about \$13,500 in revenues in FY 1992 from the sale of recovered recyclables. The breakdown of these revenues was, in order of contribution:

- Mobile Recycling \$8,688

FIGURE 4-1
PROGRAM COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(tons)

FIGURE 4-1 (CONTINUED)
PROGRAMS COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(\$ millions)

FIGURE 4-1 (CONTINUED)
PROGRAM COSTS FOR THE IMSWM SYSTEM
(ANALYZED MSW)
(\$/ton)

**FIGURE 4-2: ALLOCATION OF TOTAL COSTS FOR IMSWM
SYSTEM IN FY92**

Allocation by Functional Area
(Cost to Manage 112,000 Tons of Analyzed MSW)

GROSS COST IS \$6,620,000

TOTAL REVENUE IS \$13,500

FIGURE 4-3
ALLOCATION OF THE COSTS TO MANAGE MSW IN SCOTTSDALE
(Allocation by Function Area)

**RESIDENTIAL
GARBAGE**

**COMMERCIAL
GARBAGE**

RECYCLABLES

BRUSH

HHW

**TOTAL
MSW**

- Stationary Containers \$2,099
- Move-In Boxes \$1,129
- Office Wastepaper \$ 728
- White Goods \$ 329

This breakdown of the revenues from the recycling programs is depicted graphically in Figure 4-4.

The incremental cost for each recycling program, i.e., the cost (or savings) associated with adding the program to the IMSWM System, is the difference between the cost of managing all of the MSW with and without the inclusion of that program. The Program Incremental Cost (or Savings) is, therefore, the most appropriate measure of the impact of any particular program on the cost of managing MSW. The FY 1992 Program Incremental Cost (or Savings) for each of the City's recycling programs was, in rounded numbers:

PROGRAM	TONNAGE OF RECYCLABLES	INCREMENTAL COST (SAVINGS)
Mobile Trailer	401	\$69,400/\$173 per ton
Office Wastepaper	30	(\$900)/(\$30) per ton
Move-in Box	58	\$500/\$9 per ton
White Goods	55	\$500/\$9 per ton
Stationary Container	279	\$2,400/\$9 per ton

These numbers exclude the State of Arizona's recycling fee, which would skew the results by overstating the cost contribution of each program.

In addition to the incremental cost or savings that can be attributed to each of the recycling programs, each of them contributes materials to the economy and reduces the utilization of available landfill space. These attributes are summarized in Table 4-1.

The sections that follow, and their supporting Appendices, provide the detail behind these overall results. Section 4.2 defines that portion of the waste stream for which collection costs are known, i.e., "Analyzed MSW." Section 4.3 presents the costs incurred by the City for the management of the approximately 112,000 tons of Analyzed MSW. In Sections 4.4 and 4.5, these costs are allocated by functional area and type of MSW (i.e., residential [single-family homes] garbage, commercial garbage, brush and bulky waste, recyclables, and HHW), respectively. Section 4.6 presents the program incremental costs for the various recycling programs (i.e., mobile trailer, office wastepaper, move-in boxes and white goods, and stationary container recycling programs).

4.2 Apportionment of Waste Stream

Only a portion of the total MSW stream (i.e., Analyzed MSW) described in Section 3 is included in the economic analyses presented in this Section. A detailed discussion of the methodology used to determine this cost and the data used to conduct the associated economic analyses are presented in Appendix C.

FIGURE 4-4: REVENUES RECEIVED FOR RECOVERED MATERIALS IN FY92

Newspaper, Glass, and Aluminum Collected in Mobile Recycling Program
Newspaper and Aluminum Collected in Stationary Recycling Program

TABLE 4-1
INCREMENTAL COST AND RESOURCE CONSERVATION OF RESOURCE RECOVERY PROGRAMS
IN SCOTTSDALE, AZ (FY92)

RESOURCE RECOVERY PROGRAM	TONS MANAGED	TOTAL INCREMENTAL COST (SAVINGS)	AVERAGE INCREMENTAL COST (SAVINGS)	RESOURCE CONSERVATION	
				MATERIALS RECOVERED (tons)	LANDFILL VOLUME REDUCTION (cubic yards)
Mobile Drop-Off Recycling	401	\$69,400	\$173/Ton \$93/CuYd	204 Paper	469
				185 Glass	236
				12 Alum.	42
				401	748
Office Paper Recycling	30	(\$900)	(\$30)/Ton (\$13)/CuYd	30 Office Paper	69
Move-In-Box Recycling	58	\$500	\$9/Ton \$4/CuYd		
White Goods Recycling	47	\$500	\$11/Ton \$8/CuYd	47 Metal/ Plastic	64
Multi-Family Household Stationary Container Drop-Off Recycling	279	\$2,400	\$9/Ton \$4/CuYd	279 Paper & Aluminun	575

The reason for limiting the tonnage included in the analysis is to include only that portion of the MSW stream for which the total cost of collection, marketing, and disposal is known. Failure to limit the economic analysis to the tonnage and costs associated with Analyzed MSW would bias the results and could lead to misleading conclusions.

The Analyzed MSW in this section excludes both MSW that was self-hauled to the Tri-City Landfill and HHW.¹⁹ In both cases the cost to transport the MSW to the landfill or the HHW to the City's Corporation Yard is not known or cannot be reasonably estimated. Thus, both the costs and quantities (approximately 2,970 tons of self-hauled MSW and 11 tons of HHW) of these components are excluded from the analysis.²⁰ On the other hand, the cost of transporting recyclables to the various mobile trailer drop-off sites can be estimated because the City conducted a survey of participants in the program to determine the incremental distance traveled to each site.

Table 4-2 shows the FY 1992 tonnages of the components of both total MSW and Analyzed MSW (i.e., without self-hauled MSW and HHW, for which collection costs are unknown).

When a portion of the MSW stream is excluded from an analysis performed in this section because its collection costs are unknown, the associated marketing, and/or disposal costs are also excluded from the analysis. Consequently, the cost comparisons among types of MSW are valid and include all the costs required to manage the Analyzed MSW stream from the time when it is placed at the curb (or placed in a car/truck for delivery to a drop-off site) until it is sold, re-used, or disposed of in a landfill.

4.3 Total Costs of Analyzed MSW Management

The City's net cost of collecting, marketing recovered materials, and disposing of the approximately 112,000 tons of Analyzed MSW in FY 1992 was approximately \$6.60 million. This represents an Average Cost of \$59 per ton.

This cost was calculated by determining the total audited expenses incurred by the City in FY 1992; adjusting these costs as appropriate to satisfy the requirements of this study; and allocating costs to determine that portion of the adjusted costs attributed to the management of the FY 1992 Analyzed MSW.

4.3.1 City Reported Costs

The management of MSW in the City is operated as a separate enterprise whereby all of the expenses incurred by the City that are associated with MSW management are charged to a Sanitation Fund. Expenses incurred by the Sanitation Division (Sanitation) as well as the cost of services provided to Sanitation by other City Divisions are charge to the Sanitation Fund. These

¹⁹ Although some of the costs associated with stationary containers located on public property are not known, the unknown costs are small relative to the other costs of the program. Therefore, all of the tonnage collected as part of the stationary container program is included in the Analyzed MSW tonnage.

²⁰ Although HHW is not included in the definition of Analyzed MSW, a separate analysis of the costs incurred by the City for the HHW program, exclusive of the costs incurred by individuals to transport HHW to the Corporation Yard, is provided in Section 4.5.5.

**TABLE 4-2: PORTION OF WASTE STREAM FOR WHICH COLLECTION
COSTS ARE ESTIMATED**

WASTE TYPE	TOTAL MSW (tons)	ANALYZED MSW (tons)
GARBAGE		
Residential-Automated Collection	57,285	57,285
Residential-Manual Collection	1,283	1,283
Commercial	44,775	44,775
Self Haul to Landfill	<u>2,972</u>	<u>0</u>
Subtotal Garbage	106,315	103,343
BRUSH AND BULKY WASTE	7,868	7,868
RECYCLABLES		
Mobile Recycling Trailers	401	401
White Goods & Move-in Boxes	113	113
Stationary Containers	279	279
City Office Papers	<u>30</u>	<u>30</u>
Subtotal Recyclables	823	823
HOUSEHOLD HAZARDOUS WASTE	<u>11</u>	<u>0</u>
TOTALS	115,017	112,034

include Fleet Services, Risk Management, Customer Services, and Other Indirect City expenses for legal, accounting, purchasing, facilities maintenance, and other general government services.

Fleet Services charges Sanitation a rental fee to cover the costs of purchasing and maintaining the collection fleet and other vehicles used by Sanitation. These rents are established at the beginning of the fiscal year and reflects the prior year's costs. The City provides self insurance through the Risk Management Division of the Financial Services Department. Sanitation is charged a fee based on the prior year's claim experiences. The Customer Service Division of the Financial Services Department provides billing and collection services for Sanitation.

The resulting reported expenses for FY 1992 are provided in Table 4-3. This table shows direct charges to Sanitation of about \$5.17 million and indirect charges of about \$1.21 million, for total expenses of \$6.39 million.

4.3.2 Adjustments to the City's Reported Costs

For the purpose of this analysis, seven adjustments were made to the reported costs, and two adjustments were made to the reported recycling revenues. The total adjusted gross cost is \$6.70 million, while the adjusted net cost is \$6.68 million, both of which are about five percent higher than the reported costs. This increase is primarily attributable to the method of treating capital costs in this analysis. All of these adjustments are briefly discussed below.²¹

4.3.2.1 Other Contractual Services

Because the revenues received from the sale of the office wastepaper were greater than the charge for picking up and marketing these materials, and the contractor only billed the City if there was a net cost, costs reported for the Sanitation Division do not include the hauling charges of the office wastepaper contractor. This charge was \$20 per visit to the City. In FY 1992 the contractor made 24 visits, resulting in a total hauling charge of \$480 (i.e., 20 times 24). This amount was added to the cost of "Other Contractual Services" reported by Sanitation.

4.3.2.2 Fleet Services Expenses

As mentioned previously, Fleet Services charges a rental fee that is based on the prior year's expenses. For this analysis, rather than using these rental fees, the actual FY 1992 G&A, collection vehicle operating and maintenance expenses and capital costs, and other capital costs (e.g., capital costs of equipment used in the maintenance shop) were calculated from data provided by Fleet Service and the City's Accounting & Budgeting Division.

Table 4-4 shows the comparison of the rentals and actual costs. In this analysis a portion of the capital cost of the Corporation Yard, where the Fleet Services vehicle maintenance shop and the parking and storage lot for collection vehicles is located, is included in the Fleet Service Cost. The FY 1992 rentals do not include these costs. Furthermore, the expenses incurred to purchase equipment and furnishings in prior years are not included in the FY 1992 rentals charged to Sanitation. The

²¹ For a more detailed accounting of the methodologies and data used to make these adjustments, see Appendix C.

TABLE 4-3: STATEMENT OF REVENUES AND EXPENSES
Year Ending June 30, 1992

CATEGORY	REPORTED COSTS	ADJUSTED COSTS
<u>RECYCLABLES REVENUES</u>		
<u>SANITATION EXPENSES</u>	\$13,778	\$13,453
Salary and Wages	\$1,881,031	\$1,881,031
Landfill Expenses	933,970	933,970
HHW Contract Services	33,329	33,329
Other Contractual Services	41,143	41,623
Subtotal	<u>1,008,442</u>	<u>1,008,922</u>
Fleet Services	1,901,460	1,917,327
Property & Liability Insurance	<u>137,544</u>	<u>137,544</u>
Subtotal	2,039,004	2,054,871
Supplies & Equipment	200,906	76,245
Capital Outlays (Sanitation Only)	45,201	0
Capital Costs (Sanitation Only)	<u> </u>	<u>343,611</u>
Total Sanitation	5,174,584	5,364,680
<u>OTHER INDIRECT EXPENSES</u>		
City General & Administration	1,019,497	1,138,849
Customer Services	193,204	187,297
Subtotal	<u>1,212,701</u>	<u>1,326,146</u>
Recyclables Drop-Off (Gas and Oil)	<u>0</u>	<u>6,880</u>
Total Other Costs	1,212,701	1,333,026
GROSS COST IN FY92	\$6,387,285	\$6,697,706
<u>NET COST (EXPENSES MINUS REVENUES)</u>	<u>\$6,373,507</u>	<u>\$6,684,253</u>

SOURCES: City of Scottsdale, "Budget Worksheet," Computer Printout, March 18, 1993, and City of Scottsdale, "1993-1994 Budget Summary and City of Scottsdale, "Sanitation Fund Summary 1993-94."

actual cost shown in Table 4-4 explicitly accounts for the capital costs of the equipment and furnishings used by Fleet Services. Finally, the rental fee includes a charge of \$11,544 to account for a financial deficit in a prior year. Because this was not an actual expense that occurred in FY 1992, it was excluded from the actual cost reported in Table 4-4.

4.3.2.3 Supplies & Equipment Expenses

The reported costs for Sanitation include expenditures of \$81,290 for residential garbage containers and \$43,371 for commercial garbage containers. These items were treated as operating expenses rather than capital expenses because the unit costs were less than \$1,000. In this analysis containers are considered capital assets because they have useful lives of five to 20 years. Therefore, the total expense of \$124,661 (i.e., \$81,290 plus \$43,371) was subtracted from the total reported \$200,906 cost of Supplies & Equipment to obtain the \$76,245 adjusted cost. The capital cost of the residential and commercial containers is included in the capital costs calculation discussed below.

4.3.2.4 Capital Costs and Capital Outlays

A capital expense is the purchase of an asset or service with a useful life of more than one year. Capital expenses are often reported as capital outlays (i.e., the actual payment made during the year) or are depreciated/amortized; for example, the capital outlay is divided by the useful life of the asset. Capital assets may be purchased with cash, be financed, or be acquired by a combination of both cash and financing. If financed, interest payments on borrowed funds are reported as interest expenses.

Although either a capital outlay or depreciation/amortization approach is appropriate for generating the financial statements of non-profit organizations, neither is appropriate for estimating economic costs. The reporting of capital outlays does not recognize that the capital asset will be used over several years; therefore, its costs should be spread over several years. The depreciation and amortization plus interest approach does not adequately account for assets purchased with cash, i.e., it does not account for the time value of money. On the other hand, if a capital asset is financed, the interest payment in any year is highly dependent on the age of the debt and the repayment schedule, i.e., interest payments may vary significantly over the life of the asset.

The approach used in this analysis is to "annualize" capital expenses over the useful life of the assets assuming a 7-percent cost of capital. The cost of capital reflects the value of invested funds to the City. If the City pays cash for an asset, this approach assumes an additional imputed annual cost of 7 percent (i.e., the cost of capital) for investment in the asset. If the asset is financed with borrowed funds, the analysis substitutes an imputed cost of 7 percent for the actual interest expenses. Using this approach, the capital cost is the same regardless of the sources of funds, the repayment schedule of borrowed funds, or the age of the asset during its useful life. This approach is similar to methods used by private firms when making investment and borrowing decisions.²²

The total capital cost of \$342,611 shown in Table 4-3 was calculated using this method for calculating capital costs. This includes the costs of assets, exclusive of the collection vehicles which were included in the Fleet Service cost, used by Sanitation. These assets are reported in the City's Fixed Asset account, which is summarized in Tables B.5 of Appendix B and C.7 of Appendix C. In

²² Refer to Appendix D for a detailed discussion of determining capital costs.

TABLE 4-4: COMPARISON OF FLEET RENTAL AND ACTUAL COSTS IN FY 1992

TYPE OF COST	RENTALS	ACTUAL
General & Administrative	\$96,120	\$96,120
Vehicle O&M	1,395,096	1,196,567
Vehicle Capital Cost	398,700	532,306
Corporation Yard Capital Cost		30,116
Other	11,544	62,218
Total	\$1,901,460	\$1,917,327

NOTE: In the Rental column "Other Cost" is equal to a financial deficit from the prior year. In the Actual column "Other Cost" is equal to the capital cost for equipment and furnishings.

total, the estimated capital cost of containers, including roll-off containers, was \$306,552. This represents about 89 percent of the \$343,611 capital cost shown in Table 4-3. Another 9 percent is attributed the office space used by Sanitation at the Corporation Yard. The balance of the capital costs are for furniture, equipment, and machinery. In this analysis, this capital cost is substituted for the \$45,201 capital outlay reported by the City.

4.3.2.5 City Indirect (G&A) Expenses

The City Manager, City Clerk, City Attorney, Intergovernment Relations, Organizational Effectiveness (including Human Resources), City Auditor, Financial Services Administration, Accounting and Budgeting, Purchasing, General Services Administration, Office of Management Systems, Communications and Public Affairs, Capital Project Management, Municipal Services Administration and Facilities Management Divisions of the City provide services throughout the City including those provided to the Sanitation Division. Each year the City calculates, based on the prior year's data, the ratio of these indirect expenses to direct expenses. This ratio is used to determine the Indirect Expenses attributed to each activity.

The City's methodology for allocating these indirect expenses is very similar to the methodology used in this analysis. The major differences in this analysis are: (1) the actual FY 1992 expenses rather than the prior year's expenses are used; (2) capital outlays are excluded from the annual expenses when determining the percent of Sanitation's direct cost to the total Citywide direct costs; and (3) the capital costs are included in the cost of providing these indirect services.²³

The City allocated about 12.6 percent of the Customer Service expenses to Sanitation. The expenses included the FY 1992 capital outlays and excluded the capital costs of fixed assets purchased in prior years. In this analysis the \$187,297 attributed to Customer Services was calculated by (1) subtracting the FY 1992 capital outlays from the actual reported expenses for Customer Service; (2) adding the capital costs attributed to Customer Services; and (3) multiplying this result by 12.6 percent.

4.3.2.6 Recyclables Drop-Off Costs

Individuals who bring recyclables to the mobile recycling drop-off sites incur out-of-pocket costs for gas and oil. The \$6,880 shown in Table 4-3 was calculated by multiplying the estimated 57,360 incremental miles traveled by individuals who participated in the mobile recycling program by \$0.12, i.e., the Internal Revenue Service's allowable deduction for using a personal automobile for charitable activities in 1992.

4.3.2.7 Adjustments in Recycling Revenues

The Sanitation Division reported that it received \$13,778 in revenues for recycled materials: \$9,494 for the Mobile Trailer Recycling program, \$329 for white goods; \$1,129 for move-in-boxes; \$2,099 for the Stationary Container program; and \$728 for the Office Wastepaper program. For this analysis two small adjustments were made to the Mobile Trailer Recycling and Office Wastepaper revenue figures.

The \$9,494 reported revenues attributed to the Mobile Recycling program include revenues received

²³ A more detailed discussion of the methodology used in this study is provided in Appendix C.

from recyclables collected in Scottsdale schools in October 1991 and April 1992 as well as recyclables collected during the Earth Fest held in April 1992. In total about 37 tons of materials were recovered through these activities. The reported revenues from the Mobile Recycling program include the revenues received from these additional 37 tons of recyclables. Thus, approximately \$8,688 was received from the Mobile Recycling program and \$806 from the materials collected from these other programs.

The reported \$728 received from the office wastepaper recycling program were actually the net revenues received by the City. The contractor charged a fee of \$20 for each visit it made to the City to pick up the office wastepaper. The contractor made 24 visits in FY 1992 and charged the City \$480. This fee was offset by the revenues received by the contractor prior to the City receiving its share. Thus the gross revenues were equal to \$1,208, i.e., \$728 plus \$480.

4.3.3 Analyzed MSW Costs

Of the \$6.70 million total cost, approximately \$6.62 million, or 99 percent, is attributed to the collection, marketing of recovered materials, and disposition of the 112,000 tons of Analyzed MSW. The balance of about \$82,300 was spent to dispose of 2,970 tons of self-hauled waste brought to the Tri-City landfill, at a cost of \$28,800, and the management of 11 tons of HHW, at a cost of \$53,500. Both of these costs include a portion of the G&A expenses allocated to these activities.

4.4 Allocation of Costs by Functional Area

Within this section, the City's \$6.60 million net cost for managing the 112,000 tons of Analyzed MSW is allocated among the functional areas of G&A, collection, promotion and education, and disposal costs. To make these allocations, each detailed expenditure made by the City was categorized by functional area.

Sixty-two percent of the City's total expenses is attributed to the collection of MSW: about 25 percent for G&A expenses, and about 13 percent for landfill tip fees. Of the approximately \$1.63 million G&A expense, about 69 percent is attributed to City Indirect Costs, 11 percent to Customer Services, 7 percent to Fleet Management, and 13 percent to Sanitation. As shown in Figure 4-5, about 88 percent of the G&A expenses is operation and maintenance costs, while the balance of 12 percent is capital costs. About 44 percent of the capital costs is attributed to office space, i.e., buildings and land, and another 34 percent to machinery and equipment. The balance was for office furniture and equipment, and light motor vehicles, primarily automobiles. Over 93 percent, or about \$64,000, of the machinery and equipment capital cost is the cost of the City's mainframe computer used for payroll, billings, and most other Citywide computer related functions, which is attributed to Sanitation.

Of the gross cost of \$6.62 million, about \$4.07 million, or about 61 percent, was for the collection of garbage, brush, and recyclables. As shown in Figure 4-6, about 77 percent of the collection costs were O&M expenses. Over 71 percent of the \$3.15 million O&M expense was labor costs: \$1.73 million for collection crews, and \$0.513 for maintenance personnel. The balance was for uniforms, insurance, small tools and equipment, and miscellaneous contracts. (See Table B.3 of Appendix B for details.) About 56 percent of the \$0.918 million capital cost was for collection vehicles and another 35 percent was for purchase and repair of containers. The balance of the capital costs was for the maintenance shop building and equipment and the collection vehicle parking and storage space at the Corporation

FIGURE 4-5: GENERAL AND ADMINISTRATIVE O&M AND CAPITAL COSTS

Cost to Manage 112,000 Tons of Analyzed MSW
(Cost in Millions of Dollars)

TOTAL G&A COST OF \$1.63

CAPITAL COST OF \$0.202

FIGURE 4-6: COLLECTION O&M AND CAPITAL COSTS

Cost to Manage 112,000 Tons of Analyzed MSW
(Cost in Millions of Dollars)

TOTAL COLLECTION COST OF \$4.07

CAPITAL COST OF \$.918

Yard.

4.5 Allocation of Costs by Type of Waste

In the following subsection, the City's \$6.60 million net cost of managing the 112,000 tons of Analyzed MSW in FY 1992 is allocated to the cost of managing the 58,600 tons of residential garbage from single-family homes, 44,800 tons of commercial garbage from multi-family homes, apartment buildings, and businesses; 7,870 tons of brush; and 823 tons of recyclables. Also provided, in subsection 4.5.5, are the allocated costs of managing the 11 tons of HHW. For each type of waste, allocated costs are also broken down by functional area.

The results presented are total allocated costs, i.e., G&A costs are included in the allocation.²⁴ In general, the allocation process followed the following steps: (1) the portion of each expenditure that was applicable to the management of the 112,000 tons of Analyzed MSW was determined; (2) expenses that were dedicated to residential garbage, commercial garbage, brush, recyclables, or HHW were identified (e.g., the cost of the HHW collection day contractor was allocated to HHW); and (3) other expenses were allocated based on a number of factors such as discussed in Appendix B. Because the Sanitation Division maintains detailed records of expenses and collection crews keep track of the time spent by type of service, a good portion of the allocations were obtained from Sanitation records as shown in Table C.1 of Appendix C.

G&A costs that were not specifically allocated to a type of waste in Step 2 above were allocated to each waste type in proportion to the dollar value allocated to each type of waste for all non-G&A costs. Consequently, the absolute value of the costs attributed to the management of residential garbage, commercial garbage, brush, recyclables, and HHW reflect all costs, including G&A expenses, and the relative value of these costs is unaffected by the allocation of the G&A expenses. The slight variations in the percentage of G&A expenses among the various types of waste occur because some G&A expenses were allocated exclusively to one or another type of waste.

4.5.1 Cost of Managing Residential Garbage

The City's FY 1992 cost of managing the approximately 58,600 tons of residential garbage collected from single-family homes was approximately \$3.71 million. The Average Cost of managing these 58,600 tons of residential garbage was \$63 per ton.

The allocation by functional area of the \$3.71 million spent is shown in Figure 4-7. Of this \$3.71 million, \$2.33 million (about 63 percent) was spent on collection. Most of the residential garbage (about 98 percent) was collected using automated collection vehicles operated by a single person. An additional \$912,000 (about 25 percent) is attributed to G&A expenses. Only about \$1,360 (less than 1 percent) was spent on promotion and education expenses.

Landfill tip fees accounted for about \$467,000 (about 13 percent) of the total cost of managing residential garbage. This reflects an average cost of just under \$8 per ton at the landfills. Neither the Tri-City nor Maricopa County's Cave Creek landfill was lined. Furthermore, these fees do not account for the cost of closing and post-closure monitoring of the landfills. Since FY 1992, the tip fees in the

²⁴ The allocation procedures are provided in the tables presented in Appendix B.

FIGURE 4-7: ALLOCATION OF TOTAL COSTS TO MANAGE RESIDENTIAL GARBAGE

Allocation by Functional Area
(Cost to Manage 58,600 Tons of Residential Garbage)

TOTAL COST IS \$3,708,000

Scottsdale area have increased significantly and in 1994 range between \$14 to \$17 per ton. This increase reflects, in part, the cost to comply with Arizona's new landfill regulations, which include requirements for liners, closure, and post-closure monitoring.

4.5.2 Cost of Managing Commercial Garbage

The City's FY 1992 cost of managing the approximately 44,800 tons of commercial garbage collected by the City from multi-family homes, apartment buildings, and businesses was approximately \$1.86 million. The average cost of managing these 44,800 tons of commercial garbage was \$41 per ton. In part, the average cost of managing commercial garbage is less than the average cost of managing residential garbage because the larger containers used to pick up commercial garbage result in fewer stops per ton of garbage collected.

The allocation by functional area of the \$1.86 million spent is shown in Figure 4-8. Of this \$1.86 million, \$1.04 million (56 percent) was spent on collection. An additional \$457,000 (25 percent) is attributed to G&A expenses. Only about \$700 (less than 1 percent) was spent on promotion and education expenses.

Landfill tip fees accounted for about \$354,000 (19 percent) of the total cost of managing commercial garbage. The landfill tip fee was about \$8 per ton, as it also was for residential garbage, and reflects the cost of operating unlined landfills. Furthermore, this cost does not include the cost of closure and post-closure monitoring of the landfills.

4.5.3 Cost of Managing Brush and Bulky Wastes

The City's FY 1992 cost of managing the approximately 7,970 tons of brush and bulky wastes collected and disposed of by the City was approximately \$860,000. The Average Cost of managing these 7,970 tons of brush and bulky wastes was \$109 per ton. In part, the Average Cost of managing brush and bulky wastes is greater than the Average Cost of managing residential and commercial garbage because two-man crews are used rather than one-man crews.

The allocation by functional area of the \$860,000 spent is shown in Figure 4-9. Of this \$860,000, \$585,000 (68 percent) was spent on collection. An additional \$213,000 (25 percent) is attributed to G&A expenses. Only about \$300 (less than 1 percent) was spent on promotion and education expenses.

Landfill tip fees accounted for about \$62,000 (7 percent) of the total cost of managing brush and bulky waste. The landfill tip fee was about \$8 per ton, the same as for garbage, and reflects the cost of operating unlined landfills. Furthermore, this cost does not include the cost of closure and post-closure monitoring of the landfills.

4.5.4 Cost of Managing Recyclables

The City's FY 1992 gross cost of managing the approximately 823 tons of recyclables collected and marketed by the City was approximately \$192,000. The City earned about \$13,500 from the sale of these materials. The net cost for all the recycling programs in FY 1992 was about \$178,000. The average net cost of managing these 823 tons of recyclables was \$217 per ton. Exclusive of the state's \$0.25 per ton recycling fee charged at the landfills, the net cost for all the recycling programs in FY

FIGURE 4-8: ALLOCATION OF TOTAL COSTS TO MANAGE COMMERCIAL GARBAGE

Allocation by Functional Area
(Cost to Manage 44,800 Tons of Commercial Garbage)

TOTAL COST IS \$1,855,000

FIGURE 4-9 ALLOCATION OF TOTAL COSTS TO MANAGE BRUSH

Allocation by Functional Area
(Cost to Manage 7,870 Tons of Brush)

TOTAL COST IS \$860,000

1992 was about \$150,000, or about \$182 per ton.

The allocation by functional area of the \$192,000 gross cost is shown in Figure 4-10. Of this \$192,000, \$113,000 (59 percent) was spent on collection, \$48,100 (25 percent) on G&A expenses, \$2,200 (1 percent) on promotion and education expenses, and \$28,500 (15 percent) on the State recycling fee, charged for the disposal of MSW at the landfills, used to develop markets for recyclables. Exclusive of the State's \$0.25 recycling fee charged at the landfills, about 70 percent of the cost of managing recyclables was collection costs, 29 percent G&A expenses, and about 1 percent was promotion and education expenses.²⁵

The above results reflect the costs of collecting and marketing recyclables from the mobile trailer recycling, office wastepaper, move-in-box, white good, and stationary container recycling programs. The incremental program costs for each of these programs is discussed in Section 4.6.

4.5.5 Cost of Managing HHW

The City's FY 1992 cost of managing the approximately 11 tons of recyclables collected and marketed by the City was approximately \$53,300. The allocation by functional area of the \$53,300 cost is shown in Figure 4-11. About \$40,900 (77 percent) was spent on collection, \$11,400 (21 percent) on G&A, and \$940 (2 percent) on promotion and education.

4.6 Program Incremental Costs

In this section the estimated Program Incremental Cost of Scottsdale's mobile trailer, office wastepaper, move-in-box, white good, and stationary container recycling programs are presented.²⁶ A Program Incremental Cost (or Savings) is defined as "the difference between the cost of managing MSW with and without the inclusion of a particular program." Each Program Incremental Cost presented below reflects FY 1992 price levels and contractual relationships and can be interpreted as the FY 1992 cost or savings of a particular program.

The results of the Program Incremental Cost analysis are provided in Tables 4-5 through 4-9. Each table shows in the first column the costs incurred by the City in FY 1992, which included the costs of all of the recycling programs (i.e., "With Program"). The second column of each table (i.e., "Without Program") shows an estimate of the G&A, collection, landfill, and promotion and education expenses and revenues that would have occurred if a given program had never been implemented. The difference, i.e., the incremental cost (or savings), is provided in the third column. These incremental costs are rounded to the nearest hundred dollars to emphasize that these costs are estimates and not actual reported costs.

²⁵ The local newspaper publishes the schedule for the mobile recycling program as a public service.

²⁶ The State of Arizona's recycling fee charged at the landfills is not included in this analysis. Therefore, the results are not skewed by this fee and reflect the costs or savings of each program. However, since the money raised from these fees is used by the State to help develop markets for recycled materials, the exclusion of this fee may result in an underestimate of the incremental cost of a program or an overestimate of its savings.

FIGURE 4-10 ALLOCATION OF TOTAL COSTS TO MANAGE RECYCLABLES

Allocation by Functional Area
(Cost to Manage 823 Tons of Recyclables)

TOTAL GROSS COST IS \$192,000

TOTAL REVENUE IS \$13,500

FIGURE 4-11 ALLOCATION OF TOTAL COSTS TO MANAGE HHW

Allocation by Functional Area
(Cost to Manage 11 Tons of HHW)

TOTAL GROSS COST IS \$53,300

4.6.1 Mobile Trailer Recycling Program

The FY 1992 estimated Program Incremental Cost for the mobile trailer recycling program is about \$69,400, or \$173 per ton for the 401 tons of recyclables recovered through this program.

The principal cost of the mobile recycling program is the labor cost to staff the mobile trailers each weekend. Two Sanitation workers are assigned to collect and weigh the recyclables brought to each mobile unit, resulting in eight person-days of labor each weekend. Two of these are part-time employees hired specifically for this program. All of their hourly wages are included in the Program Incremental Cost. The other two employees are full-time Sanitation employees. Since this work occurs on the weekend, each of these Sanitation workers is paid overtime. In total, the incremental labor cost for the program was \$64,000, which represents about 80 percent of the \$80,200 incremental collection cost of the mobile recycling program. The balance of the incremental collection cost consists of \$6,900 incurred by individuals delivering recyclables to the trailers;²⁷ \$4,700 for Sanitation vehicles' O&M costs; and \$4,600 for the Sanitation vehicles' and trailers' capital costs. An additional estimated \$1,100 cost was incurred to promote the program.

These costs were partially offset by an estimated \$3,200 incremental savings in landfill tip fees and the approximately \$8,700 of revenue earned from the sale of the recyclable materials. In FY 1992 the landfill tip fees did not reflect the cost of building and operating lined landfills, nor did they include the cost of closure and post-closure monitoring. If it is assumed that these costs are about \$8 per ton,²⁸ the savings at the landfill would be almost \$6,400, and the Program Incremental Cost would be about \$66,200, or \$165 per ton.

4.6.2 Office Wastepaper Recycling Program

The FY 1992 estimated Program Incremental Savings for the office wastepaper recycling program is about \$900, or \$30 per ton for the 30 tons of recyclables recovered through this program.

The City paid the contractor \$480 to collect the wastepaper from four City buildings. This cost was offset by revenues of about \$1,210. In addition, the City saved another \$200 in landfill tip fees. If the cost of liners, closure, and post-closure monitoring are considered, the program would have saved the City about another \$240. This would have resulted in a total savings for recycling 30 tons of office wastepaper of about \$1,150, or \$38 per ton.

4.6.3 Move-in Box and White Good Programs

The FY 1992 estimated Program Incremental Cost for the move-in-box recycling program is about \$500, or about \$9 per ton for the 58 tons of recyclables recovered through this program. The FY 1992 estimated Program Incremental Cost for the white goods recycling program is also about \$500,

²⁷ This cost is an estimate of the out-of-pocket costs incurred by individuals who bring recyclables to the mobile trailer sites. It does not include the cost of their time, i.e., the value of their labor. Such an estimate is beyond the scope of this study.

²⁸ This is the approximate increase in the tip fee at the landfills in the Scottsdale area that are now complying with Subtitle D requirements.

**TABLE 4-5: INCREMENTAL COST OF THE
MOBILE RECYCLING PROGRAM**

COST CATEGORIES AND REVENUES	WITH PROGRAM	WITHOUT PROGRAM (dollars)	INCREMENTAL COST (SAVINGS)
General & Administrative	1,647,375	1,647,375	0
Collection	4,110,588	4,030,386	80,200
Landfill	933,970	937,157	(3,200)
Promotion & Education	5,535	4,401	1,100
Revenues	(13,453)	(4,765)	(8,700)
Total	6,684,015	6,614,554	69,400
Tons Managed			401
Incremental Cost per Ton			173

**TABLE 4-6: INCREMENTAL COST OF THE
OFFICE WASTEPAPER RECYCLING PROGRAM**

COST CATEGORIES AND REVENUES	WITH PROGRAM	WITHOUT PROGRAM (dollars)	INCREMENTAL COST (SAVINGS)
General & Administrative	1,647,375	1,647,375	0
Collection	4,110,588	4,110,108	500
Landfill	933,970	934,209	(200)
Promotion & Education	5,535	5,535	0
Revenues	(13,453)	(12,245)	(1,200)
Total	6,684,015	6,684,982	(900)
Tons Managed			30
Incremental Cost per Ton			(30)

**TABLE 4-7: INCREMENTAL COST OF THE
MOVE-IN-BOXES RECYCLING PROGRAM**

COST CATEGORIES AND REVENUES	WITH PROGRAM	WITHOUT PROGRAM (dollars)	INCREMENTAL COST (SAVINGS)
General & Administrative	1,647,375	1,647,375	0
Collection	4,110,588	4,108,678	1,900
Landfill	933,970	934,432	(500)
Promotion & Education	5,535	5,370	200
Revenues	(13,453)	(12,324)	(1,100)
Total	6,684,015	6,683,531	500
Tons Managed			58
Incremental Cost per Ton			9

**TABLE 4-8: INCREMENTAL COST OF THE
WHITE GOODS RECYCLING PROGRAM**

COST CATEGORIES AND REVENUES	WITH PROGRAM	WITHOUT PROGRAM (dollars)	INCREMENTAL COST (SAVINGS)
General & Administrative	1,647,375	1,647,375	0
Collection	4,110,588	4,109,633	1,000
Landfill	933,970	934,405	(400)
Promotion & Education	5,535	5,379	200
Revenues	(13,453)	(13,124)	(300)
Total	6,684,015	6,683,668	500
Tons Managed			55
Incremental Cost per Ton			9

**TABLE 4-9: INCREMENTAL COST OF THE
STATIONARY CONTAINER PROGRAM**

COST CATEGORIES AND REVENUES	WITH PROGRAM	WITHOUT PROGRAM (dollars)	INCREMENTAL COST (SAVINGS)
General & Administrative	1,647,375	1,647,375	0
Collection	4,110,588	4,104,694	5,900
Landfill	933,970	936,185	(2,200)
Promotion & Education	5,535	4,746	800
Revenues	(13,453)	(11,354)	(2,100)
Total	6,684,015	6,681,647	2,400
Tons Managed			279
Incremental Cost per Ton			9

or \$9 per ton for the 55 tons of recyclables recovered through this program. These programs are discussed together because brush collection vehicles and crews are used to collect both of these types of recyclables.

About two percent of the time spent by the brush collection vehicles and crews is devoted to the collection of move-in boxes, and one percent to white goods. Because these activities are performed by the brush collection crews with little or no overtime involved, there is no incremental labor cost.²⁹ Similarly, the City did not increase the size of its collection fleet to implement these programs, therefore, there is no incremental capital cost for these programs.

On the other hand, there are increased vehicle O&M costs for maintenance labor, materials, and fuel that reflect the increased time the brush collection vehicles are in service. The incremental collection costs reflect these estimated increases in vehicle O&M costs. A small promotional and educational expense is assumed to be required to promote these programs.

These costs are offset by the revenues earned from the sale of these recovered materials: \$1,100 for the move-in boxes and \$300 for the white goods. In addition, these programs save about \$500 and \$400 in tip fees at the landfills, respectively.

If the move-in boxes and white goods had not been collected separately for recycling, they would have been collected by the brush crews during their normal routes and disposed of in a brush landfill. If, however, these materials were required to be disposed of in a Subtitle D landfill and the costs of closure and post-closure maintenance were included in the tip fees, then the landfill savings would almost double. This would result in there being virtually no incremental cost to the move-in box program and a small \$1- to \$2-per-ton incremental savings from the white good program.

4.6.4 Stationary Container Recycling Program

The FY 1992 estimated Program Incremental Cost for the stationary container recycling program is about \$2,400, or \$9 per ton for the 279 tons of recyclables recovered through this program.

As was true of the move-in box and white goods programs, there is little or no incremental labor cost because no additional staff is required and little or no overtime is used to pick-up these materials. The principal cost of this program is the incremental O&M cost of the residential collection vehicles used in the program. Of the \$5,900 incremental collection cost, \$4,800 (82 percent) is attributed to the collection vehicle O&M cost. The balance is the estimated incremental container capital and O&M cost. To this is added a small \$800 estimated incremental cost to promote the program.

These costs are partially offset by the \$2,100 of revenue received from the sale of the materials recovered through the program and an estimated savings of \$2,200 in tip fees at the landfill. In FY 1992 the landfill tip fees did not reflect the cost of building and operating lined landfills, nor did they include the cost of closure and post-closure monitoring. If it is assumed that these cost are about \$8 per ton, then the savings at the landfill would be almost \$4,500 and there would be virtually no

²⁹ These recycling activities are performed by increasing the productivity of the collection crews. Because there would be no cost savings to the City if the move-in box and white good programs were not implemented, there is no incremental cost of these programs.

incremental cost or savings associated with the stationary container program.

5. Energy Usage Analysis

The primary forms of energy used within Scottsdale's IMSWM System are the fuels (gasoline and diesel) consumed by the collection vehicles. Fuel is also consumed by the heavy equipment at the landfills, container repair vehicles, and fleet automobiles and trucks are also presented. In addition, gasoline is consumed by individuals to transport their recyclables to the mobile drop-off sites.

5.1 Summary of Results

In FY 1992, the Scottsdale IMSWM System configuration resulted in the consumption of the equivalent of over 201,000 gallons of diesel fuel. About 97 percent of this energy consumption was for the collection of residential and commercial garbage, and brush and bulky wastes, which together account for about 99.3 percent of the MSW managed. As shown in Table 5-1, there was a significant difference between the per-ton energy consumption for garbage and brush collection (about two gallons per ton) and the per-ton consumption for collecting and delivering recyclables (about seven gallons per ton). This difference is primarily caused by the fuel consumed by individuals who delivered their recyclables to the mobile drop-off trailers.

The contribution of each of Scottsdale's recycling programs to energy consumption within the IMSWM System is presented in Table 5-2. This data clearly shows that the energy consumed by the vehicles of participants in the mobile recycling program is the largest single contributor to the relative energy inefficiency of recycling in Scottsdale.

The sections that follow provide the detail behind these summary results. Section 5.2 presents the analysis of collection vehicle energy consumption. Section 5.3 covers energy consumption at the landfills. Section 5.4 presents the analysis of energy consumed to collect and haul recyclables, and Section 5.5 analyzes energy consumed for recycling container repair.

5.2 Collection Vehicle Energy Consumption

Data on the fuel consumed by the collection vehicles, as shown in Table 5-3, was provided by the City's Fleet Services Division (Fleet Services). Some vehicles use gasoline, others use diesel fuel. Since the energy content per gallon, measured in British Thermal Units (Btus), of gasoline is less than that of diesel fuel, the use of a gallon of gasoline consumes less energy than the use of a gallon of diesel fuel. For this reason gasoline consumption is converted to equivalent gallons of diesel fuel (on a Btu basis) by multiplying the gallons of gasoline by the ratio of the Btu content of gasoline to the Btu content of diesel fuel (i.e., 127,650/146,390).³⁰

A number of adjustments were made to the data in Table 5-3 to calculate the aggregate fuel consumed by the collection vehicles, which is provided in Table 5-4. The fuel consumed by the pick-up trucks classified as "collection" vehicles by Fleet Services is excluded from the results provided in Table 5-4. Furthermore, some of the residential and brush vehicles were used by Sanitation to collect recyclables recovered through the stationary containers and move-in boxes and white goods programs. Therefore,

³⁰ According to Marks Standard Handbook for Mechanical Engineers, 8th Edition, McGraw Hill Publishers, the energy content of gasoline is about 20,750 Btu/lb. At 6.152 pounds per gallon, the Btu per gallon is 127,650. Similarly, the energy content of diesel fuel is about 18,400 Btu/lbs. At 7.956 pounds per gallon the Btu content per gallon is about 146,390.

TABLE 5-1: ENERGY CONSUMED TO MANAGE GARBAGE, BRUSH, AND RECYCLABLES
(equivalent gallons/ton)

ACTIVITY	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES
Sanitation Collection Vehicles	2.1	1.3	2.2	2.9
Individual's Cars and Trucks				4.2
Container Repair & Misc. Fleet	<.1	<.1	<.1	<.1
Landfills	0.4	0.4	0.4	
Total Fuel Equivalent (gallons/ton)	2.5	1.8	2.7	7.2
Total Fuel Equivalent (Btu/ton)	370,000	256,500	390,200	1,049,600

NOTES:

1. Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.
2. Btu content of diesel fuel is 146,390 Btu per gallon.
3. Based on 58,568, 44,775, 7,868, 793 tons of residential garbage, commercial garbage, brush, and recyclables, respectively.

**TABLE 5-2: ENERGY CONSUMPTION FOR RECYCLING
PROGRAMS IN SCOTTSDALE (FY92)**

RECYCLING PROGRAM	EQ. GAL.	TONS	GAL/ TON
MOBILE RECYCLING			
Sanitation Tractors & Trailers	1,088	401	2.7
Participant Vehicles	3,335	401	8.3
Total	4,423	401	11.0
STATIONARY CONTAINERS			
	711	279	2.5
MOVE-IN BOXES			
	357	58	6.2
WHITE GOODS			
	179	55	3.3

NOTE: Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.

TABLE 5-3: SANITATION FLEET FUEL CONSUMPTION DATA - FY91/92

ID NO.	MAKE	MODEL YEAR	FUEL TYPE	GAL/ YEAR	EQ. GAL/ YEAR	MILES/ YEAR	MILES/ EQ. GAL
ADMINISTRATION							
9051	Chevy Caprice	1988	Gasoline	201	175	2,433	13.90
TOTAL ADMINISTRATION				201	175	2,433	13.90
RESIDENTIAL COLLECTION							
2206	Dodge Pickup	1982	Gasoline	41	38	1,366	37.94
2212	Dodge Pickup	1987	Gasoline	714	623	8,999	14.44
2216	Chevy Pickup	1992	Gasoline	801	698	8,731	12.51
2420	Peterbilt 320 Side Loader	1992	Deisel	1,108	1,108	4,426	3.99
2421	Peterbilt 320 Side Loader	1992	Deisel	955	955	3,390	3.55
2422	Peterbilt 320 Side Loader	1992	Deisel	1,175	1,175	3,232	2.75
2423	Peterbilt 320 Side Loader	1992	Deisel	678	678	1,737	2.56
2431	International Side Loader	1982	Deisel	2,439	2,439	7,342	3.01
2432	International Side Loader	1984	Deisel	6,074	6,074	18,504	3.05
2433	International Side Loader	1984	Deisel	5,129	5,129	23,897	4.66
2434	International Side Loader	1984	Deisel	6,027	6,027	18,845	3.13
2435	International Side Loader	1984	Deisel	5,700	5,700	16,600	2.91
2436	International Side Loader	1984	Deisel	4,922	4,922	17,245	3.50
2437	International Side Loader	1988	Deisel	3,419	3,419	11,375	3.33
2438	International Side Loader	1988	Deisel	6,209	6,209	18,162	2.93
2439	Crain Carrier SL	1987	Deisel	6,770	6,770	14,084	2.08
2440	Peterbilt 320 Side Loader	1988	Deisel	7,177	7,177	20,352	2.84
2441	Peterbilt 320 Side Loader	1988	Deisel	6,853	6,853	20,823	3.13
2442	Peterbilt 320 Side Loader	1988	Deisel	6,899	6,899	22,332	3.24
2443	Peterbilt 320 Side Loader	1988	Deisel	6,515	6,515	22,363	3.43
2444	Peterbilt 320 Side Loader	1988	Deisel	7,581	7,581	22,830	3.01
2445	Peterbilt 320 Side Loader	1988	Deisel	6,383	6,383	21,329	3.34
2446	Peterbilt 320 Side Loader	1988	Deisel	7,393	7,393	25,642	3.47
2447	Peterbilt 320 Side Loader	1988	Deisel	6,408	6,408	21,299	3.32
2448	Peterbilt 320 Side Loader	1988	Deisel	7,575	7,575	21,740	2.87
2449	Peterbilt 320 Side Loader	1988	Deisel	7,657	7,657	25,504	3.33
TOTAL RESIDENTIAL COLLECTION				122,402	122,203	402,129	3.29
COMMERCIAL COLLECTION							
2457	Crane Carrier	1986	Deisel	2,271	2,271	2,787	1.22
2458	Crane Carrier	1986	Deisel	6,995	6,995	18,640	2.66
2459	Crane Carrier	1986	Deisel	2,493	2,493	7,435	2.98
2460	Crane Carrier	1986	Deisel	7,056	7,056	18,266	2.59
2461	Crane Carrier	1986	Deisel	3,856	3,856	11,600	3.01
2462	Crane Carrier	1987	Deisel	7,997	7,997	17,842	2.23
2463	Peterbilt 320 Front Loader	1992	Deisel	3,030	3,030	9,691	3.20
2464	Peterbilt 320 Front Loader	1992	Deisel	3,443	3,443	11,855	3.44
2465	Peterbilt 320 Front Loader	1992	Deisel	3,322	3,322	10,799	3.25
2466	Peterbilt 320 Front Loader	1992	Deisel	3,663	3,663	11,135	3.04
2467	Peterbilt 320 Front Loader	1992	Deisel	3,555	3,555	14,428	4.06
2468	Peterbilt 320 Front Loader	1992	Deisel	3,238	3,238	10,029	3.10
TOTAL COMMERCIAL COLLECTION				50,919	50,919	144,487	2.84
BRUSH							
2201	Chevy Pickup	1992	Gasoline	550	480	6321	13.17
2557	International Rear Loader	1984	Deisel	2,924	2,924	11,539	3.95
2558	International Rear Loader	1984	Deisel	2,610	2,610	11,621	4.45
2559	International Rear Loader	1984	Deisel	2,759	2,759	11,218	4.07
2560	International Rear Loader	1984	Deisel	2,968	2,968	11,760	3.96
2561	Mack Rear Loader	1985	Deisel	998	998	3,998	4.01
2562	White Rear Loader	1987	Deisel	2,847	2,847	11,839	4.16
2563	White Rear Loader	1987	Deisel	2,761	2,761	12,910	4.68
TOTAL BRUSH				18,417	18,347	81,206	4.43
ROLL OFF							
2610	Peterbilt 320 RLOF	1991	Deisel	7,260	7,260	38,000	5.23
TOTAL ROLL OFF				7,260	7,260	38,000	5.23
RECYCLABLES							
3227	GMC FB	1985	Gasoline	716	624	2,943	4.72
4802	General Trailer	1973					
4806	Eager Beaver Trailer	1990					
TOTAL RECYCLABLES				716	624	2,943	4.72
CONTAINER REPAIR							
2214	Ford Pickup	1989	Gasoline	746	651	5,600	8.60
2220	Dodge Pickup	1987	Gasoline	939	819	8,447	10.31
2215	Dodge Pickup	1989	Gasoline	2,475	2,158	19,488	9.03
2803	Trailer	1980					
2602	Yale Forklift	1984	Gasoline	346	302	564	1.87
4403	Chevy C70 Flat Bed	1986	Diesel	1,869	1,869	11,845	6.34
TOTAL CONTAINER REPAIR				6,375	5,799	45,942	7.92

NOTE: Gasoline consumption is converted to equivalent gallons of diesel fuel by multiplying by the ratio of their BTU contents, i.e., 127.65/41.46, 3.08.

SOURCE: City of Scottsdale, "Monthly Fuel Expense Summary," Computer Printout of Fleet Fuel Data for June, Report 62, July 1, 1992.

TABLE 5-4: COLLECTION FLEET FUEL CONSUMPTION (FY 1992)

VEHICLES	GALLONS/ YEAR	MILES/ YEAR	MILES/ GALLON	TONS/ YEAR	GALS./ TON
RESIDENTIAL COLLECTION	120,135	383,145	3.19	58,568	2.1
BRUSH COLLECTION	17,331	72,638	4.19	7,868	2.2
COMMERCIAL (INC. ROLL OFFS)	58,179	182,487	3.14	44,775	1.3
TOTAL COLLECTION VEHICLES	195,645	638,271	3.26	111,211	1.8

SOURCE: City of Scottsdale, "Monthly Fuel Expense Summary," Computer Printout of Fleet Prod Data for June, Report #2, July 1, 1992.

NOTE: Gallons are expressed as equivalent (on a Btu basis) gallons of diesel fuel.

a proportion of the energy consumed is subtracted from the collection of residential garbage and brush and added to the energy consumed to collect recyclables.

Once a week an automated residential vehicle picks up the recyclables deposited in the 59 300-gallon and 13 80-gallon stationary containers located throughout the City. On average, this vehicle takes about half a day (i.e., 5 hours) to complete its route. This means that approximately 0.6 percent (approximately, 52 weeks times 5 hours/week divided by 44,200 hours³¹) of the fuel consumed by the residential collection vehicles, or about 711 gallons, can be attributed to the collection of recyclables rather than residential garbage. The net result is that 120,135 gallons of diesel fuel were used to collect 58,568 tons of residential garbage. The average fuel consumption per ton was 2.1 gallons.

Similarly, once a week a brush-collection vehicle and crew were used to collect move-in boxes, and about every other week a brush-collection vehicle and crew were used to collect white goods. Each of these collections took about half a day to complete. This means that approximately three percent (52 weeks times five hours/week times two persons per crew, plus 26 weeks times five hours/week times two persons per crew divided by 26,000 hours³²) of the fuel consumed by the brush collection vehicles, or about 536 gallons, can be attributed to the collection of recyclables rather than brush.³³ The net result is that 17,331 gallons of diesel fuel were used to collect 7,868 tons of brush. The average fuel consumption per ton was 2.2 gallons.

No adjustments to the Fleet Services data were required to determine the fuel consumed to collect commercial garbage. A reported 58,179 gallons of diesel fuel were consumed to collect the 44,775 tons of commercial garbage in FY 1992. This reflects an average fuel consumption rate of 1.3 gallons per ton. Because more MSW is collected per stop for commercial customers that use 2- to 8-cubic yard and roll-off containers, there is greater fuel efficiency for collecting commercial garbage than residential garbage in Scottsdale.

5.3 Energy Consumption at the Landfills

Fiscal Year 1992 energy consumption data for the area landfills is not available. For calendar year 1993, 83,720 gallons of diesel fuel was consumed at the Maricopa County Cave Creek Landfill.

This energy was consumed to operate a tractor, two 10-wheel dump trucks, a 2,000-gallon water truck, and a pickup truck at the landfill. The County also hauled recyclables dropped-off by County residents in roll-off containers located at the landfill. The energy consumption data above includes the energy consumed to haul these recyclables.

³¹ This is equal to 52 weeks/year times 5 days/week times 17 routes/day times 1 person/route times 10 hours/day.

³² This is equal to 52 weeks/year times 5 days/week times 5 routes/day times 2 persons/route times 10 hours/day.

³³ The number of routes and times per route were obtained from a telephone conversation between Rick Pence of Scottsdale's Sanitation Division and Alan Cohen of CSI, May 5, 1994.

The recyclables were hauled an estimated 100 miles per week or about 5,200 miles in 1993. Assuming the truck averages five miles per gallon of fuel, the estimated fuel consumption for hauling recyclables is only about 1,040 gallons. The balance, or about 82,680 gallons is estimated to have been consumed to dispose of approximately 203,000 tons of garbage. The average energy consumption at the Cave Creek Landfill is estimated to be about 0.4 gallons per ton of garbage disposed (i.e., 82,680 divided by 203,000).

5.4 Energy Consumed to Collect and Haul Recyclables

In this section the energy consumed to collect and transport recyclables is presented. The City runs several recycling programs. Separate calculations are provided for the mobile trailer recycling, stationary container, move-in box, and white good programs. Because fuel consumption data is not available from the private contractor that collects the office wastepaper from City buildings, the energy consumption of this program is not included in this analysis.

5.4.1 Mobile Recycling Program

The Fleet Services data provided in Table 5-3 for "Recyclables" provides the fuel consumption data for one of the two vehicles used in the mobile recycling program. The 1985 GMC dump truck (i.e., vehicle 3227) consumed 716 gallons of gasoline, or 624 equivalent gallons of diesel fuel. This truck was used exclusively for the mobile recycling program and traveled a reported 2,943 miles in FY 1992. This mileage represents travel to and from the mobile recycling sites and to local purchasers of the materials.

The other vehicle used was the 1986 Chevy Flat Bed (i.e., vehicle 4403) listed under "Container Repair." Because this vehicle was used for multiple purposes, only a portion of the reported fuel consumption is attributed to the mobile recycling activity. Assuming the total mileage traveled by this vehicle for the mobile recycling program was 2,943 (i.e., the same as the mileage traveled by the other vehicle used in the program) then about 25 percent of the total mileage and, thus, assumed fuel consumption, is attributed to the mobile recycling program. The resulting energy consumption is estimated to be 471 gallons of diesel fuel.³⁴ The total consumption, on a diesel fuel equivalent basis, was 1,095 gallons. For the 401 tons of recyclables collected through the mobile recycling program in FY 1992, the average equivalent fuel consumption was 2.7 gallons per ton.

Energy is also consumed by individuals who transport recyclables from their homes to the mobile recycling drop-off sites. The City conducted a two-week survey from January 29 through February 6, 1994, in order to estimate the miles traveled by individuals participating in the mobile recycling program. Seven of the nine sites were included in the survey. In total, 258 individuals responded to the survey.

The survey respondents indicated where they lived, where they were prior to going to the drop-off site, and where they were going after they dropped off the recyclables. Many provided the estimated distance traveled. Others gave street addresses or major intersections as points of reference. From this information, the Sanitation Division and CSI estimated the average incremental distance traveled by

³⁴ The energy consumption for this vehicle is lower because its average energy efficiency (i.e., miles/gallon) is greater.

each participant. The incremental distance is the number of miles actually traveled less the number of miles that an individual would have traveled if he or she had not participated in the program.

The results of the survey are provided in Table 5-5. About 59 percent of the respondents made a special trip to drop-off their recyclables. The other 41 percent combined their trip with other activities such as shopping, going to church, going to the park, and playing golf. In general, people who combined trips lived farther away from the drop-off sites than those that made special trips.

The survey results were scaled to estimate the total miles traveled by all participants in the program in FY 1992. During FY 1992 the Sanitation Division kept individual worksheets indicating the number of participants using each site over an eight-month period. Sanitation records also indicate that there were a total of 14,254 participants during the year. To estimate the total miles traveled the average incremental miles traveled to each site obtained through the survey, was multiplied by the number of participants using that site over eight months. This result was scaled up for the entire year by multiplying the estimated miles traveled by the ratio of total participants to the number of participants during the eight-month period where site specific data was available.

The results of these calculations are presented in Table 5-6. An estimated 57,358 miles were traveled by individuals using the mobile drop-off sites. In Arizona, the EPA reports an average fleetwide energy efficiency for urban driving of [15] miles/gallon. The total estimated gallons of gasoline consumed are about 3,820. On an equivalent diesel fuel basis this represents 3,330 gallons. For the 401 tons of recyclables collected, this represents an average of 8.3 equivalent gallons of diesel fuel consumed by individuals per ton of material recycled.

The aggregate energy consumed collecting recyclables from the mobile recycling program was about 4,425 equivalent gallons of diesel fuel, or about 11 gallons per ton.

5.4.2 Other Recycling Programs

As discussed in Section 5.2, an estimated 711 gallons of diesel fuel were consumed to collect 279 tons of recyclables from the stationary container program. The average consumption was about 2.6 gallons per ton. An estimated 536 gallons of diesel fuel were consumed for the collection of move-in boxes and white goods: approximately two-thirds, or 357 gallons, for about 58 tons of move-in boxes, and one-third, or 179 gallons, for about 55 tons of white goods. The average diesel fuel consumed was approximately 6.2 and 3.3 gallons per ton, respectively. The smaller figure for white goods reflects, in part, the greater bulk density of white goods.

5.4.3 Hauling of Recyclables to Market

Most of the recyclables collected in Scottsdale are hauled by transfer trailer to distant markets on the West Coast and Mexico. Based on the limited data provided in Table 3-2 of Section 3, the recyclables are hauled between 300 and 1,000 miles. Assuming that 0.022 gallons of diesel fuel is consumed for each ton-mile hauled, then the energy consumed to haul recyclables collected in Scottsdale ranges between 6.6 and 22 gallons per ton.

5.5 Container Repair Services and Other Energy Consumption

Vehicles are also used for container repair services and other general uses. The total quantity of fuel

TABLE 5-5: RESULTS OF SURVEY OF PARTICIPANTS IN MOBILE RECYCLING PROGRAM

Site Locations	Dedicated Trips			Combined Trips			Total Trips		
	Number	Percent	Miles	Number	Percent	Miles	Number	Percent	Miles
Cactus Park	17	11.1	5.45	5	25.7	8.88	22	8.5	6.23
Chaparral Park	31	20.3	3.61	17	16.2	2.37	48	18.6	3.18
Eldorado Park	43	28.1	3.36	33	31.4	4.19	76	29.5	3.72
McCormick Railroad Park	4	2.6	4.90	3	2.9	2.00	7	2.7	3.66
Moutain View Park	0	0.0		0	0.0		0	0.0	
Pinnacle Peak	0	0.0		0	0.0		0	0.0	
Scottsdale Ranch Park	43	28.1	3.46	27	25.7	4.85	70	27.1	4.00
Thuderbird Park	15	9.8	4.22	20	19.0	7.69	35	13.6	6.20
Total	153	100.0		105	121.0		258	100.0	
Percent Dedicated/Combined		59.3			40.7			100.0	

NOTE: "Miles" are the average incremental miles traveled by the participants. Incremental miles are equal to the total distances traveled less the distance that would have been traveled if the individual had not participated in the program.

SOURCE: Survey conducted by the Sanitation Division January 29 through February 6, 1994.

**TABLE 5-6: ESTIMATED MILES TRAVELED BY
PARTICIPANTS IN THE MOBILE RECYCLING PROGRAM**

Site Locations	Number Participants (8 months)	Incremental Miles (miles/trip)	Total Miles
Cactus Park	1,137	6.23	7,084
Chaparral Park	2,693	3.18	8,564
Eldorado Park	1,953	3.72	7,265
McCormick Railroad Park	1,057	3.66	3,869
Moutain View Park	749	4.02	3,011
Pinnacle Peak	606	4.02	2,436
Scottsdale Ranch Park	1,051	4.00	4,204
Thunderbird Park	<u>355</u>	6.20	<u>2,201</u>
Total Incremental Miles	9,601	4.02	38,633
Adjustment for Entire Year (FY9	14,254		57,356

SOURCES: Survey conducted by the Sanitation Division January 29 through February 6, 1994 and
City of Scottsdale, Mobile Recycling Worksheets, October 12, 1991 through May 24, 1992.

NOTE: The incremental miles traveled per participant for Moutain View Park and Pinnacle Peak is
the weighted average distance traveled by participants to the other sites.

consumed by the container repair fleet was 5,799 equivalent gallons. Of this amount, 471 gallons were used for the mobile recycling program, as described in Section 5.4.1. The net amount consumed for container repair service activities was 5,328 equivalent gallons.

In FY 1992 the Sanitation Division also used four pick-up trucks and one automobile. The automobile was allocated to administration activities, three pick-up trucks to residential collection, and one pick-up truck for brush collection. The total fuel consumption was 2,307 gallons of gasoline, or 2,012 Btu equivalent gallons of diesel fuel.

6. Environmental and Safety Regulations and Permitting Requirements

The costs of compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this Case Study. As of FY 1992, none of the components of Scottsdale's IMSWM System were out of compliance with any federal, state, or local environmental laws or regulations.

6.1 Overview of Relevant Federal Environmental Legislation and Regulations

The potential environmental impacts of solid waste management facilities have led to the development of an extensive network of federal and state regulations. Embodied in many federal environmental laws is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions, including toxic air pollutants.³⁵ The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution.³⁶ The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants.³⁷ The Solid Waste Disposal Act and Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992 and currently undergoing Congressional review for reauthorization, is the main piece of federal legislation addressing with landfill disposal regulation.³⁸ In that Scottsdale's IMSWM system does not include MSW combustion, the Clean Air Act did not apply to the facilities comprising the System.

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits, "best practicable control technology" (BPT), and "best available technology" (BAT). The initial BPT limitations focus on regulating discharges of conventional pollutants such as bacteria and oxygen-consuming materials. The BAT limitations emphasize controlling toxic pollutants such as heavy metals, pesticides, and other organic chemicals. Table 6-1 provides a listing of the pollutants regulated under the NPDES.

A separate permit is required to dispose of dredge or fill material into the waters, including wetlands. The U.S. Army Corps of Engineers administers this permit program. Other regulations promulgated

³⁵ The Clean Air Act and Major Amendments are codified as 42 U.S.C. 7401-7671, 1990.

³⁶ The Clean Water Act and Major Amendments are codified as 33 U.S.C. 1251-1387, 1987.

³⁷ The Safe Drinking Water Act and Amendments are codified as 42 U.S.C. 300f-300j-11, 1988.

³⁸ The Solid Waste Disposal/Resource Conservation and Recovery Act and Major Amendments are codified as 42 U.S.C. 6901-6991k, 1992.

TABLE 6-1

POLLUTANTS REGULATED BY THE NPDES PERMIT PROGRAM

OXYGEN DEMAND: Biochemical Oxygen Demand Chemical Oxygen Demand Total Oxygen Demands Total Organic Carbon Other	METALS: Aluminum Cobalt Iron Vanadium
SOLIDS: Total Suspended Solids (Residues) Total Dissolved Solids (Residues) Other	METALS (ALL FORMS) Other metals not specifically listed under Group 1
NUTRIENTS: Inorganic Phosphorus Compounds Inorganic Nitrogen Compounds Other	INORGANIC Cyanide Total Residual Chlorine
DETERGENTS AND OILS: MBAS NTA Oil and Grease Other Detergents or Algidides	MINERALS: Calcium Chloride Fluoride Magnesium Sodium Potassium Sulfur Sulfate Total Alkalinity Total Hardness Other Minerals

under the Clean Water Act include guidelines for using and disposing of sewage sludge.

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. Table 6-2 provides the maximum contaminant levels as promulgated under this Act. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements, develop adequate procedures for enforcement, maintain records, and create plans providing emergency water supplies.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment.³⁹ The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater. These criteria also provide guidelines for sludge utilization and disposal under the Clean Water Act.

Subtitle D of RCRA primarily addresses non-hazardous waste, whereas Subtitle C of RCRA addresses hazardous waste disposal. In October 1991, the EPA promulgated revised Subtitle D regulations applicable to municipal solid waste landfills, with an effective date of October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.⁴⁰

6.2 Overview of State and Local Environmental Regulations

Municipal solid waste management is regulated in accordance with the Arizona Solid Waste Management Law (Arizona Revised Statutes, Title 49, Chapter 4, as amended). This law is administered by the Department of Environmental Quality (DEQ). The state's Solid Waste Management Law authorizes the DEQ to "define and prescribe reasonably necessary rules regarding storage, collection, transportation, disposal and reclamation of garbage, trash, rubbish, manure and objectionable wastes." The rules and regulations for the management of MSW are provided in the Arizona Administrative Code. The Tri-City landfill, located on Indian land, is regulated by the federal government.

The state's Solid Waste Management Law delegates the responsibility for solid waste management to counties, cities, and towns and authorizes these local jurisdictions to collect MSW and to own or operate MSW management facilities, or contract for such services. Municipalities with populations over 60,000 cannot prohibit private firms from providing solid waste management services to

³⁹ 40 CFR, EPA, Part 257--Criteria For Classification of Solid Waste Disposal Facilities and Practices.

⁴⁰On October 1, 1993, the Federal criteria for MSW landfills under subtitle D of RCRA were amended to extend the date of compliance for small landfills to April 9, 1994, and by delaying the effective date of subpart G, Financial Assurance, to April 9, 1995, for all MSW landfills. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for two years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. (Federal Register, "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," Vol. 58, No. 189, pages 51536-51548, 1993.)

TABLE 6-2

MAXIMUM CONTAMINANT LEVELS¹ PROMULGATED UNDER THE
SAFE DRINKING WATER ACT

CHEMICAL	MCL (mg/l)
Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon Tetrachloride	0.005
Chromium (Hexavalent)	0.05
2,4-Dichlorophenoxy Acetic Acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethane	0.005
1,1-Dichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxychlor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloroethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy Acetic Acid	0.01
Vinyl Chloride	0.002

¹ 40 CFR, EPA, Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices.

commercial and industrial establishments, but can prescribe local regulations for such activities. The City has enacted regulations for the licensing of commercial or industrial solid waste and recycling services.⁴¹

6.2.1 Landfill Disposal Regulations

In part because of: (1) Arizona's arid climate, (2) the state's relatively lax landfill regulations, and (3) the age of the landfills used by the City in FY 1992, none of the landfills utilized was constructed with liners, and no routine groundwater or methane gas monitoring was required. Furthermore, the State did not require landfill operators to plan and provide financial security for the closure of the landfill or any post-closure maintenance. Generally, the only environmental control requirement imposed on the landfills was a requirement for daily cover.

The State has recently modified its solid waste regulatory requirements. In the future, all landfills in the State must obtain an Aquifer Protection Permit and incorporate Best Available Demonstrated Control Technology (BADCT).⁴² The BADCT evaluation requires a review of liner and monitoring options, leachate collection and control options, and closure and post-closure monitoring requirements. The BADCT requirements are site specific and are determined through negotiations between the landfill owner and the DEQ.⁴³ In general, the State's new regulations incorporate the RCRA Subtitle D regulations. These requirements did not, however, apply in FY 1992 to the landfills used by the City during that period.

The Tri-City landfill, regulated by the federal government, was closed in October 1993. A new landfill developed by the Salt River Pima-Maricopa Indian Community has been designed with both clay and composite liners and a leachate collection system. The expansion of the Maricopa County's Cave Creek landfill will be designed and constructed with liners that will comply with RCRA Subtitle D part 258 requirements. The Sanifill's Lone Cactus landfill is only permitted to dispose of non-putrescible waste, i.e., landscape trimmings and construction debris, and, as such, any expansions may not be require liners and leachate control.

6.2.2 Recycling Regulations

There are no specific regulatory requirements for the processing and marketing of recyclables. The State law does require residential and commercial garbage containing putrecible materials to be collected at least twice a week. A special exemption, however, to this requirement can be obtained if a community wishes to substitute one residential collection for a recyclables collection.

The Arizona Solid Waste Recycling Act of 1990 (Recycling Act) prescribes a Statewide program to

⁴¹ City of Scottsdale, "Licenses for Commercial or Industrial Solid Waste and Recycling Services," Scottsdale City Code, September, 1992.

⁴² See "Aquifer Protection Permit Rules," October 1989 and "Aquifer Protection Permit Application Guidance Manual," September 11, 1991.

⁴³ DEQ, "BADCT Guidance Document for the Landfill Category," Draft February 2, 1990, page 5.

support recycling.⁴⁴ The Recycling Act, among other provisions, provides for a five percent preference in awarding certain State contracts to bidders offering recycled material; prescribes specifications which do not discriminate against the use of recycled materials; provides for a public education program; provides for the identification and development of markets for recovered materials; prescribes standards for newsprint quality; and establishes a landfill disposal fee.

The Recycling Act requires that all counties, cities, and town must provide "its residents with an opportunity to engage in recycling and waste reduction" (Paragraph 9-500.06). The recycling programs implemented by the City comply with this requirement.

The proceeds from the 25-cent-per-ton landfill disposal fee (Paragraph 49-836)⁴⁵ are deposited in a Recycling Fund along with monies appropriated by the legislature, gifts, and grants. Proceeds from the fund are used for research, demonstration projects, market development, and source reduction studies; implementation of the recommendations or reports prepared pursuant to the Act; public information and education; technical assistance programs concerning litter control, recycling, and source reduction; and the administration of the Recycling Act.

6.2.3 HHW Collection Day Regulations

A special permit was required for the collection and storage of HHW at the City's Corporation Yard. Because the City already had a permit for the use and storage of potentially hazardous materials (e.g., gasoline and oil used for fleet vehicles) at the Corporation Yard, the process of obtaining authorization for the HHW program was relatively simple. All of the material collected from the HHW program had to be manifested.

6.3 Overview of Occupational Health and Safety Regulations

6.3.1 Federal Regulations

The Occupational Safety and Health Act of 1970⁴⁶ imposes two basic duties on private employers. State and local governments in their roles as employers are not required to comply with these duties, which are:

- (1) To comply with occupational safety and health standards developed by the Occupational Safety and Health Administration (OSHA) pursuant to the Occupational Safety and Health Act; and
- (2) To comply with the General Duty Clause, Section 5(a)(1), which requires that

⁴⁴ "Arizona Solid Waste Recycling Act," Chapter 378, House Bill 2574, Approved June 28, 1990: Effective: September 27, 1990.

⁴⁵ The disposal fee is actually \$0.25 for each 6 cubic yards of uncompacted solid waste, \$0.25 for each 3 cubic yards of compacted solid waste, or \$0.25 per ton of solid waste received at landfills regulated by the DEQ.

⁴⁶To come: codification.

employers protect their employees from recognized hazards not regulated by an OSHA standard.

Pursuant to the Occupational Safety and Health Act, OSHA, created within the Department of Labor, is responsible for promulgating legally enforceable standards. These OSHA standards require conditions, or the adoption or use of one or more practices, means, methods, or processes, reasonably necessary and appropriate to protect workers on the job. These standards include the General Industry Standards, 29 CFR Part 1910, which apply to all workplaces unless more specific OSHA standards apply. The General Industry Standards are applicable to solid waste processing facilities and are listed in Table 6-3.

Periodic inspections, either routine or in response to complaints, are conducted by OSHA to ensure that specific applicable standards are being met and that the workplace is generally free from recognized hazards likely to cause serious injury or death. When OSHA compliance officers discover areas of non-compliance resulting in hazards, employers may be issued citations, and penalties and abatement periods may be proposed.

6.3.2 State and Local Safety Requirements

As previously discussed, all private employers are required to comply with the General Industry Standards developed by OSHA. Thus, the privately owned and operated IMSWM System facilities must comply with OSHA standards.

The State of Arizona provides all State employees, such as those employed by the City in the IMSWM System, protection against workplace health and safety hazards through its OSHA-approved State Job Health and Safety Plan. This Plan provides standards and enforcement programs, as well as voluntary compliance activities, that parallel the OSHA standards.

TABLE 6-3
OSHA STANDARDS AND RULES

OSHA STANDARDS AND RULES	REQUIREMENT
Cadmium Standard	29 CFR 1910.1027
Chemical Safety and Handling	29 CFR 1910.120
Confined Space	29 CFR 1910.146
CPR/First Aid	29 CFR 1910.151
Crane Operation	29 CFR 1910.179
Electrical Policy	29 CFR 1910.300
Emergency Response Drill	29 CFR 1910.157
Eye Protection	29 CFR 1910.133
Fire Extinguishers and 1.5" Hose	29 CFR 1910.157(g)
Flammable Materials	29 CFR 1910.120h (1&2)
Hazard Communication	29 CFR 1910.120h (1&2)
HazMat Emergency Response Team	29 CFR 1910.120i(2)
Lead Standard	29 CFR 1910.1025
Lock Out/Tag Out	29 CFR 1910.147
Machine Operating and Guarding	29 CFR 1910.212
Noise (Hearing Protection)	29 CFR 1910.95(k)
Powered Industrial Truck	29 CFR 1910.178(1)
Respirator Training	29 CFR 1910.134(b)(3)
Nuclear	10 CFR Part 31 & 32
Scaffolding	29 CFR 1926.451

Appendix A - Glossary of Terms

ALLOCATED COST (\$/year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
ANALYZED MSW:	Portion of the MSW stream for which the cost of collecting, transferring, hauling, processing, combusting, marketing, and/or disposing of such waste is known or can be reasonably estimated.
AVERAGE COST	(\$/ton): Total or Allocated Cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
AVERAGE PROGRAM INCREMENTAL COST (SAVINGS) (\$/ton):	The Program Incremental Cost divided by the number of tons of materials diverted from the landfill by the program.
BRUSH	In Scottsdale, Brush is defined as leaves, twigs, palm skins and weed cuttings, tree limbs and shrubbery clippings not exceeding three (3) feet in length (see Yard Waste).
BULKY WASTE:	Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.
COMMERCIAL MSW:	Municipal solid waste that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry); institutions (e.g., schools and government establishments); and public areas (e.g., train stations, airports, and litter from roadside).

GARBAGE:

Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.

HAZARDOUS WASTE:

Waste which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed and is defined as such in accordance with federal and State laws. Does not include Household Hazardous Waste.

HOUSEHOLD HAZARDOUS WASTES (HHW):

Materials that are separated from Residential MSW as household hazardous wastes for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.

INTEGRATED SOLID WASTE MANAGEMENT:

A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the Municipal Solid Waste stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.

MARGINAL COST (SAVINGS) (\$/ton):

The cost (savings) of managing an additional ton of MSW, garbage, trash, recyclables, or yard waste.

MARGINAL COST (SAVINGS) OF SUBSTITUTION (\$/ton):

The net cost (savings) of managing an additional ton of recyclables or yard waste less the savings (cost) of managing one less ton of garbage.

MATERIALS RECOVERY:	A term describing the extraction and utilization of materials from a waste stream.
MUNICIPAL SOLID WASTE (MSW):	Non-hazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes, construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.
PROGRAM INCREMENTAL COST (SAVINGS) (\$/year):	The difference between the cost of managing MSW with or without a particular program (e.g., curbside collection, processing, and marketing of recyclables.)
RECOVERED MATERIALS:	Recyclable materials that are recovered from MSW and may also include some contamination.
RECYCLABLE MATERIALS OR RECYCLABLES:	Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.
RECYCLE:	To convert discarded materials into useful products through reuse and remanufacturing.
RESIDENTIAL MSW:	Municipal solid waste that is generated by households.
RESIDUE:	That portion of processed MSW that is ultimately disposed of in a landfill.

RESOURCE RECOVERY:

A term describing the extraction and utilization of energy or materials from a waste stream.

SECONDARY MATERIAL:

A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."

SELF-HAUL:

The delivery of MSW or other wastes to an integrated municipal solid waste management system by a private firm or individual that is not under contract to a municipality, authority, utility, or other public entity responsible for municipal solid waste management to make such deliveries.

TOTAL NET COST OR TOTAL COST (\$/year):

The aggregate of all expenditures incurred to manage municipal solid waste, inclusive of general and administrative, planning, capital, collection, processing, transfer and haul, marketing, promotion and education, and disposal costs, less any revenues derived from resource recovery activities.

YARD WASTE:

Vegetative material that is segregated from the MSW stream for separate collection and/or processing, including grass, prunings, plants, and small tree limbs, but excluding tree stumps, land-clearing debris, and other large vegetative matter (see Brush).

WHITE GOODS:

That portion of bulky waste which consists of large appliances, such as refrigerators, stoves, washing machines, and dryers.

Appendix B

Allocation of Costs and Result Tables

The allocation procedures used to determine the cost incurred for various functions or types of waste are presented in this Appendix. The procedure involves the following steps: (1) classifying each expenditure by function; (2) determining expenditures that are totally or partially "applicable" or "not applicable" to the 112,000 tons of Analyzed MSW; (3) allocating expenditures related to the Analyzed MSW to the management of residential (i.e., single-family homes) garbage, commercial garbage, brush, and recyclables, and (4) allocating City costs to manage, exclusive of collection costs, HHW. Each of these steps is discussed below. The resulting allocations of the total net cost of \$6.85 million (see Appendix C) are provided in Tables B.1 through B.7 at the end of this Appendix.

B.1 Step 1: Classification of Expenditures by Function

The expenditures incurred by Scottsdale's Sanitation Division, provided in Table C.1 of Appendix C, as adjusted, were classified into the following functional areas: General & Administrative (G&A); Collection; Landfill; and Promotion, Education, and Public Relations.

The results of the classification are provided in Tables B.3 through B.6. For example, the \$910,221 Landfill Contract and \$23,749 Landfill Self Haul expenses listed in Table C.1 were classified as a landfill expense and listed in Table B.4: Landfill Costs (FY92). Similarly, the \$18,253 Uniform Cleaning and \$11,854 Clothing expenses were combined and listed as the \$30,107 cost of Uniform Cleaning and Purchase in Table B.3: Collection Costs (FY92).

The allocation of costs shown in Table C.1 of Appendix C was maintained in Tables B.2 through B.6. The portion of these costs listed by the Sanitation Division as "Administrative" are listed separately in Tables B.2 through B.6 and allocated using the same methodology as all other G&A costs. Some of these costs, however, are listed in tables other than Table B.2: General and Administration Costs (FY92). For example, the portion of the Advertising and Printing & Binding costs attributed by Sanitation to Administration are listed in Table B.5: Promotion/Education/Public Relations Costs (FY92), rather than in Table B.2.

The City Indirect G&A and Customer Service Costs shown in Table B.2 were derived from Table C.2 of Appendix C. For example, the sum of the \$988,002 City Indirect Cost shown in Table B.2 and the \$150,847 City Indirect Capital Cost shown in Table B.6 equals the \$1,138,849 City Indirect Cost attributed to Sanitation in Table C.2. Similarly, the Vehicle O&M and Capital Costs are derived from the data provided in Tables C.4 and C.5 of Appendix C. For example, the \$1,843 capital cost for "Fleet Administration" in Table B.6 were obtained from Table C.5. Finally, the Container capital cost in Table B.6 were derived using the data and procedures described in Section C.X of Appendix C.

The revenues from the various recycling programs shown in Table B.7 were obtained from Sanitation records.

B.2 Step 2: Determine "Applicable" and "Not Applicable" Expenses

About \$81,700 of the \$6.85 million total net cost is classified as being "not applicable" to the management of the 112,000 tons of Analyzed MSW. The \$81,700 represents costs to: (1) dispose of the 2,970 tons of MSW self-hauled to the Tri-City landfill; and (2) manage the approximately 11 tons of HHW.

Each expense in Tables B.2 through B.6 was first reviewed to determine if it could be classified as being either "applicable" or "not applicable." For example, 100 percent of the Maricopa County and Sanifill landfill costs in Table B.4 are applicable to the management of the 112,000 tons of Analyzed MSW. On the other hand, 100 percent of the HHW Contractor costs in Table B.3 are classified as "not applicable."

Because the Sanitation Division keeps detailed records, other costs that were not applicable to the management of the 112,000 tons of Analyzed MSW, such as the cost of disposing of self-hauled MSW at the Tri-City landfill, were obtained directly from its records. All other costs, principally G&A expenses, were allocated as being "applicable" or "not applicable" in direct proportion to the allocation of other costs.

B.3 Step 3: Allocate Managed MSW Costs by Type of Waste

The procedure to allocate the \$6.77 million cost to manage the 112,000 tons of Analyzed MSW to the cost of managing residential garbage, commercial garbage, brush or recyclables is similar to the procedure used to determine which costs or proportion of costs were "applicable" or "not applicable." The footnotes in Tables B.2 through B.6 describe the variables used to determine the portion of these costs apportioned to the various types of MSW. First, specific costs that are 100 percent associated with the management of a type of MSW were identified and allocated accordingly. Generally, the Sanitation records were sufficient to allocate other costs by type of MSW (see Table C.1 in Appendix C.) G&A expenses are allocated in direct proportion to level of non -G&A expenses.

Please refer to the footnotes in Tables B.2 through B.6 for more details on the variables used to allocate costs.

B.4 Step 4: Allocate Costs to Manage HHW

The costs that can be 100 percent attributed to HHW management activities were allocated to the management of HHW. For example, the Salary & Wages reported in Table B.3 for HHW was obtained from the allocation of salary & wages provided in Table C.1. G&A expenses that are not 100 attributable to HHW were allocated to HHW in direct proportion to other costs that were apportioned to the management of HHW.

TABLE B.1: SCOTTSDALE'S INTEGRATED MUNICIPAL SOLID WASTE MANAGEMENT COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
General & Administrative								
Operating & Maintenance	\$1,443,121	\$14,998	\$1,428,122	\$800,025	\$400,474	\$185,926	\$41,697	\$9,838
Capital Cost	204,254	2,411	201,843	112,186	56,564	26,732	6,361	1,569
Subtotal G&A	1,647,375	17,409	1,629,965	912,211	457,038	212,658	48,058	11,407
Collection								
Operating & Maintenance	3,192,131	40,934	3,151,197	1,779,623	788,834	484,413	98,327	40,934
Capital Cost	918,457	0	918,457	548,467	254,886	100,450	14,654	0
Subtotal Collection	4,110,588	40,934	4,069,654	2,328,090	1,043,721	584,863	112,980	40,934
Landfill	933,970	23,006	910,964	466,565	353,857	61,996	28,546	0
Promotion & Education	5,535	937	4,598	1,359	680	315	2,244	937
Revenues	13,453	0	13,453	0	0	0	13,453	0
TOTALS								
Operating & Maintenance	5,574,757	79,875	5,494,881	3,047,573	1,543,845	732,650	170,814	51,709
Capital Cost	1,122,711	2,411	1,120,300	660,652	311,450	127,182	21,015	1,569
Revenues	13,453	0	13,453	0	0	0	13,453	0
TOTAL	\$6,684,015	\$82,286	\$6,601,729	\$3,708,225	\$1,855,295	\$859,833	\$178,376	\$53,278
COST PER TON (\$/ton)			59	63	41	109	217	

SOURCES:

1. City of Scottsdale, "Budget Worksheet," Computer Printout, March 18, 1993.
2. City of Scottsdale, "1993-1994 Budget Summary."
3. City of Scottsdale, "Sanitation Fund Summary 1993-94."
4. City of Scottsdale, "Fixed Assets Inventory-As of August 4, 1993."
5. City of Scottsdale, "Indirect Service Allocation-1991-92 Budget."
6. City of Scottsdale, "Sanitation Vehicles, FY91/92."
7. City of Scottsdale, "Monthly Analysis per Vehicle for June," Computer Printout, Undated.
8. Sanitation Department, City of Scottsdale, "COSMOS DATA," Fiscal Years 79/80 through 91/92, June of each year.

ALLOCATION OF COSTS: See Tables B2 through B7.

TABLE B.2: GENERAL AND ADMINISTRATION COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANAYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
City Indirect G&A	\$988,002	\$12,694	\$975,308	\$546,722	\$273,535	\$126,769	\$28,282	\$8,206
Customer Services	183,674		183,674	102,961	51,513	23,874	5,326	
Fleet G&A	96,619		96,619	54,161	27,098	12,558	2,802	
Sanitation								
Salary & Wages	148,049	1,902	146,147	81,925	40,988	18,996	4,238	1,230
Telephone	7,722	64	7,658	4,293	2,148	995	222	64
Training & Related Travel	207	197	10		10			197
Training & Related Travel(Adm)	3,294	27	3,267	1,831	916	425	95	27
Property & Liability Insurance	7,308	61	7,247	4,063	2,033	942	210	61
Office Supplies	862		862		146	385	331	
Office Supplies (Adm)	4,451	37	4,414	2,474	1,238	574	128	37
Safety & Incentives	1,340	11	1,329	745	373	173	39	11
Subcontract	750		750	300	300	150		
Subcontract (Adm)	225	2	223	125	63	29	6	2
Other Misc.	210		210	200		4	6	
Other Misc. (Adm)	408	3	405	227	113	53	12	3
TOTAL	\$1,443,121	\$14,998	\$1,428,122	\$800,025	\$400,474	\$185,926	\$41,697	\$9,838

ALLOCATION OF COSTS:

1. Allocations are based upon the percentage of non-G&A expenses.
2. Cost categories with double listings, e.g., Office Supplies, are allocations based upon Sanitation records. Those cost allocated by Sanitation to "Administration" are allocated are allocated based upon the percentage of non-G&A costs.
3. Costs allocated to "Not Applicable" are costs allocated to HHW and Self-Hauled MSW. Only a portion of "City Indirect G&A" and "Sanitation Salary and Wages" are allocation to Self-hauled MSW.

TABLE B.3: COLLECTION COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
Vehicle O&M								
Labor	512,887		512,887	346,749	113,158	46,345	6,636	
Materials	537,810		537,810	368,570	129,962	34,451	4,826	
Fuel	132,193		132,193	80,173	38,439	11,823	1,758	
Container Repair	12,950		12,950	9,684	3,254	0	13	
Salary & Wages	1,732,982	5,138	1,727,844	846,556	453,626	358,914	68,749	5,138
Uniform Cleaning & Purchase	30,107		30,107	12,370	6,624	9,767	1,346	
Property & Liability Insurance	130,236		130,236	79,887	30,316	19,596	437	
Awards, Safety & Incentives	7,590		7,590	2,062	1,187	190	4,151	
Small Tools & Equipment	13,678	1,465	12,213	4,457	2,534	3,206	2,016	1,465
Equip./Mach. Maint. & Repair	39,864		39,864	29,090	9,735	3	1,036	
HHW Contract	33,329	33,329	0					33,329
Rentals	1,002	1,002	0					1,002
Misc.	143		143	25		118		
Office Wastepater Contract	480		480				480	
Individual Out of Pocket	6,880		6,880				6,880	
TOTAL	\$3,192,131	\$40,934	\$3,151,197	\$1,779,623	\$788,834	\$484,413	\$98,327	\$40,934

ALLOCATION OF COSTS:

1. Fraction of residential, brush, and commercial Salary & Wages are allocated to recyclables for the collection of move-in boxes, white goods, and stationary containers.
2. Container Repair cost portion of Salary & Wages, Uniform Cleaning & Purchase, Property & Liability Insurance, Small Tools & Equipment, and Equip./Mach. Maint. & Repair is allocated in proportion to the ratio of the capital costs of the containers (see Table B.5).

TABLE B.4: LANDFILL COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
Tri-City Landfill	\$897,637	\$23,006	\$874,631	\$440,133	\$349,216	\$57,482	\$27,800	
Maricopa County Landfill	26,908		26,908	26,432			476	
Sanifill Landfill	9,425		9,425		4,641	4,514	270	
TOTAL	\$933,970	\$23,006	\$910,964	\$466,565	\$353,857	\$61,996	\$28,546	\$0

NOTE: The landfill cost attributed to "Recyclables" is a state fee of \$0.25/ton charged at the landfills for funding statewide recycling activities.

ALLOCATION OF COSTS:

1. The cost of disposing of the MSW self hauled to the Tri-City landfill is allocated to "Not Applicable." The state's recycling fee for this MSW is allocated to "Recyclables."
2. Based upon Sanitation records of tonnage and cost of disposal at each landfill.

TABLE B.5: PROMOTION/EDUCATION/PUBLIC RELATIONS COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
Advertising	\$1,123	\$893	\$230				\$230	\$893
Advertising (Adm)	51		51	29	14	7	1	
Printing & Binding	1,988	44	1,944				1,944	44
Printing & Binding (Adm)	2,373		2,373	1,330	666	308	69	
TOTAL	\$5,535	\$937	\$4,598	\$1,359	\$680	\$315	\$2,244	\$937

ALLOCATION OF COSTS:

1. Portion of Advertising and Printing & Binding expenses are allocated to HHW based on Sanitation records.

The balance is allocated based on the proportion of non-G&A expenses (i.e., using the same methodology as allocating G&A expenses).

TABLE B.6: CAPITAL COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
Fleet Capital Cost								
Administration	\$1,843		\$1,843	956	533	312	42	
Collection	513,411		513,411	266,401	148,491	86,902	11,617	
Container Repair	17,052		17,052	10,651	5,937		464	
Corporation Yard	30,116		30,116	15,627	8,710	5,098	681	
Motor Vehicles	12,045		12,045	6,250	3,484	2,039	273	
Machinery & Equipment	49,364		49,364	25,614	14,277	8,356	1,117	
Office Furniture	809		809	420	234	137	18	
Subtotal	624,640	0	624,640	325,919	181,666	102,843	14,212	0
Sanitation								
Corporation Yard	31,044	399	30,645	17,179	8,595	3,983	889	258
Machinery & Equipment	1,962		1,962	944	449	95	474	
Machinery & Equipment (Adm)	2,368	30	2,338	1,310	656	304	68	20
Office Furniture	620		620				620	
Office Furniture (Adm)	902	12	890	499	250	116	26	7
Structures & Improvements	153	2	151	85	42	20	4	1
Containers	306,552		306,552	229,230	77,022		300	
Subtotal	343,601	443	\$343,158	249,247	87,013	4,517	2,381	286
City General & Administration	150,847	1,938	148,909	83,473	41,763	19,355	4,318	1,253
Customer Services	3,623	30	3,593	2,014	1,008	467	104	30
TOTAL	\$1,122,711	\$2,411	\$1,120,300	\$660,652	\$311,450	\$127,182	\$21,015	\$1,569

SOURCES:

1. City of Scottsdale, "Sanitation Vehicles, FY91/92."
2. City of Scottsdale, "Fixed Assets Inventory as of August 4, 1993," Computer Printout.

ALLOCATION OF COSTS:

1. Allocation of the "Fleet Services" collection vehicle capital cost is based upon fleet data.
2. Allocation of "Container Repair" capital costs based upon ratio of non-brush vehicle capital costs. No containers are used to collect brush.
3. Allocation of other "Fleet Services" capital costs are based upon the ratio of the collection vehicles' capital costs.
4. Allocation of Sanitation G&A Capital Costs is based upon the ratio of non-G&A expenses (i.e., same methodology used to allocate G&A expenses.)

TABLE B.7: RECYCLING REVENUES (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	RESIDENTIAL GARBAGE	COMMERCIAL GARBAGE	BRUSH	RECYCLABLES	HHW
Mobile Recycling	\$8,688		\$8,688				\$8,688	
White Goods	329		329				\$329	
Move-in-Boxed	1,129		1,129				\$1,129	
Stationary Containers	2,099		2,099				\$2,099	
Office Waste Paper	1,208		1,208				\$1,208	
TOTAL	\$13,453	\$0	\$13,453	\$0	\$0	\$0	\$13,453	\$0

SOURCE: City of Scottsdale, "Year-to-Date Figures/Recycling Program."

Appendix C

Methodology, Assumptions, and Data Used to Calculate Costs

The methodology and data used to calculate total cost and net cost of managing Analyzed MSW in Scottsdale, i.e., collecting, marketing recovered materials, and disposing of MSW, are presented in this Appendix. The methodology consists of six steps: (1) determining the Sanitation Division's total reported cost; (2) adjusting the Sanitation Division's total reported cost, as necessary; (3) determining the City of Scottsdale's indirect G&A cost that should be allocated to Sanitation; (4) estimating the cost to individuals who participate in the Mobile Trailer Recycling program; (5) determining the revenues received from the sale of recyclable materials; (6) combining these expenses and revenues to obtain the FY 1992 net cost of managing Analyzed MSW in Scottsdale. Each of these steps is described below.

C.1 Step 1: Determining the Sanitation Division's Total Reported Costs

The Sanitation Division's total FY 1992 reported expenditure is \$5,174,584.¹ Table C.1 was developed from a series of computer printouts provided by Sanitation.² The reported \$5.17 million total cost consisted of \$1.88 million for Salaries & Wages; \$3.05 million Contractual Services, including those provided by the City's Fleet Services Division; \$0.201 million for the purchase of Supplies & Equipment; and \$0.045 million for Capital Outlays.

The allocation of these costs to various activities is based upon detailed records maintained by the Sanitation Division, including an accounting of each employee's time devoted to each type of service.

C.2 Step 2: Adjusting Sanitation's Reported Cost

For the purpose of this analysis, four adjustments were made to the reported costs: (1) modifying the Fleet Services charges to Sanitation; (2) adding the hauling fee for the office wastepaper recycling program; (3) capitalizing refuse and commercial container expenses; and (4) substituting capital costs for capital outlays.

C.2.1 Fleet Services Charges to Sanitation

"Fleet Management provides administrative support, supervision, and mechanical maintenance for the City's Fleet. Performs an on-going preventative maintenance and refurbishment program and in conjunction with the Purchasing Division Stores Supply, is responsible for the inventory and supplies purchased to support all preventative maintenance for repair work on the City's Fleet."³

¹ City of Scottsdale, "1993-94 Budget Summary," Actual 1991-92 Expenditures, page 56.

² Sanitation Division, City of Scottsdale, "Consolidated Company Budget Worksheet, Fiscal Year 1993-94," Actual Expenditures 1991-92, March 18, 1993.

³ City of Scottsdale, "Fleet Services & Personnel Positions," page 1.

Fleet Management charges each division rental fees for the services it provides. Since Fleet Services is an enterprise activity of the City, all of its expenses (i.e., capital, O&M, and G&A) must be recovered through the rental fees it charges to other divisions of the City.⁴

In FY 1992 Fleet Services charged Sanitation rental fees totalling \$1.90 million, as shown in Table C.2. Because rental fees are established at the beginning of each fiscal year, the \$1.90 million cost reflects expenditures made in FY 1991, not FY 1992. Furthermore, the rental fees reflect the capital outlays made in FY 1991 and do not take into account capital expenses that occurred prior to FY 1991.

For this analysis, rather than using these rental fees, the actual FY 1992 G&A, collection vehicle operating and maintenance expenses and capital costs, and other capital costs (e.g., capital costs of equipment used in the maintenance shop) were calculated from data provided by Fleet Services and the Fixed Asset account of the City.

Specifically, the FY 1992 collection fleet and other vehicle O&M cost was \$1.20 million (as shown in Table C.3); the FY 1992 collection fleet and other vehicle capital cost was \$0.532 million (as shown in Table C.4); and the FY 1992 capital cost for the maintenance shop, other equipment, and furnishing was \$0.092 million (\$0.030 million for the maintenance shop and vehicle storage yard at the Corporation Yard, and \$0.062 million for other capital assets).

The collection Fleet O&M costs in Table C.3 were derived from the data in Table C.5. For example, the Administration costs in Table C.3 are the maintenance labor, materials, and fuel costs for the Chevy Caprice shown on Table C.5. The O&M costs for the residential collection vehicles shown in Table C.5 were reduced by 0.6 percent, i.e., the estimated time the residential trucks were used for the stationary container recycling program. For example, the \$346,749 maintenance labor cost for the residential vehicles shown in Table C.3 is equal to the \$348,842 labor cost shown in Table C.5 times 0.994 (i.e., 1 minus 0.06). Similarly, the O&M costs for the brush collection vehicles were reduced by 3 percent based on the estimated 2 percent of the time these vehicles were used for the move-in box and the estimated 1 percent of the time they were used for the white good, recycling programs.

The O&M costs attributed to recycling are equal to the sum of the portion of cost of the residential and brush vehicles attributed to the collection of recyclables as described above and the O&M cost of the vehicles and trailers used for the mobile recycling program. This includes about 25 percent of the O&M cost of vehicle number 4403, which is primarily used for container repairs. The cost of this vehicle allocated to recycling was subtracted from the costs attributed to container repairs.

The collection Fleet Capital Costs in Table C.4 were derived from the data in Table C.6. The procedure used to allocate the vehicle capital costs in Table C.6 to obtain the costs shown in Table C.4 is the same methodology used to allocate the O&M costs.

The Corporation Yard and other capital costs used by Fleet Services were obtained from a computer list of fixed assets owned by the City. A portion of this fixed asset list is summarized

⁴ City of Scottsdale, "Fleet Services & Personnel Positions," page 7.

in Table C.7. The capital costs shown in Table C.2 are equal to 28.7 percent of the cost shown in Table C.7, which represents the percentage of Fleet Services rents charged to Sanitation in FY 1992 (i.e., \$1,901,460 divided by \$6,632,519).

Finally, the rental fee includes a charge of \$11,544 to account for a financial deficit that occurred prior to FY 1992, therefore, it was excluded from the actual FY 1992 cost reported in Table C.2.

C.2.2 Adding Cost of Hauling Office Wastepaper

Because the revenues received from the sale of the office wastepaper were greater than the charge for picking up and marketing these materials, and the contractor only bills the City if there is a net cost, the Sanitation Division's reported costs do not include the hauling charges of the office wastepaper contractor. This charge was \$20 per visit to the City. In FY 1992 the contractor made 24 visits, resulting in a total hauling charge of \$480 (i.e., \$20 times 24). This amount was added to the cost of "Other Contractual Services" reported by Sanitation.

C.2.3 Capitalizing Residential and Commercial Garbage Containers

The expenditures reported for Sanitation include \$81,290 for "Refuse Containers" and \$43,371 for "Commercial Containers." In accordance with a recently enacted City accounting policy that expenses all items with a unit cost of less than \$1,000, these items were treated as operating expenses for FY 1992 rather than as capital costs. In this analysis containers are considered capital assets because they have useful lives of five to 20 years. Therefore, the total expenses of \$124,661 (i.e., \$81,290 plus \$43,371) was subtracted from the total reported \$200,906 cost of Supplies & Equipment to obtain the \$76,245 adjusted cost. In this analysis the costs of the residential and commercial containers are included in Sanitation's capital costs as discussed in the next section.

C.2.4 Substituting Capital Costs for Capital Outlays

The \$45,201 capital outlay shown in Table C.1 is replaced with a calculated capital cost of \$343,611. This includes the capital cost of assets used by Sanitation, exclusive of the collection vehicles included in the Fleet Service capital cost. These assets are reported in the computer printout of the City's Fixed Assets which is summarized in Table C.7.⁵

As indicated previously, some container costs are not included in the Fixed Asset account because they were treated as operating expenses rather than capital assets. Except for the capital costs of the roll-off containers (i.e., 20-, 30-, and 40-cubic yard containers) reported in Table C.7, the capital costs of the residential and commercial containers were estimated using the following procedures: (1) the number of containers purchased each year was estimated from an accounting

⁵ The capital costs reported in Table C.7 were estimated using the procedure described in Appendix D. The estimated useful lives of the assets are based upon the range of useful lives provided by the City, i.e., 25 years for buildings and improvements, 20 years for Machinery and Equipment, 3 to 10 years for motor vehicles, and 5 to 10 years for furniture, fixtures, and office equipment.

of the number of containers owned at the end of each fiscal year from 1980 through 1992;⁶ (2) the unit purchase prices for the containers from 1980 through 1992 were estimated by deflating the 1992 prices for the containers at 5 percent a year;⁷ (3) the total container costs were estimated by multiplying the estimated unit prices by the estimated number of containers purchased each year; and (4) the capital cost of these containers was calculated using the procedure described in Appendix D and assuming useful lives of seven years for 20-gallon residential containers, 10 years for 80- and 300-gallon residential containers, and 15 years for the commercial containers. The resulting estimated capital cost of residential containers is \$229,530, and for commercial containers it is \$69,186, as shown in Table C.8.⁸

Adding these costs to the \$7,836 capital cost of the roll-off containers (see Table C.7) results in a total capital cost for residential and commercial containers of \$306,552 (i.e., \$229,530 plus \$69,186, plus \$7,836). Thus, the container capital costs represent just over 89 percent of the total Sanitation capital cost of \$343,611.

C.3 Step 3: Determining Sanitation's Portion of the City's Indirect G&A Costs

Prior to the beginning of the fiscal year the City determines the percentage of its indirect G&A costs that should be allocated to Sanitation and other City activities. The procedure used by the City is to determine the ratio of Direct Operating Service expenses, such as those spent on police, fire, water resources, and sanitation, to Indirect Operating Services, such as legal, accounting, purchasing, and facilities maintenance. This ratio is then multiplied by the Sanitation's direct expenses to obtain Sanitation's share of the City's indirect G&A expenses.

Symbolically this procedure uses the following relationship:

$$ID = [(IO)/DO] \times (SE) \quad \text{Equation 1}$$

where

ID = City Indirect G&A expenses allocated to Sanitation;
 IO = the total Indirect Operating Service expenses;
 DO = the total Direct Operating Service expenses; and
 SE = Sanitation's direct operating expenses.

This equation can be rearranged as follows:

$$ID = [(SE)/(DO)] \times IO. \quad \text{Equation 2}$$

⁶ Sanitation, "COSMOS Data," Fiscal Years 79/80 through 91/92. For example, see Sanitation, "Solid Waste Information Package," June 1992, page S-19.

⁷ This is the average rate of change in the U.S. Consumer Price Index over this time period.

⁸ These costs are 80 and 77 percent of the value of the residential and commercial containers, respectively, assuming they are valued at 1992 prices.

That is, Sanitation's share of the City's Indirect G&A expenses can be calculated by multiplying the total Indirect G&A by the ratio of Sanitation direct operating costs to the total Direct Operating Service expenses. For this study the second equation is used because it reduces data requirements by eliminating the need to estimate capital costs for most City Departments.

The methodology for allocating indirect expenses used in this analysis differs from the one used by the City as follows: (1) the actual FY 1992 expenses are used rather than the prior year's expenses; (2) capital outlays are excluded from the annual expenses when determining the percentage of Sanitation's direct cost to the total Citywide direct costs; and (3) the capital costs are included in the cost of providing these indirect services. The data used to estimate the City's Indirect G&A expenses are provided in Table C.9.

The Direct Operating Service expenses are calculated by subtracting the capital outlays from the total expenses. For example, the Direct Operating Service expense for the Economic Development Division is \$2,799,416 minus \$186,990, which equals \$2,612,426. The capital outlays are subtracted in this way to avoid anomalies that may occur if one division makes an unusually high number of purchases of capital asset in a given year.

The total Direct Operating Service expense were equal to \$83,632,922. This is the value of "OD" in the Equation 2 above. The total Direct Operating Service expense (i.e., "SE" in Equation 2) for Sanitation is \$5,129,383. The ratio of Sanitation's direct cost to the total City direct cost, i.e., Sanitation's share of the City's Indirect G&A expenses, is 6.13 percent.

The City's Indirect G&A expenses are calculated by subtracting the capital outlays from the total expense and adding the associated capital cost. For example, the Indirect Operating Service expense for "Accounting and Budget" is equal to \$1,024,506 minus \$33,912 plus \$44,425, which equals \$1,035,019.

The total Indirect Operating Service expenses (i.e., "ID" in Equation 2) is \$18,578,293. Sanitation's share of this expense is \$1,138,849 (i.e., 6.13 percent of \$18,578,293). Of this amount \$150,847, or about 15 percent, are capital expenditures for office space, office furniture and equipment, and other fixed asset.

The capital costs shown on Table C.9 were obtained for Table C.7.

The City also allocated about 12.6 percent of the Customer Service expenses to Sanitation. The expenses included the FY 1992 capital outlays and excluded the capital costs of fixed assets purchased in prior years. In this analysis the \$187,000 attributed to Customer Services was calculated by: (1) subtracting the FY 1992 capital outlays from the actual reported expenses for Customer Services; (2) adding the capital costs attributed to Customer Services; and (3) multiplying this result by 12.6 percent i.e., $(\$1,500,233 - \$45,870 + \$28,135) \times 0.1262$.

C.4 Step 4: Estimating Cost to Individual Participating in Mobile Recycling Program

Individuals who bring recyclables to the mobile recycling drop-off sites incur out-of-pocket costs for gas and oil. The \$6,880 estimated cost was calculated by multiplying the estimated incremental miles traveled by individuals who participated in the mobile recycling program by

\$0.12. This was the Internal Revenue Service's allowable deduction for using a personal automobile for charitable activities in 1992.

The City of Scottsdale conducted a survey over the two-week period of January 29 through February 6, 1994, in order to estimate the miles traveled by individuals participating in the mobile recycling program. Seven of the nine sites were included in the survey. In total, 258 individuals responded to the survey.

The survey respondents indicated where they lived, where they were prior to going to the drop-off site, and where they were going after they dropped off the recyclables. Many provided the estimated distance traveled. Others gave street addresses or major intersections as points of reference. From this information the Sanitation Division and CSI estimated the average incremental distance traveled by each participant. The incremental distance is the number of miles actually traveled less the number of miles that an individual would have traveled if he or she had not participated in the program.

The results of the survey are provided in Table 6.4. About 59 percent of the respondents made a special trip to drop-off their recyclables. The other 41 percent combined their trip with other activities such as shopping, going to church, going to the park, and playing golf. In general, people who combined trips lived farther away from the drop-off sites than those who made special trips.

The survey results were scaled to estimate the total miles traveled by all participants in the program in FY 1992. During FY 1992 the Sanitation Division kept individual worksheets indicating the number of participants using each site over an eight-month period. Sanitation records also indicate that there were a total of 14,254 participants during the year. To estimate the total miles traveled, the average incremental miles traveled to each site, obtained by the survey, was multiplied by the number of participants using that site over eight months. This result was scaled up for the entire year by multiplying the estimated miles traveled by the ratio of total participants to the number of participants during the eight-month period, where site specific data was available.

An estimated 57,358 miles were traveled by individuals using the mobile drop-off sites. Multiplying this mileage by \$0.12 gives the total cost estimate of \$6,880.

C.5 Step 5: Determining the Revenues Received from the Sale of Recycled Materials

The Sanitation Division reported that it received \$13,778 in revenues for recycled materials: \$9,494 for the Mobile Trailer Recycling program; \$329 for white goods; \$1,129 for move-in-boxes; \$2,099 for the Stationary Container program; and \$728 for the Office Wastepaper program. For this analysis, two small adjustments were made to the Mobile Trailer Recycling and Office Wastepaper revenue figures.

The \$9,494 reported revenues attributed to the Mobile Recycling programs include revenues received from recyclables collected at schools in October 1991 and April 1992 as well as recyclables collected in April from the Earth Fest. In total about 37 tons of materials were recovered from these activities, which was added to the 401 tons collected through the Mobile Trailer Recycling program. Thus, approximately \$8,688 was received from the Mobile Recycling

program (i.e., \$9,494 times 401.43 divided by 438.66).

The reported \$728 received from the office wastepaper recycling program was actually net revenues received by the City. The contractor charged a fee of \$20 for each visit it made to the City to pick up the office wastepaper. The contractor made 24 visits in FY 1992 and charged the City \$480. This fee was offset by the revenues received by the contractor prior to the City receiving its share. Thus, the gross revenues were equal to \$1,208, i.e., \$728 plus \$480.

C.6 Step 6: Combining Revenues and Expenses

The reported and adjusted revenues and expenses are provided in Table C.10. The effect of these adjustments was to increase the reported FY 1992 net cost by about 4.9 percent. Most of this increase can be attributed to the use of capital costs in this analysis rather than capital outlays.

TABLE C.1: ACTUAL SANITATION EXPENDITURES IN SCOTTSDALE, ARIZONA (FY92)

ACCOUNT	TOTAL	ADM.	RESIDENTIAL COLLECTION	COMMERCIAL COLLECTION	ROLL-OFF COLLECTION	BRUSH REMOVAL	RECYCLING	CONTAINER REPAIR	HHW
Salaries & Wages	\$1,881,031	\$148,049	\$774,912	\$390,778	\$38,775	\$358,914	\$68,655	\$95,810	\$5,138
Advertising	\$1,174	\$51					\$230		\$893
Other Professional	200		200						
Postage & Freight	129	119				4	6		
Telephone	7,392	7,392							
Long Distance	330	330							
Training	815	805		10					
Train Rel Travel	2,386	2,386							
Business Conferences	300	103							197
Printing & Binding	4,361	2,373					1,944		44
Maintenance Machinery	240							240	
Uniform Cleaning	18,253		7,415	3,615	319	4,728	637	1,539	
Misc. Maintenance	3					3			
Property & Liability Insurance	137,544	7,308	66,840	25,932		19,596	420	17,448	
Other Rentals	1,002								1,002
Commercial Driver	95		25			70			
CDL Physical	48					48			
Fleet	1,901,460	3,744	1,084,536	548,664	20,040	182,268	12,696	49,512	
Subcontract & Ind Mem	975	225	300	300		150			
Ref, Award, Indem	3,440		1,625	1,040		190		585	
Landfill Contract	910,221		481,207	312,324	52,727	63,963			
Landfill - Self haul	23,749					23,749			
HHW Contract	33,329								33,329
Total Contractual Services	\$3,047,446	\$24,836	\$1,642,148	\$891,885	\$73,086	\$294,769	\$15,933	\$69,324	\$35,465
Office Supplies	\$2,754	\$2,422				\$1	\$331		
Clothing	11,854		2,908	2,002		5,039	706	1,199	
Safety & Incentives	5,490	1,340					4,150		
Photographic	211	211							
Other Operating Supplies	2,559	2,029		146		384			
Small Tools & Equipment	13,756	78	3,831	1,515	809	3,206	2,015	837	1,465
Small Tools-Refuse Container	81,290							81,290	
Small Tools-Com. Containers	43,371							43,371	
Materials to Rep Bldg	1,074		76				998		
Mat/Repair Equipment	(14)			(14)					
Mat/Repair Equipment	29,887							29,887	
Mat/Repair Ref	8,674							8,674	
Total Supplies & Equipment	\$200,906	\$6,080	\$6,815	\$3,649	\$809	\$8,630	\$8,200	\$165,258	\$1,465
Total Capital Outlay	\$45,201	\$0			\$45,201				
Total Cost	\$5,174,584	\$178,965	\$2,423,875	\$1,286,312	\$157,871	\$662,313	\$92,788	\$330,392	\$42,068

SOURCE: City of Scottsdale, "Budget Worksheet," Computer Printout, March 18, 1993.

TABLE C.2: COMPARISON OF FLEET RENTAL AND ACTUAL COSTS IN FY92

TYPE OF COST	RENTALS	ACTUAL
General & Administrative	\$96,120	\$96,120
Vehicle O&M	1,395,096	1,196,567
Vehicle Capital Cost	398,700	532,306
Corporation Yard Capital Cost		30,116
Other	11,544	62,218
Total	\$1,901,460	\$1,917,327

NOTE: In the Rental column "Other Cost" is equal to a financial deficit from the prior year. In the Actual column "Other Cost" is equal to the capital cost for equipment and furnishings.

TABLE C.3: COLLECTION FLEET O&M COSTS – FY91/92
(DOLLARS)

	LABOR	MATERIALS	FUEL	TOTAL COST
ADMINISTRATION	499	56	172	727
RESIDENTIAL	346,749	368,570	80,173	795,492
BRUSH	46,345	34,451	11,823	92,619
COMMERCIAL (INC. ROLL OFFS)	113,158	129,962	38,439	281,559
CONTAINER REPAIR	5,075	3,231	4,644	12,950
SUBTOTAL	511,326	536,215	135,079	1,182,621
RECYCLABLES	6,636	4,826	1,758	13,219
TOTAL	518,461	541,097	137,009	1,196,567

SOURCES: City of Scottsdale, "Monthly Analysis per Vehicle for June," Computer Printout, pages 8,9,10,22, & 23.

**TABLE C.4: CAPITAL COST OF COLLECTION VEHICLES
(DOLLARS)**

EXPENSE	PURCHASE PRICE	TOTAL PRICE	CAPITAL COST
ADMINISTRATION	10,875	11,006	1,843
RESIDENTIAL	1,938,638	2,186,177	266,401
BRUSH	496,599	518,917	86,902
COMMERCIAL (INC. ROLL OFFS)	1,523,661	1,531,554	148,491
CONTAINER REPAIR	100,871	104,531	17,052
SUBTOTAL	4,059,770	4,341,179	518,846
RECYCLABLES	82,742	85,826	11,617
TOTAL	4,153,387	4,438,011	532,306

SOURCE: City of Scottsdale, "Sanitation Vehicles, FY91/92."

TABLE C.5: COLLECTION FLEET OPERATING & MAINTENANCE COSTS - FY91/92
(DOLLARS)

MAKE	MODEL YEAR	LABOR	MATERIALS	FUEL	TOTAL COST
Chevy Caprice	1988	499	56	172	727
ADMINISTRATION		499	56	172	727
Dodge Pickup	1982	714	262	34	1,010
Dodge Pickup	1987	1,759	711	603	3,073
Chevy Pickup	1992	1,306	1,770	678	3,754
Peterbilt 320 Side Loader	1992	12,436	3,104	1,108	16,648
Peterbilt 320 Side Loader	1992	9,147	3,596	640	13,383
Peterbilt 320 Side Loader	1992	5,899	3,825	818	10,542
Peterbilt 320 Side Loader	1992	6,506	1,215	396	8,117
International Side Loader	1982	7,616	11,624	1,619	20,859
International Side Loader	1984	10,664	10,115	3,907	24,686
International Side Loader	1984	15,661	16,673	3,374	35,708
International Side Loader	1984	17,836	18,545	3,946	40,327
International Side Loader	1984	20,390	25,403	3,769	49,562
International Side Loader	1984	19,189	26,937	3,210	49,336
International Side Loader	1986	5,926	4,771	2,235	12,932
International Side Loader	1986	17,908	22,219	4,072	44,199
Crain Carrier SL	1987	27,350	21,230	4,321	52,901
Peterbilt 320 Side Loader	1988	20,830	22,393	4,692	47,915
Peterbilt 320 Side Loader	1988	14,805	18,239	4,355	37,399
Peterbilt 320 Side Loader	1988	18,923	20,928	4,503	44,354
Peterbilt 320 Side Loader	1988	9,881	10,967	4,261	25,109
Peterbilt 320 Side Loader	1988	15,990	22,922	4,970	43,882
Peterbilt 320 Side Loader	1988	15,623	14,180	4,161	33,964
Peterbilt 320 Side Loader	1988	16,988	27,179	4,842	49,009
Peterbilt 320 Side Loader	1988	13,912	19,979	4,202	38,093
Peterbilt 320 Side Loader	1988	15,103	16,408	4,950	36,461
Peterbilt 320 Side Loader	1988	26,480	25,600	4,991	57,071
TOTAL RESIDENTIAL COLLECTION		348,842	370,795	80,657	800,294
Crane Carrier	1986	6,921	8,110	1,805	16,836
Crane Carrier	1986	13,039	13,002	4,588	30,629
Crane Carrier	1986	9,025	10,278	1,630	20,933
Crane Carrier	1986	13,743	18,063	4,584	36,390
Crane Carrier	1986	8,630	12,821	2,531	23,982
Crane Carrier	1987	15,734	30,152	5,299	51,185
Peterbilt 320 Front Loader	1992	6,413	7,676	1,960	16,049
Peterbilt 320 Front Loader	1992	6,544	3,018	2,241	11,803
Peterbilt 320 Front Loader	1992	7,918	8,092	2,174	18,184
Peterbilt 320 Front Loader	1992	7,281	2,991	2,396	12,668
Peterbilt 320 Front Loader	1992	4,530	3,765	2,318	10,613
Peterbilt 320 Front Loader	1992	5,051	4,013	2,109	11,173
TOTAL COMMERCIAL COLLECTION		104,829	121,981	33,635	260,445
Chevy Pickup	1992	1,347	464	467	2,278
International Rear Loader	1984	10,976	10,758	1,935	23,669
International Rear Loader	1984	5,936	5,727	1,693	13,356
International Rear Loader	1984	6,811	3,031	1,803	11,645
International Rear Loader	1984	7,327	4,982	1,945	14,254
Mack Rear Loader	1985	1,688	1,214	670	3,572
White Rear Loader	1987	6,916	3,559	1,863	12,338
White Rear Loader	1987	6,777	5,782	1,813	14,372
TOTAL BRUSH		47,778	35,517	12,189	95,484
Peterbilt 320 RLOF	1991	8,329	7,981	4,804	21,114
TOTAL ROLL OFF		8,329	7,981	4,804	21,114
GMC FB	1985	849	376	605	1,830
General Trailer	1973	594	755		1,349
Eager Beaver Trailer	1990	639	99		738
Ford 340 Tractor	1980	705	131		836
TOTAL RECYCLABLES		2,787	1,361	605	4,753
Ford Pickup	1989	789	771	630	2,190
Dodge Pickup	1989	2,031	982	2,079	5,092
Dodge Pickup	1987	771	282	791	1,844
Yale Forklift	1984	342	485	225	1,052
Trailer	1980	165	181	0	346
Chevy C70 Flat Bed	1986	1,299	705	1,222	3,226
CONTAINER REPAIR		5,397	3,406	4,947	13,750

City of Scottsdale, "Monthly Analysis per Vehicle for June," Computer Printout, pages 8,9,10,22, & 23.

TABLE C.6: CAPITAL COST OF COLLECTION VEHICLES

(DOLLARS)

MAKE	MODEL YEAR	DATE IN SERVICE	DATE RETIRED	AGE (YRS)	PURCHASE PRICE	TOTAL PRICE	CAPITAL COST
Chevy Caprice ADMINISTRATION	1988	01-Apr-88		4.25	10,875	11,006	1,843
					10,875	11,006	1,843
Dodge Pickup	1982	12-Jan-82	09-Dec-91	10.47	8,811	8,811	0
Dodge Pickup	1987	23-Oct-86		5.69	11,913	11,993	2,008
Chevy Pickup	1992	09-Dec-91		0.56	14,290	16,423	1,537
Peterbilt 320 Side Loader	1992	21-Jan-92		0.44	120,902	126,804	9,367
Peterbilt 320 Side Loader	1992	21-Jan-92		0.44	120,902	127,123	9,390
Peterbilt 320 Side Loader	1992	21-Jan-92		0.44	120,902	128,307	9,478
Peterbilt 320 Side Loader	1992	21-Jan-92		0.44	120,902	128,203	9,470
International Side Loader	1982	01-Sep-81		10.84	60,000	60,000	0
International Side Loader*	1984	01-Feb-85	21-Jan-92	7.41	87,980	100,383	9,396
International Side Loader*	1984	15-Feb-85	21-Jan-92	7.38	87,980	90,761	8,495
International Side Loader*	1984	01-Feb-85	21-Jan-92	7.41	87,980	115,787	10,837
International Side Loader*	1984	01-May-85		7.17	87,980	111,313	18,641
International Side Loader*	1984	11-Oct-83		8.73	87,980	102,283	0
International Side Loader*	1986	02-Dec-85		6.58	95,920	95,920	16,064
International Side Loader*	1986	13-Oct-86		5.72	57,958	70,634	11,829
Crain Carrier SL	1987	29-Jun-89		3.01	35,000	35,000	5,861
Peterbilt 320 Side Loader	1988	20-Oct-87		4.70	72,119	85,789	14,367
Peterbilt 320 Side Loader	1988	01-Dec-87		4.58	72,119	86,166	14,430
Peterbilt 320 Side Loader	1988	11-Jan-88		4.47	72,119	86,642	14,510
Peterbilt 320 Side Loader	1988	05-Feb-88		4.40	72,119	87,793	14,702
Peterbilt 320 Side Loader	1988	14-Mar-88		4.30	72,119	83,774	14,029
Peterbilt 320 Side Loader	1988	14-Apr-88		4.21	72,119	82,256	13,775
Peterbilt 320 Side Loader	1988	08-Sep-88		3.81	72,119	83,768	14,028
Peterbilt 320 Side Loader	1988	20-Dec-88		3.53	72,119	83,828	14,038
Peterbilt 320 Side Loader	1988	08-Sep-88		3.81	72,119	83,800	14,034
Peterbilt 320 Side Loader	1988	08-Sep-88		3.81	72,119	83,800	14,034
TOTAL RESIDENTIAL COLLECTION					1,950,340	2,199,373	268,009
Crane Carrier	1986	14-Mar-86	17-Oct-91	6.30	120,722	120,722	5,982
Crane Carrier	1986	14-Mar-86	09-Dec-91	6.30	120,722	120,722	8,918
Crane Carrier	1986	14-Mar-86	04-Nov-91	6.30	120,722	120,722	6,979
Crane Carrier	1986	14-Mar-86	09-Dec-91	6.30	120,722	120,722	8,918
Crane Carrier	1986	14-Mar-86	09-Dec-91	6.30	120,722	120,722	8,918
Crane Carrier	1987	15-Jun-87		5.05	119,119	119,630	20,034
Peterbilt 320 Front Loader	1992	25-Oct-91		0.68	117,889	118,910	13,585
Peterbilt 320 Front Loader	1992	17-Oct-91		0.70	117,889	118,569	13,981
Peterbilt 320 Front Loader	1992	25-Nov-91		0.60	117,889	119,248	11,927
Peterbilt 320 Front Loader	1992	09-Dec-91		0.56	117,889	119,239	11,161
Peterbilt 320 Front Loader	1992	09-Dec-91		0.56	117,889	119,526	11,187
Peterbilt 320 Front Loader	1992	09-Dec-91		0.56	117,889	118,306	11,073
TOTAL COMMERCIAL COLLECTION					1,430,063	1,437,038	132,663
Chevy Pickup	1992	09-Dec-91		0.56	14,290	14,290	2,393
International Rear Loader	1984	01-Dec-84		7.58	65,606	65,606	10,987
International Rear Loader	1984	01-Dec-84		7.58	65,606	66,947	11,211
International Rear Loader	1984	01-Dec-84		7.58	65,606	66,714	11,172
International Rear Loader	1984	01-Dec-84		7.58	65,606	66,975	11,216
Mack Rear Loader	1985	15-Nov-84		7.63	88,532	88,532	14,826
White Rear Loader	1987	26-Oct-87		4.68	73,356	83,061	13,910
White Rear Loader	1987	26-Oct-87		4.68	73,356	82,841	13,873
TOTAL BRUSH					511,958	534,966	89,590
Peterbilt 320 RLOF	1991	22-Mar-91		1.28	93,598	94,516	15,828
TOTAL ROLL OFF					93,598	94,516	15,828
GMC FB	1985	05-Sep-85		6.82	21,026	21,281	3,564
General Trailer	1973	21-Feb-74		18.37			0
Eager Beaver Trailer	1990	12-Jun-90		2.05	4,981	5,050	846
Ford 340 Tractor	1980	01-Jun-80		12.09	12,863	12,863	0
TOTAL RECYCLABLES					38,870	39,194	4,410
Ford Pickup	1989	20-Dec-88		3.53	14,952	16,312	2,732
Dodge Pickup	1987	04-Nov-86		5.66	11,913	12,268	2,054
Dodge Pickup	1989	10-Jan-89		3.47	16,679	16,865	2,824
Trailer	1980	06-Oct-80		11.74	2,711	2,711	0
Yale Forklift	1984	07-Nov-84		7.65	3,639	3,655	612
Chevy C70 Flat Bed	1986	16-Dec-85		6.54	67,789	70,107	11,741
CONTAINER REPAIR					117,683	121,918	19,963

*capital costs did not include purchase price for body. Prices in this table are twice the reported costs.

by of Scottsdale, "Sanitation Vehicles, FY91/92."

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE AQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
General Government	Legislative	Machinery & Equipment			3,002	20	283
General Government	Legislative	Office Furniture			21,522	8	3,604
General Government	City Manager	City Hall Land	Sep-67	25	405,008	40	30,379
General Government	City Manager	City Hall Remodeling	Dec-88	4	49,179	25	4,220
General Government	City Manager	City Hall Remodeling	Dec-89	3	332,230	25	28,509
General Government	City Manager	City Hall Plan/Design	Dec-89	3	73,551	25	6,311
General Government	City Manager	City Hall Furnishings	Dec-88	4	48,630	8	8,144
General Government	City Manager	Municipal Office Building Land	Dec-91	1	161,000	40	12,076
General Government	City Manager	Municipal Office Building Land	Dec-91	1	285,800	25	24,525
General Government	City Manager	One Civic Center Land	May-85	7	1,918,090	40	143,874
General Government	City Manager	One Civic Center Building	May-85	7	7,197,158	25	617,592
General Government	City Manager	Civic Center Buildings	Apr-69	23	711,797	25	61,080
General Government	City Manager	Civic Center Improvements	Dec-73	19	14,596	25	1,252
General Government	City Manager	Other Structures & Improvements	Dec-79	13	99,008	25	8,496
General Government	City Manager	Motor Vehicles			19,078	6	4,002
General Government	City Manager	Machinery & Equipment			11,626	20	1,097
General Government	City Manager	Office Furniture			29,902	8	5,008
General Government	City Clerk	Motor Vehicles			12,899	6	2,706
General Government	City Clerk	Machinery & Equipment			4,492	20	424
General Government	City Clerk	Office Furniture			73,908	8	12,377
General Government	Elections	Office Furniture			13,795	8	2,310
General Government	City Attorney	Motor Vehicles			20,772	6	4,358
General Government	City Attorney	City Attorney Office Furnishings	Dec-88		99,159	8	16,606
General Government	City Attorney	Machinery & Equipment			1,312	20	124
General Government	City Attorney	Office Furniture			81,920	8	13,719
General Government	Intergovernment Relations	Motor Vehicles			23,739	6	4,980
General Government	Intergovernment Relations	Machinery & Equipment			2,022	20	191
General Government	Intergovernment Relations	Office Furniture			7,502	8	1,256
General Government	Organizational Effectiveness	Other Structures & Improvements	Jul-91	1	5,794	25	497

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993
(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE ACQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
General Government	Organizational Effectiveness	Other Structures & Improvements	Feb-93	-1	7,458	25	
General Government	Organizational Effectiveness	Office Furniture			101,620	8	17,018
General Government	City Auditor	Office Furniture			38,518	8	6,451
General Government	Office of Environmental Affairs	FAA Flight Standards	Jul-93	-1	15,312	25	
General Government	Office of Environmental Affairs	Machinery & Equipment	Aug-92	0	25,095	20	
General Government	Office of Economic Dev.	CDBG Planning	Dec-88	4	22,888	25	1,964
General Government	Office of Economic Dev.	TPC Improvements	Nov-90	2	25,000	25	2,145
General Government	Office of Economic Dev.	Arizona Canal Master Dev. Plan	Dec-90	2	31,534	25	2,706
General Government	Office of Economic Dev.	Canal Bank Lookout View Point	May-90	2	17,001	25	1,459
General Government	Office of Economic Dev.	Office Furniture			9,866	8	1,652
General Government	City Court	Parking	Jan-64	28	59,146	40	4,436
General Government	City Court	Other Structures & Improvements			17,229	25	1,478
General Government	City Court	Machinery & Equipment			16,947	20	1,600
General Government	City Court	Office Furniture			179,787	8	30,109
Financial Services	Administration	Other Structures & Improvements	Dec-80	12	34,525	25	2,963
Financial Services	Administration	Machinery & Equipment			3,750	20	354
Financial Services	Administration	Office Furniture			107,184	8	17,950
Financial Services	Accounting & Budget	Machinery & Equipment			2,392	20	226
Financial Services	Accounting & Budget	Office Furniture			263,927	8	44,199
Financial Services	Tax Audit	Other Structures & Improvements	Dec-90	2	3,716	25	319
Financial Services	Tax Audit	Office Furniture			39,337	8	6,588
Financial Services	Risk Management	Office Furniture			45,953	8	7,696
Financial Services	Purchasing	Warehouse	Dec-74	18	175,518	25	15,061
Financial Services	Purchasing	Pallet Racks and Shelving	Jun-87	5	26,519	25	2,276
Financial Services	Purchasing	Other Structures & Improvements			27,477	25	2,358
Financial Services	Purchasing	Motor Vehicles			58,815	6	12,339
Financial Services	Purchasing	Machinery & Equipment (Fleet)			34,171	20	3,225
Financial Services	Purchasing	Machinery & Equipment			118,259	20	11,163
Financial Services	Purchasing	Office Furniture			184,411	8	30,883
Financial Services	Customer Services	Mobile Vehicles			89,398	6	18,755
Financial Services	Customer Services	Automated Meter Reading System	May-92	0	44,105	20	4,163

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993
(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE ACQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
Financial Services	Customer Services	Machinery & Equipment			16,055	20	1,516
Financial Services	Customer Services	Office Furniture			22,097	8	3,701
Management Services	General Services Administration	Other Structures & Improvements			1,674	25	144
Management Services	General Services Administration	Motor Vehicles			2,464	6	517
Management Services	General Services Administration	Machinery & Equipment			3,721	20	351
Management Services	General Services Administration	Office Furniture			94,717	8	15,862
Management Services	Office of Management Systems	Other Structures & Improvements			8,526	25	732
Management Services	Office of Management Systems	Motor Vehicles			47,291	6	9,921
Management Services	Office of Management Systems	Machinery & Equipment			11,066,389	20	1,044,589
Management Services	Office of Management Systems	Office Furniture			741,884	8	124,242
Management Services	Communications & Public Affairs	Other Structures & Improvements			3,533	25	303
Management Services	Communications & Public Affairs	Motor Vehicles			14,493	6	3,041
Management Services	Communications & Public Affairs	Machinery & Equipment			141,988	20	13,403
Management Services	Communications & Public Affairs	Office Furniture			72,714	8	12,177
Management Services	Capital Project Management	Motor Vehicles			47,268	6	9,917
Management Services	Capital Project Management	Machinery & Equipment			1,103	20	104
Management Services	Capital Project Management	Office Furniture			8,258	8	1,383
Management Services	Office of Emergency Management	Land	Sep-74	18	40,855	40	3,064
Management Services	Office of Emergency Management	Streets and Storm Drains			48,038	20	4,534
Management Services	Office of Emergency Management	Motor Vehicles			20,283	6	4,255
Management Services	Office of Emergency Management	Machinery & Equipment			2,634	20	249
Management Services	Office of Emergency Management	Office Furniture			2,365	8	396
Municipal Services	Administration	Machinery & Equipment			15,882	20	1,499
Municipal Services	Administration	Office Furniture			17,190	8	2,879
Municipal Services	Facility Maintenance/Mechanical	Motor Vehicles			77,336	6	16,225
Municipal Services	Facility Maintenance/Mechanical	Machinery & Equipment			5,554	20	524
Municipal Services	Facility Maintenance/Mechanical	Office Furniture			3,073	8	515
Municipal Services	Facility Maintenance/Gen.Building	Motor Vehicles			185,397	6	38,895
Municipal Services	Facility Maintenance/Gen.Building	Machinery & Equipment (Fleet)			3,560	20	336
Municipal Services	Facility Maintenance/Gen.Building	Machinery & Equipment			1,120	20	106
Municipal Services	Facility Maintenance/Gen.Building	Office Furniture			6,752	8	1,131

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993
(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE ACQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
Financial Services	Customer Services	Machinery & Equipment			16,055	20	1,516
Financial Services	Customer Services	Office Furniture			22,097	8	3,701
Management Services	General Services Administration	Other Structures & Improvements			1,674	25	144
Management Services	General Services Administration	Motor Vehicles			2,464	6	517
Management Services	General Services Administration	Machinery & Equipment			3,721	20	351
Management Services	General Services Administration	Office Furniture			94,717	8	15,862
Management Services	Office of Management Systems	Other Structures & Improvements			8,526	25	732
Management Services	Office of Management Systems	Motor Vehicles			47,291	6	9,921
Management Services	Office of Management Systems	Machinery & Equipment			11,066,389	20	1,044,589
Management Services	Office of Management Systems	Office Furniture			741,884	8	124,242
Management Services	Communications & Public Affairs	Other Structures & Improvements			3,533	25	303
Management Services	Communications & Public Affairs	Motor Vehicles			14,493	6	3,041
Management Services	Communications & Public Affairs	Machinery & Equipment			141,988	20	13,403
Management Services	Communications & Public Affairs	Office Furniture			72,714	8	12,177
Management Services	Capital Project Management	Motor Vehicles			47,268	6	9,917
Management Services	Capital Project Management	Machinery & Equipment			1,103	20	104
Management Services	Capital Project Management	Office Furniture			8,258	8	1,383
Management Services	Office of Emergency Management	Land	Sep-74	18	40,855	40	3,064
Management Services	Office of Emergency Management	Streets and Storm Drains			48,038	20	4,534
Management Services	Office of Emergency Management	Motor Vehicles			20,283	6	4,255
Management Services	Office of Emergency Management	Machinery & Equipment			2,634	20	249
Management Services	Office of Emergency Management	Office Furniture			2,365	8	396
Municipal Services	Administration	Machinery & Equipment			15,882	20	1,499
Municipal Services	Administration	Office Furniture			17,190	8	2,879
Municipal Services	Facility Maintenance/Mechanical	Motor Vehicles			77,336	6	16,225
Municipal Services	Facility Maintenance/Mechanical	Machinery & Equipment			5,554	20	524
Municipal Services	Facility Maintenance/Mechanical	Office Furniture			3,073	8	515
Municipal Services	Facility Maintenance/Gen.Building	Motor Vehicles			185,397	6	38,895
Municipal Services	Facility Maintenance/Gen.Building	Machinery & Equipment (Fleet)			3,560	20	336
Municipal Services	Facility Maintenance/Gen.Building	Machinery & Equipment			1,120	20	106
Municipal Services	Facility Maintenance/Gen.Building	Office Furniture			6,752	8	1,131

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993

(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE AQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
Municipal Services	Facility Maintenance/Custodial	Office Furniture			39,467	20	3,725
Municipal Services	Field Services/Traffic Signals	Motor Vehicles			262,712	6	55,116
Municipal Services	Field Services/Traffic Signals	Machinery & Equipment (Fleet)			109,199	20	10,308
Municipal Services	Field Services/Traffic Signals	Machinery & Equipment			38,652	20	3,648
Municipal Services	Field Services/Traffic Signals	Office Furniture			8,178	8	1,369
Municipal Services	Field Services/Signs & Markings	Motor Vehicles			108,928	6	22,853
Municipal Services	Field Services/Signs & Markings	Motor Vehicles	Feb-93	-1	132,739	6	
Municipal Services	Field Services/Signs & Markings	Machinery & Equipment (Fleet)			3,999	20	378
Municipal Services	Field Services/Signs & Markings	Machinery & Equipment			52,934	20	4,997
Municipal Services	Field Services/Signs & Markings	Office Furniture			2,892	8	484
Municipal Services	Field Services/Asphalt	Motor Vehicles			189,835	6	39,827
Municipal Services	Field Services/Asphalt	Office Furniture			22,635	8	3,791
Municipal Services	Field Services/Shoulder & Drainage	Motor Vehicles			408,707	6	85,745
Municipal Services	Field Services/Shoulder & Drainage	Machinery & Equipment (Fleet)			294,990	20	27,845
Municipal Services	Field Services/Medians & ROW	Motor Vehicles			247,119	6	51,844
Municipal Services	Field Services/Medians & ROW	Machinery & Equipment (Fleet)			71,035	20	6,705
Municipal Services	Field Services/Downtown Imp.	Motor Vehicles			10,776	6	2,261
Municipal Services	Field Services/Downtown Imp.	Machinery & Equipment (Fleet)			8,354	20	789
Sanitation	Administration	New Corporation Yard (30,401 sq ft)	Jan-88	4	361,772	25	31,044
Sanitation	Administration	Structures and Improvements			1,784	25	153
Sanitation	Administration	Motor Vehicles			10,916	6	2,290
Sanitation	Administration	Machinery & Equipment			1,181	20	112
Sanitation	Administration	Office Furniture			5,388	8	902
Sanitation	Residential Collection	Motor Vehicles			1,375,852	6	288,648
Sanitation	Residential Collection	Motor Vehicles	Aug-92	0	655,890	6	
Sanitation	Residential Collection	Machinery & Equipment (Fleet)			9,998	20	944
Sanitation	Container Repair	4-yard Commercial Containers	Sep-87	5	15,616	15	1,715
Sanitation	Container Repair	4-yard Commercial Containers	Jan-89	3	6,805	15	747
Sanitation	Container Repair	4-yard Commercial Containers	May-89	3	3,563	15	391
Sanitation	Container Repair	4-yard Commercial Containers	Oct-89	3	5,938	15	652

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993
(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE AQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
Sanitation	Container Repair	4-yard Commercial Containers	Nov-89	3	5,531	15	607
Sanitation	Container Repair	4-yard Commercial Containers	May-90	2	5,938	15	652
Sanitation	Container Repair	4-yard Commercial Containers	Jan-91	1	7,852	15	862
Sanitation	Container Repair	6-yard Commercial Containers	Jun-88	4	9,087	15	998
Sanitation	Container Repair	6-yard Commercial Containers	Nov-88	4	9,565	15	1,050
Sanitation	Container Repair	6-yard Commercial Containers	Jan-89	3	4,304	15	473
Sanitation	Container Repair	6-yard Commercial Containers	May-89	3	10,014	15	1,100
Sanitation	Container Repair	6-yard Commercial Containers	Oct-89	3	10,014	15	1,100
Sanitation	Container Repair	6-yard Commercial Containers	Nov-89	3	10,014	15	1,100
Sanitation	Container Repair	6-yard Commercial Containers	May-90	2	5,007	15	550
Sanitation	Container Repair	6-yard Commercial Containers	Jan-91	1	8,417	15	924
Sanitation	Container Repair	6-yard Commercial Containers	Jul-91	1	10,030	15	1,101
Sanitation	Container Repair	6-yard Commercial Containers	Sep-91	1	10,521	15	1,155
Sanitation	Container Repair	8-yard Commercial Containers	Jun-88	4	6,093	15	669
Sanitation	Container Repair	8-yard Commercial Containers	Nov-88	4	5,539	15	608
Sanitation	Container Repair	8-yard Commercial Containers	Feb-89	3	3,877	15	426
Sanitation	Container Repair	8-yard Commercial Containers	May-89	3	2,320	15	255
Sanitation	Container Repair	8-yard Commercial Containers	Dec-89	3	1,740	15	191
Sanitation	Container Repair	8-yard Commercial Containers	May-90	2	2,900	15	318
Sanitation	Container Repair	8-yard Commercial Containers	Jan-91	1	4,638	15	509
Sanitation	Container Repair	8-yard Commercial Containers	Jul-91	1	3,078	15	338
Sanitation	Container Repair	8-yard Commercial Containers	Sep-91	1	3,313	15	364
Sanitation	Container Repair	Machinery & Equipment			9,100	20	859
Sanitation	Container Repair	Motor Vehicles			136,402	6	28,617
Sanitation	Container Repair	Machinery & Equipment (Fleet)			14,801	20	1,397
Sanitation	Commercial Collection	4-yard Commercial Containers	Feb-81	11	14,700	15	1,614
Sanitation	Commercial Collection	4-yard Commercial Containers	Aug-81	11	14,700	15	1,614
Sanitation	Commercial Collection	6-yard Commercial Containers	Oct-85	7	13,388	15	1,470
Sanitation	Commercial Collection	6-yard Commercial Containers	Apr-86	6	12,495	15	1,372
Sanitation	Commercial Collection	6-yard Commercial Containers	Nov-80	12	4,724	15	519
Sanitation	Commercial Collection	6-yard Commercial Containers	Feb-81	11	12,411	15	1,363

TABLE C.7: ASSETS - CITY OF SCOTTSDALE AS OF AUGUST 4, 1993
(CONTINUED)

DEPARTMENT	DIVISION	ASSET DESCRIPTION	DATE ACQUIRED	AGE (YRS)	COST (\$)	LIFE (YRS)	CAPITAL COST (\$)
Sanitation	Commercial Collection	6-yard Commercial Containers	Feb-85	7	6,441	15	707
Sanitation	Commercial Collection	6-yard Commercial Containers	Feb-85	7	5,692	15	625
Sanitation	Commercial Collection	8-yard Commercial Containers	Mar-86	6	6,741	15	740
Sanitation	Commercial Collection	Commercial Containers	Jan-86	6	14,963	15	1,643
Sanitation	Commercial Collection	Commercial Containers	Dec-86	6	16,140	15	1,772
Sanitation	Commercial Collection	Commercial Containers	Apr-87	5	15,213	15	1,670
Sanitation	Commercial Collection	Commercial Containers	Jul-84	8	16,239	15	1,783
Sanitation	Commercial Collection	20-Cubic Yard Roll-Off Containers	Sep-91	1	22,936	15	2,518
Sanitation	Commercial Collection	30-Cubic Yard Roll-Off Containers	Sep-91	1	23,790	15	2,612
Sanitation	Commercial Collection	40-Cubic Yard Roll-Off Containers	Sep-91	1	24,643	15	2,706
Sanitation	Commercial Collection	Machinery & Equipment			4,761	20	449
Sanitation	Commercial Collection	Motor Vehicles			1,448,606	6	303,911
Sanitation	Brush Removal	Motor Vehicles			548,911	6	115,159
Sanitation	Brush Removal	Machinery & Equipment			1,002	20	95
Sanitation	Recycling	Motor Vehicles			34,968	6	7,336
Sanitation	Recycling	Machinery & Equipment (Fleet)			5,017	20	474
Sanitation	Recycling	Office Furniture			3,702	8	620
Sanitation	Roll-Off Collection	Motor Vehicles			184,250	6	38,655
Sanitation	Roll-Off Collection	Motor Vehicles	Mar-93	-1	22,031	6	
Sanitation	Roll-Off Collection	20-Cubic Yard Roll-Off Containers	Nov-92	0	6,233	15	
Sanitation	Roll-Off Collection	20-Cubic Yard Roll-Off Containers	May-93	-1	8,310	15	
Sanitation	Roll-Off Collection	30-Cubic Yard Roll-Off Containers	Nov-92	0	6,837	15	
Sanitation	Roll-Off Collection	30-Cubic Yard Roll-Off Containers	May-93	-1	2,279	15	
Sanitation	Roll-Off Collection	40-Cubic Yard Roll-Off Containers	Oct-92	0	32,131	15	
Sanitation	Roll-Off Collection	40-Cubic Yard Roll-Off Containers	May-93	-1	10,388	15	
Fleet Management	Administration	New Corporation Yard (102,762 sq ft)	Jan-88	4	1,222,868	25	104,935
Fleet Management	Administration	Vehicle Wash System	Oct-93	-1	202,712	25	
Fleet Management	Administration	Motor Vehicles			200,036	6	41,967
Fleet Management	Administration	Machinery & Equipment (Fleet)			109,285	20	10,316
Fleet Management	Administration	Office Furniture			16,831	8	2,819

SOURCE: City of Scottsdale, "Fixed Assets Inventory-As of August 4, 1993," Computer Printout.

TABLE C.8: CONTAINERS INVENTORY CAPITAL COST COST ESTIMATE

FISCAL YEAR	RESIDENTIAL			SUBTOTAL	COMMERCIAL			SUBTOTAL	CAPITAL COST	
	20 GALLON	80- GALLON	300- GALLON		2 to 4 CY	5 & 6 CY	8- CY		RESIDENTIAL	COMMERCIAL
91/92	6,389	108,540	44,722	159,650	16,294	21,351	285	37,930	23,006	4,164
90/91	6,084	108,483	45,643	160,210	41,747	67,320	14,378	123,444	23,073	13,554
89/90	5,795	56,958	40,564	103,317	14,779	19,366	7,456	41,601	14,960	4,568
88/89	5,519	153,778	46,933	206,229	14,663	35,491	1,160	51,313	29,601	5,634
87/88	5,256	137,341	36,793	179,390	13,405	32,389	11,985	57,779	25,768	6,344
86/87	5,006	124,049	54,204	183,259	12,767	25,469	4,783	43,018	26,308	4,723
85/86	4,767	134,787	37,935	177,489	12,159	45,064	15,608	72,830	25,476	7,996
84/85		104,642	31,783	136,426	11,580	15,174	202	26,956	19,424	2,960
83/84		99,126	30,270	129,396	11,949	16,774	4,131	32,854	18,423	3,607
82/83		113,450	51,538	164,988	16,421	20,400	184	37,004	23,491	4,063
81/82					12,925	19,429	175	32,529		3,571
80/81					33,978	12,483	167	46,628		5,120
79/80					12,292	13,800	159	26,250		2,882
TOTAL	38,815	1,141,153	420,385	1,600,353	224,956	344,509	60,671	630,137	229,530	69,186
MAX	44,720	1,438,842	525,835	2,009,397	302,940	442,299	74,060	819,299	288,024	89,955

SOURCES: Changes in container inventory based on Sanitation, "COSMOS DATA," Fiscal Years 79/80 through 91/92, June.

TABLE C.9: CITY GENERAL & ADMINISTRATION COST ALLOCATION (FY92)

DESCRIPTION	TOTAL EXPENSE	CAPITAL OUTLAY	CAPITAL COST	DIRECT OPERATING SERVICE (a)	INDIRECT OPERATING SERVICE (b)
GENERAL GOVERNMENT					
Legislative	481,623	6,774	3,887	474,849	
City Manager	743,652		956,585		1,700,217
City Clerk	385,239		15,507		400,746
Elections	152,518	6,675	2,310	145,843	
City Attorney	1,487,775	40,965	34,807	318,299	1,155,661
Intergovernmental Relations	176,298		6,427		182,723
Organizational Effectiveness	1,549,451	15,497	17,515		1,551,469
City Auditor	368,018	9,197	6,451		365,272
City Court	1,172,949	12,478	37,623	1,160,471	
Economic Development	2,799,416	186,990	9,926	2,612,426	
Office of Environmental Affairs	265,594	92,150		173,444	
SUBTOTAL	9,582,531	370,726	1,091,018	4,885,332	5,356,088
FINANCIAL SERVICES					
Administration	201,896		21,267		223,163
Accounting & Budget	1,024,506	33,912	44,425		1,035,019
Tax Audit	467,461		6,907	467,461	
Risk Management	2,383,742	4,622	7,696		
Contribution to Risk Management	200,000			150,000	50,000
Purchasing	1,159,803	9,949	77,305		1,227,159
Customer Service	1,500,233	45,870	28,135	1,454,363	
SUBTOTAL	6,937,641	94,353	185,735	2,071,824	2,535,341
MANAGEMENT SERVICES					
General Services Administration	151,146		16,874		168,020
Office of Management Systems	3,177,370	151,488	1,179,484		4,205,366
Communication and Public Affairs	630,154	29,207	28,924	300,474	314,936
Capital Project Management	528,657		11,404		540,061
Office of Emergency Management	185,459		12,498	185,459	
SUBTOTAL	4,672,786	180,695	1,249,184	485,933	5,228,383
MUNICIPAL SERVICES					
Administration	180,846	2,940	4,378	101,660	78,122
Facilities Management	5,319,214	2,940	64,086		5,380,360
Field Services	6,108,624	5,577	317,960	6,103,047	
Sanitation	5,174,584	45,201	858,178	5,129,363	
Fleet Management	6,632,519	2,771,248	321,721		
SUBTOTAL	23,415,787	2,827,906	1,566,323	11,334,090	5,458,482
POLICE	18,431,599	344,688		18,086,911	
TRANSPORTATION	2,992,986	70,845		2,922,141	
COMMUNITY SERVICES	14,483,671	94,172		14,389,499	
PLANNING & ZONING	5,954,570	58,176		5,896,394	
FIRE	6,209,822	21,225		6,188,597	
WATER RESOURCES	17,519,922	147,720		17,372,202	
DEBT SERVICE	34,497,433				
CONTINGENCY	4,152,701				
TOTAL FY92 EXPENSES	148,851,449	4,210,506		83,632,922	18,578,293
PERCENT SANITATION				6.13%	1,138,849

NOTES:

(a) Direct Operating Service column is equal to Total Expense less Capital Outlay.

(b) Indirect operating Service column is equal to Total Expense less Capital Outlay plus Capital Cost.

SOURCES:

1. City of Scottsdale, "1993-1994 Budget Summary" and City of Scottsdale, "Indirect Service Allocation - 1991-92 Budget."
2. List of Capital Outlays FY91/92 by Department/Division provided by Nancy Swick, City of Scottsdale, Accounting and Budget, May 1994.
3. City of Scottsdale, "Fixed Assets Inventory-As of August 4, 1993.

TABLE C-10: STATEMENT OF REVENUES AND EXPENSES
Year Ending June 30, 1992

CATEGORY	REPORTED COSTS	ADJUSTED COSTS
RECYCLABLES REVENUES	\$13,778	\$13,453
SANITATION EXPENSES		
Salary and Wages	\$1,881,031	\$1,881,031
Landfill Expenses	933,970	933,970
HHW Contract Services	33,329	33,329
Other Contractual Services	41,143	41,623
Subtotal	1,008,442	1,008,922
Fleet Services	1,901,460	1,917,327
Property & Liability Insurance	137,544	137,544
Subtotal	2,039,004	2,054,871
Supplies & Equipment	200,906	76,245
Capital Outlays (Sanitation Only)	45,201	0
Capital Costs (Sanitation Only)		343,611
Total Sanitation Expenses	\$5,174,584	\$5,364,680
OTHER INDIRECT EXPENSES		
City General & Administration	\$1,019,497	\$1,138,849
Customer Services	193,204	187,297
Subtotal	1,212,701	1,326,146
Recyclables Drop-Off (Gas and Oil)	0	6,880
Total Other Indirect Expenses	\$1,212,701	\$1,333,026
TOTAL COST IN FY92	\$6,387,285	\$6,697,706
NET COST IN FY92	\$6,373,507	\$6,684,253

SOURCES: City of Scottsdale, "Budget Worksheet," Computer Printout, March 18, 1993, and City of Scottsdale, "1993-1994 Budget Summary," and City of Scottsdale, "Sanitation Fund Summary 1993-94."

Appendix D

Capital Cost Calculation

A capital expense is the purchase of an asset or service with a useful life of greater than one year. Accountants report capital expenses as either capital outlays, i.e., the actual payment made during the year, or depreciated/amortized expenses, e.g., using straight-line depreciation the capital outlay is divided by the useful life of the asset.

Capital assets may be purchased entirely with cash, financed over time using borrowed funds, or utilize a combination of the two. If totally or partially financed, interest payments on borrowed funds are reported by accountants as interest expenses.

Following these accounting practices, the cost of a capital asset in a given reporting period (e.g., fiscal year) is reported as either the capital outlay incurred, or the depreciation/amortization expense incurred in the reporting period, plus interest paid, if any, on borrowed funds to finance the capital asset. Some financial reports, such as a cash flow analysis, also report the actual debt service, i.e., principal plus interest payments, on borrowed funds.

Although these approaches are appropriate for generating financial statements of non-profit organizations, none is an appropriate measure of the economic capital costs of the asset. The reporting of capital outlays does not recognize that a capital asset will be used over two or more years and that, therefore, its costs should be spread over the asset's useful life. The depreciation/amortization approach does not adequately distinguish between the same asset purchased with cash or with borrowed funds. Because loan repayment and debt service payments, and in particular the interest portion of such payments, can vary significantly from year to year based solely on the means of borrowing funds and not the use of the asset, these expenses are not an appropriate measure of the capital cost of the asset.

The approach used in the report to calculate capital costs is to "annualize" or "capitalize" capital outlays over the useful life of the asset using a cost of capital of 7 percent.¹ Generally, the cost of capital reflects the rate of return expected on invested funds.

Using this approach the capital cost of an asset is independent of the method used to pay for the asset, and has the same annual value over the useful life of the asset.

To illustrate the method used to calculate capital costs and compare it to the other ways of reporting capital expenses, consider a transfer tractor and trailer with a 5 year useful life and a purchase price of \$105,000.

To estimate the annual capital cost the purchase price, i.e., capital outlay, of \$105,000 is multiplied by the following capitalization factor:

where "r" is the cost of capital, or .07 in this analysis, and "n" is the useful life of the

¹The cost of capital is related to the rates of return that can be earned on invested funds and the rates of interest that must be paid on borrowed funds. As the economy changes and interest rates increase or decrease, the cost of capital may also change over time. The 7-percent cost of capital is about the mid-point of cost of capital often used for public entities.

$$\frac{r}{1 - [1/(1+r)^n]}$$

asset.

Substituting .07 for "r" and 5 for "n" in the above equation results in a capitalization factor of:

$$0.2539 = \frac{.07}{1 - [1/(1.07)^5]}$$

Multiplying \$105,000 by this capitalization factor results in an annual capital cost of \$25,610. Capitalization factors for various costs of capital and useful lives of assets are provided in Table D.1.

Table D.2 shows the difference between the capital cost calculated above for this tractor/trailer over its five-year useful life and the capital expenses reported using various accounting procedures. This table clearly shows that the differences among these reporting procedures are significant. Also note that the capital cost as calculated above is identical to the loan repayment or debt service schedule on a seven-percent loan with a constant annual repayment schedule, as shown in Case 7 in Table D.2.

TABLE D.1: CAPITALIZATION FACTORS

NUMBER YEARS	COST OF CAPITAL					
	5%	6%	7%	8%	9%	10%
2	0.5378	0.5454	0.5531	0.5608	0.5685	0.5762
3	0.3672	0.3741	0.3811	0.3880	0.3951	0.4021
4	0.2820	0.2886	0.2952	0.3019	0.3087	0.3155
5	0.2310	0.2374	0.2439	0.2505	0.2571	0.2638
10	0.1295	0.1359	0.1424	0.1490	0.1558	0.1627
15	0.0963	0.1030	0.1098	0.1168	0.1241	0.1315
20	0.0802	0.0872	0.0944	0.1019	0.1095	0.1175
30	0.0651	0.0726	0.0806	0.0888	0.0973	0.1061
40	0.0583	0.0665	0.0750	0.0839	0.0930	0.1023
50	0.0548	0.0634	0.0725	0.0817	0.0912	0.1009

**TABLE D.2: COMPARISON OF CAPITAL COSTS AND OTHER ACCOUNTING METHODS -
PURCHASE OF TRACTOR/TRAILER WITH 5-YEAR USEFUL LIFE FOR \$105,000**

YEAR	CAPITAL COST	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8
1	25,609	105,000	112,350	112,350	21,000	28,350	28,350	25,609	28,350
2	25,609	0	6,072	5,880	21,000	27,072	26,880	25,609	26,880
3	25,609	0	4,704	4,410	21,000	25,704	25,410	25,609	25,410
4	25,609	0	3,241	2,940	21,000	24,241	23,940	25,609	23,940
5	25,609	0	1,675	1,470	21,000	22,675	22,470	25,609	22,470

DEFINITION OF CASES:

CASE 1: Capital Outlay reporting. Purchased with cash.

CASE 2: Capital Outlay reporting. Financed with borrowed funds. Interest 7%. Constant annual payments

CASE 3: Capital Outlay reporting. Financed with borrowed funds. Interest rate of 7%. Constant principal payment, interest paid on unpaid balance.

CASE 4: Straight line depreciation/amortization reporting. Purchased with cash.

CASE 5: Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual payments.

CASE 6: Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7%. Constant principal payment

CASE 7: Debt Service reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual payments

CASE 8: Debt Service reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual principal payments.

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