

April 1996

**THE URBAN PERFORMANCE OF UNIT PRICING:
AN ANALYSIS OF VARIABLE RATES FOR
RESIDENTIAL GARBAGE COLLECTION IN URBAN AREAS**

by:

by Scott Bauer and Marie Lynn Miranda
School of the Environment
Duke University
Box 90328
Durham, NC 27708
919-613-8023
mlm@env.duke.edu

Supplemental Research Product C from a cooperative agreement titled:

Evaluating Unit-Based Pricing of Residential Municipal Solid Waste as a
Pollution Prevention Mechanism

U.S. EPA Cooperative Agreement #CR822-927-010

Project Officer

Dr. Michael J. Podolsky
Office of Policy, Planning and Evaluation
U.S. Environmental Protection Agency
Washington, D.C. 20460

Report prepared for:

Office of Policy, Planning and Evaluation
U.S. Environmental Protection Agency
Washington, D.C. 20460

TABLE OF CONTENTS

1. Introduction	1
2. Summary of the Literature Review	2
3. Method	4
4. Descriptions of the Three Case Study Communities	5
Grand Rapids, Michigan	5
Lansing, Michigan	7
San Jose, California	10
Comparison of Case Study Cities	13
5. Outcomes	15
Garbage Disposal	15
Waste Diversion	16
Waste Reduction	19
Undesirable Diversion	20
The Complexity of Public Education Programs	22
Service to Multi-Unit Complexes	23
Customer Base Stability	24
Added Administrative Expense	27
The Impact of Variable Rates on Disadvantaged Residents	27
Low-Income Participation	28
6. Conclusions	29
Appendix 1. Descriptions of Other Ten Unit Pricing Cities	33
Appendix 2: Interviews Conducted	41
References	42

1. INTRODUCTION

The United States population creates an enormous amount of garbage at rates that have increased steadily over the past several decades. In 1960, the U.S. produced 87.8 million tons of municipal solid waste. By 1990, U.S. waste generation had increased to 198 million tons. The Environmental Protection Agency (EPA) predicts that the nation will produce 217.8 million tons of garbage in the year 2000.¹ While absolute waste levels continue to grow, the rate of growth is slowing. The EPA projects that per capita waste generation will decline from its current rate of 4.4 pounds per person per day to 4.3 pounds per person per day by the year 2000.² Despite these encouraging projections, much work in the area of solid waste management remains to be done.

Current high levels of waste generation present an array of environmental problems. Landfill disposal remains the most widely used waste management method. In 1990, 66.7% of the country's garbage was disposed of in landfills, while 17% was recycled and 16% was incinerated.³ The number of operating landfills fell from 8,000 in 1988 to 5,812 by the end of 1991,⁴ and officials estimate that 80% of those that are now operational will close within 20 years.⁵ Although new landfills and those that remain open tend to be larger, it is becoming increasingly complicated to site and construct new facilities. The stringent requirements imposed on landfills by Subtitle D of the 1984 Resource Conservation and Recovery Act Amendments, coupled with growing "Not In My Backyard" sentiment, make siting new landfills a much more difficult, lengthy, and expensive process.

The emphasis on landfill disposal is a concern from a global environmental perspective, as well. As garbage, particularly organic material, decomposes in landfills, it releases methane, a highly effective greenhouse gas. Reducing the amount of organic material disposed of in landfills reduces greenhouse gas emissions from such facilities. Furthermore, shifting from landfill disposal to recycling increases the amount of recycled material available as manufacturing inputs, and reduces the demand for raw materials. Increased consumer demand for goods with less packaging and reusable products also conserves raw materials, as well as the energy expended in converting those materials to finished products.

Unit pricing receives attention as a municipal solid waste management tool with the potential to encourage waste reduction and recycling.⁶ Ordinarily, communities either charge residents a flat fee for waste collection services or finance the services with local tax receipts. Under these financing schemes, individuals essentially face a zero marginal cost to producing more garbage, even though collection and disposal costs for that waste do increase. Under a unit pricing system, residents pay by the unit of garbage that they set out for collection. If the system is volume-based, the unit is usually a bag, can, or

¹ Felton, 1995.

² Felton, 1995.

³ "What's New in the Waste Stream," October 1992.

⁴ Glenn, April 1992.

⁵ U.S. Congress OTA 1989, 1.

⁶ Throughout this report, "unit pricing," "variable rate pricing," and "variable collection fees" are used interchangeably.

tag. If it is weight-based, then residents pay by the pound. Unit pricing sends a more accurate pricing signal to the household generators of solid waste. The unit price encourages residents to reduce the amount of garbage that they set out for collection, either through waste reduction behavior or through municipal diversion programs, like curbside recycling and yard waste collection.

More than 1,400 communities nationwide use some form of unit pricing.⁷ While the economic theory behind variable rate pricing for waste collection services is fairly well understood, the actual performance of variable pricing programs is somewhat less clear. Experts disagree about the effect of variable collection fees on household waste disposal behavior, as well as about the seriousness of potential negative side effects. Furthermore, skepticism remains regarding whether variable rates can be successful everywhere, or if they are only suitable for certain types of communities. In particular, questions remain about whether variable rate incentives encourage waste reduction and recycling in an urban context. To address these concerns directly, this paper focuses on the question: how does unit pricing for residential waste collection perform in large, urban areas?

Part 2 of this study examines the existing unit pricing literature to highlight key areas of agreement and disagreement among solid waste professionals regarding the performance of variable rate pricing. The study uses the literature to identify issues of particular importance to urban unit pricing communities. Part 3 presents the study's methodology. Part 4 describes three urban unit pricing cities and their materials collection programs, and Part 5 analyzes the outcomes in these and 10 other urban variable rate communities. Finally, Part 6 offers recommendations for the successful implementation of an urban unit pricing system.

2. SUMMARY OF THE LITERATURE REVIEW⁸

The unit pricing literature addresses several issues, including the underlying economic theory, the various system design alternatives, the potential benefits of and problems with variable collection fees, and considerations in implementing variable rates. The authors of this literature base their findings on empirical studies of unit pricing communities, interviews with solid waste experts, and theoretical models of waste generation behavior.

The literature primarily focuses on the effect of unit pricing on residential waste generation and waste disposal behavior. Economic theory indicates that a shift from flat rates to variable rates will lead to increased source reduction and materials diversion.⁹ Although it is sometimes difficult to isolate the impact of variable collection fees from other factors, the empirical evidence indicates that variable rates generally increase residential recycling levels and participation rates.¹⁰ Analysts disagree, however, as to

⁷ Estimate based on Miranda's database of unit pricing communities.

⁸ For a thorough review of the literature, please refer to Miranda, et. al, Unit Pricing Programs for Residential Municipal Solid Waste: An Assessment of the Literature, 1995.

⁹ Cargo, 1976; Wertz, 1976; Kemper and Quigley, 1976; Stevens, 1977; Miedema, 1983; Zak and Chartrand, February 1989; Menell, 1990; Skumatz and Breckinridge, June 1990; EPA, September 1990; Jenkins, 1991; EPA, February 1991; Project 88, May 1991; Fiske, March/April 1992; Fullerton and Kinnaman, 1993; Lewis, June/July 1993; Morris and Holthausen, 1994; U.S. Conference of Mayors, June 1994; Canterbury, April 1994; Guerrieri, September 1994; Lemoine, 1992.

the effect of unit pricing on overall waste generation. Some researchers conclude that variable fees do encourage households to source reduce, while others feel that variable rates have no significant impact on residential waste generation.¹¹

The various alternatives for container type, fee structure, degree of privatization, and complementary programs may be important factors in the success of a unit pricing program.¹² Local concerns play a significant role in the design of the system. For example, if concern about unstable hauler revenue exists, a city may opt for a multi-tier pricing structure. Also, if rodent infestation is a significant problem, a city may prefer subscription cans to bags.

The literature identifies many problems that may hamper the success of unit pricing. Five of these issues are particularly significant in an urban context. They are:

Undesirable Diversion.¹³ Illegal dumping may be exacerbated in urban areas. Cities have a large number of easily accessible commercial dumpsters. Residents may use these dumpsters for their garbage. They may also dispose of their garbage in alleys, along the street, or in public trash cans.

Complexity of Public Education Programs.¹⁴ Education programs in densely populated cities present special challenges. Programs need to reach large numbers of very diverse types of people who respond to different kinds of messages. Therefore, education costs under an urban unit pricing system may be high.

¹⁰ "Seattle Engineers," November 1985; Katz, February 1989; Riggie, February 1989; Deisch, December 1989; Goldberg, February 1990; Kourik, November 1990; Adamec, March 1991; Skumatz, March 1991; Stone and Harrison, August 1991; Harder and Knox, April 1992; "New Jersey Town," February 1993; Woods, July 1993; Richards, August 1993; Grogan, October 1993; Khator and Huffman, October 1993; Miranda, et. al., 1994; Moriarty, January 1994; Fullerton and Kinnaman, March 1994; "Pushing the Limits," March 1994; Cuthbert, May 1994; Toomey, May 1994; Guerrieri, September 1994; Reschovsky and Stone, Winter 1994; Emmer and Neidhart.

¹¹ Albrecht, 1976/1977; Savas et. al., 1977; Stevens, January 1977; Efaw and Lanen, August 1979; "Seattle Engineers," November 1985; Katz, February 1989; Riggie, February 1989; Skumatz, January 1990; Goldberg, February 1990; University of Illinois, May 1990; Morris and Byrd, Fall 1990; Alderden, November 1990; Jenkins, 1991; Enos, February 1991; Adamec, March 1991; Stone and Harrison, August 1991; Laplante and Luckert, October 1991; Hong, November 1991; Harder and Knox, April 1992; Hayes, December 1992; "New Jersey Town," February 1993; Miller, September 1993; Morris and Holthausen, 1994; Miranda, et. al., 1994; Fullerton and Kinnaman, March 1994; Cuthbert, May 1994; Guerrieri, September 1994.

¹² Skumatz, January 1990; Morris and Byrd, Fall 1990; EPA, September 1990; Andresen, November 1990; Browning and Becker, November 1990; Lambert, 1991; Johnson and Carlson, February 1991; EPA, April 1991; Blume, May 1991; Skumatz, July 1991; Roy, 1992; Harder and Knox, April 1992; Andresen, November 1994; "New Jersey Town," February 1993; Miller, September, 1993; Skumatz, November 1993; Miranda et. al., 1994; EPA, February 1994; Norris, February 1994; Canterbury, April 1994; Skumatz et. al., November 1994.

¹³ Goldberg, February 1989; Katz, February 1989; Deisch, December 1989; Skumatz, January 1990; University of Illinois, May 1990; Morris and Byrd, Fall 1990; EPA, September 1990; Alderden, November 1990; Browning and Becker, November 1990; Dobbs, February 1991; Chua and Laplante, April 1991; Blume, May 1991; Harder and Knox, April 1992; Dinan, May/June 1992; Andresen, November 1992; "New Jersey Town," February 1993; Stavins, Spring 1993; Fullerton and Kinnaman, May 1993; Scarlett, May 1993; Skumatz, June 1993; Miller, September 1993; Miranda et. al., 1994; Bender, January, 1994; Fullerton and Kinnaman, March 1994; Canterbury, April 1994; Guerrieri, September 1994; Reschovsky and Stone, Winter 1994; Skumatz, undated.

¹⁴ Skumatz, January 1990; Harder and Knox, April 1992; EPA, February 1994; Canterbury, April 1994.

Service to Multi-Unit Complexes.¹⁵ The prevalence of multi-unit housing complexes present problems for urban unit pricing municipalities. Multi-unit complexes typically have one or more common dumpsters, making it difficult to charge each household according to the amount of garbage that it produces. Instituting a system that does measure each household's waste production may be prohibitively expensive.

Added Administrative Costs.¹⁶ Running an urban waste collection operation, with attendant administrative costs and bureaucratic complexities, is complicated. An urban unit pricing system may exacerbate these already high costs.

Impact on Disadvantaged Residents.¹⁷ Cities often have a high percentage of lower income, elderly, or handicapped residents. Variable fees may represent an undue burden on poor households, and services that meet the needs of the elderly or handicapped may be too expensive for them to afford.

The unit pricing literature provides a background understanding of the performance of variable collection rates. It offers some preliminary evidence of unit pricing's impact on waste disposal behavior, and highlights some potential problems. This information focuses the analysis in this paper.

3. METHOD

To explore the performance of unit pricing in urban areas, the authors of this report initially solicited basic background information on waste collection systems and program outcomes from solid waste officials in 13 American cities. The authors chose the 13 urban unit pricing municipalities based on the literature and conversations with various solid waste officials and experts. The authors then selected three of these cities for in-depth case studies based on a variety of criteria, including: geographical diversity; system design diversity; availability of data; and helpfulness of solid waste staff. The three case study cities are: Lansing and Grand Rapids, Michigan¹⁸; and San Jose, California. Together, these three cities allow for both intra- and inter-regional comparisons of the performance on unit pricing. The other 10 cities in the report are: Fremont, Oakland, and San Francisco, California; Colorado Springs, Colorado; Plantation, Florida; St. Paul, Minnesota; Portland, Oregon; Wilkes-Barre, Pennsylvania; and Spokane and Tacoma, Washington. (See Appendix 1 for description of these 10 communities.)

¹⁵ Riggle, February 1989; Skumatz, January 1990; Harder and Knox, April 1992; Bender et. al., January 1994; Canterbury, April 1994; Reschovsky and Stone, Winter 1994.

¹⁶ Savas et. al., 1977; Morris and Byrd, Fall 1990; EPA, September 1990; EPA, February 1991; Blume, May 1991; "New Jersey Town," February 1993; Angelo, April 1993; "Taking," July 1993; Canterbury, April 1994; Guerrieri, September 1994; Reschovsky and Stone, Winter 1994.

¹⁷ Kemper and Quigley, 1976; Albrecht, 1976/1977; Efaw and Lanen, August 1979; Morris and Byrd, Fall 1990; EPA, September 1990; Jenkins, 1991; Lambert, 1991; Hong, November 1991; Stavins, Spring 1993; Scarlett, May 1993; Woods, July 1993; Miller, September 1993; Reschovsky and Stone, Winter 1994.

¹⁸ EPA personnel sponsoring this project expressed a particular interest in the Midwest -- hence, the selection of both Lansing and Grand Rapids.

The authors made site visits to each of the three case study cities. During the visits, the authors met with officials in each city's solid waste department. These officials gave the authors more in-depth information about materials collection and disposal in their cities, described the history of their collection programs, provided waste stream and cost and revenue data, discussed their education and enforcement efforts, and explained any problems with their systems. The authors also spoke with representatives of some of the private hauling firms operating in the three cities to obtain similar information. To ascertain the degree of undesirable diversion, the authors spoke with street maintenance personnel, commercial haulers, charitable organizations, a few downtown property management companies, 10 random multi-unit complex managers, and 20 random small business owners in each city. The authors followed up their site visits with telephone conversations to obtain any additional necessary information. (See Appendix 2 for a list of interviews conducted.)

The analysis in this paper focuses on unit pricing outcomes in the three case study communities, supplemented whenever possible with information from the other 10 cities. In order to judge the effect of unit pricing on these outcomes, the authors also compare some of the data from the case study cities to data from nearby, similar cities that have traditional tax-financed garbage collection services. These "partner cities" are Flint, Michigan, and San Diego, California.

4. Descriptions of the Three Case Study Communities

This section provides a description of the solid waste collection systems in the three case study communities.¹⁹ Brief descriptions of the other ten cities appear in Appendix 1.

GRAND RAPIDS, MICHIGAN

Grand Rapids is the seat of Kent County and is located on the Grand River 25 miles east of Lake Michigan in the southwestern part of the lower peninsula. With a population of 189,000, approximately 80% of its households are in single-family dwellings. The city produces furniture, automobile parts, seating for religious and educational institutions, and wallboard. In addition, gypsum mining is a significant component of Grand Rapids' economy. The city is also a wholesale distribution center for much of Michigan's agricultural produce.

Materials Collection

Grand Rapids began using variable collection rates in 1972. Residents in single-family dwellings may receive weekly collection service from the city, or they may choose one of 23 licensed private hauling firms. The largest private haulers are Waste Management, Able Sanitation, and Laidlaw Waste Systems. The city offers its customers several options. They may purchase 30-gallon city refuse bags at a variety of local stores. A package of 10 bags costs \$8.50. They may also purchase 85¢ city refuse tags. Residents must attach the tags to regular 30-gallon garbage bags, 30-gallon cardboard boxes, or bundled waste not exceeding 30 pounds. The third option is a 30-gallon city refuse container. Residents

¹⁹ For a more detailed description of Grand Rapids, Lansing, and San Jose, see Miranda and Aldy, Unit Pricing of Residential Municipal Solid Waste: Lessons From Nine Case Study Communities, 1995.

may purchase the containers for \$10 each, and each container must have an annual refuse license sticker. The cost of an annual sticker is \$44.20, or 85¢ per week. The city collects bulk items, such as bundled branches and boards, tires, small appliances, furniture, and Christmas trees, if residents tag them with a regular city refuse tag. Major appliances, such as refrigerators, stoves, dishwashers, washer/dryers, and water heaters, require a \$10 appliance sticker. The city serves 40,000, or about two-thirds, of the city's single-family households. The city does not offer collection service to multi-unit complexes. Private haulers serve those complexes, as well as all commercial establishments.

Grand Rapids initiated a voluntary city-wide curbside recycling program in August, 1994, and began collecting yard waste curbside in March, 1995. The city contracts with Waste Management of Michigan to run both programs. Waste Management collects recycling and yard waste weekly on the same day as city trash pickup. The city provides residents with an 18-gallon bin for glass bottles and jars, plastic (coded 1 and 2), and tin, aluminum, and steel cans. Residents put out household batteries, newspapers, magazines, and catalogs in separate paper bags. They put leaves, grass clippings, brush, small twigs and garden plants in clear city yard waste bags. They bundle together larger branches and brush and mark them with a city yard waste tag. Bags cost \$7.50 for a package of ten, and tags are 75¢ each. Residents pay \$1.75 per month to participate in the recycling program, and Waste Management bills every four months. Part of the monthly recycling charge is subsidized by the city, but that subsidy will be phased out over the next few years. About 18,000 households participate in the recycling program, but the city does not yet have an estimate for participation in the yard waste program.

Materials Disposal

The city sends all of the garbage it collects to the Kent County Mass Burn Incinerator, a waste-to-energy facility. The county owns the incinerator, and charges a tipping fee of \$59.51 per ton. Waste Management processes the recyclables it collects at its own facility on the southern edge of the city, and sells the material to regional buyers. The regional markets are, for the most part, stable, and prices are good. Waste Management delivers the yard waste it collects to a composting facility owned by Compost Soil Technology, an independent firm. The facility charges a \$6 per ton tipping fee.

Enforcement

The city only collects garbage placed in a city refuse bag or can, or marked with a city refuse tag. Containers may not exceed 30 pounds. Residents tag bulky items with a city refuse tag or an appliance sticker. Collection personnel sort recyclables at the curb and leave any contaminants behind. They also leave behind yard waste bags containing other refuse. Yard waste bags and bundled brush may not exceed 30 pounds. Collection personnel mark any uncollected garbage with a city refuse violation tag. Residents must correct the problem within 7 days, or the city will remove the tagged refuse and bill the property owner \$40 for administrative costs and \$20 for collection and disposal, plus \$10 for each appliance. The city distributes about 4,100 refuse violation notices each year, and bills about 390 residents.

Education

Grand Rapids only engages in substantial citizen education efforts when it significantly changes the waste collection service (e.g., the start of curbside recycling and yard waste collection). Before these programs started, the city sent mass mailings to every resident explaining the programs and encouraging them to participate. It also ran television, radio, and newspaper public service announcements. Beyond

these start-up programs, the city provides informational brochures upon request.

Cost and Revenue Sources

Table 4-1 shows the costs for Grand Rapids' solid waste collection program. The city receives about \$3 million in revenue from the sale of bags, tags, and containers. The city's general fund finances the remaining collection costs.

Table 4-1: City of Grand Rapids Materials Collection Costs in FY '95

Expenditure Category	Amount
Garbage Collection	
Equipment	\$1,500,000
Labor	\$1,500,000
Disposal	\$2,350,000
Other (Administration, Education, and Materials)	\$150,000
Recycling	\$285,000
Yard Waste	\$300,000
TOTAL	\$6,085,000

LANSING, MICHIGAN

Lansing, the capital of the state of Michigan, is located at the junction of the Red Cedar, Sycamore, and Grand Rivers in Ingham County. The city lies approximately 80 miles northwest of Detroit. With a population of 127,000, roughly 70% of its households are in single-family dwellings. Lansing's economy is dominated by the automobile industry and state government operations, as well as manufacturing facilities associated with the automobile industry, such as fabricated metal plants.

Materials Collection

Lansing began using variable collection rates in August, 1975. The city provides weekly service to any single-family dwelling.²⁰ Residents may alternatively obtain service from one of a number of private waste haulers. Households on the city service purchase 30-gallon city refuse bags. The bags cost \$7.50 for a package of five and are available at numerous local stores. For bulk waste, such as furniture and appliances, the city sells \$20 bulk collection stickers. The city currently collects garbage from

²⁰ The city considers multi-unit buildings with four units or less to be single-family residences.

approximately 50% of the city's single-family residents, or about 19,000 households. The other 50% are, for the most part, served by one of two private hauling firms: Waste Management of Midwest Michigan and Granger Container Service. The private haulers offer their customers larger base levels of service, and they bill less frequently. The city does not provide collection service to multi-unit households. Three major commercial hauling firms, Waste Management, Granger, and Allied Disposal Company, serve most of Lansing's multi-unit complexes and businesses.

Lansing introduced a weekly curbside recycling program in November, 1991, and added weekly yard waste collection the following spring. Unlike the city's garbage service, the diversion programs are exclusive and they serve all 38,000 single-family households. Residents commingle clear, brown, and green glass, steel and aluminum cans, and plastic bottles (coded 2) in an 18-gallon city recycling bin. They separately set out newspapers in brown paper grocery bags, and bundled magazines and catalogs. From the end of March through November, the city collects leaves, grass, garden clippings, weeds, and bundled brush. It collects Christmas trees during the first two weeks of January. Residents set out yard waste in any common 30-gallon paper or plastic bag. They tie branches or brush together with string or twine in four foot bundles.

Materials Disposal

The city takes all of the garbage it collects either to a landfill located on the northern city limits, or to a large landfill facility eight miles away. Granger owns the large facility, and the current tipping fee is \$10.86 per cubic yard, or about \$36 per ton. The city processes recyclables at its own transfer facility, and sells them to buyers within the state. The regional markets for all of the materials that the city collects are good. The city takes yard waste to the nearby Great Lakes Compost Facility, which Granger also owns. The tipping fee is three-tiered: the first 5,000 cubic yards of material costs \$6.15 per cubic yard; the next 5,000 yards is \$5.40 per cubic yard; and any amount above 10,000 cubic yards costs \$4 per cubic yard. Great Lakes composts the yard waste it receives and distributes it to local buyers.

Enforcement

Collection personnel only collect garbage in green city bags, and they do not pick up ripped or overstuffed bags. They also leave behind any nonrecyclable material placed in the city recycling bins, or yard waste bags that weigh more than 30 pounds. City refuse inspectors tag any uncollected waste with a violation notice, and residents must properly dispose of such waste. According to city officials, inspectors tag a few bags each day. If the city eventually collects any tagged garbage, it bills the property owner a minimum of \$225 for the costs incurred in the process.

Education

Each package of city refuse bags contains a brochure explaining the different materials the city collects and instructions for preparing garbage, recycling, and yard waste for collection. When a resident makes a mistake, the city leaves that person an "oops" tag that also explains the correct way to prepare materials. The city distributes additional information upon request, and operates a hotline that residents may call if they have any questions. In addition, Lansing uses billboards, television, radio, and local newspapers to inform residents about the city's waste collection services. Solid waste officials make presentations in local public schools, and the city has hired a consultant to help them with their public outreach. Finally, the city pays Urban Options Consultants, a nonprofit organization, \$12,000 per year to

provide citywide education on backyard yard waste composting and grasscycling. City residents may purchase compost bins at a reduced price (\$20 instead of \$30).

Costs and Revenues

Lansing funds its \$1.4 million garbage collection program entirely from the sale of city refuse bags. An annual \$55 per household fee finances the city's diversion programs -- \$25 for recycling, \$18 for yard waste collection, and \$12 for education and promotion. The programs also received \$2.3 million in start-up funds from Michigan's Department of Natural Resources, and they receive some annual revenue from the sale of recyclables. Table 4-2 shows the expenditure breakdown for all of Lansing's solid waste programs.

Table 4-2: City of Lansing Materials Collection Costs in FY '95

Expenditure Category	Amount
Garbage Collection	
Labor	\$430,000
Equipment	\$340,000
Disposal	\$340,000
Bulk Pick-up and Disposal	\$90,000
Materials (Bags)	\$70,000
Miscellaneous Administration	\$100,000
Recycling	
Recycling Collection	\$1,000,000
Recycling Transfer Station	\$190,000
Yard Waste	
Yard Waste Collection	\$510,000
Yard Waste Disposal	\$130,000
Education and Promotion	\$370,000
TOTAL	3,600,000

SAN JOSE, CALIFORNIA

San Jose, the seat of Santa Clara County, lies in the Santa Clara Valley seven miles to the south of San Francisco Bay and 50 miles from San Francisco. With a population of 782,000, approximately 60% of its households are in single-family dwellings. The city's population has grown significantly since 1940, when only 68,457 people resided within the city limits. San Jose is a major processing and distribution center for the region's agricultural production. In addition to agriculture, San Jose produces computers, electronic components and motor vehicles. The city's economy is also affected by a National Aeronautics and Space Administration (NASA) facility and the Naval Air Station.

Materials Collection

San Jose began using variable collection rates on July 1, 1993. The city named its waste collection program RECYCLE PLUS! and it serves all single-family and multi-unit residents. It includes weekly garbage collection, curbside recycling, and yard waste pick-up all on the same day. The city contracts with GreenTeam and Western Waste to provide garbage and recycling collection. GreenTeam serves the northern half of San Jose, as well as all multi-unit complexes, and Western Waste serves the southern half. The city also uses two private contractors for its yard waste program. Browning-Ferris Industries (BFI) serves the northern half of the city, and GreenWaste Recovery serves the southern half. Table 4-3 shows the cart size choices for single-family residents. Residents may purchase extra waste stickers for \$3.50 each whenever they have more garbage than their carts will hold. They may call to arrange for special pickup of bulky items, like furniture or appliances at a cost of \$18 for up to three items.

Table 4-3: San Jose Single-Family Garbage Collection Rates and Service Level Distribution

Cart Size	Monthly Fee	% of Residents
32-gallon	\$13.95	86
64-gallon	\$24.95	13
96-gallon	\$37.50	1
128-gallon (32-gallon and 96-gallon carts)	\$55.80	One Household

San Jose started its recycling program in 1987, and added yard waste collection in 1989. The city provides single-family residents with three 18-gallon recycling bins: one for glass containers; one for junk mail, magazines, and mixed paper; and one for newspaper. Residents use a fourth container, typically their old garbage cans, for commingled aluminum, tin, and metal cans, juice boxes and milk cartons, plastic bags, bottles, and jugs, scrap metals, and textiles. They flatten corrugated cardboard and stack it alongside the four containers, and the city provides special jugs for used motor oil upon request. Residents pile their grass clippings, leaves, and small branches in the street or on city-issued tarps on the edge of their lawns.

Multi-unit complexes²¹ use 1-to-8-cubic-yard garbage bins and may request 1 to 6 pickups per week. The fee varies by bin size and collection frequency. Building managers may arrange for bulky good collection at a fee of \$55.50 for one to three items, and \$18.50 for each additional item above three. Complexes also receive three 96-gallon recycling containers. The city includes the cost of recycling collection in the garbage fee. The first container is for newspaper, the second for mixed paper, and the third for all other materials. Complexes may also provide a corrugated cardboard bin. Yard waste collection is available upon request. Multi-unit residents wishing to dispose of used motor oil must take it to one of several San Jose service stations that accept used oil for recycling.

Materials Disposal

The city's contractors send all of their garbage to the Newby Island facility, 15 minutes north of the city center. BFI owns the facility and charges a tipping fee of \$26.11 per ton. GreenTeam and Western Waste each have their own recycling processing facilities where they sort and bundle the material they collect and sell it to local buyers. Regional markets for recyclables are good. The yard waste collected by BFI and GreenWaste Recovery goes to one of three composting facilities that charge \$22 per ton.

Enforcement

The haulers only collect garbage in city carts, or in bags marked with an extra waste tag. The top of the cart must be fully closed with no garbage piled on top. They will also only collect bulky waste for which residents have made special arrangements. The haulers visually inspect recycling and yard waste set-outs, and do not collect material that contains contaminants. Yard waste piles may be no larger than five feet wide and five feet high. The haulers leave a non-collection notice whenever they do not collect waste. Any resident receiving such a notice must take care of the problem before the next collection date. Repeated violations result in an on-site visit from a representative of the city's Environmental Services Department. In the event of extreme abuse of the system, fines are possible.

Education

San Jose employs a wide variety of educational techniques. The city runs a hotline staffed by 20 employees. They answer 1,500 daily telephone calls from residents with questions about service or billing. The city also has an array of literature that it mails to residents upon request, and it puts informational notices on every residential bill. All of the literature is printed in three languages: English, Spanish, and Vietnamese. Every recycling bin has a written notice in the same three languages indicating acceptable materials for recycling pickup. Finally, the city conducts a multi-media advertising campaign, consisting of local television, radio, and newspaper announcements. English, Vietnamese, and Spanish radio stations broadcast the radio spots.

The city spent \$1.5 million in start-up education during 1993. It sent letters to every resident informing them of the new pricing system. The letters contained postcards that the residents returned indicating the level of service they wanted. City officials also attended numerous neighborhood meetings to explain the new system and answer any questions. Finally, the city ran a series of public service

²¹ Townhouses, mobile homes, and complexes with 4 to 8 units choose whether to receive single-family service or multi-family service. Any complex with 9 or more units is automatically considered a multi-family dwelling.

announcements in local newspapers, and on the radio and television.

San Jose State's Center for Development of Recycling, a small operation relying heavily on student volunteers, plays an important role in city-wide citizen education efforts. The Center receives all of its funding, \$40,000 per year, from Santa Clara County. It acts as a clearinghouse of information on recycling in San Jose and Santa Clara County. The city and its contractors commonly refer businesses, residents, and officials from other cities to the Center to satisfy their information requests. The Center's activities include: radio and newspaper advertisements; hotlines for source reduction campaigns, phone book recycling, and other special events; education material for city and county libraries; displays at local conventions and fairs; workshops on topics like the disposal of construction and demolition debris; and a series of ongoing projects, including directories of San Jose recyclers, reuse opportunities in the area, and used-appliance collectors.

Cost and Revenue Sources

Table 4-4 shows all of San Jose's residential waste and recycling collection costs. The costs are broken down by service to single-family residents and service to multi-unit residents.

Table 4-4: San Jose Waste Collection Expenditures in FY '96

Expenditure	Single-Family Portion of Cost	Multi-Unit Portion of Cost	Total Cost
Garbage and recycling collection -- payments to contractors	\$26,900,000	\$5,200,000	\$32,100,000
Garbage disposal	\$3,700,000	\$2,100,000	\$5,800,000
Household hazardous waste disposal	\$100,000	\$50,000	\$150,000
Yard waste collection and processing -- payments to contractors	\$8,600,000	\$2,200,000	\$10,800,000
Billing service	\$1,400,000	\$700,000	\$2,100,000
Administration	\$600,000	\$300,000	\$900,000
Outreach and Education	\$600,000	\$350,000	\$950,000
TOTAL	\$41,900,000	\$10,900,000	\$52,800,000

Table 4-5 shows all of the waste service's revenue sources. Under A.B. 939, the California Integrated Waste Management Act of 1989, the state gives funds to localities for waste diversion and reduction efforts. A.B. 939 sets statewide waste diversion goals, and requires all municipalities to divert 25% of their garbage from landfills by 1995, and 50% by 2000. The city provides \$1 million to cover the cost of low-income rates, and all licensed commercial and residential haulers in San Jose pay the franchise fees. Transfer payments from the city's General Fund cover any annual revenue shortfall.

Table 4-5: San Jose's Revenue Sources for Waste Collection System in FY '96

Revenue Source	Amount
Customer Payments	\$42,000,000
A.B. 939 payments and franchise fees	\$9,000,000
Low-income subsidy	\$1,000,000
TOTAL REVENUE	\$52,000,000
Revenue Shortfall	approx. \$1,000,000

COMPARISON OF CASE STUDY CITIES

The similarities and differences among the three case study cities' waste collection systems allow for some interesting comparisons. For example, container types, either bag/tag or subscription can, may affect residents' waste reduction efforts and the cost of the system. Also, open and closed franchise systems may have different impacts on waste disposal behavior. Furthermore, recycling program characteristics, like materials collected and required participation, may impact the success of waste diversion efforts. Table 4-6 summarizes the program components in each of the three case study cities. Part 5 of this report develops these comparisons and shows how program differences affect outcomes.

Table 4-6: Comparison of Three Case Study Cities

	Grand Rapids	Lansing	San Jose
Date Unit Pricing Began	1972	August, 1975	July, 1993
Garbage Collection			
# Households	40,000 (57.6%)	19,000 (37.4%)	185,000 (73.7%)
Container	bag or tag	bag	cart
System	open	open	closed franchise
Curbside Recycling			
# Households	18,000 (25.9%)	38,000 (74.6%)	185,000 (73.7%)
Materials	glass, aluminum, steel, tin, #1 and #2 plastic, newspapers, magazines, catalogs, batteries	glass, aluminum, steel, tin, #2 plastic, newspapers, magazines, catalogs	glass, aluminum, steel, tin, scrap metal, #1 and #2 plastic, newspapers, magazines, catalogs, junk mail, mixed paper, corrugated cardboard, juice and milk cartons, textiles
Mandatory?	No	Yes	Yes
Fee	\$21 per year	\$25 per year	None
Curbside Yard Waste			
# Households	N/A	38,000	185,000
Dates	N/A	April - November	year-round
Mandatory?	No	Yes	Yes
Fee	75¢ 30-gallon bags	\$18 per year	None

5. OUTCOMES

This section presents an analysis of the outcomes in the three case study cities and many of the other ten cities. These outcomes include residential waste disposal behavior, some of the problems identified in the literature, and other issues revealed by the case study site visits.

GARBAGE DISPOSAL

The evidence from the three case studies clearly demonstrates that unit pricing reduces landfilled or incinerated waste in urban communities. For example, San Jose adopted variable rates for single-family garbage collection at the beginning of Fiscal Year 1994 (July 1, 1993). Table 5-1 compares 1994 single-family garbage set-outs in San Jose with garbage set-outs in Fiscal Year 1993.

Table 5-1: Landfilled Waste in San Jose Before and After Unit Pricing

		Fiscal Year 1993 (before unit pricing)	Fiscal Year 1994 (after unit pricing)	% Change
Landfilled Garbage	Total (tons)	250,000	197,900	- 21%
	Per Household (lbs/month)	224	177	

Since Lansing and Grand Rapids have used variable collection rates since the early 1970's, before and after data is not available from those two cities. However, both cities significantly increased their collection fees in the early 1990's, and those increases had a substantial effect on the amount of disposed waste. Lansing increased its bag price from \$1.00 to \$1.50 at the beginning of Fiscal Year 1992 (July 1, 1991). The bag/tag price increase in Grand Rapids was more gradual, from 35¢ for bags and 25¢ for tags in Fiscal Year 1987 to 85¢ for both in Fiscal Year 1995. Table 5-2 shows the impact of Lansing's fee increase, and Table 5-3 shows the impact in Grand Rapids.

Table 5-2: Landfilled Waste in Lansing Before and After Fee Increase

Fiscal Year	Unit Price	Households Served	Landfilled Garbage (tons/year)	Per Household Landfilled Garbage (lbs/month)	Bags per Pick-up
1991	\$1.00	19,000	16,000	140	1.5
1992	\$1.50	20,500	10,000	81	1.3

Table 5-3: Incinerated Waste in Grand Rapids Over Time

Dates	Price for City Bag/Tag	Households	Total Incinerated Waste (tons)	Per Household Incinerated Waste (lbs/month)
7/86 - 6/87	35¢/25¢	35,000	51,000	242
7/89 - 6/90	45¢/35¢	41,000	53,000	215
1/93 - 6/93	85¢/75¢	40,000	22,500	187
7/93 - 6/94	85¢/75¢	40,000	45,700	190
8/94 - 1/95	85¢ for both	40,000	22,700	189

Based upon the experiences of the three case study communities, as well as anecdotal evidence from other unit pricing municipalities, variable collection fees successfully induce urban households to reduce the amount of garbage that they set out for collection. These households may reduce set-outs by either diverting more material through municipal recycling and yard waste collection programs, or by engaging in source reduction behavior.

WASTE DIVERSION

The case studies confirm that unit pricing increases recycling and yard waste diversion in urban areas. All three cities have relatively aggressive recycling programs. They all collect recyclables curbside once per week, and residents may put out a wide variety of materials. San Jose provides the strongest proof of unit pricing's positive impact on waste diversion. The city already had a curbside recycling and yard waste collection program in place when it adopted variable collection rates. Table 5-4 shows the effect of the new volume-based fees on total and per household recycling and yard waste set-outs, as well as on the city's overall single-family residential waste diversion rate.

Table 5-4: Unit Pricing's Impact on Waste Diversion in San Jose

		Fiscal Year 1993 (before unit pricing)	Fiscal Year 1994 (after unit pricing)	% Change
Recyclables	Total (tons)	30,800	75,700	+ 146%
	Per Household (lbs/month)	28	68	
Yard Waste	Total (tons)	66,500	96,800	+ 46%
	Per Household (lbs/month)	60	86	
Diversion	Rate ²²	28%	47%	+ 68%

Lansing and Grand Rapids did not introduce curbside recycling and yard waste collection until after the cities already had variable collection rates. However, as Table 5-5 demonstrates, diversion figures from all three case study cities compare favorably with similar figures from the partner cities.

²² Diversion Rate = Waste Diverted (recycling or yard waste) / Total Waste Generated * 100

Table 5-5: Diversion Levels in Case Study and Partner Cities

	Lansing	Grand Rapids	Flint	San Jose	San Diego
Time Period	1/94 - 12/94	8/94 - 1/95	1/94 - 12/94	7/93 - 6/94	7/93 - 6/94
Per Household Recycling (lbs/month)	15	54	N/A	68	48
Per Household Yard Waste (lbs/month)	25	22 ²³	13	87	35

The per household quantities of recycling and yard waste collected in Lansing are, for the most part, lower than the quantities collected in the other two unit pricing cities. Lansing collects recycling from all 38,000 single-family households, while only 19,000 of them use the city's fee-per-bag garbage service. If the recycling behavior of non-fee-per-bag households dominates the aggregate data, then residents subscribing to the fee-per-bag service may actually recycle at rates comparable to households in San Jose and Grand Rapids. Lansing residents may also emphasize source reduction over waste diversion as a means of lowering garbage set outs. San Jose has the most aggressive recycling program -- it is mandatory, the city does not charge any separate fee, and it collects the greatest variety of materials -- and the highest per household diversion levels.

All of the evidence from the three case studies indicates that unit pricing significantly increases urban residential waste diversion. Table 5-6 presents the available recycling figures from six of the other unit pricing cities. Five of these six communities experienced recycling rates greater than the national average. Most communities employing unit pricing also provide curbside recycling collection. The recycling rates for unit pricing communities should be higher than the national average, since this average includes many communities which do not have recycling programs.

²³ This is an estimate of the yard waste tonnage that city officials expect to collect in 1995.

Table 5-6: Recycling In Other Cities

City	Time Frame	Per Household Recycling (lbs/month)
Oakland	January, 1994 - December, 1994	26
San Francisco	January, 1993 - December, 1993	55
Plantation	October, 1993 - September, 1994	32
St. Paul	January, 1994 - December, 1994	30
Portland	July, 1993 - June, 1994	47
Wilkes-Barre	January, 1994 - December, 1994	22
1992 Per Household Recycling National Average: 23.6 lbs/month ²⁴		

WASTE REDUCTION

The impact of unit pricing on overall urban residential waste generation is unclear, and the case studies provide little evidence of increased household source reduction behavior. Since the diversion and garbage collection programs in Lansing and Grand Rapids serve different sets of households, total waste figures are not available from those cities. Table 5-7 shows single-family residential waste figures from San Jose. Total per household waste levels among single-family residents actually increased the year after the city adopted variable collection rates. However, projections based on the first six months of waste generation indicate that single-family households are on pace to reduce their total waste levels in Fiscal Year 1995.

²⁴The per household recycling national average was calculated from 1992 national recycling data provided in Franklin Associates, Ltd. (p. 2-12, 1994) and the Bureau of Census 1992 estimate of the number of households in the United States.

Table 5-7: Total Single-Family Waste Levels in San Jose

		Fiscal Year 1993	Fiscal Year 1994	Fiscal Year 1995 (1st Half)
Total Waste	Total (tons)	347,300	370,400	166,600
	Per Household (lbs/month)	312	331	298
% Change	From Previous Year	---	+ 7%	- 10%

San Jose's educational and promotional efforts emphasize waste diversion as a means of reducing residential garbage set-outs. In doing so, the city may create an environment in which waste diversion and source reduction are substitutes for one another -- residents neglect to source reduce because they focus all of their attention on increased recycling and yard waste diversion. Diversion participation, especially when residents are already familiar with the city's curbside recycling and yard waste programs, is easier than source reduction. Perhaps only after maximizing their reasonable waste diversion efforts are residents turning their attention to waste reduction, explaining the subsequent decline in waste levels during the first six months of Fiscal Year 1995. It is also possible that waste diversion provides a transition path for San Jose residents.²⁵ Diversion gives them a short-term opportunity to lower their waste collection costs while they adjust their waste disposal behavior to the new unit pricing system. Eventually, they may adopt waste minimization techniques.

UNDESIRABLE DIVERSION

There are many forms of undesirable diversion: littering; dumping garbage in commercial or multi-unit dumpsters; giving junk to charitable organizations, like the Salvation Army; and putting nonrecyclable contaminants in recycling bins or yard waste set-outs. Undesirable diversion is no worse in the unit pricing case study cities than in similar cities without variable collection rates (such as the partner communities). Furthermore, the amount of money spent by each city to clean up illegal dumping varies widely, and is not necessarily related to the severity of the dumping problem. Table 5-8 compares estimates of illegal dumping and dumping cleanup costs in the three case study cities with dumping levels and cleanup costs in the two partner cities. These undesirable diversion levels reflect best estimates of the cities' waste management officials.

²⁵ Miranda, et al, 1994.

Table 5-8: Illegal Dumping in the Case Study and Partner Cities

City	Amount of Annual Dumping		Annual Cleanup Costs	
	Total (tons)	Per Capita (lbs)	Total (\$)	Per Capita (\$)
Lansing	300	4.7	52,500	.41
Grand Rapids	30	.3	15,000	.08
Flint	N/A	N/A	52,500	.37
San Jose	170	.4	500,000	.64
San Diego ²⁶	fraction of 3,800	fraction of 6.8	fraction of 127,000	fraction of .11

San Jose officials attempted to determine whether or not there was an increase in illegal dumping when the city implemented variable collection fees in August, 1993. The task was difficult, because before 1993 the city did not make a coordinated effort to track illegal dumping. The amount of waste collected from city streets does appear to have increased since 1993, but that observed increase may be due to better reporting, rather than actual tonnage increases. Also, residents and businesses in San Jose may be more sensitive to illegal dumping as a result of discussions about dumping around the time that the city adopted unit pricing. Officials in Grand Rapids observe that increases in illegal dumping seem to coincide with garbage rate increases.

Around one-quarter of 20 randomly selected small business owners in each of the three case study cities complain about people regularly throwing waste in their dumpsters. City schools and multi-unit complexes sometimes have similar complaints. Furthermore, a few charitable organizations in the three cities report large percentages of useless donations, and residents sometimes drop off actual bags of household garbage.

Most of the private commercial haulers in each of the three cities will fit their dumpsters with locks at their customers' request. Some haulers bear the cost of locking the dumpsters themselves, while others charge their customers. Those businesses that have locked dumpsters generally report that the locks eliminate illegal dumping. Sometimes immediately after a lock is installed, people will dump a few items or bags of garbage on the ground next to the dumpster. That behavior usually stops, however, after a few weeks.

Some city street maintenance personnel, business owners, and multi-unit complex managers search through dumped garbage bags for a name or address, and, if possible, bill that person for the cost of cleanup. Some cities also levy fines for littering. Oakland city officials say that a high-profile anti-dumping crackdown in their city significantly reduced illegal dumping. In general, this practice seems to work as a scare tactic, and may prevent individuals that get caught from ever dumping again.

²⁶ The same cleanup crew that picks up dumped garbage also collects vegetation cuttings from city green spaces, trash from city refuse containers, and other abatements. City officials were unable to estimate the percentage of this crew's collections that is illegal dumping.

Illegally dumped waste often consists of bulky items, like furniture, carpets, and old appliances. The high fee that most cities charge for the disposal of such waste may encourage residents to dump. Fremont's collection service offers residents two free bulk goods pickups each year. Residents call the solid waste department to arrange for a pick-up time. The amount of bulk waste dumping in Fremont is minimal, and city officials credit the free pick-up program.

Some illegal dumping may not be caused by residents. Dumped waste sometimes consists of construction debris or large quantities of yard waste. These materials are most likely dumped by construction contractors and landscaping operations. Furthermore, some city officials say that commuters from neighboring towns bring garbage into work with them and dump it in their cities.

THE COMPLEXITY OF PUBLIC EDUCATION PROGRAMS

Educational costs tend to be higher in urban unit pricing municipalities, although the amount of money spent by each city varies widely. Table 5-9 compares annual public education and outreach expenditures in the three case study cities with similar expenditures in the two partner cities. Unit pricing municipalities may use more aggressive solid waste management techniques, in general, and therefore spend more on education. Officials from all three case study cities say that their education expenditures temporarily increase whenever they introduce new programs, such as recycling or yard waste collection.

Table 5-9: Annual Educational Expenditures in the Case Study and Partner Cities

	Lansing	Grand Rapids	Flint	San Jose	San Diego
Total (\$)	370,000	negligible	6,000	1,000,000	250,000
Per Capita (\$)	2.19	negligible	.04	1.28	.23

The educational and promotional efforts in each of the three case study cities may play a role in the relative success of their diversion programs. San Jose households divert more material than Grand Rapids or Lansing households, and San Jose has an extensive public education program. However, San Jose residents also face uniform variable garbage collection rates. Lansing spends the most money per capita on public education, but only half of the city's single-family households pay per-bag fees. Grand Rapids residents divert significantly more waste than Lansing residents, and although the city spends very little on education, nearly two-thirds of its single-family households pay volume-based rates. San Jose's combination of city-wide unit pricing and aggressive education seems to have the greatest impact on residential disposal behavior.

Educational efforts may be more complicated in an urban setting. If a city has a large, non-English speaking minority, as does San Jose, then all educational materials must be printed in multiple languages, and if the city has a hotline, some operators must be able to speak other languages. Multi-lingual brochures and hotlines are not necessarily more expensive, but they do require city officials to consult with personnel that are fluent in other languages.

The case study cities' educational efforts focus on recycling, and although both Lansing and San Jose provide some information on backyard composting, the cities give very little instruction about source reduction techniques. This may explain the apparent preference among residents of the three cities for waste diversion as a means of lowering garbage collection costs.

SERVICE TO MULTI-UNIT COMPLEXES

The case study cities experienced little success designing variable rate systems for residents of multi-unit complexes. Lansing and Grand Rapids do not make their collection service available to multi-unit households. Private hauling firms provide multi-unit service in both cities. The firms typically rent large garbage containers, like dumpsters, to complexes, and although the prices of the containers vary by size and collection frequency, the cost is almost always spread evenly among all residents. This implies that households experience zero marginal costs for the disposal of waste and no economic incentive to reduce their waste generation.

San Jose does provide service to multi-unit complexes, but it also uses common garbage receptacles, and individual residents do not experience any pricing incentive. The lack of an incentive has resulted in significant discrepancies in the waste diversion behavior of multi-unit and single-family residents. Table 5-10 compares single-family and multi-unit household waste disposal behavior between July, 1994 and December, 1994. San Jose officials report that contamination in multi-unit recycling bins is high.

**Table 5-10: Single-Family and Multi-Unit Household
Waste Disposal Behavior in San Jose**

	Single-Family		Multi-Unit	
	Total (tons)	Per Household (lbs/month)	Total (tons)	Per Household (lbs/month)
Landfilled Garbage	79,200	142	67,600	150
Recyclables	39,200	70	8,000	18
Recycling Diversion Rate	35%		10%	

San Jose officials cite several possible explanations for the low multi-unit diversion rate. Residents of multi-units, primarily rental properties, tend to be more transitory than single-family residents, and therefore may not feel as much interest in the city's solid waste reduction efforts, or take the time to learn about diversion options. Furthermore, the city depends on multi-unit managers to pass along educational materials to their tenants. Commonly off-site, managers may not have a very close relationship with their tenants. Residents in multi-unit complexes, which typically have a common dumpster or other waste receptacles, do not experience the same direct pricing incentive that single-family residents do to lower their garbage levels. The non-monetary costs of recycling, such as storage, could also affect the multi-unit diversion rate. If multi-unit households have less space than single unit households, then the relatively lower multi-unit diversion rate may reflect the higher cost of storage. However, some multi-unit buildings provide recycling bins in their parking lots, which could eliminate the

storage costs. San Jose solid waste officials are experimenting with ways to improve the level of multi-unit waste diversion. These include a direct mail campaign to multi-unit residents, a multi-media advertising strategy aimed at apartment dwellers, a recycling rebate program, and a multi-unit pilot project.

Wilkes-Barre, Pennsylvania has a variable rate pricing system for some multi-unit households. Residents of complexes with 5 to 19 units may participate in the city's fee-per-bag collection system. They, like single-family residents, purchase city refuse bags and put them out in front of their building on collection day. However, the system has problems. For example, it is difficult to identify those responsible for putting out non-city bags. The city does not collect non-city bags, and it is the building manager's responsibility to arrange for their disposal. The system also leads to piles of garbage bags in front of apartment buildings on every collection day. The system will not work in larger cities with greater numbers of multi-unit complexes -- the amount of garbage bags on the street would be overwhelming.

While the experiences of the 13 cities in this report do not offer very positive suggestions for implementing a variable rate multi-unit collection program, the evidence from San Jose bolsters the conclusion that unit pricing increases waste diversion. The single-family households that face per-unit garbage fees divert a much greater percentage of their waste than do multi-unit residents, who are not charged by the amount of trash they throw away. The difference between single-family and multi-unit per household garbage generation is even more significant when one considers that single-family households tend to be larger. The evidence also indicates that recycling contamination, sometimes thought to be a problem specific to unit pricing, is not necessarily linked to variable garbage fees. Contamination of multi-unit recycling containers is significantly worse than single-family recycling contamination. Finally, San Jose's struggles with multi-unit collection reinforce the importance of public education to the success of a unit pricing program. The city depends on multi-unit managers to disseminate its educational material to residents, and the failure of those managers to do so clearly inhibits participation in municipal diversion programs. Since multi-unit fees vary according to dumpster size and collection frequency, managers have an incentive to encourage their tenants to lower their garbage set-outs. Making that incentive clearer to multi-unit managers may encourage them to educate residents.

CUSTOMER BASE STABILITY

Lansing and Grand Rapids have open solid waste collection systems. Each household in the two cities can choose the city or one of several private haulers to be its service provider. A city requires a certain number of residential customers to make its collection service financially feasible. The problem with an open system is it does not guarantee that a city will have the number of customers it needs. The percentage of residents using Lansing's garbage service has been steadily declining over the last 15 years, from over 80% of the city's single-family households in the late 1970's to just around 50% now. The two large private hauling firms in the city have managed to gradually pull customers away from the city by providing more generous base levels of service, and by charging rates that are just below those charged by the city.

Grand Rapids has a more stable customer base than Lansing, but a key difference between the two cities is that Grand Rapids partially subsidizes its waste collection service from general city revenues. Grand Rapids charges collection rates that are significantly lower than they would be if the system were entirely self-sufficient. Consequently, private haulers are unable to compete with the city service. Unfortunately, the subsidy, like a flat rate system, still partially spreads waste disposal costs equally over all citizens, regardless of their individual levels of waste generation.

Under an open system, residents are not exposed uniformly to the same pricing incentives. In both Lansing and Grand Rapids, the private haulers tend to offer their customers much larger base levels of service than the 30-gallon units that the city programs use. They also bill their customers much less frequently -- usually once every few months. Tables 5-11 and 5-12 compare the cities' collection rates to the rates charged by the largest private haulers in Lansing and Grand Rapids. They also show the equivalent disposal capacity available under each collection option.

Table 5-11: Garbage Collection Fees and Capacity in Lansing

Hauler	Fee	Capacity ²⁷ (in gallons) Monthly Cost:			
		\$12	\$15	\$11	\$13.40
City	\$1.50 per 30-gallon bag	240	300	220	268
Waste Management	\$12 per month for 63-gallon cart; \$15 per month for 104-gallon cart	252	416	--	--
Granger	\$11 per month for 60-gallon cart; \$13.40 per month for 90-gallon cart and 3 30-gallon bags	--	--	240	720

Table 5-12: Garbage Collection Fees and Capacity in Grand Rapids

Hauler	Fee	Capacity (in gallons) Monthly Cost:		
		\$15	\$17	\$17.35
City	85¢ for 30-gallon bag or tag; \$44.20 per year for 30-gallon can	529	600	612
Waste Management	\$15 per month for 64-gallon cart; \$17 per month for 104-gallon cart	256	416	--
Able	\$17.35 per month for 90-gallon cart	--	--	360

Lansing's open system may not change the disposal behavior of high waste generators. The private hauler's smaller carts provide roughly the same monthly disposal capacity per dollar as the city's service (252 versus 240 gallons). However, the haulers' large carts are significantly more generous than the city's program (416 versus 300 gallons). Therefore, high waste generators may be drawn to private hauling services and continue to produce large quantities of garbage. The open system allows such individuals to avoid the waste reduction incentives of the city's per unit fees. In Grand Rapids, the city

²⁷ Assuming 4 pickups per month for private haulers.

subsidizes its collection program and city collection fees are substantially lower than private hauling fees. Residents receive greater disposal capacity for their dollar from the city than they do from any of the private haulers' service options. However, because the city fees are so low, residents have less incentive to reduce their waste.

Lansing's Public Works Department is considering some service changes that may increase its program's competitiveness. The Department wants to make city garbage carts available to all of its customers. The carts will be purchased for a one-time fee, and will provide the same convenience of the private haulers' carts. Residents will put their city garbage bags in the cart and wheel it out to the curb on collection day. The carts will prevent dogs and rodents from tearing into the bags, and they will advertise the city program more effectively than the city refuse bags currently do because carts remain on the street all day, as opposed to bags that are picked-up first thing in the morning. The Department is also trying to convince the City Council to levy a fee on all private haulers to make up for the fact that it was not allowed to lower collection rates last year. The revenue generated by the fee, which would be based on the volume of waste collected by each hauler, will be used to identify and prosecute unlicensed hauling operations.

Table 5-13 identifies the type of waste collection system in each of the 13 cities in this report.

Table 5-13: Waste Collection Systems

City	Collection System
Lansing, MI	open system; city provides voluntary collection service
Grand Rapids, MI	open system; city provides voluntary collection service
San Jose, CA	exclusive franchise system; city contracts with two private haulers
Fremont, CA	exclusive franchise system; city contracts with one private hauler
Oakland, CA	exclusive franchise system; city contracts with one private hauler
San Francisco, CA	exclusive franchise system; city contracts with two private haulers
Colorado Springs, CO	open system; city does not run a collection program
Plantation, FL	exclusive franchise system; city contracts with one private hauler
St. Paul, MN	open system; haulers are required to have variable rates; city does not run a collection program
Portland, OR	open system with rates set by city; city does not run a collection program
Wilkes-Barre, PA	open system; city provides voluntary collection service
Spokane, WA	exclusive franchise system; city runs its own collection program
Tacoma, WA	exclusive franchise system; city runs its own collection program

ADDED ADMINISTRATIVE EXPENSE

Unit pricing may require a billing system to keep track of each household's regular service level, to charge for any extra waste set-outs, and to bill residents for collection services. San Jose spends \$2.1 million per year on its residential billing system, or \$7.90 per household served. That expense, however, is only 4% of the city's total residential solid waste budget, and the city will eventually use the system for other city services, as well, such as water and sewer. Spokane and Tacoma, Washington also have billing systems for their unit pricing programs. Spokane annually spends \$600,000 for its system, or \$8 per household served, and Tacoma spends \$200,000, or \$2.85 per household served. Bag or tag programs, like those in Lansing and Grand Rapids, eliminate the need for a billing system. They only require a small staff to track bag and tag sales, monitor bag and tag inventories, distribute bags and tags to area merchants, and collect bag and tag revenues.

With the possible exception of the cost of a billing system, urban unit pricing municipalities do not experience higher administrative costs than do cities with traditional pricing systems. Table 5-14 compares general administrative costs in each of the case study cities with costs in the two partner cities. Neither of the partner cities have a billing system because their waste collection programs are funded directly out of city tax revenues.

Table 5-14: Annual Administrative Costs (Excluding Billing) for Case Study and Partner Cities

	Lansing	Grand Rapids	Flint	San Jose	San Diego
Total (\$)	100,000	150,000	300,000	900,000	600,000
Per Household Served (\$)	5.26	3.75	6.38	3.40	2.07

THE IMPACT OF VARIABLE RATES ON DISADVANTAGED RESIDENTS

In general, city officials do not feel that unit pricing places a significant burden on low-income, elderly, or otherwise disadvantaged residents. Garbage generation varies positively with income, so many low income families face lower waste collection costs.²⁸ Elderly households tend to produce less garbage, as well. Furthermore, unit pricing gives these disadvantaged households the chance to lower their garbage collection costs by diverting as much waste as possible through curbside recycling and/or yard waste collection. However, City Council members often express concern over this issue, so the impact of variable rates on disadvantaged residents may be a politically significant problem. In Grand Rapids, for example, the city partially subsidizes the solid waste collection program with revenue from the general

²⁸ Albrecht, 1976/1977; Cargo, 1976; Chua, April 1991; Efaw, 1979; Emmer; Jenkins, 1991; Morris, 1994; Richardson and Havlicek, 1978.

fund because City Council members want to keep collection fees low. Table 5-15 summarizes the assistance that various cities offer to special needs residents.

Table 5-15: Efforts to Aid Special Needs Residents

City	Assistance Measure	Annual Cost (if available)
Lansing	1,500 free bulk collection stickers per year	\$30,000
Grand Rapids	Food Stamp recipients receive 4 free refuse tags monthly	\$900,000
San Jose	50% discount on 32-gallon service level for 1 to 3 person households with incomes less than 175% of federal poverty line; 50% discount on 64-gallon service level for 4+ person households with incomes less than 175% of federal poverty line	\$1,000,000
Fremont	15% discount to residents qualifying for other utility lifeline rates	
Oakland	\$1 per month discount on recycling fees	
San Francisco	discount on 20-gallon container for all elderly residents	
Tacoma	50% discount on 60-gallon service to residents that qualify for electric utility lifeline rate	

LOW-INCOME PARTICIPATION

Solid waste officials from several of the cities in this report observe that recycling participation and waste diversion rates in low-income and minority neighborhoods are significantly below city-wide averages. They generally accredit this discrepancy to a lack of knowledge about recycling, and a lack of interest due to more pressing, personal financial concerns. The problem with this low diversion participation is that disadvantaged households are not making full use of the opportunity they have under a unit pricing system to reduce their garbage disposal costs. Officials in Portland, for example, say that residents in low-income neighborhoods tend to use the city's 60-gallon cart size, rather than one of the smaller, less expensive service levels. If these residents participate more fully in the waste diversion options available to them, they may be able to shift down to one of the lower service levels.

6. CONCLUSIONS

The 13 cities in this report provide examples of ways that urban municipalities may overcome the potential problems with variable garbage collection rates. Their struggles and successes form the basis of this section's recommendations for successfully implementing unit pricing in an urban setting.

URBAN WASTE REDUCTION AND DIVERSION

Unit pricing encourages greater waste diversion in urban cities, but not necessarily waste reduction. Residents may be more familiar with municipal diversion programs and may find it easier to increase their diversion efforts rather than adopt waste reduction techniques. Furthermore, many solid waste educational programs emphasize waste diversion as a means of lowering household collection costs. Increased source reduction education may cause residents to balance their diversion efforts with more waste reduction behavior. Waste diversion may also provide residents with the opportunity to lower their waste collection bills as they learn to source reduce. Complementing these diversion programs, backyard composting and grasscycling may also avail residents with the opportunity to reduce their waste generation.

Officials from smaller unit pricing communities report greater overall waste reduction under variable collection rates.²⁹ Households in suburban or rural areas appear to engage in more source reduction behavior than do urban households. Solid waste officials in small towns may be more successful in educating residents because of the homogeneity of the population and the small size of the municipality. The more aggressive waste diversion programs in large urban areas may encourage greater diversion participation at the expense of source reduction. Future statistical analyses will illustrate the nature and extent of this diversion/reduction trade-off. In addition, statistical analysis of a large dataset could illustrate which demographic variables may perform well as predictors of success of unit pricing programs.

Recycling programs appear to be quite viable in urban areas. All three case study cities have good regional markets for their recyclables. Unit pricing in large population centers, by increasing residential waste diversion, increases and stabilizes the supply inputs to companies that process recyclables.

UNDESIRABLE DIVERSION

Urban unit pricing cities do not necessarily experience higher levels of illegal dumping. Furthermore, the dumping that does occur tends to be dumping in commercial dumpsters, as opposed to littering. Although dumping in commercial dumpsters may represent a significant cost to individual small businesses and non-profit charitable organizations, from a societal standpoint, it is preferable to dumping on the street. Dumping in dumpsters merely transfers disposal costs from individuals to the owners of the dumpsters. Littering, on the other hand, creates additional societal costs by forcing communities to expend resources on litter collection. It requires cities to employ street cleanup crews, and generates negative aesthetic effects. City officials may still be concerned about this issue, however, because of the heightened sensitivity to dumping that often accompanies the transition to variable collection fees.

²⁹ Miranda and Aldy, *Unit Pricing of Residential Municipal Solid Waste: Lessons From Nine Case Study Communities*, 1995.

Officials may also be concerned about the effect that illegal dumping may have on their city's image.

Since illegally dumped garbage is often bulk waste, cities may decrease dumping by offering citizens inexpensive or free bulk goods pickup days. Fremont, California offers two free bulk waste collection days each year, and the city experiences very little illegal dumping. Solid waste officials must weigh the cost of illegal dumping in their community against the foregone revenue from bulk waste collection. For example, Lansing's collection service picked up 3,452 bulky items in Fiscal Year 1994. The city sells its bulky waste collection stickers for \$20, so it received about \$69,000 in revenue from the sale of the stickers. The cost of litter cleanup in the city was around \$52,000, so even if free bulk collection eliminated all dumping, the city would lose money. However, the city might significantly reduce dumping by lowering the cost of bulk collection stickers. Grand Rapids charges \$10 for its bulk collection stickers, generating \$28,000 in revenue in Fiscal Year 1994, but the city only spends about \$15,000 per year in litter cleanup.

Inexpensive locks (\$10 to \$40) usually prevent people from dumping trash in commercial dumpsters. Multi-unit complex managers may put automatic locking mechanisms on their dumpsters, to ensure that people do not leave them unlocked, and give every resident a key. Some managers hide their dumpsters in enclosures, preferably gated, or put them where the managers or complex residents can monitor them.

Solid waste officials do not count on the cooperation of city police in their efforts to cut down on illegal dumping. Urban police officers have more pressing matters of concern than illegal garbage dumping, and officials from many of the cities in this report say that they get little attention from their cities' police departments. Therefore, civil penalties for dumping are preferable to criminal ones because civil penalties do not require police action. Fines and enforcement rules are most effective if they are in place before the start of a unit pricing program. High profile sanctions near the beginning of a program are also effective. Cities with the power to search dumped waste and enforce penalties on the basis of its content (i.e., trace garbage with an envelope or discarded bill) may experience fewer problems with undesirable diversion.

EDUCATIONAL COMPLEXITY

For unit pricing to succeed, citizens must understand their disposal options. Therefore, public education and outreach are very important in a city with variable collection rates. Unit pricing cities spend more money on education than do cities with flat rate or tax-financed garbage systems. Furthermore, public education is somewhat more complex in an urban setting, although diverse outreach techniques, like multi-lingual literature, are fairly easy to produce.

Unit pricing education routinely focuses on waste diversion as a means of lowering household garbage collection costs. Cities often neglect to educate residents about source reduction techniques. Education has a very positive impact on recycling participation and total waste diversion in the three case study cities. Source reduction education may have similarly positive effects, and lead to clearer waste reduction in urban unit pricing municipalities.

MULTI-UNIT COLLECTION

Based upon the experiences of the cities in this report and given current technology, urban unit

pricing municipalities cannot reasonably incorporate multi-unit households into their variable collection fee system. Therefore, variable rate collection systems must have enough single-family customers to sustain the service. For example, unit pricing is effective in San Jose, where over half of the households are in single-family dwellings, but it would probably have little impact in Manhattan, where almost all of the residents live in apartment buildings. Of the 13 cities covered by this report, San Francisco has the highest percentage of multi-unit households. Nearly two-thirds of the city's households are in multi-unit complexes.

UNSTABLE CUSTOMER BASE

A uniform garbage collection rate schedule ensures that every resident receives the same pricing incentive. Portland has an open system, with over 50 different haulers serving the city's residents. However, the city has a garbage rate board, similar to other utility rate boards, that sets collection rates on an annual basis. Every licensed hauler in the city must use the city-imposed service levels, and charge the exact rates set by the board.

The only way to ensure customer base stability is to have a closed waste collection system. Under a closed system, only the city or the city's waste contractor(s) may provide residential service. The potential downside of this type of arrangement is that the lack of competition may make the system inefficient. However, cities can create cost-savings incentives by having haulers periodically submit competitive bids for the city contract. All of the cities in this study with exclusive contractors have this type of bidding system.

The other advantage of an exclusive franchise system is that it is much easier to track total residential waste disposal figures. This allows officials to monitor annual levels of landfilled waste, as well as recycling and yard waste tonnages, to see whether the city is meeting source reduction and waste diversion goals. It also allows officials to identify areas in need of improvement. In open collection systems, city officials often cannot track total residential waste because private haulers are usually unwilling or unable to release their waste collection figures. To address this problem, cities may wish to require the release of such information as a condition of licensing.

ADMINISTRATIVE COST

With the exception of the possible need for a residential billing system, unit pricing has little impact on administrative costs. Even the cost of a billing system is not exorbitant. In the case of San Jose, it represents less than 5% of the city's total residential solid waste budget. Cities also often use their billing system for several city services.

IMPACT ON DISADVANTAGED RESIDENTS

Since this issue is highly inflammatory, city solid waste officials often consider some form of low-income assistance for garbage collection costs, especially if the cost of that assistance does not represent a significant portion of the solid waste department's budget. Furthermore, low diversion rates in disadvantaged neighborhoods show that low-income families are not taking advantage of their cost-savings opportunities, and therefore either require some assistance or better public education.

LOW-INCOME DIVERSION PARTICIPATION

San Jose officials are making an effort to reach disadvantaged residents with more education. Their multi-lingual literature is aimed at non-English speaking, low-income households, and the multi-unit pilot study they are planning will be oriented towards apartment complexes in disadvantaged areas. Portland officials are also aiming special education efforts at large cart users in an attempt to encourage them to reduce their waste through increased recycling. Officials have actually visited poor neighborhoods and met with residents to try to help them learn about ways that they may reduce their weekly garbage set-outs.

In the absence of educational efforts, city officials may make provisions for assisting disadvantaged residents with their waste disposal costs. Otherwise, the impact of variable collection fees on these residents is a significant problem, and the collection program may lose the support of city leaders. Furthermore, unassisted poor residents may resort to illegal dumping to lower their collection costs. City officials from all three case study cities report that dumping is more common in low-income neighborhoods.

APPENDIX 1: DESCRIPTIONS OF OTHER TEN UNIT PRICING CITIES

Fremont, California

Fremont has an exclusive franchise agreement with Browning-Ferris Industries (BFI) to provide all of its residential and commercial waste collection services. Residents may choose one of four different city can sizes: a 20-gallon trash container for \$16.73 per month; a 32-gallon container for \$16.99 per month; a 64-gallon container for \$18.20 per month; or a 96-gallon container for \$25.22 per month. The cost includes curbside recycling and yard waste collection. Residents are given three recycling bins: one for mixed paper, including junk mail, magazines, catalogs, paperboard, and telephone books; one for newspapers; and one for glass, tin, aluminum, steel, plastic (coded 1 and 2), and milk and juice cartons. In addition, they may stack corrugated cardboard alongside their bins. Residents also receive a 96-gallon yard waste cart. Collection for garbage, recycling and yard waste is on the same day each week. Two times each year, residents may arrange for free pick-up of bulky goods, such as furniture and appliances. Multi-unit complexes commonly use dumpsters, and collection fees vary with the size of the container and the frequency of collection. Those that participate in the recycling program have large totes for recyclables.

The impact of garbage collection fees on low-income or special needs residents is sometimes an issue in Fremont, and the city offers a 15% discount to residents that qualify for similar lifeline rates from other utilities. Illegal dumping is not much of a problem, and city officials feel that mandatory service cuts down on dumping -- if residents have to receive at least the basic level of trash service, they might as well use it. Otherwise, some people might try to avoid collection fees altogether by dumping all of their garbage. Officials also report that few bulky goods are dumped, and credit that to the two free annual pickups offered by the city. The city does not spend very much on education, although it does have a community outreach employee. It also sends out a newsletter every few months to every resident, and places periodic public information notices in local newspapers. Finally, the city has experienced little added administrative cost due to its variable rate program because the contractor handles billing and many other administrative responsibilities.

Oakland, California

Oakland has an exclusive franchise agreement with Oakland Scavenger, which is owned by Waste Management of Alameda County, to provide residential and commercial garbage collection service. Oakland Scavenger serves all of Oakland's 145,000 households. Residents rent city garbage cans from Oakland Scavenger, and pay \$10.08 per month for a 20-gallon can, or \$13.74 for a 32-gallon can. Each additional 32-gallon can costs \$16.49 per month. Collection is weekly. The fees include weekly curbside recycling collection. Three small recycling contractors each serve one-third of the city. They collect newspaper, mixed paper, corrugated cardboard, glass, aluminum, tin, plastic (coded 1 and 2), and used motor oil. The city does not have a yard waste collection program, although Waste Management has a compost facility that is used by professional landscapers. The facility received 21,000 tons of material in 1994. Multi-unit complexes either have city cans or dumpsters. The dumpsters cost \$10.76 per month for each unit in the complex, regardless of the size of the container.

The city does not currently make any provisions for special needs residents. However, the lack of special rates has been an issue, and the City Council is considering adopting them. Also, elderly and disabled residents have been expressing their dissatisfaction with the elimination of back door collection service. Low-income residents do receive a \$1 per month discount on the recycling portion of their fees. Oakland has made a concerted effort to eliminate illegal dumping. The city used to be a virtual dumping ground for residents of neighboring cities, but some high profile arrests have significantly reduced the level of commuter dumping. In addition, the city has set up security cameras and stakeouts to try to catch dumpers, and enacted harsh penalties, including high fines and jail time. City maintenance crews are now collecting about 1,000 tons of material per month, but that includes tree trimmings, rubbish from city refuse cans, and other waste that is not illegally dumped garbage. They report that the waste that is dumped tends to be bulky goods, like furniture and major appliances. The City Council continues to be concerned about the problem because of its impact on Oakland's image in the region. The city spends about \$300,000 on education each year, plus another \$100,000 from various grants. There is a quarterly newsletter, plus an additional 1 to 2 mailings per year. The city also places periodic public information notices in the local newspapers. Oakland Scavenger handles all of the administrative responsibilities, including billing for garbage collection and other utilities, so the city bears no administrative costs.

Of the 65,000 single-family households that the city serves, 8% use the 20-gallon can, 81% use one 32-gallon can, 11% use two 32-gallon cans, and less than 1% use three or more 32-gallon cans. Some 11,000 households in multi-unit complexes use city cans, and the other 42,000 have dumpster service. Oakland Scavenger uses three different types of garbage trucks. Rear end loaders (REL) currently pick up all of the city cans, although a few years ago they also collected from some dumpsters. Front end loaders (FEL) collect from all of the dumpsters in the city, and roll off vehicles (R/O) pick up debris boxes, which are used largely by industrial or construction operations. In 1992, Oakland Scavenger collected 147,000 REL tons, 43,000 FEL tons, and 65,700 R/O tons. In 1993, when the city's curbside recycling program started, the REL tons dropped to 133,000, while the FEL and R/O tonnages each jumped by about 6,000. In 1994, REL tonnages dropped again to 120,000 tons, while FEL tons climbed to 63,600 and R/O fell to 64,000. The drop in REL tonnages from 1992 to 1994 could indicate a reduction in residential waste through increased recycling, or could be accounted for by increased dumpster dumping, which would explain the increase in FEL and R/O tonnages. However, the drop could also be due to the shift of some of dumpsters from REL to FEL service. The city produced a total of 467,000 tons of waste in 1992, 417,000 in 1993, and 489,000 in 1994. It collected 19,500 tons of recyclables in 1993, or 22 pounds per household per month, and 23,000 tons in 1994, or 26 pounds per household per month.

San Francisco, California

San Francisco has a population of 724,000. The 305,000 households in the city (106,000 in single-family dwellings and 199,000 in multi-unit complexes) are served by two private waste hauling firms. The two firms, Golden Gate Disposal and Sunset Scavenger, which are both owned by Norcal Waste Systems, are licensed by the city and they each serve half of the city. The rates for garbage collection are set by a rate board. Currently, residents may choose a 20-gallon can for \$9.17 per month or a 32-gallon can for \$10.66 per month. Additional 32-gallon cans are each \$6.51 per month. Multi-unit complexes may choose to receive dumpster service. The cost of the service is based on a combination of factors, including room count, the frequency of collection service, and the volume of the container.

The city's weekly recycling collection program is run by the same two private hauling firms under a seven-year contract that expires September 30, 1997. The program is financed by waste collection

revenues and the sale of recyclables. Curbside service is available to single-family dwellings and multi-family complexes with up to 5 units. About 170,000 households fall into this category, and they all receive curbside service. Complexes with 6 or more units may receive apartment service, and about 86,000 of the roughly 136,000 apartment households are in buildings with recycling collection. The city collects newspaper, junk mail, magazines and catalogs, cardboard, dry food boxes, telephone books, office paper, paper bags, glass, aluminum, tin, steel, and plastic (coded 1). The city's recycling contract has a unique feature: a revenue floor (\$1.6 million in 1992). If revenues from the sale of recyclables fall below the floor, the contractors absorb the loss. Any revenues above the floor are rebated to the residents. The rebate in 1992 was almost \$1 million, and it was \$778,000 in 1993. Besides an annual Christmas tree collection program, the city has no yard waste collection program.

San Francisco does offer a lifeline rate for elderly residents, \$8.23 per month for the 20-gallon container, regardless of income. The city does not offer any other special rates. According to city solid waste officials, the impact of the city's rate structure on low-income residents has never really been an issue. Illegal dumping, on the other hand, has been a serious problem. Dumping takes place in streets, alleys, and dumpsters, and can be any material from common household garbage to large bulky items. However, city officials do not perceive the problem as being any worse in San Francisco than it is in any other dense urban area, and they have not observed any correlation between the quantity of illegally dumped material and periodic garbage rate increases. The city spends about \$400,000 on citizen education each year, consisting of mailings, informational campaigns, radio spots, displays at local fairs and events, advertisements in bus shelters and train stations, and presentations at area schools. It bears no administrative cost from the system because the contractors handle all of the billing and other administrative responsibilities.

In 1990, city residents generated 308,000 tons of garbage, or about 170 pounds per household per month. Residents diverted 39% of their waste, or 66 pounds per household per month, through curbside recycling, recycling drop-offs, and buy-back programs for certain materials. In 1993, 72% of city residents regularly recycled, and they recycled 20% of their garbage, or 56,000 tons. Of the 170,000 households that are served, each household recycled roughly 55 pounds of material each month. The city also estimates that residents reduced their garbage by 12,000 tons from the previous year through source reduction efforts.

Colorado Springs, Colorado

Colorado Springs is an example of a completely privately run waste collection system. The city plays no role in residential waste collection. It does not even license haulers. Residents may choose between many hauling firms for their garbage service, but most use one of four companies: Waste Management, Browning-Ferris Industries, Bestway, and Western Disposal. Waste Management gives residents several service options. They may rent Waste Management containers, and set out for weekly collection: one 34-gallon can plus one standard 30-gallon trash bag for \$9.50 per month; two cans and two bags for \$11.00 per month; or three cans and three bags for \$13.00 per month. Residents may also supply their own cans and pay \$10.50 per month for a 35-gallon can and bag, \$13.50 for a 65-gallon can and two bags, or \$15 for a 95-gallon can and three bags. The rates include biweekly curbside recycling collection of cans, glass, newspaper, and plastic (coded 1 and 2).

Because the city does not oversee or coordinate residential waste collection in Colorado Springs, there are no aggregate waste figures available for the city, and there is no information on any problems

with the collection system.

Plantation, Florida

Plantation has an exclusive franchise agreement with Southern Sanitation, a subsidiary of Waste Management, to provide collection service to all 67,000 city residents, as well as businesses. Single-family households are served twice per week, and Southern Sanitation will only collect garbage that is in city refuse bags. Residents must purchase the bags from local supermarkets at a cost of \$27.94 for a box of 18. Each box also contains 4 clear bags for recyclables. Southern Sanitation also collects recycling. Residents commingle glass, aluminum, steel, tin, plastic (coded 1, 2, and 3), and waxed juice and milk cartons in the clear recycling bags, and put out bundled newspapers separately. The contractor's policy is that it will only pick up recyclables that are in the city's recycling bags, but this rule is not strictly enforced. Collection is once per week, on the same day as one of the garbage collection days. All of the city's single-family dwellings receive curbside recycling service. Plantation has no yard waste collection program. Most multi-unit complexes have common dumpsters, and the service rate depends on the size of the container and the frequency of collection. They also have 90-gallon totes for recyclables. Some 80% of the city's multi-unit residents live in complexes with recycling service.

The city does not have any provisions for low-income or special needs residents, and that has never been an issue of concern. Furthermore, despite having no preventive measures, there is very little illegal dumping in Plantation, and the city spends less than \$500 per year to clean up dumped garbage. Businesses and multi-unit complexes are responsible for policing their own dumpsters, and the city has received very few complaints of "dumpster dumping." The city does spend \$6,000 to \$7,000 per year on community education, which consists of brochures that are available upon request, and informational packets for new residents that include 12 free recycling bags. Finally, the city's fee-per-bag program eliminates the need for a billing system, and unit pricing has not been administratively difficult or costly.

Between October 1, 1993 and September 30, 1994, Southern Sanitation collected 5,800 tons of recyclables, or about 32 pounds per household per month. About 85% of that material, or 4,900 tons, came from the 22,000 single-family households, while the rest was collected from the 8,000 multi-unit households that live in complexes with recycling service. Therefore, single-family residents diverted 37 pounds per household per month, while multi-unit residents only recycled 19 pounds per household per month. Over the same period, the city produced 32,000 tons of residential and commercial waste. A break-down was not available.

St. Paul, Minnesota

The city of St. Paul does not operate a refuse collection service. Instead, it licenses private hauling firms, and each of the city's 115,000 households chooses one of the firms. There are 28 firms currently operating in the city and they each have a significant market share. No one firm has more than 10% to 15% of the households. A 1990 city ordinance required haulers to use variable collection fees, but most already had variable rate pricing structures in place at the time.

Since 1987, the city has run a curbside and apartment recycling program through its contractor, the St. Paul Neighborhood Energy Consortium. The program serves all households, including 29,000 apartments in 960 buildings. The contractor collects newspaper, cardboard, magazines, junk mail, phone books, glass, aluminum, steel, tin, textiles, and small reusable goods. Curbside collection is twice per month, and apartment complexes each arrange their own collection schedule. The city has no yard waste collection program, but the licensed refuse haulers are required to provide separate weekly yard waste service between April and November. There are also seven Ramsey County yard waste drop-off sites.

The city does not offer any reduced rates for low-income or special needs residents, and officials do not believe that it is an issue because poor and elderly residents tend to produce less waste, anyway. Illegal dumping is also not much of a problem, although it does occur. The city does not have any estimate of the quantity of dumping per year. It receives a few complaints each year from businesses and apartment complexes. The city annually spends \$200,000 on public education. Each year, it mails two brochures to every resident, as well as a waste reduction guide. The city does not advertise very much in local papers, or on the television or radio. Finally, the private haulers handle all of their own administration and billing, so the city's administrative costs are essentially zero.

Because residential collection is scattered among so many private haulers, the city does not have total waste generation figures. It estimates that households produce around 115,000 tons of waste each year. The city does know that it collected 21,000 tons of recyclables in 1994. Therefore, it estimates that 94,000 tons of residential garbage, or 136 pounds per household per month, were landfilled last year.

Portland, Oregon

Portland has an open franchise system for residential waste collection. Some 55 private haulers are currently licensed by the city to collect residential garbage from the 125,000 households in single family dwellings, or multi-unit complexes with four units or less. The number of haulers has steadily decreased by about 10% each year over the past several years. Residents are fairly well distributed among all of the haulers, and no single operation has more than 10,000 customers. The city sets the rates that waste haulers may charge for weekly residential service: a 20-gallon can is \$14.60 per month; a 32-gallon can is \$17.60; a 35-gallon wheeled cart is \$19.30; a 60-gallon cart is \$24.05; and a 90-gallon cart is \$27.10. Residents may choose can combinations with greater total volumes, and they may also choose to have garbage picked up only once per month for a monthly fee of \$9.90. The different haulers may distribute their own cans, but they must meet the volume specifications that the city has established. Some 6% of the city's residents choose the once-per-month service, 19% use the 20-gallon can, 49% use the 32-gallon can, 9% use the 35-gallon can, 7% use the 60-gallon can, 5% use the 90-gallon can, and the remaining 5% use multiple cans. Multi-unit complexes with more than four units are considered commercial establishments, and their collection rates are not set by the city. They tend to be served by common dumpsters. The city acknowledges that multi-unit residents do not receive the same pricing incentives that single-family households do, so it has made a considerable capital investment in recycling shelters for multi-unit complexes. Officials feel that multi-unit diversion rates would be even lower without these shelters.

Weekly recycling collection and biweekly yard waste collection are included in the residential rates. The 17 haulers with 3,000 or more customers each collect their own materials, while the rest have an agreement that designates one company with the collection responsibility for all of their customers. Every resident receives a standard yellow city recycling bin, and the haulers collect newspaper, glass, used motor oil, corrugated cardboard, tin, aluminum, non-ferrous and ferrous metals, magazines, plastic (coded 2), scrap paper, steel aerosol cans, milk and juice containers, and aseptic juice boxes. For yard waste collection, residents put their trimmings in a 30-gallon bag or can. The cost of the first yard waste container is included in the residents' garbage bill, but additional containers are \$1 for each.

The city does not offer any special rates to low-income, elderly, or disabled residents, but solid waste officials are concerned about the impact of variable rates on disadvantaged households. They have observed a tendency among low-income residents to select the larger cart sizes, rather than lowering their garbage bills by recycling more and switching to a smaller container. Officials are attempting to encourage these residents to take advantage of this cost savings opportunity through education aimed at large cart users. Illegal dumping does not appear to be a serious problem in terms of the quantity of material dumped, but it does receive a lot of attention from the city. The solid waste division pays the Bureau of Buildings \$287,000 to cover the cost of nuisance cleanups, although solid waste officials believe that figure overstates the true cost of cleanup. Officials believe that because residents may choose to have no garbage collection service, illegal dumping is increased -- some people may try to save money by dumping their garbage rather than paying to have it collected. The city does not have any annual estimates of the amount of dumped garbage. Portland spends a little over \$100,000 per year on public education. The city distributes quarterly brochures to every resident, and a survey postcard once each year. The city sponsors public service announcements on local radio stations, and performs public outreach programs in city neighborhoods. Finally, the city coordinates some area-wide education efforts with Metro, the Portland Metropolitan regional authority. Each hauler has its own billing system, so the city does not incur any billing costs. The city spends a total of \$1.5 million on oversight of the residential waste collection system, and most of those costs are covered by franchise fees that the city collects from licensed private waste haulers. The city's budget includes funding for a citizen hotline, which receives about 15,000 calls per year, ranging from complaints to questions about the collection system.

In Fiscal Year 1994, city residents diverted 34% of their garbage through curbside recycling and yard waste collection programs. The city collected 35,300 tons of recyclables, or 47 pounds per participating household per month, and 12,800 tons of yard waste, or 17 pounds per household per month. Since Portland began its current recycling and yard waste collection programs in 1992, residential waste generation has consistently decreased. In Fiscal Year 1992, city residents produced 106,000 tons of garbage, or 140 pounds per household per month. That figure fell to 98,700 tons, or 132 pounds per household per month, in Fiscal Year 1993, and by Fiscal Year 1994, the amount of residential garbage had fallen again to 95,700 tons, or 128 pounds per household per month.

Wilkes-Barre, Pennsylvania

Wilkes-Barre has an open residential garbage collection system. Residents may choose to receive their service from the city or from one of several private haulers. Once per week, the city picks up city refuse bags, which are sold in supermarkets and local convenience stores for \$1.25 each. The city provides service to almost 13,000 of the 15,000 households in single-family dwellings or multi-unit buildings with up to four units. Building managers of housing complexes with 5 to 19 units individually decide whether they will have their complex participate in the city program, or whether they will contract

with a private hauler for dumpster service. Residents in complexes on the city service, like single-family residents, must purchase city refuse bags and put them out on the street for weekly collection. Some 3,700 households in 5-to-19-unit complexes are on the city service. Complexes with 20 or more units may only receive collection service from private haulers.

Wilkes-Barre's curbside recycling program is mandatory. Residents pay a \$10 annual fee, and over 80% participate regularly. On the same day as garbage collection, the city collects newspaper, steel, tin, aluminum, plastic (coded 1 and 2), glass, and corrugated cardboard. In addition, between October and December the city collects leaves weekly. Residents rake them into the street on collection day, and suction vehicles pick them up. There are drop-off locations for other yard debris that opened in 1994.

The city does not offer any special rates to low-income, elderly, or disabled residents. Officials feel that disadvantaged households can actually save money under the fee-per-bag system by reducing their weekly garbage set-outs. The issue has arisen from time to time, but has never been very significant. Illegal dumping has actually improved under the fee-per-bag system. The biggest problem the city had been experiencing was with residents of neighboring variable rate localities coming into Wilkes-Barre and taking advantage of the flat fee collection system by leaving their garbage in front of peoples' homes. When the city switched to unit pricing, it began searching dumped garbage for some form of identification and fining identified dumpers \$500. There is now 50% less out-of-town garbage dumped on Wilkes-Barre streets, and the city is saving about \$250,000 on reduced collection and disposal costs. The city conducted 9 months of intensive education immediately before and after it switched to variable rates, but it does not do any continuous education now. The city currently receives 2 to 3 calls each month from residents needing information. Wilkes-Barre has also not experienced any administrative cost increases, and the fee-per-bag system alleviates the need for a billing service.

The fee-per-bag system started city-wide in January of 1994. Residential waste fell from 20,000 tons, or 202 pounds per household per month, in 1993 to 15,000 tons, or 152 pounds per household per month, in 1994. Interestingly, recycling tonnages actually dropped between 1993 and 1994. In 1993, the city collected 2,400 tons of recyclables, or 24 pounds per household per month, while in 1994, it only collected 2,200 tons, or 22 pounds per household per month. However, in 1994 the city had to suspend collection for 9 weeks because of severe weather. It would have collected, on average, another 460 tons of material during those 9 weeks, which would have brought the yearly total up to almost 2,700 tons, or 27 pounds per household per month. In 1994, the city also collected 3,200 tons of leaves and 2,200 tons of dropped-off yard debris.

Spokane, Washington

The weekly residential garbage collection program in Spokane is run by the city, and it serves all 177,000 residents. Residents provide their own receptacles (can, box, or bag) and are assessed a collection fee based on the size and number of containers they use. A 20-gallon container is \$8.56 per month, one 30-gallon container is \$11.07, and each additional 30-gallon container is \$6.01 per month. Collection personnel will not pick up a receptacle that is clearly too big. They also have a computer routing slip every day that lists each address and the number of receptacles for which the household is signed up. If a household puts out more garbage than it is supposed to, it is assessed a \$2.25 charge. The city also provides weekly curbside recycling collection on the same day as garbage collection. The cost of the program is included in the garbage collection fees. Residents may set out newspaper, glass, plastic (coded 1 and 2), aluminum, tin, cardboard, magazines, brown paper bags, and used batteries in city-

issued recycling bins. The city does not have a yard waste collection program, but residents may drop off their yard waste at the city's compost facility. The first 400 pounds of material is free, and the fee for amounts greater than 400 pounds is \$20 per ton. Multi-unit complexes are generally served by common dumpsters. The service rate depends on the size of the receptacle and the frequency of collection. They also have large recycling carts, and pay a premium equal to 10% of their garbage collection fee for recycling service.

Although it is sometimes an issue, the city does not offer special rates for low-income households or back door service for elderly and handicapped residents. Illegal dumping has been a problem. The city employs four nuisance abatement officers that attempt to trace dumped garbage to its owners and bill them for the cleanup costs. The city spends very little on regular public education, but it did spend \$200,000 on promotional activities at the start of the curbside recycling program. The waste-to-energy plant offers tours, and the city does make regular presentations in schools. It operates a recycling hotline, and will send out informational brochures on request. Finally, billing for garbage collection costs \$600,000 per year and is handled by a central city utility billing service. The computer routing system was complicated to set up, but works well now with 95% to 99% accuracy.

Tacoma, Washington

The city runs its own garbage collection service in Tacoma for all 70,000 households, as well as businesses. It is an exclusive system, and no private haulers operate in the city. Residents may choose two different sized city cans: a 60-gallon container for \$17.00 per month, or a 90-gallon container for \$25.50 per month. Collection is weekly. The city also provides weekly curbside recycling collection of glass, aluminum, steel, plastic and newspaper. Yard waste is collected curbside once every two weeks. Residents put grass, leaves, and other trimmings in 32-gallon containers. They may set out as many containers as they want. Multi-unit complexes are served by a common receptacle, typically a dumpster. The fee is based on the size of the container and the frequency of collection.

The city offers a reduced garbage rate to anyone that qualifies for the electric utility's discount. The discount is about 50% off the basic level of service. The city has not experienced significant levels of illegal dumping. The dumping that does occur tends to be concentrated in blighted areas, like abandoned or run-down property. The city has a "blightmobile" that responds to complaints about dumping in such areas, and the property owners are billed for the cost of cleanup. Residents may bring their garbage to the city's landfill for a minimum charge (\$3 regardless of the amount), and officials believe that this policy cuts down on dumping. The city spends about \$50,000 per year on educational efforts, including periodic advertisements in local newspapers, and on the television and radio, a biannual mailing to every resident, and support for environmental curriculum development in the schools. Its administrative costs are not exorbitant, but the refuse portion of the city's combined utility billing system does cost \$200,000 per year.

Some 63% of Tacoma's single-family households and 30% of its commercial clients, which include multi-unit complexes, are signed up for recycling service. In February of 1995, the city collected a total of 520 tons of yard waste, 614 tons of recyclables, and 13,000 tons of garbage, so the city-wide diversion rate for the month was 8%.

APPENDIX 2: INTERVIEWS CONDUCTED

Three Case Study Cities

Grand Rapids, Michigan

Willie Alexander, Supervisor, Department of Public Works
Stacy Dubose, Administrative Assistant, Department of Public Works
Donald Joswick, Director, Department of Public Works
Dick Strating, Waste Management of Western Michigan

Lansing, Michigan

Steve Anspach, Surface Maintenance Supervisor, Operations and Maintenance Division
Jim Campfield, Superintendent, Operations and Maintenance Division
Ron Kreinbrink, Assistant Superintendent, Operations and Maintenance Division
Lenora Jadun, Director, Department of Public Service
Robert Moyer, Solid Waste Supervisor, Operations and Maintenance Division

San Jose, California

Mary Ellen Dick, Integrated Waste Management Program Manager
Tim Kirby, Administrative Manager, Center for Development of Recycling
Paul Ledesma, Environmental Technician II, Environmental Services Department
Christopher Petak, Environmental Technician, Integrated Waste Management
William Toomey, Senior Environmental Specialist, Integrated Waste Management
Jo Zientek, Environmental Technician II, Integrated Waste Management

Other Ten Unit Pricing Cities

Fremont, California: Ken Pianin and Peter Doty, Eco Associates, Integrated Waste Management Department
Oakland, California: Paul Brown, Recycling Supervisor
Plantation, Florida: Paul DeBernardo, Recycling Coordinator
Portland, Oregon: Todd Burton, Bureau of Environmental Services
San Francisco, California: Chris Keller, Solid Waste Management Program
Spokane, Washington: Bob Alderson, Recycling Coordinator; Phil Williams, Solid Waste Project
St. Paul, Minnesota: Rick Person, Solid Waste Coordinator
Tacoma, Washington: Walter Forslund and Dave Frutiger, Refuse Utility; Bob Foss, Solid Waste Collection Supervisor Assistant; Charlene Gallagher, Recycling Coordinator
Wilkes-Barre, Pennsylvania: John Bergold, Director of Recycling

Partner Cities

Flint, Michigan: Hans Kuhlman, Deputy Director, Department of Public Works; Ed Henry, Waste Collection Supervisor
San Diego, California: Phil Balmanno, Environmental Services Department; Maureen Owen, Recycling Specialist; Nader Tirandazi, Associate Administrative Analyst, Refuse Collection Division

REFERENCES

- Adamec, Barbara. "Volume-Based Collection Fees: A Success Story." Resource Recycling. March, 1991.
- Albrecht, Oscar W. "An Evaluation of User Charges for Solid Waste Collection and Disposal." Resource, Recovery and Conservation. Vol. 2. 1976/1977.
- Alderden, Jim. "Volume-Based Rates, Dream or Nightmare?" Recycling Today. November, 1990.
- Andresen, Katya. "Communities Weigh Merits of Variable Rates: Residents' Fees for Garbage Disposals." World Wastes. November, 1992.
- Angelo, James J. Should Brevard County, Florida Adopt a Unit Pricing Program for Municipal Solid Waste? Undergraduate Honors Project, Sanford Institute of Public Policy, Duke University. April, 1993.
- Bender, Rodd; Briggs, Wyman; and De Witt, Diane. Toward Statewide Unit Pricing in Massachusetts: Influencing the Policy Cycle. Master's Degree Project. John F. Kennedy School of Government. January, 1994.
- Blume, Daniel. Under What Conditions Should Cities Adopt Volume-Based Pricing for Residential Solid Waste Collection? Master's Memo, Institute of Policy Sciences and Public Affairs, Duke University. May, 1991.
- Browning, Marilyn and Becker, Jeanne. Volume-Based Garbage Collection Fees: An Analysis of Ten Illinois Programs. A Report Prepared by Becker Associates, Inc. November, 1990.
- Canterbury, Janice. Pay-As-You-Throw: Lessons Learned About Unit Pricing of Municipal Solid Waste. EPA Office of Solid Waste report # EPA530-R-94-004. April, 1994.
- Cargo, Douglas R. Solid Wastes: Factors Influencing Generation Rates. Research Paper No. 174. Chicago, IL: University of Chicago Department of Geography.
- Chua, Dale H.H. and Laplante, Benoit. Litter and Waste Management: Disposal Taxes, User Charges, and Penalties. April, 1991.
- Cuthbert, Richard. "Variable Disposal Fee Impact." Biocycle. May, 1994.
- Deisch, Mitchell. "Mt. Pleasant 'Goes Green': A User Fee Success Story." Resource Recovery. December, 1989.
- Dinan, Terry. "Solid Waste: Incentives That Could Lighten the Load." EPA Journal. May/June, 1992.
- Dobbs, Ian M. "Litter and Waste Management: Disposal Taxes Versus User Charges." Canadian Journal of Economics. February, 1991.

- Efaw, Fritz and Lanen, William. Impact of User Charges on Management of Household Solid Waste. Report prepared by Mathtech, Inc. August, 1979.
- Emmer, Terri and Neidhart, Jim. An Analysis of the Effects of Volume-Based Waste Disposal Fees on Consumer Behavior. Department of Resource Economics, University of New Hampshire.
- Enos, Gary. "Residents Clean Up With Waste-Cutting Incentive." City and State. February 25, 1991.
- Environmental Protection Agency. Unit Pricing: Providing an Incentive to Reduce Municipal Solid Waste. Report # EPA/530-SW-91-005. February, 1991.
- Environmental Protection Agency. Charging Households for Waste Collection and Disposals: The Effects of Weight or Volume-Based Pricing on Solid Waste Management. Report # . September, 1990.
- Environmental Protection Agency. Seattle Solid Waste Utility Garbage by the Pound Pilot Project Summary. Draft Report. April, 1991.
- Felton, Mary K. "A Snapshot of Waste Generation and Recovery." Resource Recycling. January 1995.
- Fiske, Gary S. "Rates: A Powerful Tool to Reduce the Waste Stream." Solid Waste and Power. March/April, 1992.
- Franklin Associates, Ltd. The Role of Recycling in Integrated Solid Waste Management to the Year 2000. Prepared for Keep America Beautiful, Inc. September 1994.
- Fullerton, Don and Kinnaman, Thomas. Garbage, Recycling, and Illicit Burning or Dumping. National Bureau of Economic Research Working Paper # 4374. May, 1993.
- Fullerton, Don and Kinnaman, Thomas. Household Demand for Garbage and Recycling Collection with the Start of a Price per Bag. National Bureau of Economic Research working paper # 4670. March, 1994.
- Glenn, Jim. "Financing Recycling Programs." Biocycle. November, 1989.
- Goldberg, Dan. "The Magic of Volume Reduction." Waste Age. February, 1990.
- Grogan, Peter L. "Target Seattle." Biocycle. October, 1993.
- Guerrieri, Tony M. An Assessment of Unit Pricing for Municipal Solid Waste. A Report for the Pennsylvania Joint Legislative Air and Water Pollution Control and Conservation Committee. September, 1994.
- Harder, Greg and Knox, Linda. "Implementing Variable Trash Collection Rates." Biocycle. April, 1992.
- Hayes, Jeffrey. "Let the Market Replace the Madness: How to Control Rising Solid Waste." Public Works. December, 1992.

- Hong, Seonghoon. An Economic Analysis of Household Recycling of Solid Wastes: The Case of Portland, Oregon. PhD Dissertation. Department of Agriculture and Resource Economics. Ohio State University. November 21, 1991.
- Jenkins, Robin. Municipal Demand for Solid Waste Disposal Services: The Impact of User Fees. PhD Dissertation, Department of Economics, University of Maryland. 1991.
- Johnson, Margit and Carlson, William L. "Calculating Volume-Based Garbage Fees." Biocycle. February, 1991.
- Katz, Marvin. "Collection Strategies of the Nineties?" Waste Age. February, 1989.
- Kemper, Peter and Quigley, John M. The Economics of Refuse Collection. Cambridge, MA: Ballinger Publishing Company. 1976.
- Khator, Renu and Huffman, John. "A Survey of Recycling Coordinators." Biocycle. October, 1993.
- Kourik, Robert. "What's So Great About Seattle?" Garbage. November, 1990.
- Lambert, Abigail F. Rate Proposal for a Weight-Based Pricing System for Residential Waste Collection in Durham, North Carolina. Master's Project, School of the Environment, Duke University. 1991.
- Laplante, Benoit and Luckert, Martin. The Wastepaper Dilemma: Can Newsprint Recycling Legislation Kill Two Birds with One Stone? Department of Economics, Laval University. October, 1991.
- Lemoine, Pam. "Recovering the Costs of Solid Waste Management." Solid Waste Issues and Answers. 1992.
- Lewis, Thomas A. "Waste Not, Want Not." National Wildlife. June/July, 1993.
- Menell, Peter S. "Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste." Ecology Law Quarterly. Vol. 17, 655. 1990.
- Miedema, Allen K. "Fundamental Economic Comparisons of Solid Waste Policy Options." Resources and Energy. Vol. 5. 1983.
- Miller, Chaz. "Pay as You Throw: Less Weight? More Stuffing!" Waste Age. September, 1993.
- Miranda, Marie Lynn; Everett, Jess W.; Blume, Daniel; and Roy, Barbeau A., Jr. "Market-Based Incentives and Residential Municipal Solid Waste." Journal of Policy Analysis and Management. Vol. 13, No. 4. 1994.
- Miranda, Marie Lynn; Scott D. Bauer; and Joseph E. Aldy. Unit Pricing Programs for Residential Solid Waste: An Assessment of the Literature. School of the Environment, Duke University, 1995.
- Miranda, Marie Lynn and Joseph E. Aldy. Unit Pricing of Residential Municipal Solid Waste: Lessons

- from Nine Case Study Communities. School of the Environment, Duke University, 1995.
- Moriarty, Patrick. "Financing Waste Collection for Maximum Diversion." Biocycle. January, 1994.
- Morris, Glenn E. and Byrd, Denise C. "Unit Pricing for Solid Waste Collection." Popular Government. Fall, 1990.
- Morris, Glenn E. and Holthausen, Duncan M., Jr. "The Economics of Household Solid Waste Generation and Disposal." Journal of Environmental Economics and Management. Vol. 26. 1994.
- "New Jersey Town Weighs in on Trash by the Pound: Mendham, New Jersey." World Wastes. February, 1993.
- Norris, James L. "Recycling and computerized garbage tracking cut city's costs." Public Works. February, 1994.
- Project 88 -- Round II. Incentives for Action: Designing Market-Based Environmental Strategies. A Policy Symposium Sponsored by Senator Timothy Wirth and Senator John Heinz. May, 1991.
- "Pushing the Limits of Backyard Composting." Biocycle. March, 1994.
- Reschovsky, James D. and Stone, Sarah E. "Market Incentives to Encourage Household Waste Recycling: Paying for What You Throw Away." Journal of Policy Analysis and Management. Vol. 13, No. 1. Winter, 1994.
- Richards, Bill. "Recycling in Seattle Sets National Standard but is Hitting Snags." Wall Street Journal. August 3, 1993.
- Richardson, Robert A. and Havlicek, Jr., Joseph. "Economic Analysis of the Composition of Household Solid Wastes." Journal of Environmental Economics and Management. Vol. 5. 1978.
- Riggle, David. "Only Pay for What You Throw Away." Biocycle. February, 1989.
- Roy, Barbeau A. Unit-Based Pricing for Municipal Solid Waste Collection. Undergraduate Thesis, Department of Economics, Duke University. 1992.
- Savas, E.S.; Baumol, Daniel; and Wells, William. "Financing Solid Waste Collection." The Organization and Efficiency of Solid Waste Collection. Lexington Books. 1977.
- Scarlett, Lynn. Mandates or Incentives? Comparing Packaging Regulations with User Fees for Trash Collection. Reason Foundation publication No. 158. May, 1993.
- "Seattle Engineers Say: Variable Can Rate Encourages Recycling." Waste Age. November, 1985.
- Skumatz, Lisa A. "The Buck is Mightier Than The Can." Biocycle. January, 1990.
- Skumatz, Lisa A. "Garbage by the Pound: The Potential of Weight-Based Rates." Resource Recycling.

July, 1991.

Skumatz, Lisa; Van Dusen, Hans; and Carton, Jennie. "Garbage By The Pound: Ready to Roll with Weight Based Fees." Biocycle. November 1994.

Skumatz, Lisa A. "Introducing the Hybrid Variable Rate System." Biocycle. November, 1993.

Skumatz, Lisa A. Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation. Reason Foundation Publication No. 160. June, 1993.

Skumatz, Lisa. Variable Rates: Using Your Rate Structure to Encourage Waste Reduction and Recycling. Draft Paper. Undated.

Skumatz, Lisa and Breckinridge, Cabell. Variable Rates in Solid Waste: Handbook for Solid Waste Officials, Vol. I and II. Report funded by the EPA and City of Seattle Solid Waste Utility. June 1990.

Stavins, Robert N. "Market Forces Can Help Lower Waste Volumes." Forum for Applied Research and Public Policy. Spring, 1993.

Stevens, Barbara. Pricing Schemes for Refuse Collection Services: The Impact on Refuse Generation. Research Paper # 154. Columbia University Graduate School of Business. January, 1977.

Stone, Sarah and Harrison, Ellen. "Residents Favor User Fees." Biocycle. August, 1991.

"Taking the Innovative Approach to Waste Hauling." Biocycle. July, 1993.

Toomey, William A. "Meeting the Challenges of Yard Trimmings Diversion." Biocycle. May, 1994.

University of Illinois Solid Waste Management Newsletter. "Volume-Based Garbage Rates." May, 1990.

U.S. Conference of Mayors. A Primer on Variable Rate Pricing for Solid Waste Services. June, 1994.

U.S. Congress OTA. Facing America's Trash. Office of Technology Assessment: Washington, D.C. 1989.

Wertz, Kenneth L. "Economic Factors Influencing Households' Production of Refuse." Journal of Environmental Economics and Management. Vol. 2. 1976.

"What's New in the Waste Stream." Biocycle. October, 1992.

Woods, Randy. "Puget Sound's Other Success Story." Waste Age. July, 1993.

Zak, Stephanie and Chartrand, Douglas. An Introduction to User Fees. Report prepared for the Rutland Regional Commission. February, 1989.