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Source-Separation and Mixed Waste Recycling Systems: A Comparative Analysis



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Source-Separation and Mixed Waste Recycling Systems: A Comparative Analysis



Prepared for:

**SWANA Applied Research Foundation
FY2013 Recycling Group Subscribers and
FY2013 Collection Group Subscribers**



December 2013

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1.0 INTRODUCTION

The purpose of this report is to provide recycling managers with up-to-date technical and programmatic information regarding residential source-separation and mixed waste recycling systems.

The ultimate goal of both systems is to recover recyclables from municipal solid waste (MSW) that meet the specifications of the secondary materials markets that will purchase the recovered materials and/or products.

To meet market specifications, curbside recyclables collection services originally required residents and businesses to keep recyclables separated from their wastes and to place each type of recyclable in separate bins at the curb for collection. While this approach produced recyclables of high quality, it was inconvenient for residents and required the provision of an additional curbside collection service that was relatively inefficient and expensive.

Over the last 20 years, improvements in processing technologies have enabled collection agencies to provide recyclables collection services – such as single-stream or dual-stream recycling – that are more efficient, less costly, and, perhaps most importantly, more convenient for the resident. During this time, numerous communities also implemented a residential curbside collection service for yard waste, which is often banned from landfill disposal. As a result, residential customers typically receive three curbside collection services on a regular basis: (1) mixed waste collection, (2) yard waste collection, and (3) recyclables collection. Residents are required to assist in these services by separating their discards into these three categories, placing them into their assigned containers, and moving the containers to and from the curb on their collection days.

Municipal solid waste managers are now facing another "watershed" moment as they are tasked with the implementation of collection and processing systems for organic wastes. As with materials recycling, there is – once more – a need to implement collection services that are efficient, cost-effective, and convenient to the resident. In this regard, many communities are staying with the source-separation approach and instructing residents to place their food waste and other organics in the yard waste container.

Some communities, however, are starting to consider and implement other residential recycling options. For example, the City of Houston, Texas, was recently awarded a \$1 million grant from the Bloomberg Philanthropies "2012-2013 Mayors Challenge" to support the city's implementation of its "One Bin For All" residential recycling program.¹ As described in its grant application (see Figure 1-1), this program will instruct residents to place all their discards into a single bin

¹The Mayors Challenge is a competition to inspire American cities to generate innovative ideas that solve major challenges and improve city life – and that ultimately can be shared with cities across the nation.

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for collection and will rely on processing technologies to separate out recyclables and organics from the mixed residential waste at a central processing facility.

The SWANA Applied Research Foundation's (ARF) Recycling Group decided to target this topic for investigation during FY2013 (July 2012 through June 2013). The goal of this research project was to conduct a comparative analysis of the costs, benefits, and issues associated with residential source-separation and mixed waste recycling systems. Due to the relatively limited amount of funding, the analysis that was conducted was limited to systems that have been implemented to serve residents living in multi-family buildings.

This report presents the results of the research conducted for this project, which was conducted with input and support provided by the FY2013 ARF Recycling and Collection Group Subscribers listed in Table 1-1.²

TABLE 1-1		
SWANA ARF FISCAL YEAR 2013 GROUP SUBSCRIBERS		
Jurisdiction	Representative	Title
SWANA ARF Fiscal Year 2013 Recycling Group Subscribers		
Edmonton, Alberta, Canada	Christian Felske, PhD, P Eng.	Director – Engineering, Processing and Disposal
Fairfax County, VA	Pamela Gratton	Chief, Recycling and Administrative Services
North Vancouver, British Columbia, Canada	Allen Lynch	Manager – Waste Reduction
Solid Waste Agency of Northern Cook County, IL	Dave Van Vooren	Executive Director
Monterey CA Regional Waste Management District	Tim Flanagan	Assistant General Manager
Tucson, AZ	Fran LaSala	Environmental Manager
SWANA ARF Fiscal Year 2013 Collection Group Subscribers		
Charlotte, NC	Victoria Johnson	Solid Waste Services Director
Manteca, CA	James Stone	Deputy Director of Public Works
Tucson, AZ	Pat Tapia	Collections Administrator
Whitby, ON Canada	Murray Gale	Superintendent - Solid Waste Management

² The SWANA Applied Research Foundation was founded in 2001 with the purpose of conducting collectively-defined and funded applied research on pressing solid waste issues. It is funded by local governments and other organizations that contribute a "penny per ton" of waste managed to the Foundation on an annual basis. For more information on the SWANA Applied Research Foundation, please contact Jeremy O'Brien, Director of Applied Research, SWANA, (301) 585-2898.



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Idea Summary: *One Bin for All is a revolutionary idea for residents to discard all materials in one bin, treating "trash" as valuable assets and dramatically increasing recycling using game changing technologies.*

What if everything you put in a waste bin could be recycled? What if "trash" became extinct? And what if you no longer had to sort your plastic cups from your glass jar from your banana peel?

What if Houston led an innovation that transformed the way we think about all discarded materials? It can happen here.

One Bin for All is a revolutionary idea for residents to discard all materials in one bin, treating "trash" as valuable assets, dramatically increasing recycling using game changing technologies.

Recycling, admittedly, is difficult. Though I am an avid recycler, I can be stumped by aluminum foil or a wet paper towel or a plastic straw. Not surprisingly, so are millions of citizens, and it is estimated that cities only effectively recycle about 30 percent of their trash.

Houston is a can-do city with world-class engineering and refining sectors. I believe that technology can do a better job separating trash from recyclables, and am working on creating a public-private partnership to construct and operate a high-tech recycling and sorting facility, diverting up to 75 percent of the material residents discard (up from Houston's current 14 percent) - using technology from the mining and refining industries, not individuals. Residents will be able to place all discarded materials in one bin and technology will do the rest.

This cost-neutral, technological innovation represents a huge paradigm shift, changing how people will think about "trash" and recycling in the future. Houston will apply proven technologies and new processes, redefining municipal solid waste from a liability to a valuable asset. Houston already has a well-established industrial and energy base. This development will provide incentives for networks and businesses to form around newly separated materials that will be available as feedstocks.

This first-of-its-kind innovation uses technology in a way that has never been done before. Allowing technology and new process systems to sort household "trash" and derive an initial 55 percent diversion rate, and upwards of 75 percent with composting, anaerobic digestion and catalytic conversion (biomass-to-fuel) is more efficient and effective. The technologies (shredders, sensors, density separators, and optical scanners) have been used previously in the waste, mining, or refining industries, but will be combined in a new process which will yield a much higher diversion rate. This system has the potential for cities across the globe to reduce greenhouse gas emissions and make a significant contribution to improved air quality, provide an easy-to-use program for residents, save money and increase revenues.

Our innovation will:

- Provide every residence with curbside One Bin for All services;
- Decrease the volume of waste sent to landfills and increase recycling rates;
- Improve air quality by eliminating truck routes and reducing methane emissions from landfills; and
- Manage costs associated with waste collection and disposal and recycling, saving cities money.

By building the first total material resource recovery facility in the US, Houston has the opportunity to improve the health and quality of life of its citizens, divert more municipal solid waste than any other large City in the nation, save money, change the way citizens think about materials, reduce extraction of raw materials and influence other cities to embrace this transformation.

Houston is a city of solutions. If you can dream it, you can achieve it here. One Bin for All.

*Bloomberg Philanthropies - 2012-2013 Mayors Challenge. <http://mayorschallenge.bloomberg.org/index.cfm?objectid=19B99FC0-0426-11E2-9FD1000C29C7CA2F>

Figure 1-1
*Houston: One Bin For All**

2.0 THE SOURCE-SEPARATION RECYCLING SYSTEM

2.1 Introduction

The implementation of residential source-separation recycling programs began in earnest in the early 1990s. By 2011, it was estimated that there were more than 9,800 curbside collection programs in the United States to collect source-separated recyclables that served over 70 percent of the population.³

As described above, residential source separation programs typically involve the provision of three, regularly-scheduled curbside collection services for residential customers: (1) mixed waste (2) yard waste, and (3) recyclables. Residents are required to assist in these services by separating their discards into these three categories and placing them into their assigned bins or wheeled containers at the curb.

One of the premier residential source-separation programs in the United States has been implemented by the city of Seattle – a city well-known for its strong environmental ethic and commitment to recycling. In addition to achieving very high diversion rates, the city has made a commitment to the principles of full-cost accounting, accurate accounting of diversion rates, and public transparency with respect to the costs and performance levels associated with each of its recycling services.

In the 2011 update of the *Seattle Solid Waste Management Plan*, the city committed to achieving a 60 percent recycling goal by 2012 and set a new goal of 70 percent to be achieved by 2025.⁴

For these reasons, the SWANA ARF selected the city of Seattle for analysis as an excellent representative of a modern residential source-separation recycling system.

2.2 Seattle's Solid Waste Management System

Seattle Public Utilities (SPU) – a department in the government of the city of Seattle – is responsible for the provision of water supply, wastewater and stormwater management, and solid waste management services to the residents, businesses, and industries in the city's jurisdiction.

Almost 714,000 tons of MSW were generated in Seattle and managed in 2012.⁵ The city's 2012 estimated population of 634,535 is divided into single-family (163,483 households) and multi-

³ US EPA Office of Solid Waste. *Municipal Solid Waste in the United States: 2011 Facts and Figures*. (EPA-530-R-13-001). May 2013. www.epa.org.

⁴ Seattle Public Utilities. *Picking Up the Pace Toward Zero Waste: Seattle's Solid Waste Plan - 2011 Revision*.

⁵ Seattle Public Utilities. *2012 Recycling Rate Report*.



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family residents (132,840 households).⁶ The 132,840 multi-family units are housed in 5,980 apartment complexes with an average of 22 units per complex.

The *Seattle Solid Waste Plan - 2011 Revision* includes a graphic of the city's MSW system, which is presented in Figure 2-1 and summarized below:

- SPU has divided the city into two residential franchise collection districts, each of which is provided with garbage, organics collection, and recyclables collection services. For single-family residences, garbage and organics are collected on a weekly basis while recyclables are collected every other week. For multi-family residences, the collection frequency for garbage varies according to the needs of the building while organics are still collected weekly and recyclables every other week.
- The collected wastes are transported to either of two transfer facilities (north or south) while the organics and recyclables are hauled directly to processors. From the transfer facilities, waste is trucked to an intermodal rail station, from which it is transported by train approximately 250 miles to the Columbia Ridge Landfill (located near Arlington, Oregon, and owned by Waste Management, Inc.) for disposal.

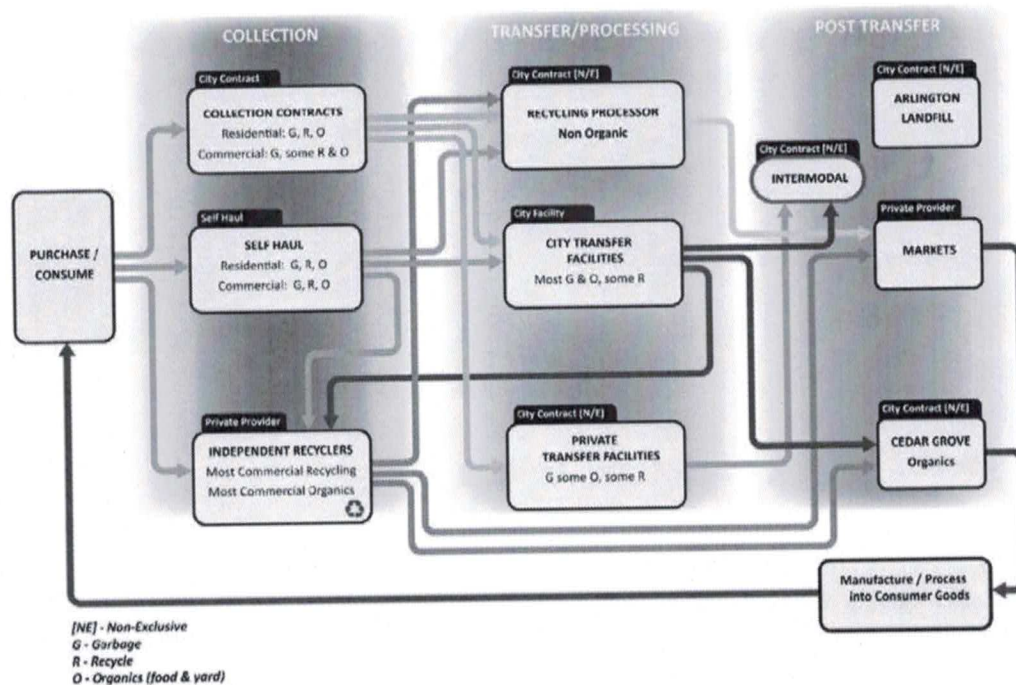


Figure 2-1. Seattle's Integrated MSW Management System
 (Source: Seattle Solid Waste Plan - 2011 Revision)

⁶ Seattle Public Utilities – Economic Services Section. *Seattle Garbage Report – Second Quarter 2013*.

2.3 Single-Family Collection Services

2.3.1 Introduction

Single-family residences in Seattle are defined to include detached single-family houses, duplexes, and multi-family buildings with four or less housing units. The distinguishing factor about this service is that cans (12, 20 or 32 gallons in size) or carts (64 or 96 gallons) are used for garbage collection. In contrast, multi-family residences utilize dumpsters for garbage collection.

Two companies – Waste Management, Inc., and Cleanscapes, Inc. – are under contract with SPU to collect the residential garbage, recycling, and organics generated in the city's two franchise collection districts. Current contracts began in March 2009 and will run at least until 2017.

Each company provides up to three collection services (recyclables collection, food and yard wastes collection, and garbage collection) to each residence. Residents are required by law to subscribe to the garbage collection service. They are provided the recyclables collection as a free service, which they are encouraged to use. However, residents may opt out of the organics collection if they have an approved backyard composting operation.

The collection services are provided on the same day to each residence or apartment building. Garbage and organics are collected every week while recyclables are collected every other week.

2.3.2 Recyclables Collection

In Seattle, the placement of recyclable paper, cardboard, glass and plastic bottles, and aluminum and tin cans in garbage containers is banned by city ordinance. As a result, the SPU provides recyclables collection services to the residents and businesses in Seattle through its two franchise contract haulers.

Single-family residents can utilize either 64- or 96-gallon rollout containers, which are provided free of charge, for the collection of their recyclables. Residents are instructed to place recyclables commingled into the container, which is collected on an every-other-week basis at the curb.

The SPU specifies what discarded products and materials can be placed in the recycling cart, which are listed in Table 2-1. In this regard, it is noteworthy that a number of items are not considered recyclable and therefore cannot be placed in the recycling cart for collection.

TABLE 2-1
Seattle's Residential Source-Separation Recyclables Collection Service
Items and Materials Collected in the Recycling Cart

Acceptable Items and Materials	Not Acceptable
<ul style="list-style-type: none"> Aluminum foil and food trays Plastic plant pots Plastic bags (bagged together) Plastic bottles, jars and tubs Pill bottles (no prescription vials) Glass bottles and jars Lids wider than 3 inches Metal cans Paper (dry) Plastic trays, cup, containers Cardboard (unwaxed, flattened) Scrap metal (less than 2 ft. x 2 ft. x 2 ft.) 	<ul style="list-style-type: none"> Used motor oil (in 1-gallon, sealed containers) Drinking glasses Empty gasoline cans Window pane glass Foil pouches Blister packs Egg cartons (foam) Keys Motor oil containers Used oil filters Packing peanuts Prescription drug containers

2.3.3 Organics Collection

Yard wastes are banned from disposal in MSW landfills in the state of Washington.

SPU provides single-family residents with a weekly collection service for organics.⁷ Residents can choose a different-size wheeled cart (13-, 32- or 96-gallon) to participate in this service. Either container is provided free of charge as a part of the collection service. Residents are not provided with an in-house organics container.

SPU charges single-family residents for the organics collection service with rates varying by size of container (see Table 2-2). All single-family residents must subscribe to the service, unless they compost their food waste in an approved, backyard compost system.

TABLE 2-2
Seattle's Food and Yard Waste Collection Service
Monthly Rates for Single-Family Residents

Service Level (weekly)	Curb or Alley (per month)	Weight Limit	Dimensions
13-gallon (mini-can)	\$4.95	20 pounds	11"W x 12"D x 27"H
32-gallon	\$7.45	60 pounds	21"W x 23"D x 40"H
96-gallon	\$9.50	180 pounds	29"W x 34"D x 46"H
extra yard waste (per bundle)	\$4.75	60 pounds	4' x 2' x 2'

⁷ SPU increased the collection frequency for organics from single-family residences from bi-weekly to weekly in April 2009.

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The organics collection service includes the collection of meat, poultry, seafood, and bones as well as yard trimmings, food-soiled paper, and food scraps. However, kitty litter, diapers, oil, and grease are not accepted for collection in the organics container (see Table 2-3).

TABLE 2-3
Seattle's Residential Organics Collection Service
Items Collected in the Organics Cart

Acceptable Items and Materials	Not Acceptable
FOOD-SCRAPS <ul style="list-style-type: none"> ▪ Fruit and vegetables ▪ Bread, pasta, grains ▪ Eggshells, nutshells ▪ Coffee grounds, filters ▪ Tea bags ▪ Meat, fish, and chicken ▪ Dairy products - milk, butter, cheese ▪ Shells and bones 	<ul style="list-style-type: none"> ▪ Biodegradable containers (unless approved by the City's compost contractor) ▪ Styrofoam containers ▪ Dirty coated paper cups, and plates. Clean ones can be recycled ▪ Disposable utensils ▪ Grease and fats in lidded container ▪ Facial or toilet tissue ▪ Diapers ▪ Pet waste and litter
FOOD-SOILED PAPER <ul style="list-style-type: none"> ▪ Paper towels, napkins - kitchen only ▪ Paper plates - uncoated only ▪ Food-soiled newspaper ▪ Greasy pizza boxes ▪ Shredded paper ▪ Paper bags (uncoated) with food scraps ▪ Compostable bags ▪ Approved compostable tableware 	
YARD WASTE <ul style="list-style-type: none"> ▪ Plant material ▪ Grass ▪ Leaves, branches, twigs - up to 4 inches in diameter and 4 feet in length ▪ Plant and tree trimmings ▪ House plants - no pots ▪ Small amounts of sod - less than 60 pounds ▪ Holiday trees - no tinsel, ornaments, no longer than 6 feet long and 4 inches in diameter ▪ Bundles up to 4 feet long and 2 feet in diameter, tied with natural twine 	

Residents are prohibited from using plastic bags to contain organic discards but can use compostable bags. SPU acknowledges that odors and flies are potential problems associated with the organics collection service. The following guidelines have been issued to help residents to address these issues:

- Use old newspaper to line carts and kitchen containers and/or wrap food scraps in newspaper or paper towels.

- To reduce odors, sprinkle baking soda in the kitchen container, and food and yard waste cart.
- Wash kitchen containers thoroughly with detergent and water after every use.
- Use a vacuum cleaner to remove fruit flies.
- Put melon scraps immediately into the organics cart and cover the cart.
- Rub vinegar around the rim of kitchen containers.
- Cover food scraps in the organics cart with yard waste, shredded paper, or damp newspaper.
- Take the organics cart out to the curb each week even if it is not full.

2.3.4 Garbage Collection

All single-family residents are required to subscribe to a weekly collection service for garbage.

Residents can choose a can (12- or 20-gallon) or wheeled cart (32-, 64- or 96-gallon) to participate in this service. The can or roll-out container is provided as a part of the collection service.

Residents are allowed to place wastes that are not collected in the recycling or organics carts into the garbage container, including diapers, feminine hygiene products, cat litter and animal feces, clothing, linens, rags, and plastic items (i.e., wrappers and films) not targeted for recycling (see Table 2-4).

TABLE 2-4 Seattle's Residential Garbage Collection Service Items and Materials Collected in the Garbage Cart	
Acceptable Items and Materials	Not Acceptable
<ul style="list-style-type: none"> ▪ Styrofoam containers ▪ Dirty coated paper cups and plates. Clean ones can be recycled ▪ Disposable utensils ▪ Grease and fats in lidded container ▪ Facial or toilet tissue ▪ Diapers ▪ Pet waste and litter ▪ Household trash/litter ▪ Hoses ▪ Garden tools ▪ Bundles tied with wire, nylon cording, or plastic banding ▪ Loose soil ▪ Rocks/gravel ▪ Biodegradable containers unless marked "Approved" by City's compost facility contractor 	<ul style="list-style-type: none"> ▪ Syringes and other sharps ▪ Painted or treated wood ▪ Ducts ▪ Small appliances ▪ Microwave ovens ▪ Bulky wastes ▪ Large appliances ▪ Bed frames ▪ Electronics ▪ Computers/laptops ▪ Monitors ▪ Copiers/fax machines

SPU charges residents for the garbage collection service on a volume-based fee schedule (see Table 2-5). The revenues received for this service are used to pay for both the waste collection and the recyclables collection services.

Service Level (weekly)	Curb or Alley (per month)	Backyard (per month)	Weight Limit	Dimensions
micro-can (12-gallon)	\$18.65	not available	20 pounds	18"W x 15"D x 13"H
mini-can (20-gallon)	\$22.90	not available	30 pounds	15"W x 16"D x 21"H
one can (32-gallon)	\$29.80	\$41.70	60 pounds	24"W x 33"H
one 64-gallon cart	\$59.60	\$83.45	120 pounds	27"W x 29"D x 41"H
one 96-gallon cart	\$89.40	\$125.15	180 pounds	29"W x 34"D x 46"H

It is important to note that there are some items (such as discarded electronics or painted wood) that are not accepted in the garbage container. Residents are encouraged to drop these items off at one of the City's transfer stations or to have them collected at the curb. Both of these options involve additional fees.

2.3.5 Bulky Waste Collection

SPU does not provide a regularly scheduled bulky waste collection services but offers single-family residents the option of scheduling a curbside collection service for bulky waste items on an as-needed basis. The following items are collected as part of the bulky waste service:

- Appliances, refrigerators, freezers, stoves, dishwashers, dryers, trash compactors, air conditioners, and washing machines.
- Beds (box springs and mattresses).
- Furniture, dressers, cabinets, tables, chairs, and sofas.

SPU charges a fee of \$30 per item for this service.⁸ Residents can also drop their bulky waste off at one of SPU's two transfer stations for a fee of \$30 per appliance or \$30 per trip for other bulky wastes.

⁸SPU charges \$38 for refrigerators containing CFCs.

2.3.6 Electronics Collection

SPU provides single-family residents with an option to request the curbside collection of electronics waste (such as computers, monitors, and televisions) on an as-needed basis. SPU charges a fee of \$20 per pickup for this service.⁹

Residents can also drop their bulky waste off at one of SPU's two transfer stations for a fee of \$30 per appliance or \$30 per trip for other bulky wastes.

2.3.7 What's Not Collected Curbside

Based on an analysis of the items that are allowed to be placed in one of the three bins or set out for bulky waste or electronics collection, it appears that the following items are not collected at the curb by any of the services.

- Oil-based paint, paint thinners, and stains.
- Florescent light bulbs and tubes.
- Household cleaning products.
- Lawn and garden products.
- Propane and butane tanks.
- Antifreeze and other automotive products.
- Needles and syringes.
- Pool and spa supplies.
- Solvents.

Residents are encouraged to drop off these items free of charge at one of SPU's two household hazardous waste drop-off locations.¹⁰

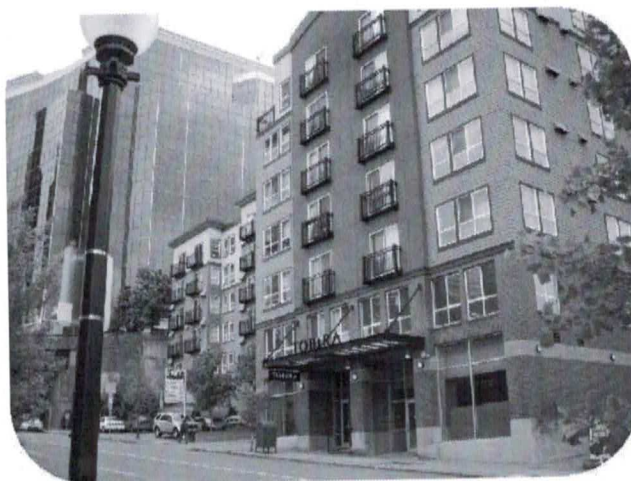
2.4 Multi-Family Collection Services

2.4.1 Introduction

About 45 percent of Seattle's population of 634,535 residents live in multi-family apartment buildings. The 132,840 apartment units contained in the approximately 6,000-multi-family buildings equate to about 22 units per building. As described above, multi-family buildings are defined by SPU as buildings which contain more than four apartment units and utilize dumpsters for garbage collection.

⁹Three items and 60-pound limit.

¹⁰Residents can also use one of King County's household hazardous waste drop-off sites or mobile service.



*Figure 2-2. Seattle Multi-Family Building
Source: Seattle Solid Waste Plan - 2011 Revision*

2.4.2 Recyclables Collection

Multi-family building managers can utilize 1-, 1.5- or 2-CY dumpsters or either 64- or 96-gallon rollout containers, which are provided free of charge, for the collection of recyclables from their residents. Residents are instructed to place recyclables commingled into the rollout containers, which is collected on an every-other-week basis at the curb. Recycling dumpsters used in larger buildings are collected once per week. SPU does not charge multi-family building managers for the recyclables collection service.

2.4.3 Organics Collection

Seattle apartment and condominium properties of five or more units are required by law to provide a food waste collection cart for residents to use. As a result, SPU provides organics collection services to multi-family buildings in Seattle through its two franchise contract service providers.

The same rules that are described above for single-family residents for recycling organics apply to multi-family residents. Of particular importance in this regard is the prohibition against the use of plastic bags to contain the food wastes.



Figure 2-3. Organics Collection Containers at a Multi-Family Building in Seattle
(Source: Seattle Solid Waste Plan - 2011 Revision)

SPU offers two multi-family building service options:

- Curb/Alley Weekly Service – Carts must be set out weekly at the curb or alley by 7:00 a.m. and retrieved after collection. This is the most economical option.
- On-Site Service – Collectors access and empty the carts wherever they are located and at the desired collection frequency. Weekly collection is the most common option.

SPU has developed guidelines for the cart sizes and collection frequencies that are likely to be needed by apartment buildings of different sizes (see Table 2-6).¹¹ The monthly rates charged by SPU for organics collection from multi-family buildings are presented in Table 2-7. In this regard, it should be noted that all carts include compostable liners for carts used primarily for food waste and that the service provider driver is required to insert a fresh liner in each cart after the cart is tipped.

TABLE 2-6 Recommended Organics Cart Sizes for Apartment Buildings*	
Size of Building	Recommended Cart Size
5 - 20 units	32 gallon (60 lb. weight limit)
20 - 40 units	64 gallon * (120 lb. weight limit)
40 - 100 units	96 gallon ** (180 lb. weight limit)
100 or more units	Add an additional 96 gallon cart **
*Larger cart sizes are recommended if apartment building owners have yard waste.	

¹¹These guidelines are based on the monitoring of 40 properties over a year's timeframe.