

# Broward County 2023 Waste Generation Study Final Report

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# 1 EXECUTIVE SUMMARY

## 1.1 BACKGROUND

Broward County (County) together with 30 of its 31 municipalities created the Solid Waste Working Group (SWWG) in 2019 to explore recycling opportunities and provide long-term and sustainable solid waste solutions. As a result, an interlocal agreement (ILA) creating the Solid Waste and Recyclable Materials Processing Authority of Broward County, Florida (Authority) was presented to all municipalities in the County in the Summer of 2023. Twenty-eight municipalities and the County signed on to the ILA and agreed to participate in the Authority.

The infrastructure and programs necessary for the Authority to manage solid waste in the County are directly correlated with the quantity of waste generated. Special assessments, sometimes referred to as non-ad valorem assessments, are a local government revenue source that can be used to fund all or a portion of the Authority’s costs. Unlike ad valorem taxes which are based on property value, non-ad valorem assessments are based on the level of service and/or impact to the solid waste management system. The amount levied to recover these costs is apportioned among the assessed properties in accordance with the benefits provided. Larger waste generators are assessed higher fees and conversely, lower generators are assessed lower fees.

To have an equitable and defensible non-ad valorem assessment program in Florida, there must be a fair and reasonable apportionment of the Authority’s system costs among the benefiting properties who receive the solid waste services. To this end, the SWWG contracted with SCS Engineers (SCS) to perform a waste generation study to estimate the amount of waste disposed of by residential and commercial properties in the County annually.

## 1.2 PROJECT METHODOLOGY

The Broward County Property Appraiser (BCPA) database uses 100 different Use Codes to describe the types of activity that occur on residential and commercial properties. Use Codes for residential properties were combined into two Residential Use Code Groups: Single-family homes and Multi-family housing. Waste quantities generated by Single-family homes were estimated from hauler reports submitted to municipalities for a recent yearlong timeframe. Municipalities that provided annual waste quantity reports for this project include:

- City of Hallandale Beach
- City of Fort Lauderdale
- City of Margate
- Town of Southwest Ranches
- Unincorporated Broward County
- City of Weston

Waste generated by multi-family housing (apartments and condominiums) and commercial businesses is typically aggregated in dumpsters and collected by front-load collection vehicles. To measure waste quantities disposed by these entities, SCS coordinated the purchase and installation of four on-board scales on front-load waste collection vehicles operated by three waste collection haulers. Waste quantities were measured in the following four jurisdictions:

- Town of Davie
- City of Miramar
- City of Oakland Park
- City of Pompano Beach

SCS staff rode waste collection vehicles over the span of seven weeks (35 days) and recorded waste quantities measured by the on-board scale system during normal collection routes selected by the hauler. The customers were then matched to parcels in the BCPA database to identify the parcel's Use Code (i.e., multi-family housing or type of business activity such as retail store, office building, restaurant, etc.) and Total Living Area (TLA), which reflects the building floor space in square feet.

Use Codes for commercial properties were combined into 16 Commercial Use Code Groups which are anticipated to have similar waste generation patterns based on SCS's prior experiences with such studies. The Commercial Use Code Groups are detailed in Section 3.1.2 of this report and include:

- Retail-1 (Single-Story Store)
- Retail-2 (Shopping Center)
- Office
- Transportation
- Eating & Drinking
- Auto Service/Sales/Repair
- Entertainment (Indoor)
- Entertainment (Outdoor)
- Hotel/ Motel
- Manufacturing/ Warehouse
- Agriculture
- Church
- Education
- Medical
- Other
- Parking & Mobile Homes

In some cases the hauler customer was easily matched to a parcel. In other cases, the matching process was more complex. Some parcels include multiple hauler customers; hence the waste quantities from multiple customers were combined to reflect the waste generated by a single parcel. In other cases, SCS was only able to record the weight of a single hauler customer on a parcel that had multiple customers; hence the building floor space (TLA) was adjusted to reflect the portion of the property that generated the waste measured.

Waste quantity measured for each parcel were then divided by the TLA to derive pounds generated per square foot per week, then multiplied by 52.14 (weeks per year) to reflect an annual waste generation rate. The waste generation rates were then averaged per Use Code Group.

## 1.3 PROJECT RESULTS

### 1.3.1 Residential Properties

The single-family residential waste generation rate is estimated to be 1.3 tons per home per year. It should be noted that yard trimmings, bulky wastes, and recycling quantities were excluded from the single-family residential waste generation rate. This rate is in the range of uniform residential waste generation rates for single-family houses seen in other jurisdictions.

Residential special assessments in other U.S. communities typically charge a uniform fee per single-family house regardless of the home size. Assuming the average home size in Broward County is about 2,300 square feet, the waste generation rate can also be expressed as 1.1 pounds/square foot/year for the average home<sup>1</sup>. The conversion to 1.1 pounds/square foot/year is presented for comparison to other waste generation rates derived from the field study. SCS recommends a uniform fee for all single-family houses regardless of size.

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<sup>1</sup> Converting the uniform waste generation rate per single-family house involves the following equation: 1.3 tons/single-family house X 2000 pounds/ton ÷ 2300 square feet/average single-family house.

The multi-family housing waste generation rate is estimated to be 0.9 pounds/square foot/year. This was derived from measured waste quantities at 49 residential condominium complexes which included collection points (one or more dumpsters) serving 8,955 dwelling units. Special assessments for multi-family housing can be based on the size of an individual dwelling in the case of condominiums, or the size of the entire multi-family complex in the case of apartments.

Table 1. Summary of Commercial Waste Generation Rates

Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Single-Family Houses *	78,778	1.1	NA	NA
Multi-Family Housing	8,955	0.9	0.8	1.1
<b>Total Residential</b>	<b>87,733</b>			

\* Note: The waste generation rate for Single-Family Houses was estimated to be 3.1 tons per house per year. This converts to 1.1 pounds/square foot/year for a 2,300 square foot house and is presented for comparison purposes.

### 1.3.2 Commercial Properties

Table 2 presents a summary of commercial waste generation rates by Commercial Use Code Group along with the 80 percent confidence interval, which is a measure of precision. It should be noted that the routes selected by the waste collection hauler did not include properties in the Transportation Use Code Group. Also, there was only one property measured in the Parking and Mobile Home Use Code Group.

Table 2. Summary of Commercial Waste Generation Rates

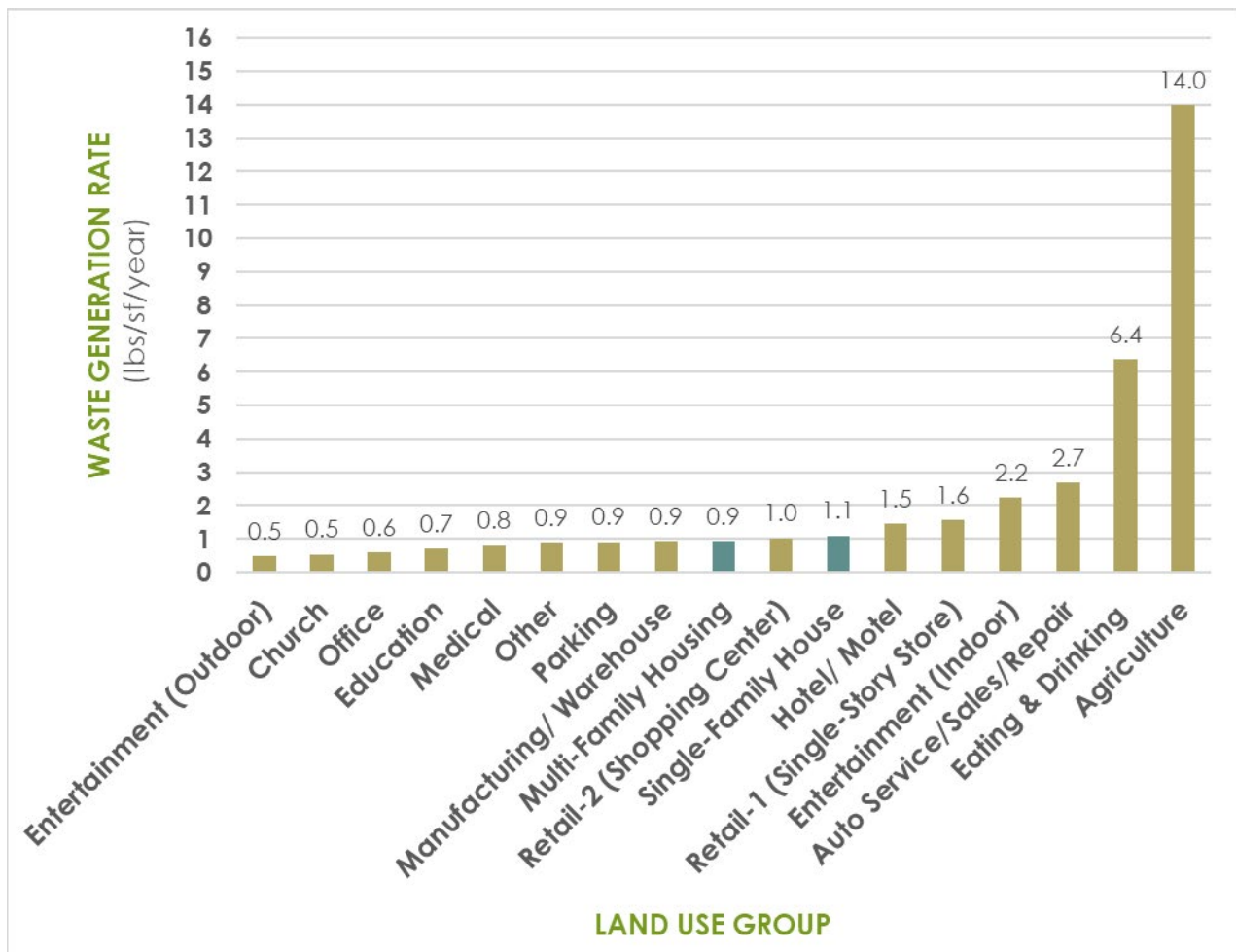
Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Entertainment (Outdoor)	11	0.5	0.2	1.0
Church	24	0.5	0.4	0.8
Office	145	0.6	0.5	0.7
Education	51	0.7	0.5	0.9
Medical	15	0.8	0.6	1.2
Other	31	0.9	0.6	1.3
Parking & Mobile Homes	1	0.9	NA	NA
Manufacturing/ Warehouse	450	0.9	0.8	1.0
Retail-2 (Shopping Center)	57	1.0	0.8	1.3
Hotel/ Motel	10	1.5	1.2	1.7
Retail-1 (Single-Story Store)	142	1.6	1.3	1.8
Entertainment (Indoor)	13	2.2	1.6	3.2
Auto Service/Sales/Repair	100	2.7	2.1	3.3
Eating & Drinking	134	6.4	5.5	7.5

Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Agriculture	15	14.0	8.7	21.9
<b>Total Commercial</b>	<b>1,199</b>			

### 1.3.3 Comparison of Residential and Commercial Waste Generation Rates

Exhibit 1 presents the waste generation rates for 15 of the 16 commercial Use Code Groups. It should be noted that the routes selected by the waste collection hauler did not include properties in the Transportation Use Code Group.

Exhibit 1. Waste Generation Rates for Residential and Commercial Use Code Groups



## 2 BACKGROUND

### 2.1 PURPOSE OF THIS STUDY

Broward County (County) together with 30 of its 31 municipalities created the Solid Waste Working Group (SWWG) in 2019 to explore recycling opportunities and provide long-term and sustainable solid waste solutions. As a result, an interlocal agreement (ILA) creating the Solid Waste and Recyclable Materials Processing Authority of Broward County, Florida (Authority) was presented to all municipalities in the County in the Summer of 2023. Twenty-eight municipalities and the County signed on to the ILA and agreed to participate in the Authority.

The infrastructure and programs necessary for the Authority to manage solid waste in the County are directly correlated with the quantity of waste generated. Special assessments, sometimes referred to as non-ad valorem assessments, are a local government revenue source that can be used to fund all or a portion of the Authority's costs. Unlike ad valorem taxes which are based on property value, non-ad valorem assessments are based on the level of service and/or impact to the solid waste management system. The amount levied to recover these costs is apportioned among the assessed properties in accordance with the benefits provided. Larger waste generators are assessed higher fees and conversely, lower generators are assessed lower fees.

To have an equitable and defensible non-ad valorem assessment program in Florida, there must be a fair and reasonable apportionment of the Authority's system costs among the benefiting properties who receive the solid waste services. To this end, the SWWG contracted with SCS Engineers (SCS) to perform a waste generation study to estimate the amount of waste disposed of by residential and commercial properties in the County annually.

### 2.2 WASTE GENERATION AND ASSESSMENT PROGRAMS

The infrastructure and programs necessary for the Authority to manage solid waste in the County are directly correlated with the quantity of waste generated. Hence, costs for the solid waste management system are distributed proportionately to the individual generators based on their impact to the system. Larger waste generators are assessed higher fees and conversely, lower generators are assessed lower fees.

Waste generation rates for single-family homes are typically based on the quantity of waste generated by the average home rather than by the square footage of the home. Accordingly, the SCS derived waste generation rates for single-family houses using information supplied by the hauler to each of the seven reporting municipalities. The annual waste quantities reported for each municipality were divided by the number of single-family homes serviced to derive an average waste quantity generated per home. Sometimes solid waste assessment programs adjust the waste generation rates applied to townhomes, duplexes, and mobile homes to reflect smaller home sizes and hence less waste generated annually.

Waste from multi-family housing is typically collected on commercial hauler routes because both multi-family housing and commercial businesses aggregate their waste in dumpsters. Dumpsters are serviced by haulers using a front-load collection vehicle that has forks capable of lifting the dumpster and emptying its contents into the truck's hopper. Commercial waste generation is highly variable based on the type of business activity and the size of the building. For this reason, developing waste generation rates for commercial properties was based on the following steps:



1. **Define Waste Generators** - To allocate solid waste system costs in an equitable manner, property types are grouped into separate waste-generating business activity such as office, retail, restaurants, and others.
2. **Field Testing** –Waste generated by commercial properties varies significantly by the type of business activity, size of the operation (e.g., building size), seasonal changes, and other geographic influences such as climate, population demographics, and tourism to name a few. For this reason, it is important to measure actual waste generated by various property types in each community to develop waste generation rates specific to that community.
3. **Coordination with the BCPA Database** - The building use classifications maintained by property appraisers are specific to individual jurisdictions within the County. While there are some common property uses among varying jurisdictions, each jurisdiction is unique in the way they classify properties. Property appraisers establish the building classification coding systems in each county in Florida. Commercial waste generation rates should correlate with the land use codes utilized by the property appraiser in that county. Additionally, the property appraiser maintains information about the building size which is used to develop waste generation rates.
4. **Develop Waste Generation Rates For Each Measured Property** – The waste generation rate for individual properties included in the field testing is based on the waste quantity measured during field testing, the property’s use code (i.e., an indicator of the type of waste generating activity), and the size of property’s building (e.g., total living area). These metrics are used to develop a waste generation rate for each individual property.
5. **Develop Countywide Waste Generation Rates by Use Code Group** – The waste generation rates for each property are then combined into broader use code groupings that correlate with the land uses in the BCPA database. A statistical analysis is conducted to derive the mean waste generation rate and 80 percent confidence limits for each Use Code Group.
6. **Establish Waste Generator Categories** – Once waste generation rates are established for each Use Code Groups, the groups are then placed in waste generator categories, typically low, medium, and high for the purposes of assigning a solid waste fee. Assigning Use Code Groups to waste generator categories is beyond the scope of this study; however, the waste generation rates presented herein can be incorporated into the development of a solid waste assessment program.

## 2.2.1 Equity and Administrative Effort

The degree of equity is related to the level of administrative effort needed to maintain the solid waste assessment program. In general, the more detailed the classifications of waste generators, especially for commercial properties, the greater the administrative requirements, but the greater the equality. If, for example, all commercial properties were assessed on the basis of what they individually generated, the system would require a separate classification for each property and a high level of administrative effort to maintain. However, if the commercial properties were grouped into broader generation categories, maintenance would be less onerous, but equality would be less than an assessment on an individual generation basis. Hence, communities using waste generation rates as a basis for a solid waste assessment typically group generators into broader categories.

## 2.2.2 Appeals Process

It is important to note that solid waste assessments are based on groupings of generators with similar waste generating activity (e.g., offices, retail, restaurants). As described above and presented later in this report, there is still a high degree of variability within the generator category groupings. Individual waste generators may operate differently and hence generate lower quantities of waste than other similar businesses. For this reason, an appeals process can be used to reduce the solid waste fee assessed to commercial properties that generate less waste.

Waste assessment programs typically have an appeal process. Most programs have established an informal process whereby a Board-designated individual is established as the hearing officer for appeals. Like most public appeals processes, if satisfaction is not obtained at the first level of appeal, the next level could be by the Board of County Commissioners and, thereafter, whatever legal course of action is available.

## 3 PROJECT METHODOLOGY

### 3.1 STUDY DESIGN

#### 3.1.1 Overview

The Waste Generation Study for the County examined waste generation for residential and commercial properties. The waste generation rate for single-family houses was calculated based on disposal records from the following communities that reported this information:

- **City of Hallandale Beach** – 3,513 single-family homes
- **City of Fort Lauderdale** – 39,027 single-family homes
- **City of Margate** – 13,052 single-family homes
- **Town of Southwest Ranches** – 2,540 single-family homes
- **Unincorporated Broward County** – 4,335 single-family homes
- **City of Weston** – 16,311 single-family homes

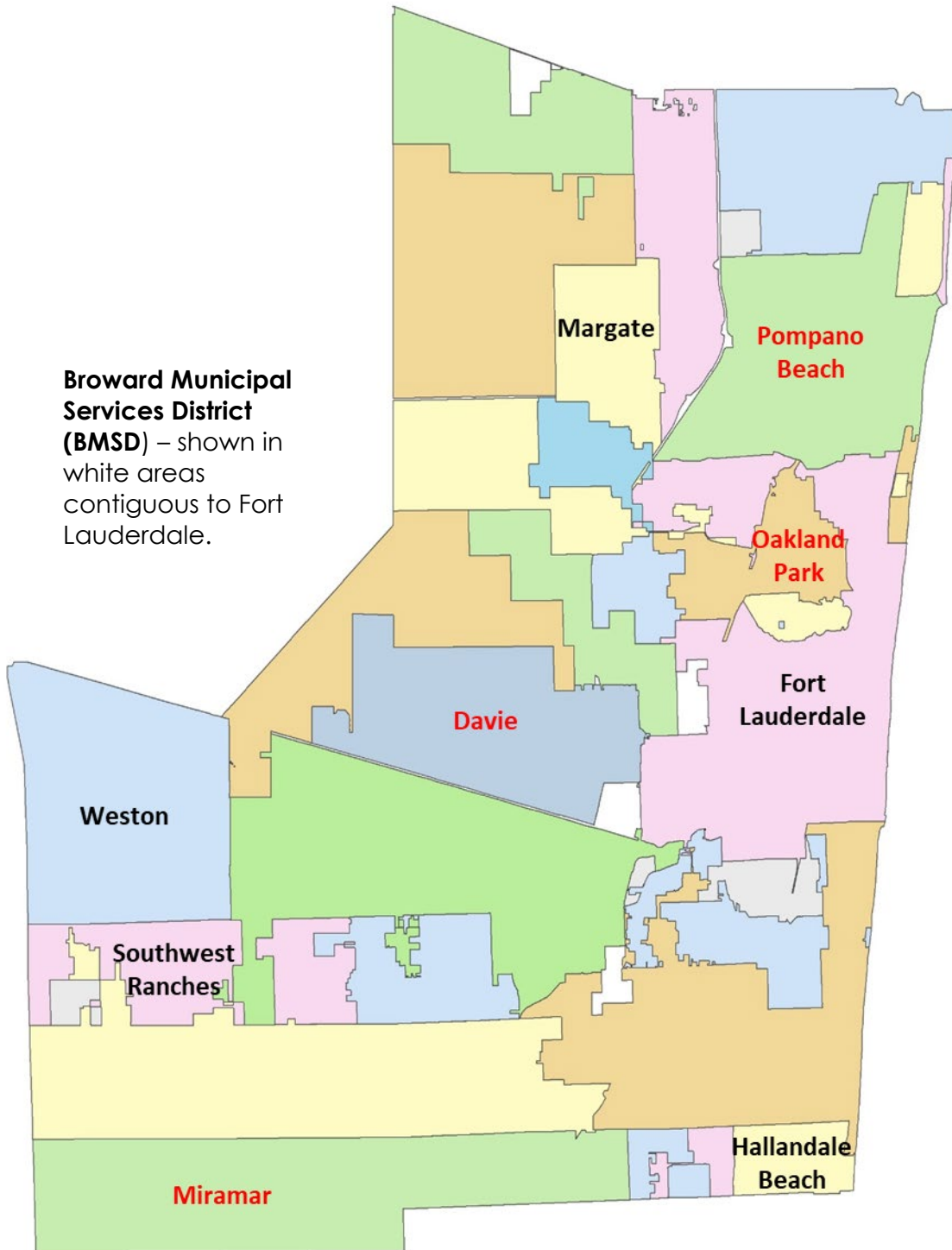
A field study was conducted to measure the waste generated by commercial properties and multi-family housing with assistance of waste collection haulers in four of the County's municipalities:

- **Town of Davie** is centrally located in the County, has a population of approximately 106,000 residents, a median annual household income of approximately \$84,000, and includes suburban and rural areas with significant agricultural and farming land.
- **City of Miramar** is located in the southwest corner of the County, has a population of approximately 137,000 residents, a median annual household income of approximately \$81,000 and is mostly suburban.
- **City of Oakland Park** is north of Fort Lauderdale, has a population of approximately 44,000 residents, a median annual household income of approximately \$65,000, and is mostly suburban.
- **City of Pompano Beach** is located in the northeast region of the County bordering the Atlantic Ocean, has a population of approximately 112,000 residents, a median annual household income of approximately \$61,000, and is mostly suburban with coastal elements.

In planning the field study, participating waste collection haulers agreed to provide a listing of commercial customers for one route in each selected municipality. The hauler in Davie provided a listing of four routes which contributed significantly to the amount of data collected for most of the Use Code Groups. The waste collection haulers' customers on the selected routes were matched to a parcel in the BCPA database to define the Use Code and Total Living Area (TLA), which reflects the building floor space in square feet. Together with the waste collection quantities recorded, the Use Code and TLA were used to calculate the waste generation rate (i.e., pounds of waste generated per square foot of building space per year) for each Use Code Group.

**Exhibit 2** presents a map identifying the municipalities that provided residential waste collection information and the municipalities where waste quantities were measured at select commercial properties.

Exhibit 2. Map of Participating Municipalities



**Note:** Municipalities in black text provided residential waste collection information. Municipalities in red text were included in the commercial waste field study.

### 3.1.2 Development of Use Code Groups

The BCPA database uses 100 different Use Codes to describe the types of activity that occur on parcels in the County. Each property is defined by a single Use Code. As presented in **Table 3**, the residential Use Codes were combined into three Use Code Groups. **Table 4** presents the 16 commercial Use Code Groups which are anticipated to have similar waste generation patterns based on our prior experiences with such studies.

Table 3. Description of Residential Use Code Groups

Residential Use Code Group	Number of Properties in BCPA Database	Use Codes Included
Single-Family Houses	390,464	01 - Single family
Multi-Family Housing	287,851	02 - Manufactured Housing 03 - Multi-family – 10 units or more 04 - Condominium 05 - Cooperatives 07 - Miscellaneous residential (migrant camp, boarding homes, etc.) 08 - Multi-family – less than 10 units
<b>Total Residential</b>	<b>678,315</b>	

Table 4. Description of Commercial Use Code Groups

Commercial Use Code Group	Number of Properties in BCPA Database	Use Codes Included
Retail-1 (Single-Story Store)	3,226	11 - Stores, 1-story
Retail-2 (Shopping Center)	1,840	12 - Mixed use (store and office or store and residential or residential combo) 13 - Department stores 14 - Supermarkets 15 - Regional shopping centers 16 - Community shopping centers
Office	6,704	17 - Office buildings, non-professional services buildings, one-story 18 - Office buildings, non-professional services buildings, multi-story 19 - Professional services building 23 - Financial institutions (banks, savings & loan companies, mortgage companies, credit services)
Transportation	329	20 - Airports (private or commercial), bus terminals, marine terminals, piers, marinas
Eating & Drinking	930	21 - Restaurants, cafeterias 22 - Drive-in restaurants

Commercial Use Code Group	Number of Properties in BCPA Database	Use Codes Included
Auto Service/ Sales/Repair	1,474	26 - Service stations 27 - Auto sales, repair and storage, auto-service shops, body and fender shops, commercial garages, farm and machinery sales and services, auto rental, marine equipment, mobile home sales, motorcycles, construction vehicle sales
Entertainment (Indoor)	249	32 - Enclosed theatres, enclosed auditoriums 33 - Nightclubs, cocktail lounges, bars, yacht clubs, social clubs, tennis clubs, clubhouses 34 - Bowling alleys, skating rinks, pool halls, enclosed arenas 77 - Clubs, lodges, union halls 79 - Cultural organizations, facilities
Entertainment (Outdoor)	1,709	31 - Drive-in theatres, open stadiums 35 - Tourist attractions, permanent exhibits, other entertainment facilities, fairgrounds 37 - Race tracks, horse, auto or dog 38 - Golf courses, driving ranges 82 - Forests, parks, recreational areas 97 - Outdoor recreational or park land subject to classified use assessment
Hotel/ Motel	2,830	39 - Hotels, motels
Manufacturing/ Warehouse	9,163	29 - Wholesale outlets, produce houses, manufacturing outlets 41 - Light manufacturing, small equipment manufacturing plants, small machine shops, instrument manufacturing, printing plants 43 - Lumber yards, sawmills, planing mills 44 - Packing plants, fruit & vegetable packing plants, meat packing plants 48 - Warehousing, distribution terminals, trucking terminals, van & storage warehousing 49 - Open storage, new & used bldg. supplies, junk yards, auto wrecking, fuel storage, equipment & materials storage 91 - Utility, gas & electricity, telephone & telegraph, locally assessed railroads, water & sewer service, pipelines, canals, radio/television communication
Agriculture	1,124	30 - Florist, greenhouses 52 - Cropland soil capability class II 63 - Grazing land soil capability class IV 66 - Orchard groves, citrus, etc. 67 - Poultry, bees, tropical fish, rabbits, etc. 69 - Ornamentals, miscellaneous agriculture
Church	968	71 - Churches
Education	678	72 - Private schools and colleges 83 - Public county schools – includes all property of board of public instruction 84 - Colleges
Medical	332	73 - Privately owned hospitals 74 - Homes for the aged 75 - Orphanages, other non-profit or charitable services 78 - Sanitariums, convalescent & rest homes 85 - Hospitals

Commercial Use Code Group	Number of Properties in BCPA Database	Use Codes Included
Other	779	76 - Mortuaries, cemeteries, crematoriums 86 - Counties (other than public schools, colleges, hospitals) including non-municipal 87 - State other than military, forests, parks, recreational areas, colleges, hospitals 88 - Federal other than military, forests, parks, recreational areas, hospitals, colleges 89 - Municipal other than parks, recreational areas, colleges, hospitals
Parking & Mobile Homes	4,529	28 - Parking lots (commercial or patron), mobile home parks
<b>Total Commercial</b>	<b>36,864</b>	

Use Codes omitted from the Use Code Groups because there were no properties assigned in the BCPA database include:

- 06 - Retirement homes (not eligible for exemption under section 196.192 F.S)
- 24 - Insurance company offices
- 25 - Repair service shops (excluding automotive), radio and TV repair, laundromats
- 36 - Camps
- 42 - Heavy industrial, heavy equipment manufacturing, large machine shops, foundries, etc.
- 45 - Canneries, fruit & vegetable, bottlers & brewers, distillers, wineries
- 46 - Other food processing, candy factories, bakeries, potato chip factories
- 47 - Mineral processing, phosphate processing, cement plants, refineries, clay plants, etc.
- 50 - Improved agricultural
- 51 - Cropland soil capability class I
- 53 - Cropland soil capability class III
- 54 - Timberland – site index 90 & above
- 55 - Timberland – site index 80-89
- 56 - Timberland – site index 70-79
- 57 - Timberland – site index 60-69
- 58 - Timberland – site index 50-59
- 59 - Timberland not classified by site index to pines
- 60 - Grazing land soil capability class I
- 61 - Grazing land soil capability class II
- 62 - Grazing land soil capability class III
- 64 - Grazing land soil capability class V
- 65 - Grazing land soil capability class VI
- 68 - Dairies, feed lots
- 82 - Forests, parks, recreational areas
- 90 - Leasehold interests (government owned property leased by a non-governmental lessee)
- 92 - Mining lands, petroleum lands, or gas lands

Use Codes omitted from the Use Code Groups because they are unlikely to generate waste include:

- 10 - Vacant commercial
- 40 - Vacant industrial
- 70 - Vacant institutional
- 80 - Vacant governmental
- 94 - Right-of-way, streets, roads, irrigation channel, ditch, etc.
- 95 - Rivers & lakes, submerged lands
- 96 - Sewage disposal, solid waste, borrow pits, drainage reservoirs, waste lands, marsh, etc.
- 98 - Centrally assessed
- 99 - Acreage not zoned agricultural

### 3.1.3 Selection of Waste Generators

It was initially envisioned that this project would: 1) establish sampling targets (the number of properties to be sampled) for each of the Use Code Groups and 2) multiple waste collection haulers would provide listings of their customers so that specified geographic areas and generators could be targeted. However, waste collection haulers are understandably protective of their customer lists and consider this to be proprietary information. Instead of sharing the entirety of their customer list, the waste collection haulers that agreed to participate in this study worked collaboratively with SCS to select routes that included businesses from most of the Use Code Groups for the audit.

SCS shared the Use Code Groups with the waste collection haulers and asked that the route(s) selected for this study include as many Use Code Groups as possible. Rather than establish sample sizes for each Use Code Group prior to the field study, the Use Groups were established, and the number of properties measured by Use Code Group was dependent on the route selected by the waste collection hauler.

Support requested from the waste collection haulers included provision of customer information serviced on the selected routes and allowance for an SCS staff person to ride along in waste collection vehicles during normal collection activities. Customer information included the following:

- Customer name and address
- Number and size of waste collection containers
- Collection frequency (i.e., number of collections per week)
- Collection days of the week

In addition, the waste collection haulers used waste collection vehicles with calibrated on-board scales to service the selected routes, which enabled SCS to record the weight of each collection event.

To minimize disruption to each hauler's operations, SCS collected waste quantity information during regularly scheduled routes. As a result, some Use Code Groups were oversampled, and some Use Code Groups were under sampled. A statistical analysis incorporated the varying sample sizes into the development of the waste generation rates, which is discussed further in Section 4 of this report.

### 3.1.4 Sampling Schedule

Sampling occurred over multiple time periods between November 2022 and June 2023 to best accommodate each waste collection hauler's preferences, vehicle issues/repairs/maintenance, and scale issues and repairs. This allowed a broad spectrum of seasons to be represented in the data collected for this study. Field sampling during the following timeframes:



- Town of Davie – November 2022 through February 2023
- City of Miramar – February 2023
- City of Oakland Park – March 2023
- City of Pompano Beach – June 2023

In virtually all cases, samples from a route were obtained on one or more days during a week. For example, if SCS staff rode along on a selected route on a Monday and Tuesday, but the waste collection vehicle or scale broke on a Wednesday, we resumed the field study on a Wednesday after the waste collection vehicle or scale was repaired. Routes were not monitored on Saturdays, so businesses with a Saturday collection were pro-rated based on their waste generation patterns during the week.

**Exhibit 3** presents the schedule for waste collection vehicle scale installation, staff training, data collection, and scale and/or waste collection vehicle repairs and maintenance.

Exhibit 3. Field Study Schedule

Field Study Schedule	WEEKS																																			
	OCT '22				NOV '22				DEC '22				JAN '23				FEB '23				MAR '23				APR '24				MAY '24				JUN '23			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<b>Scale Installation</b>																																				
Install and Calibrate Truck Scales	█	█																																		
<b>Training</b>																																				
SCS Staff Training for Data Collection					█	█																														
<b>Truck Routes</b>																																				
Town of Davie Route 1																																				
Town of Davie Route 2																																				
Town of Davie Route 3																																				
Town of Davie Route 4																																				
City of Oakland Park Route																																				
City of Miramar Route																																				
City of Pompano Beach Route																																				

█ SCS riding route and collecting data  
 █ Truck/Scale Maintenance/Repairs

### 3.2 WASTE QUANTITY SAMPLING

SCS recommended the use of on-board waste collection vehicle scale systems to measure the quantities (i.e., weights) of waste generated by commercial properties and placed in dumpsters for disposal. On-board waste collection vehicle scale systems developed by Creative Microsystems and sold as “LoadMan” were procured and installed on four waste collection vehicles owned and operated by three different waste collection haulers operating in the Town of Davie and the Cities of Miramar, Pompano Beach, and Oakland Park.

Waste generated by commercial properties is often placed in dumpsters and collected by waste collection haulers using a front-load waste collection vehicle. A front-load collection vehicle utilizes forks in the front of the vehicle to hook into the sides of the dumpsters so that the dumpster can be picked up and loaded over the front cab into the hopper at the rear of the waste collection vehicle. After the waste



Front-load Waste Collection Vehicle Picking Up a Dumpster

contents are emptied, the forks lower the dumpster down to its original location.

LoadMan scales use a dynamic weigh-in-motion system for front-load waste collection vehicles. Specifically, the scale system measures the full weight of the dumpster during the lift and then measures the empty dumpster on the way down, and then subtracts the full weight from the empty weight to display the weight of the waste. The LoadMan scale system can accurately and precisely weigh dumpster contents without stopping, pausing or slowing down in the up motion or down motion. Hence, the vehicle drivers do not need to adjust their process.

A tablet connects to the on-board scale system through Bluetooth and provides the full dumpster weight, the empty dumpster weight, and the resulting weight of the waste.

SCS staff rode in the waste collection vehicles and recorded the weights of waste disposed by commercial properties during their regular collection schedule on selected routes. Commercial properties could have just one or several customers. One or more customers could share one or more dumpsters. Some customers are collected just once per week while others are collected six days per week. Haulers provided customer name, addresses, numbers of dumpsters, and waste collection schedule (days of the week waste is collected) for the selected routes only. SCS staff recorded the weight of each dumpster and confirmed the customer name and address during collection.



View of Tablet Indicating Scale is Ready to Weigh

At the end of each day, the recorded waste quantities were transmitted to the SCS Project Manager. The dumpster weights for each customer were aggregated for the week. Annual waste quantities were extrapolated from the weekly weights and then each customer was matched to a property in the BCPA database.

### 3.2.1 SCS Staff Training for Data Collection

The scale manufacturer of the Loadman on-board waste collection vehicle scales, Creative Microsystems, provided training on how to use the tablet provided with each scale to record the waste quantities for each dumpster serviced by the participating waste collection haulers. Training was also provided to representatives of each participating waste collection hauler.

### 3.3 VERIFICATION SURVEY

Using the waste collection hauler's routing information and customer lists, customers were matched to assessed property owners using physical addresses as well as Use Codes in the BCPA database to the extent possible. By matching the customer to the BCPA database, the Use Code and TLA were identified.

The participating waste collection haulers were the sole waste collection service providers in the jurisdictions targeted for this study. As such, this study avoided issues related to multiple waste collection haulers servicing customers within a single parcel (e.g., a shopping center where each tenant contracts separately for waste collection services and utilizes different waste collection haulers), which facilitated the matching process.

To verify the correct matching between waste collection hauler customer and parcel in the BCPA database, SCS utilized online resources such as GoogleMaps.com, the BCPA Interactive Map, individual business websites, and Geographic Information System (GIS) software. When online resources did not confirm proper matching, SCS staff conducted site visits to confirm the name of the business, assigned Use Code Group (i.e., type of business) and TLA.

However, in some cases it was not possible to match a particular customer with a particular assessed property due to physical address discrepancies or questionable dumpster usage (i.e., more than one business type contributing waste to a single dumpster); these properties were removed from the analysis.

### 3.4 DATA MANAGEMENT AND QA/QC PROCEDURES

Data acquired for this project was managed through several steps:

- **Waste Collection Hauler-Provided Route Sheets** – As stated above, SCS requested that each waste collection hauler identify a commercial waste collection route that included a wide variety of business types. SCS then scheduled a mutually-workable weeklong “ride-along” where SCS staff would ride in the waste collection vehicle to record the waste quantities measured by the on-board waste collection vehicle scale system for each dumpster serviced for each customer. To facilitate data recording, the waste collection haulers provided route sheets that identified the customers by business name, address, and service level (i.e., number/size of dumpsters and collection days). This information was converted into a spreadsheet format where the rider could record the weights for the expected number of dumpsters on the normal collection day.
- **Development of a Project Database** - Data recorded into daily spreadsheets was emailed to the SCS Project Manager at the end of the day. The SCS Project Manager transcribed the data into a master spreadsheet for the project. Data transcribed into the master spreadsheet was compared to the daily spreadsheet by an SCS staff member to confirm weights were associated with the correct customer.
- **Submission of Project Database to Statistician** - When data collection for each jurisdiction was completed, the updated Project Database was sent to Charles Davis, PhD, the Principal Statistician of EnviroStat, our subconsultant that has experience with analysis of data to support waste generation studies.
- **Matching Customers to Parcels** - EnviroStat and GIS System Specialists at SCS coordinated matching customers to parcels in the BCPA database. In some cases, multiple customers were combined into a single parcel. This was especially true for shopping centers that had multiple tenants. In other cases, especially with residential and commercial condominiums, multiple parcels used a single waste collection service. In these cases, the parcels were combined so that the total TLA reflected the waste quantity measured. As mentioned previously, multiple methods were used to confirm the use code and TLA measured properties.

## 4 PROJECT RESULTS

### 4.1 NUMBER OF PROPERTIES MEASURED

Customers were matched with the BCPA database to ascertain their assigned Use Code. These Use Codes and corresponding Use Code Group assignments were reexamined while preparing these final statistics. In total, the field study measured waste quantities at 49 multi-family housing complexes and 1,199 commercial properties that could be matched to parcels in the BCPA database. **Table 5** presents the final count of measured properties by Use Code Group and jurisdiction.

Table 5. Summary of Measured Properties by Use Code Group and Jurisdiction

Use Code Group	Number of Properties in BCPA Database	Number of Properties Measured				
		Davie	Miramar	Oakland Park	Pompano Beach	Total
<b>Residential Properties</b>						
Multi-Family Housing *	287,851	4,463	106	1,199	3,187	8,955
<b>Commercial Properties</b>						
Retail-1 (Single-Story Store)	3,226	77	8	40	17	142
Retail-2 (Shopping Center)	1,840	43	6	2	6	57
Office	6,704	73	33	23	16	145
Transportation	329	0	0	0	0	0
Eating & Drinking	930	88	11	24	11	134
Auto Service/Sales/Repair	1,474	67	4	18	11	100
Entertainment (Indoor)	249	8	0	3	2	13
Entertainment (Outdoor)	1,709	8	1	1	1	11
Hotel/ Motel	2,830	3	3	1	3	10
Manufacturing/Warehouse	9,163	112	107	77	154	450
Agriculture	1,124	14	0	1	0	15
Church	968	13	0	3	8	24
Education	678	42	2	3	4	51
Medical	332	12	1	1	1	15
Other	779	17	4	6	4	31
Parking & Mobile Homes	4,529	0	0	1	0	1
<b>Total Commercial</b>	<b>36,864</b>	<b>577</b>	<b>181</b>	<b>204</b>	<b>238</b>	<b>1,199</b>

\* Note: There were 8,955 residential condominium dwelling units (each a separate parcel in the BCPA database) that contributed to 49 condominium complexes where the quantity of waste disposed was measured. Waste quantities measured at each of the 49 condominium complexes were distributed evenly to the contributing dwelling units (parcels).

The most Use Code Groups are well represented in the sampling. Two Use Code Groups that were not sampled sufficiently include:

- **Transportation** – This Use Code Group includes private airports, bus terminals, marinas, and piers. These properties were not included in the selected waste collection hauler routes.
- **Parking & Mobile Homes** – This Use Code Group includes parking lots, parking garages and manufactured home parks, RV parks, and improvements not suitable for occupancy. There was only one large property in this Use Code Group measured during the field study. A closer examination of this property indicates it is a 54-acre parcel with significant building space and a large parking area. There are multiple customers on this parcel including a public library, cultural center, and an educational center. The entire parcel has a Use Code description of a parking garage. SCS derived a waste generation rate for this property and included it in **Table 8** in Section 4.2.2 for informational purposes.

Another consideration is that there are 4,529 properties with a Use Code of 28 (making it the third largest Use Code Group by number of properties) and yet only one property within this Use Code Group was included in our study. It is possible that the majority of parcels correctly coded as Parking and Mobile Homes do not receive waste collection because they do not generate waste.

## 4.2 WASTE GENERATION RATES

### 4.2.1 Residential

#### Single-Family Houses

**Table 6** presents a summary of annual waste quantities collected by six reporting jurisdictions along with the number of single-family homes to derive the residential waste generation rate. Note that the waste quantities excluded yard waste, recycling, or bulky wastes. The single-family residential waste generation rate is 1.3 tons per home per year.

Table 6. Residential Single-Family Waste Generation Rate

Jurisdiction	Number of Single-Family Homes	Median Annual Household Income	Annual Waste Tons from Single-Family Homes	Waste Generation Rate (Tons/Home/Year)
Hallandale Beach	3,513	\$45,000	6,632	1.9
Fort Lauderdale	39,027	\$75,000	49,012	1.3
Margate	13,052	\$74,000	15,580	1.2
Southwest Ranches	2,540	\$166,000	3,305	1.3
Broward Municipal Services District	4,335	NA	7,252	1.7
Weston	16,311	\$132,000	23,548	1.4
<b>Total</b>	<b>78,778</b>		<b>105,327</b>	<b>1.3</b>

SCS is aware of only a few waste generation studies with similar scope to this study from which to compare waste generation rates of single-family houses. The annual quantity of waste generated by single-family houses can vary significantly due to multiple factors including but not limited to:

- Number of people residing in each single-family house,

- Types and quantities of yard trash, precipitation, and length of growing season,
- Availability and use of curbside and drop-off recycling programs,
- Availability and use of curbside and drop-off organic collection programs, and
- Economic conditions.

Other jurisdictions that measured waste generation rates for single-family homes include:

- **Montgomery County, MD** – 0.8 tons of waste per single-family house annually. Basis of their residential solid waste charge.
- **Prince George’s County, MD** – 1.0 tons of waste per single-family house annually. Based on a 2022 residential recycling capture rate study.
- **Palm Beach County, FL** – 1.1 tons of garbage and trash and 0.85 tons of vegetation per single-family home annually. Based on a 1997 Residential Generation Study.
- **Prince William County, VA** – 1.3 tons of waste per single-family home annually. Basis of their residential solid waste charge.

The Broward County waste generation rate of 1.3 tons of waste per single-family house is comparable to other jurisdictions.

Residential special assessments in other U.S. communities typically charge a uniform fee per single-family house regardless of the home size. Assuming the average home size in Broward County is about 2,300 square feet, the waste generation rate can also be expressed as 1.1 pounds/square foot/year for the average home<sup>2</sup>. The conversion to 1.1 pounds/square foot/year is presented for comparison to other waste generation rates derived from the field study. SCS recommends a uniform fee for all single-family houses regardless of size.

It should be noted that yard trimmings, bulky wastes, and recycling quantities were excluded from the single-family residential waste generation rate.

## Multi-Family Housing

The multi-family housing waste generation rate was derived from measured waste quantities at 49 residential condominium complexes which included collection points (one or more dumpsters) serving 8,955 dwelling units. Special assessments for multi-family housing can be based on the size of an individual dwelling in the case of condominiums, or the size of the entire multi-family complex in the case of apartments. The average waste generation rate for multi-family housing is 0.9 pounds/square foot per year.

**Table 7** presents a summary of residential waste generation rates by Residential Use Code Group along with the 80 percent confidence interval, which is a measure of precision.

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<sup>2</sup> Converting the uniform waste generation rate per single-family house involves the following equation:  
 $1.3 \text{ tons/single-family house} \times 2000 \text{ pounds/ton} \div 2300 \text{ square feet/average single-family house}$ .

Table 7. Summary of Commercial Waste Generation Rates

Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Single-Family Houses *	78,778	1.1	NA	NA
Multi-Family Housing	8,955	0.9	0.8	1.1
<b>Total Residential</b>	<b>87,733</b>			

\* Note: The waste generation rate for Single-Family Houses was estimated to be 3.1 tons per house per year. This converts to 1.1 pounds/square foot/year for a 2,300 square foot house and is presented for comparison purposes.

## 4.2.2 Commercial

An estimated waste generation rate was computed for each property for which the Use Code and TLA could be identified upon being matched to a parcel in the BCPA database. Weekly waste quantities were derived for each waste collection hauler customer by summing the waste quantities measured during the weeklong route. Customers are serviced between one and six times per week. The weekly waste generation rate for each property was then divided by the TLA and multiplied by 52.14 to provide the annual waste generation rate.

The waste generation rates for all customers within the same Use Code Group were averaged; the geometric mean was used to reduce the effect of particularly high values. This process was completed for each jurisdiction and then for the County; all measured data combined for all jurisdictions.

**Table 8** presents a summary of commercial waste generation rates by Commercial Use Code Group along with the 80 percent confidence interval, which is a measure of precision.

Table 8. Summary of Commercial Waste Generation Rates

Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Entertainment (Outdoor)	11	0.5	0.2	1.0
Church	24	0.5	0.4	0.8
Office	145	0.6	0.5	0.7
Education	51	0.7	0.5	0.9
Medical	15	0.8	0.6	1.2
Other	31	0.9	0.6	1.3
Parking & Mobile Homes	1	0.9	NA	NA
Manufacturing/ Warehouse	450	0.9	0.8	1.0
Retail-2 (Shopping Center)	57	1.0	0.8	1.3
Hotel/ Motel	10	1.5	1.2	1.7
Retail-1 (Single-Story Store)	142	1.6	1.3	1.8
Entertainment (Indoor)	13	2.2	1.6	3.2
Auto Service/Sales/Repair	100	2.7	2.1	3.3

Use Code Group	Number of Properties Measured	Waste Generation Rate (lbs/sf/year)	80% Confidence Interval	
			Lower Limit	Upper Limit
Eating & Drinking	134	6.4	5.5	7.5
Agriculture	15	14.0	8.7	21.9
<b>Total Commercial</b>	<b>1,199</b>			

### Agriculture Use Code Group

The high ratios for the Agriculture Use Code Group were not anticipated. To investigate this, the TLA values for the Use Code Groups were compared. It turns out that properties in the Agriculture Use Code Group tend to have relatively low building space. This suggests that the high ratios for Agriculture properties are more a function of the small TLA than large amounts of waste being generated. It is also possible that waste generated by agricultural customers includes manure and/or organic materials, both of which are dense materials that make the waste heavier. SCS only observed the waste collection process without a chance to examine the type of waste being disposed.

### Compactors

This study measured waste quantities by outfitting front-load commercial collection vehicles with a scale capable of measuring the full and empty weight of dumpsters collected. Some of the haulers' customers used dumpsters with compaction. We noted higher waste quantities in dumpsters with compaction.

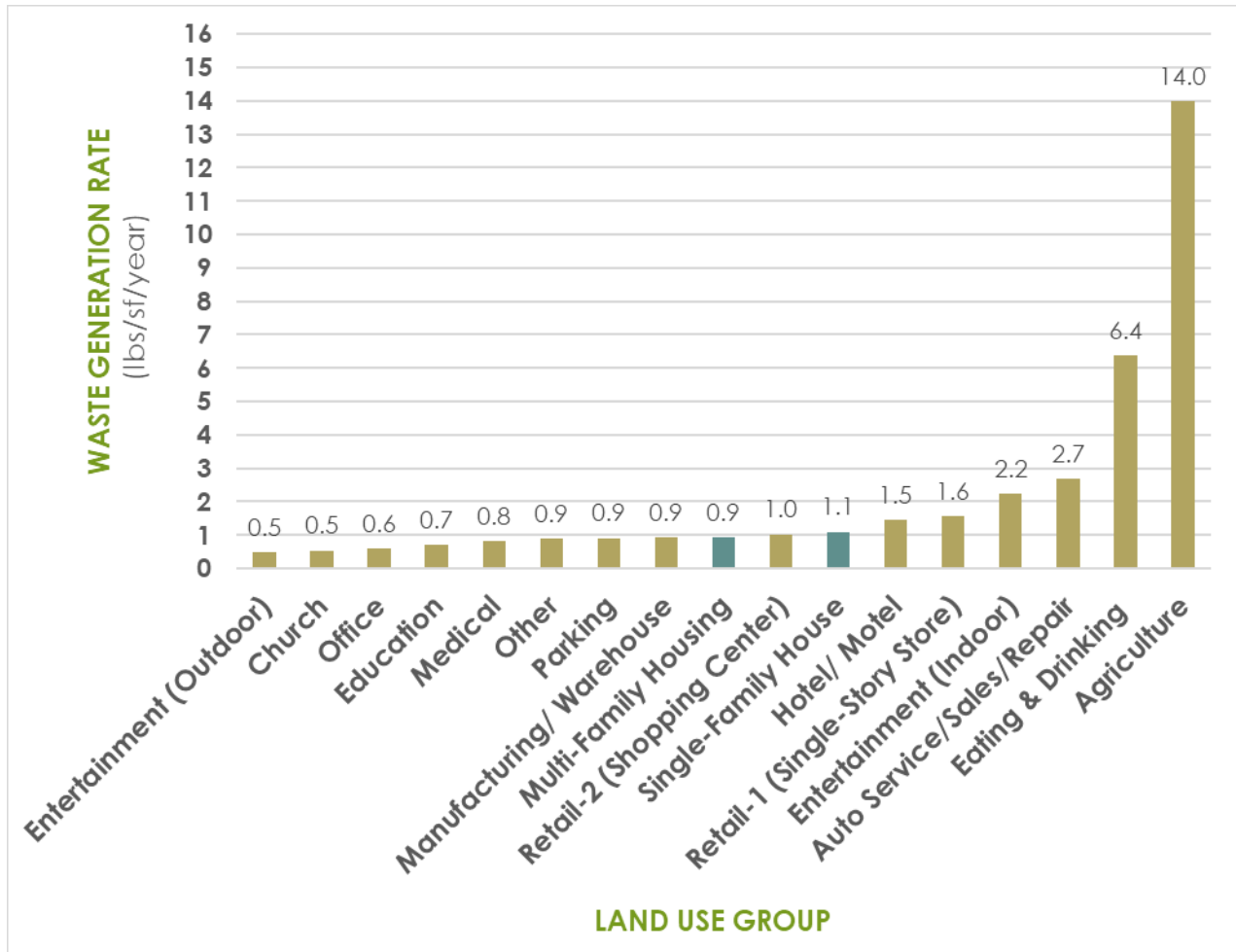
It is recognized that some businesses use roll-off containers with or without compaction to aggregate their waste for collection by a hauler with a roll-off collection vehicle. These types of containers are serviced individually by replacing the full container with an empty container of similar size. The full container is then delivered and emptied at a disposal site. Participating haulers noted that roll-off containers are typically used by very large commercial businesses and that most of their customers use dumpsters only. Roll-off containers are also used to contain waste from a special event such as an office clean-out or a construction project which are not part of a business's regular operation and hence would not be included in this study. Because we were able to measure a variety of Use Code Groups that used dumpsters of varying sizes with and without compaction, we don't believe the absence of measured roll-off containers impacts the waste generation rates derived for this study.

### 4.2.3 Comparison of Residential and Commercial Waste Generation Rates

Exhibit 4 presents the waste generation rates graphically. Residential rates are in teal and the commercial rates are in gold.



Exhibit 4. Waste Generation Rates (Ranked from Lowest to Highest)



\* Note: The waste generation rate for Single-Family Houses was estimated to be 3.1 tons per house per year. This converts to 1.1 pounds/square foot/year for a 2,300 square foot house and is presented for comparison purposes.

### 4.3 PRECISION AND CONFIDENCE

The individual property waste generation rates were plotted for each Use Code Group (See Appendix A). As evidenced in the plots, the distributions of waste generation rates appear highly skewed. Accordingly, numerical summaries as well as comparisons among municipalities are performed using log transformations, with estimates involving the geometric mean, which is approximately the median (i.e., 50<sup>th</sup> percentile) of the distribution.

Using the log-transformed waste generation rates for each jurisdiction, a simple one-way ANOVA (i.e., ANalysis Of VAriance) was performed to assess systematic difference between the municipalities among the Use Code Groups. The ANOVA indicated that Use Code Group Manufacturing/Warehouse differed from other Use Code Groups with statistical significance. Further examination of the data revealed that the difference was due to the large number of Manufacturing/Warehouse properties sampled. Differences between the municipalities is fairly small compared with the overall variation of Manufacturing/Warehouse properties and likely reflects the relatively large number of samples rather than substantial differences in waste generation patterns among municipalities.

The next step is to calculate the summary statistics for the estimated annual waste generation rates for each Use Code Group. Lower and upper 80 percent confidence limits were calculated for each Use Code Group. The 80 percent confidence interval for the geometric mean is defined as an interval expected to contain the geometric mean in 80 percent of future replications of the study (i.e., sampling from the same population and using the same methods). SCS is aware of only a few waste generation studies similar in scope to this study and most do not present confidence intervals.

**Exhibits 5 and 6** present the waste generation rates (i.e., geometric means) for each Use Code Group and the associated 80 percent confidence intervals. **Exhibit 5** presents the lower waste generation rates without Use Code Groups “Eating and Drinking” and “Agriculture” so the variations can be more easily noted. **Exhibit 6** presents a combined range of the Use Code Groups presented in **Exhibit 5** with 80 percent confidence intervals for “Eating and Drinking” and “Agriculture”.

Exhibit 5. Waste Generation Rates and Associated Confidence Intervals for Lower Waste Generating Use Code Groups

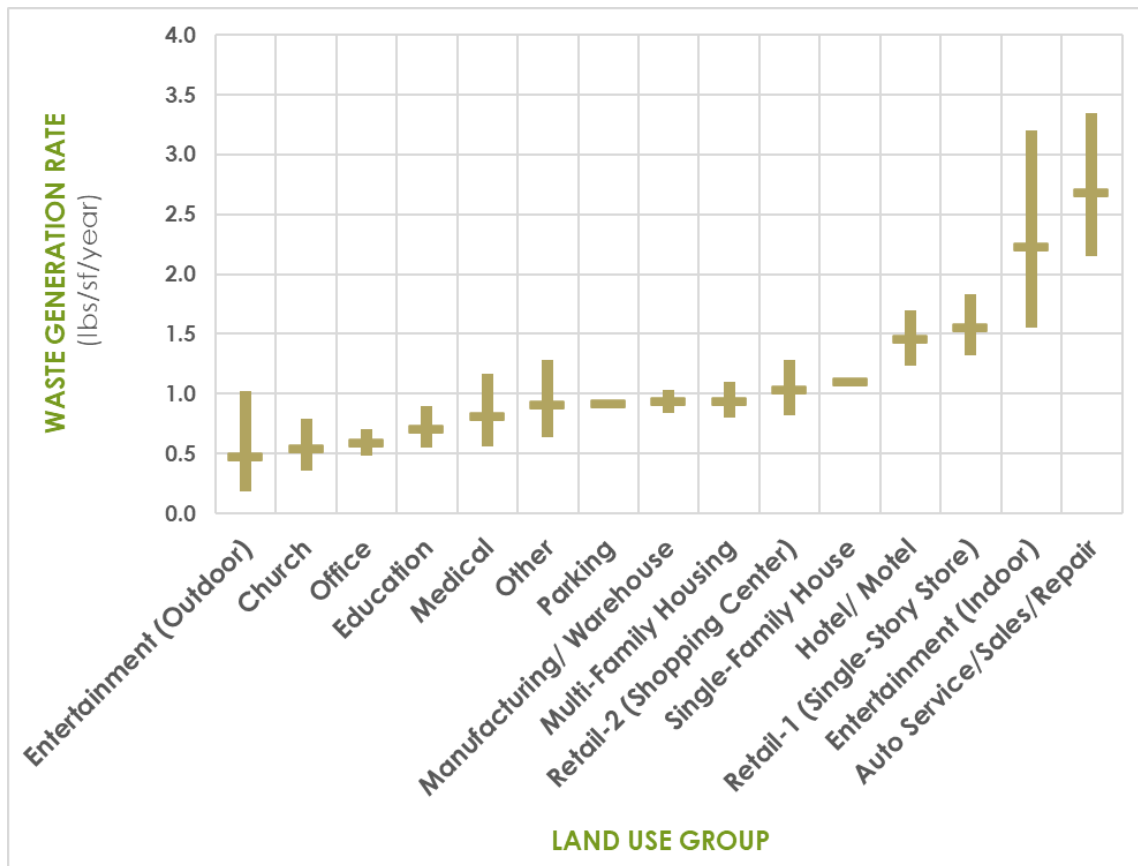
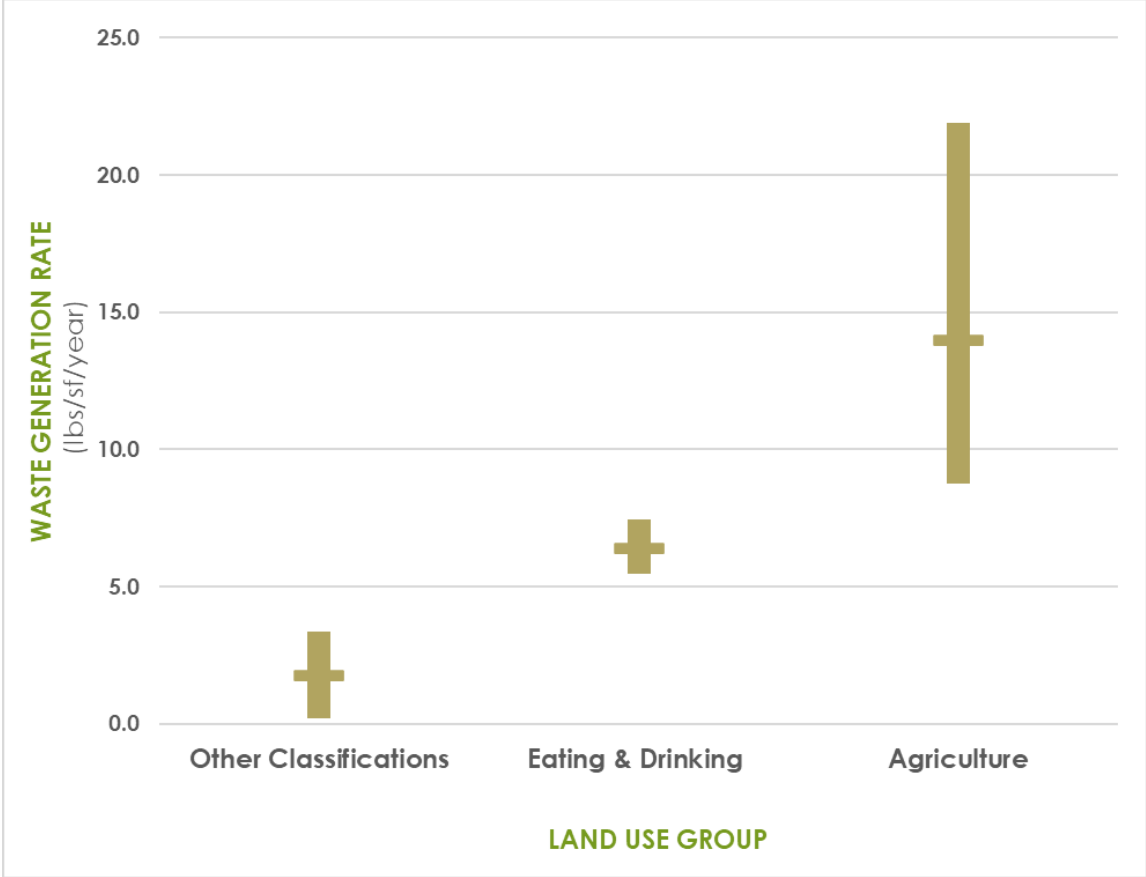


Exhibit 6. Waste Generation Rates and Associated Confidence Intervals for Eating and Drinking Establishments and Agricultural Establishments

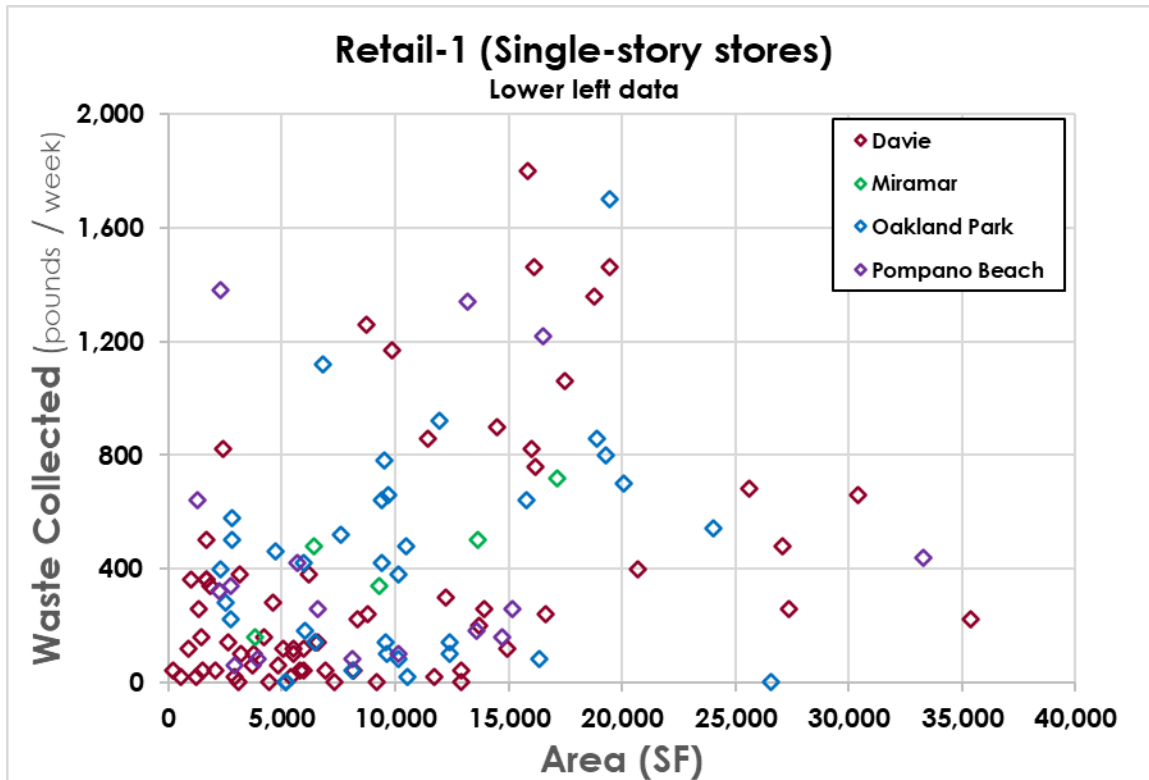
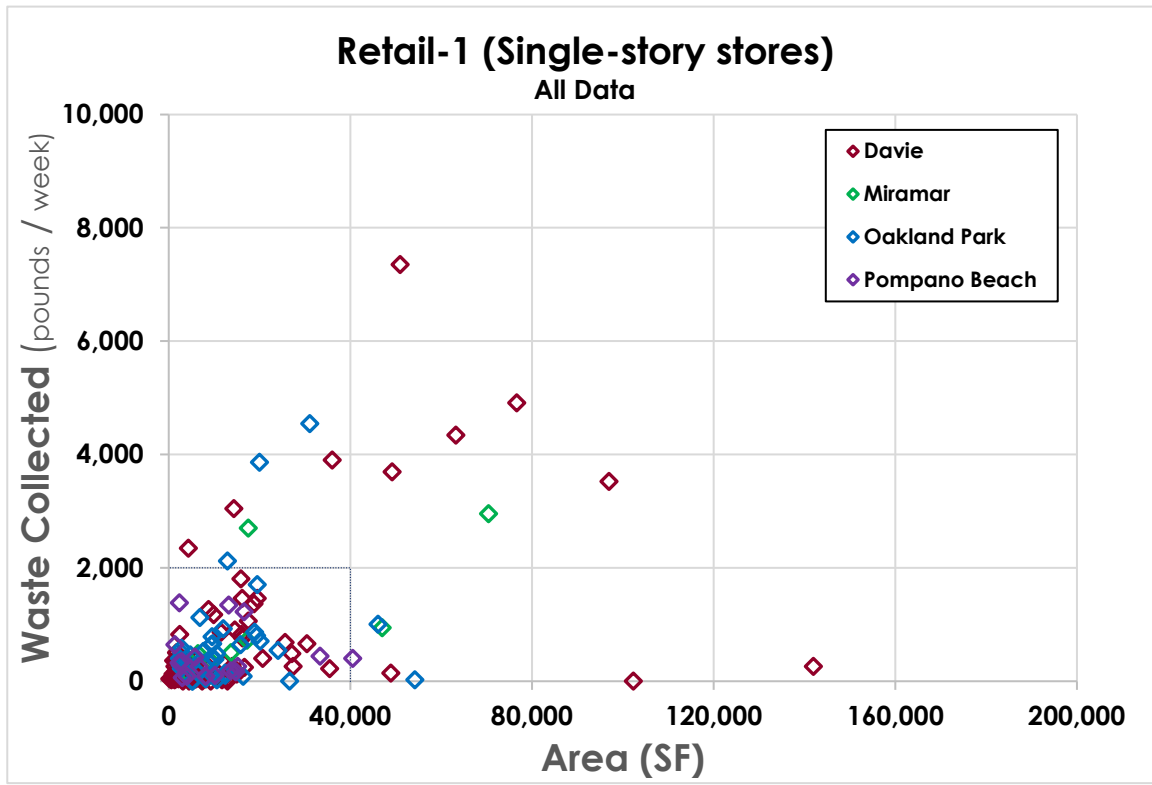


## Appendix A Plots of Waste Generation Rates By Use Code Group

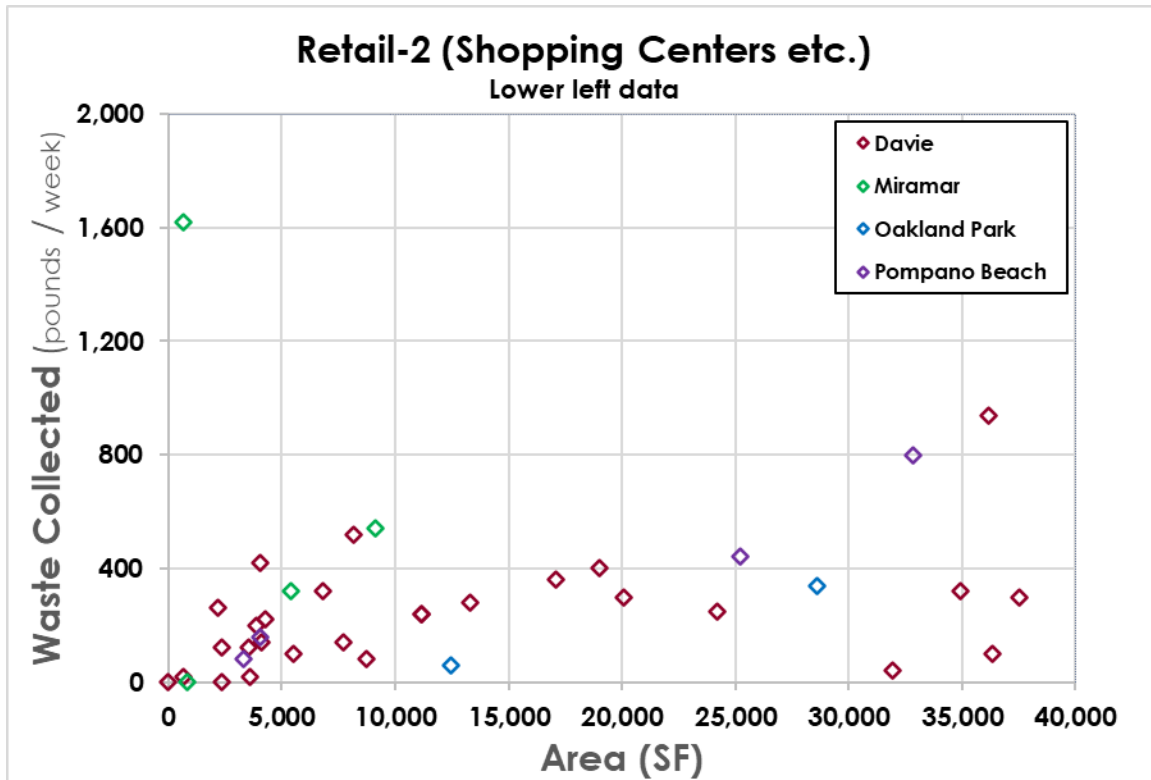
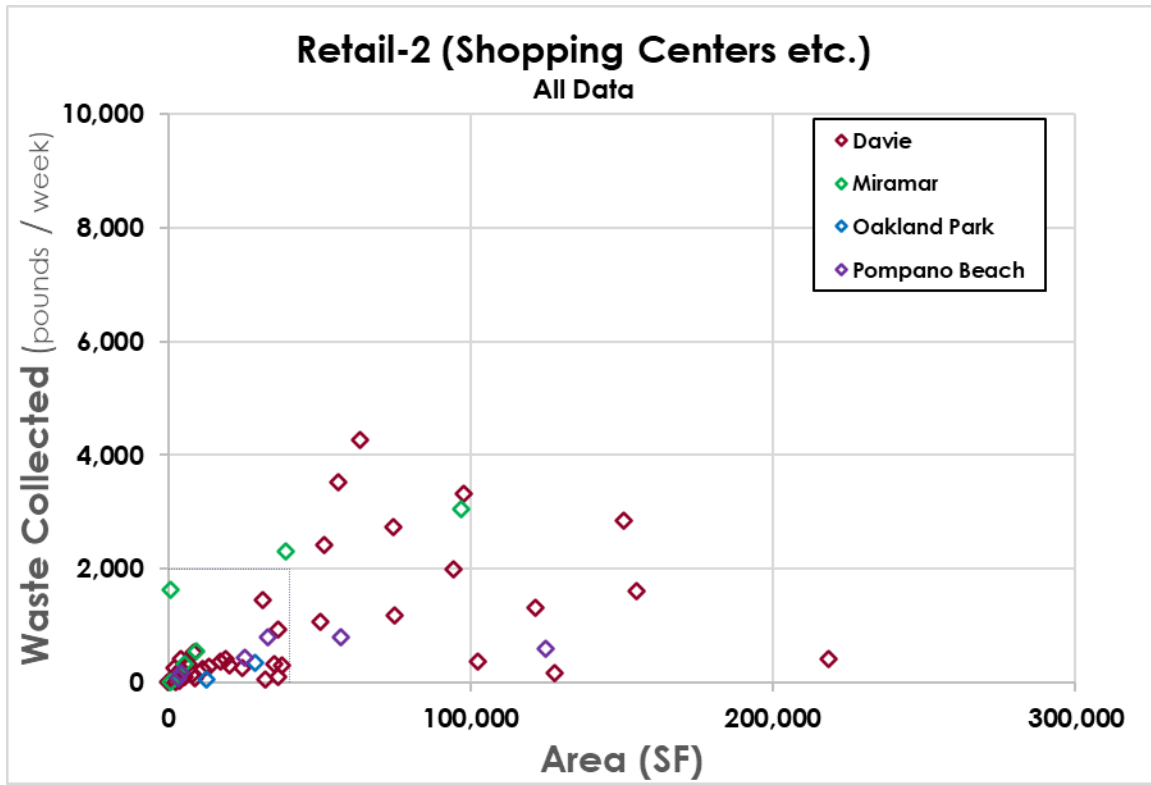
This Appendix A contains plots of waste amounts collected (in pounds per week) against the Total Living Area (TLA) in square feet (SF). The TLA is taken from the Broward County Property Appraiser database. For commercial properties, this is the area used by the business.

On each page, the top plot includes all data for the stated Use Code Group. In many cases, there are many points in the lower left-hand corner. The second plot on the page expands the lower left-hand corner for easier examination.

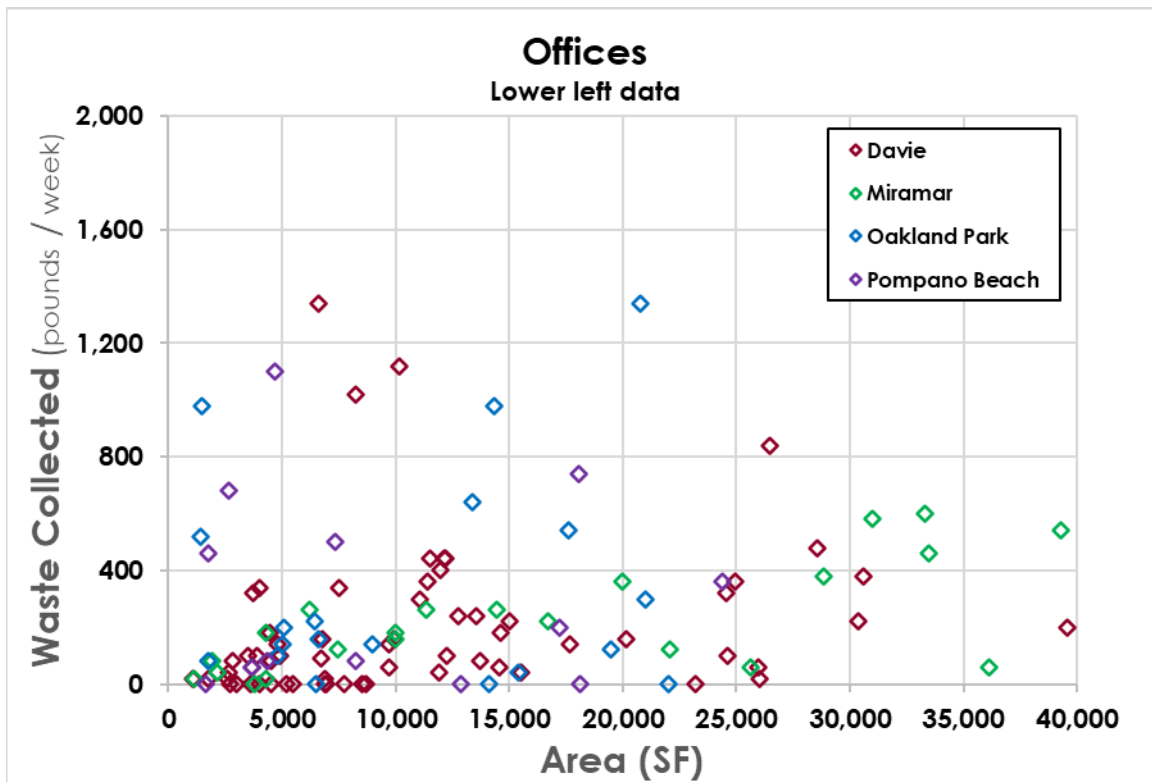
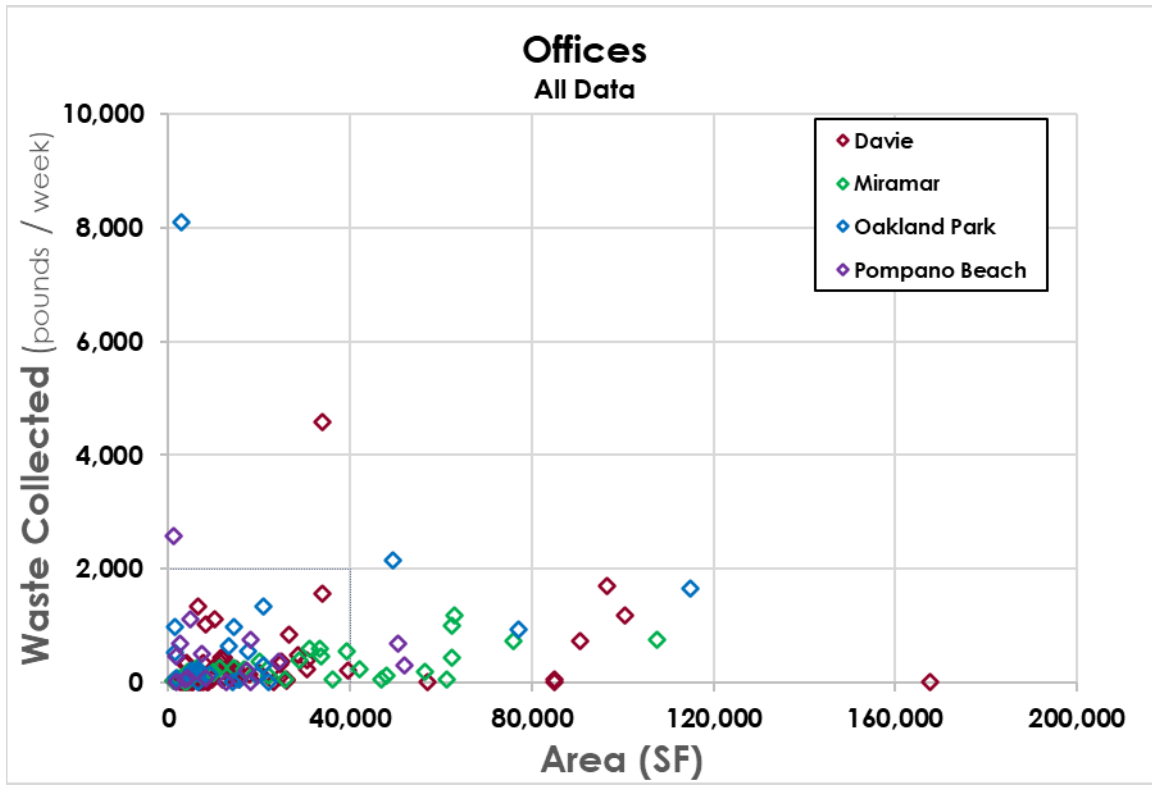
## Retail-1 (Single-Story Store)



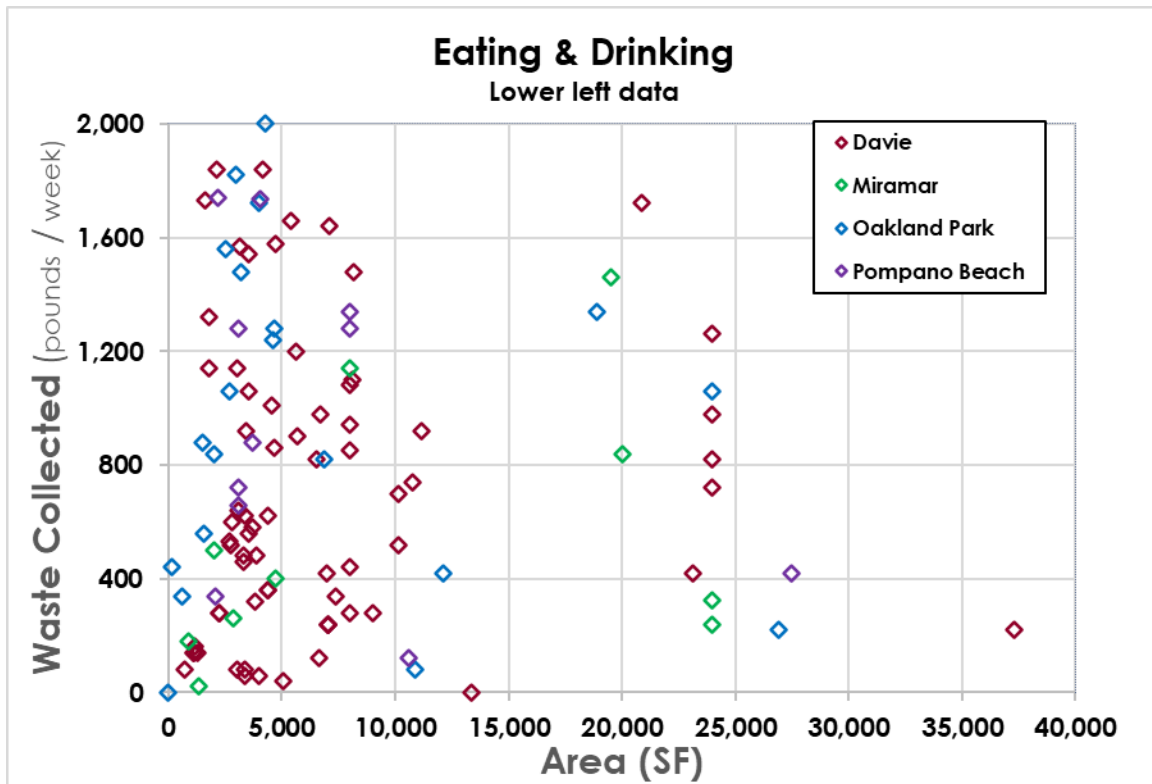
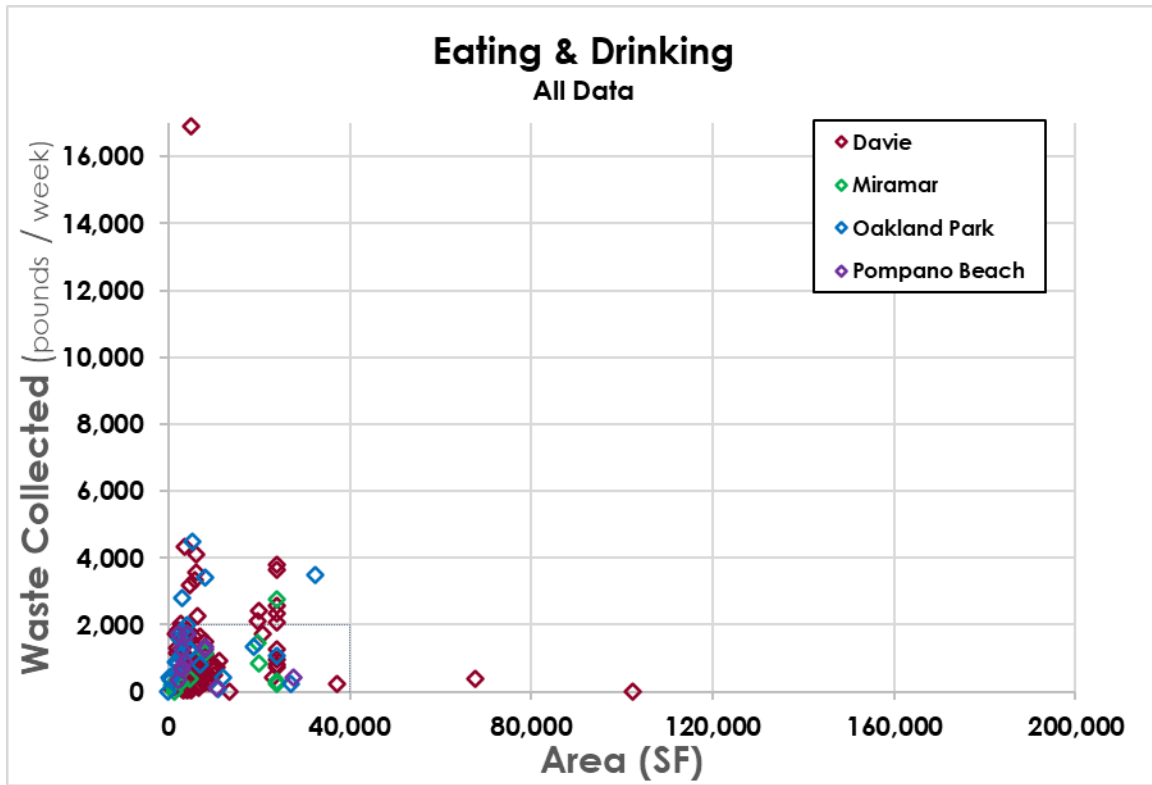
## Retail-2 (Shopping Center)



# Office

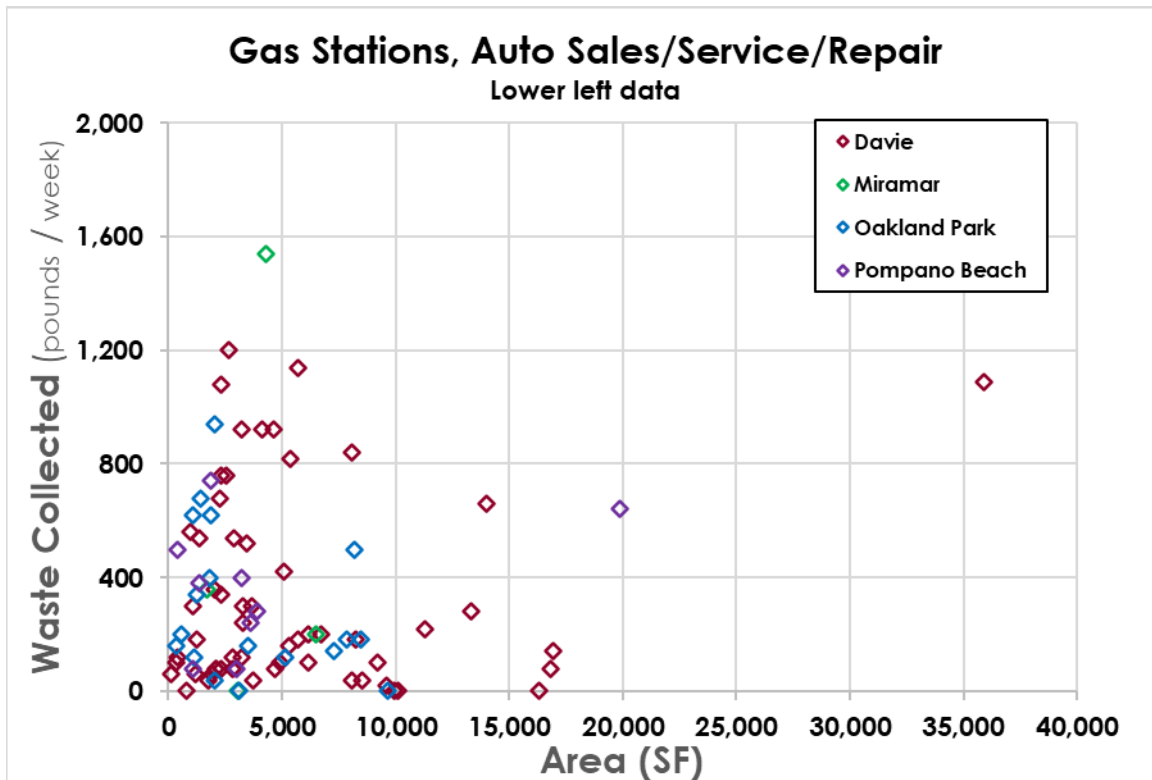
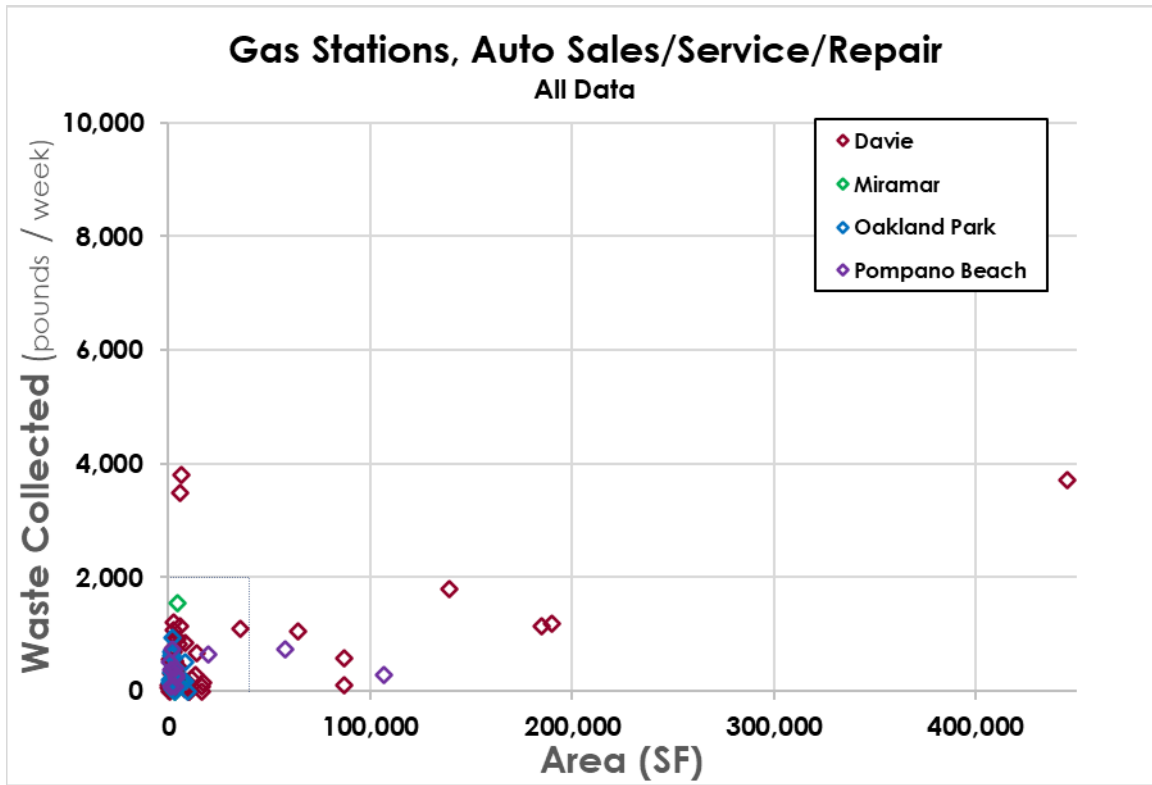


# Eating and Drinking

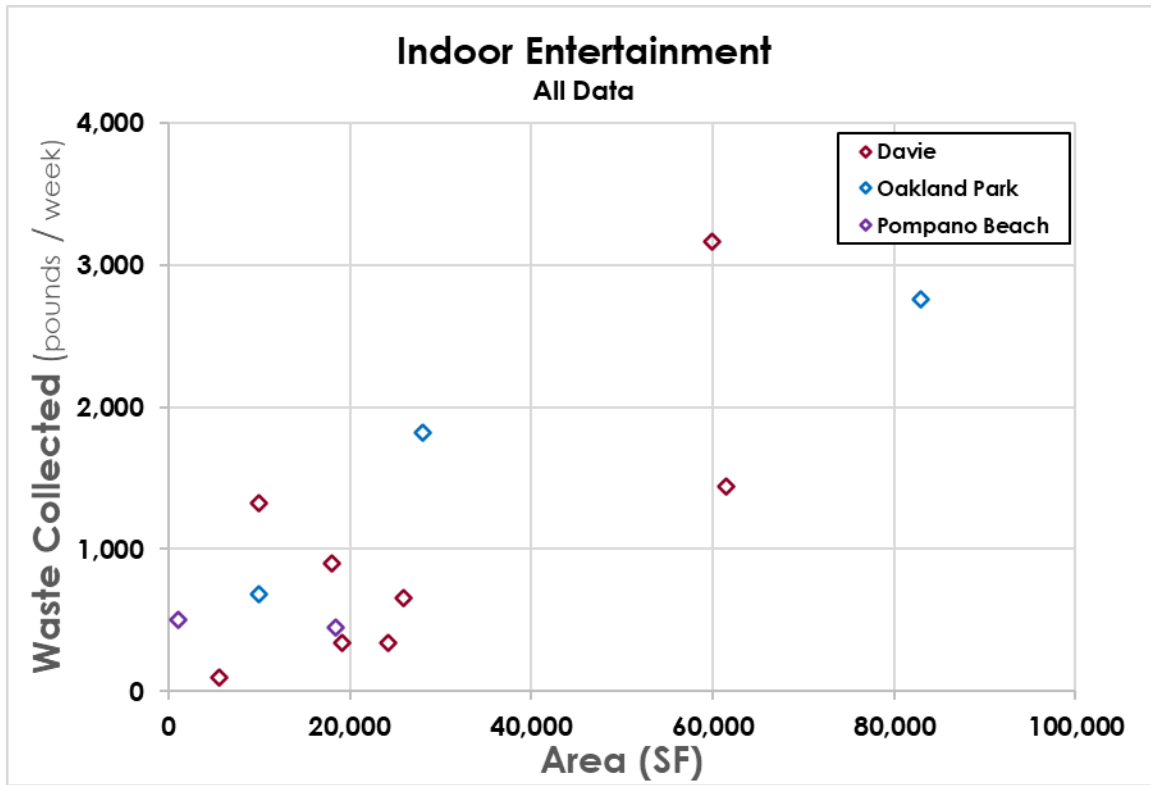




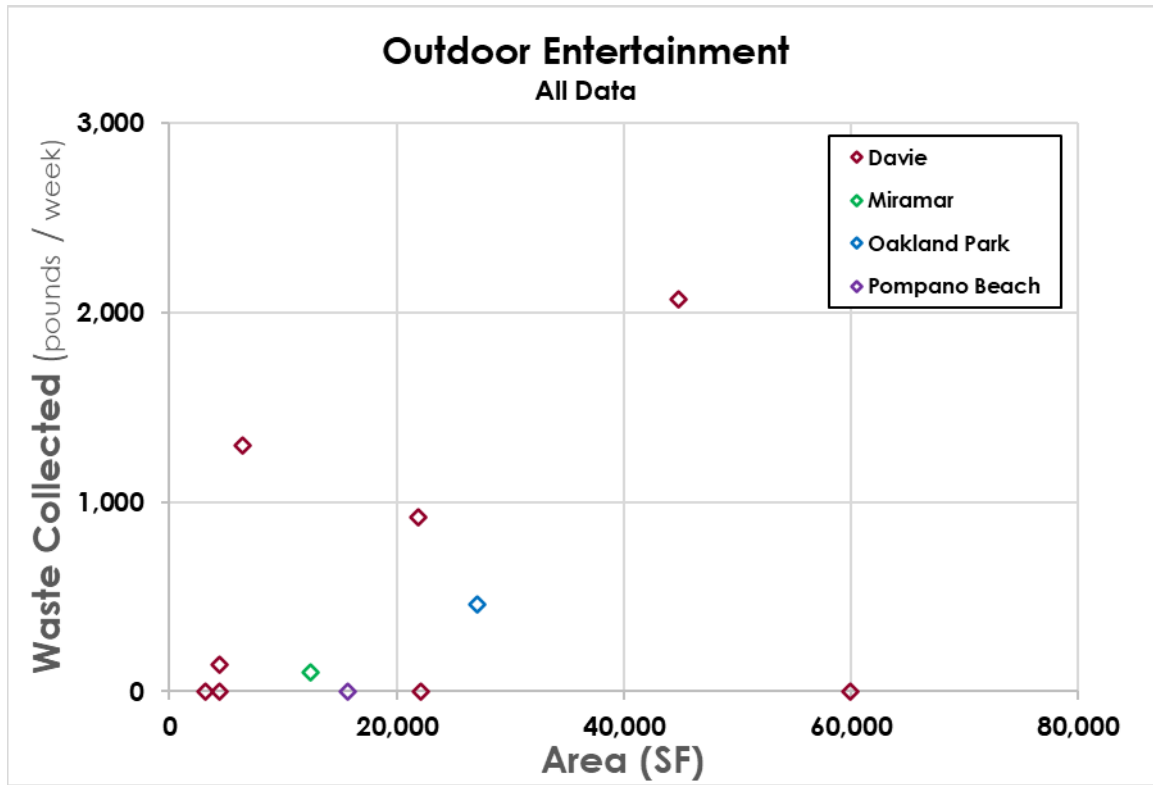
# Auto Service/Sales/Repair



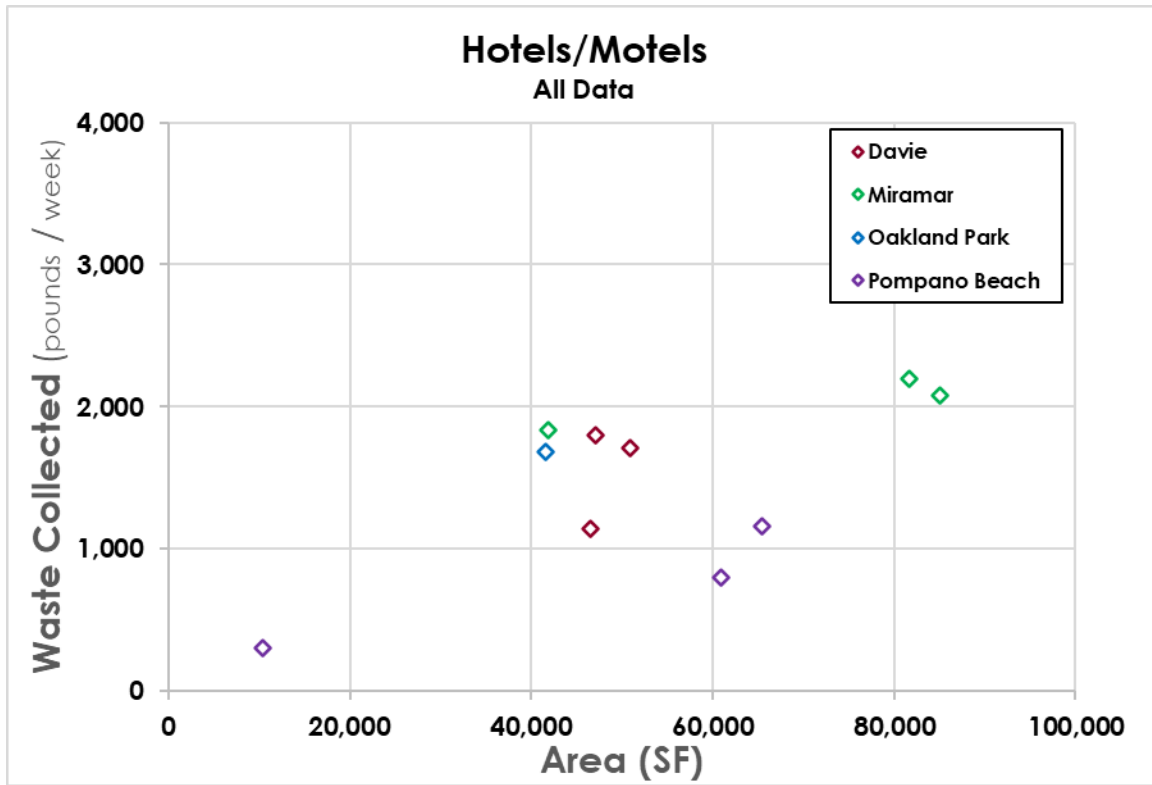
## Entertainment (Indoor)



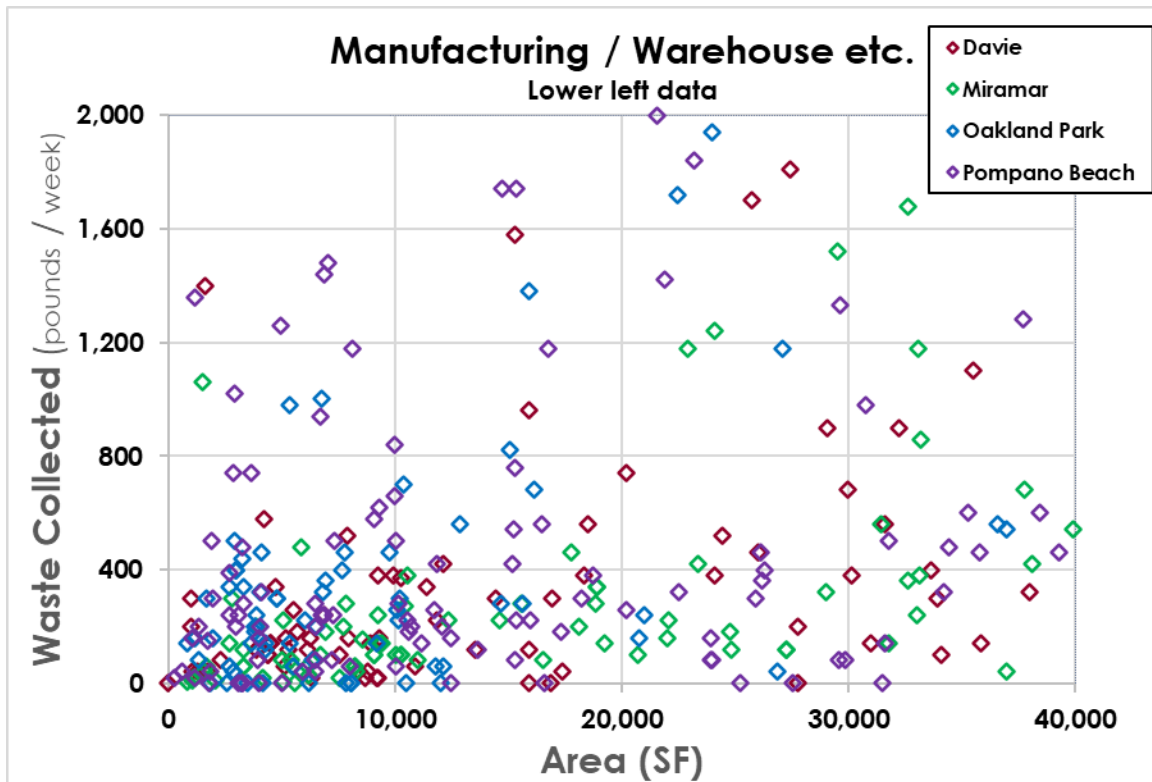
# Entertainment (Outdoor)



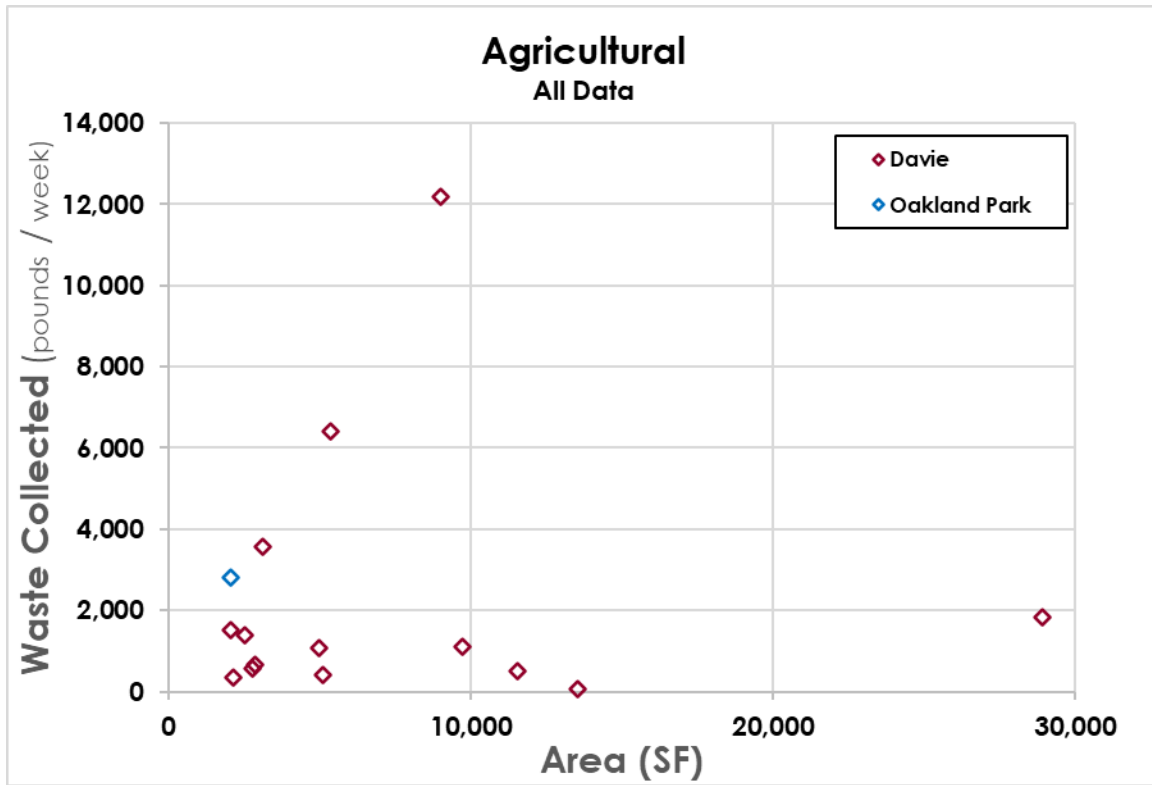
# Hotel/ Motel



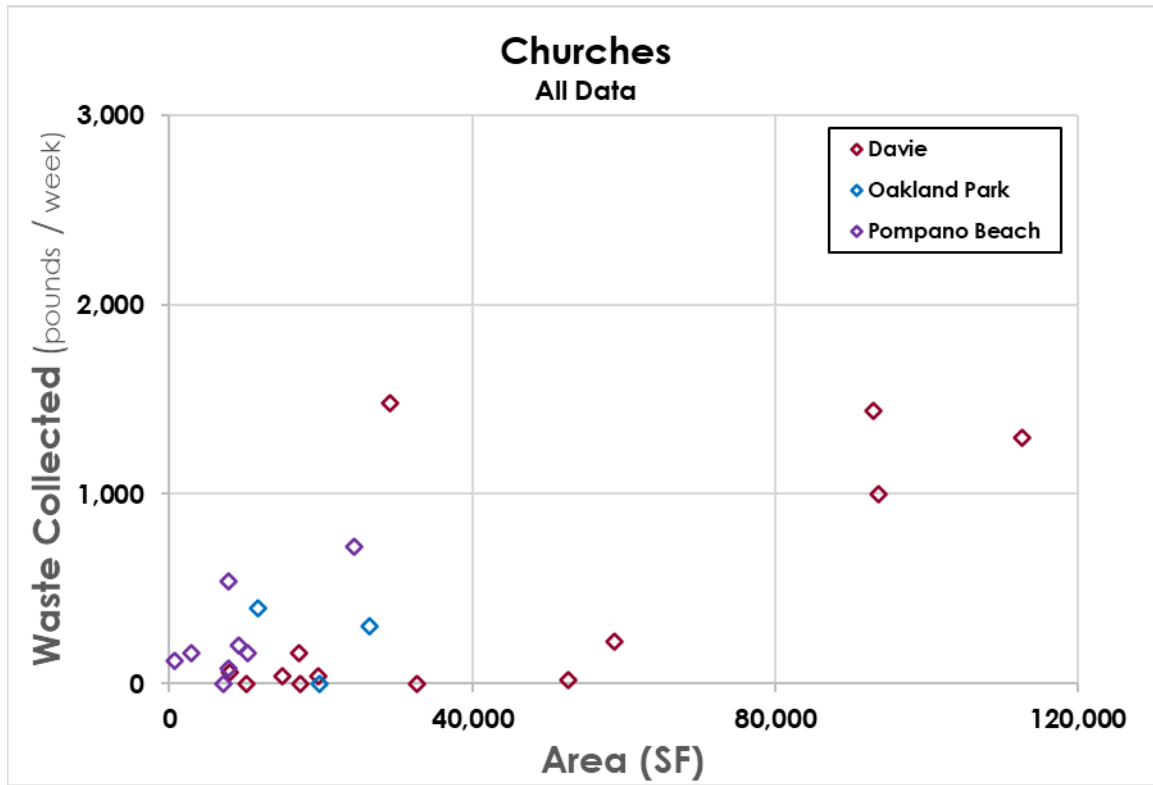
# Manufacturing/ Warehouse



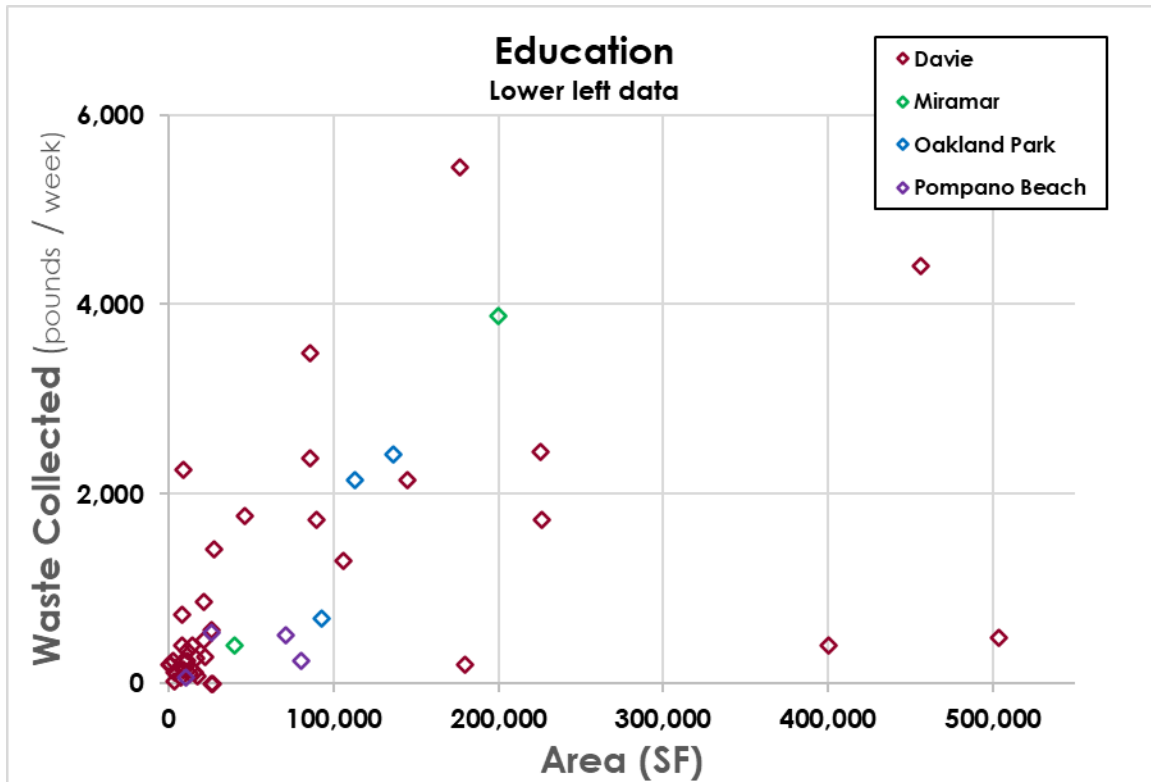
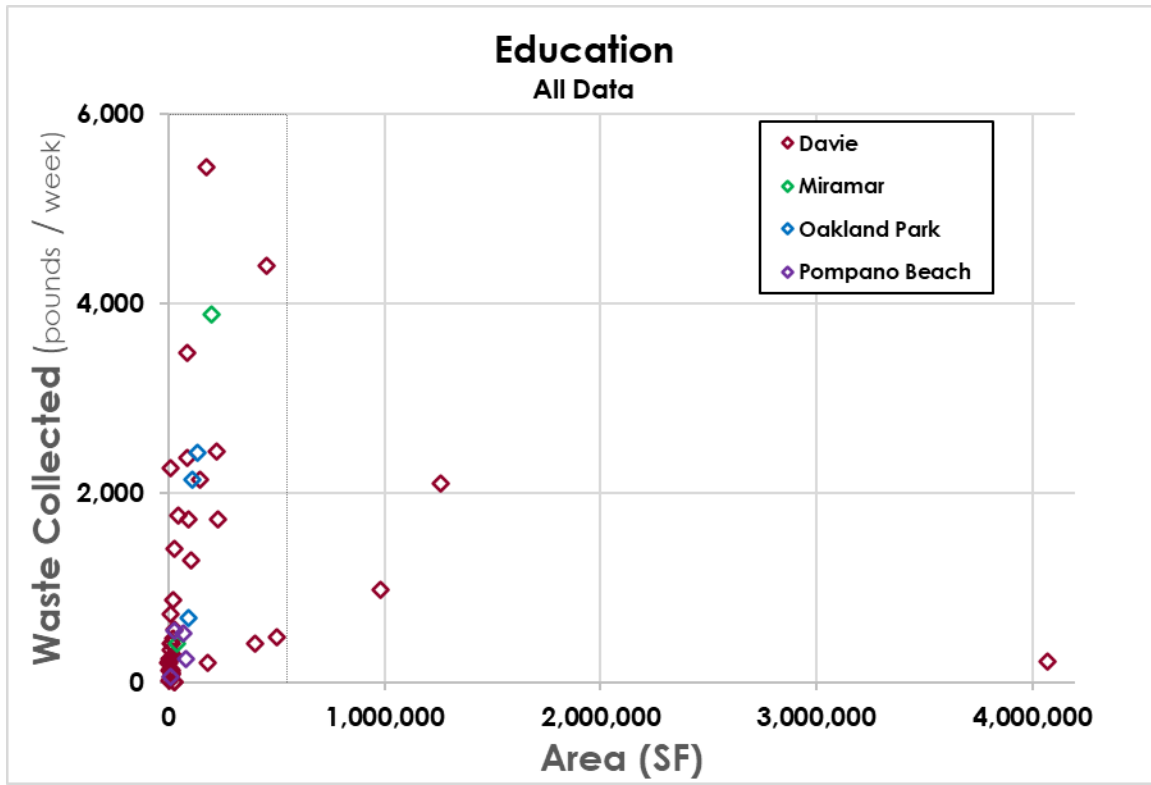
# Agriculture



# Churches

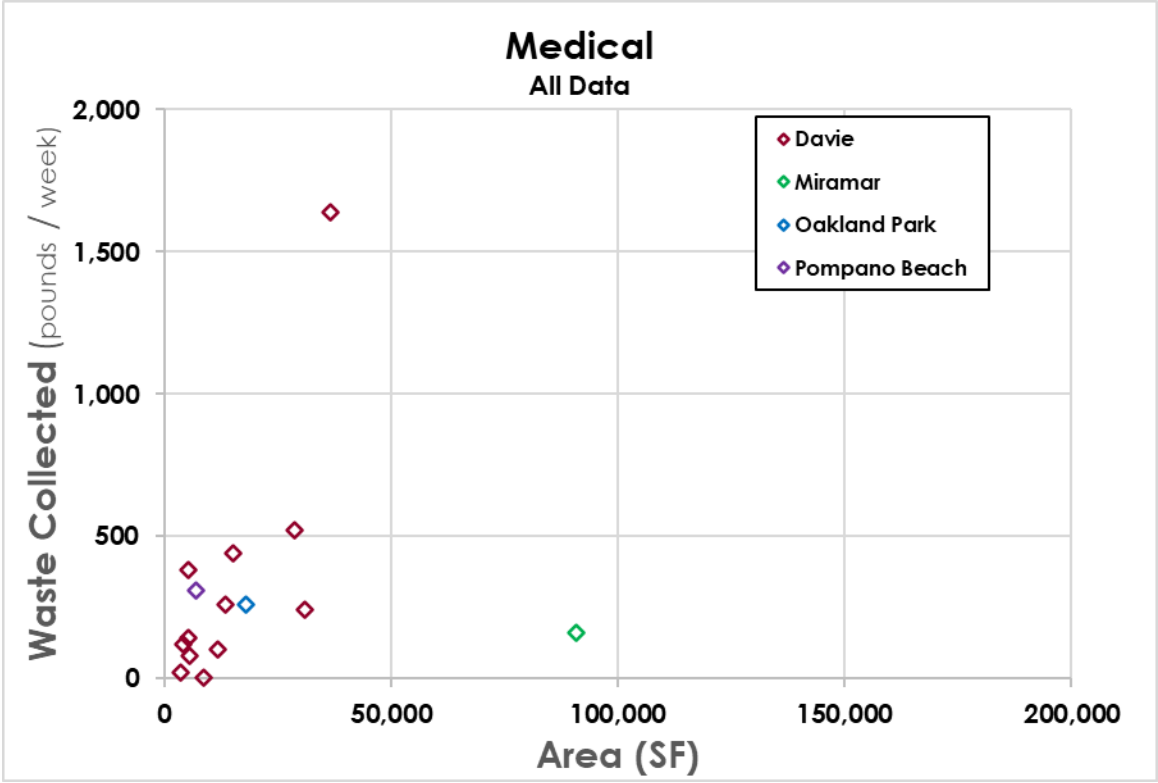


# Education

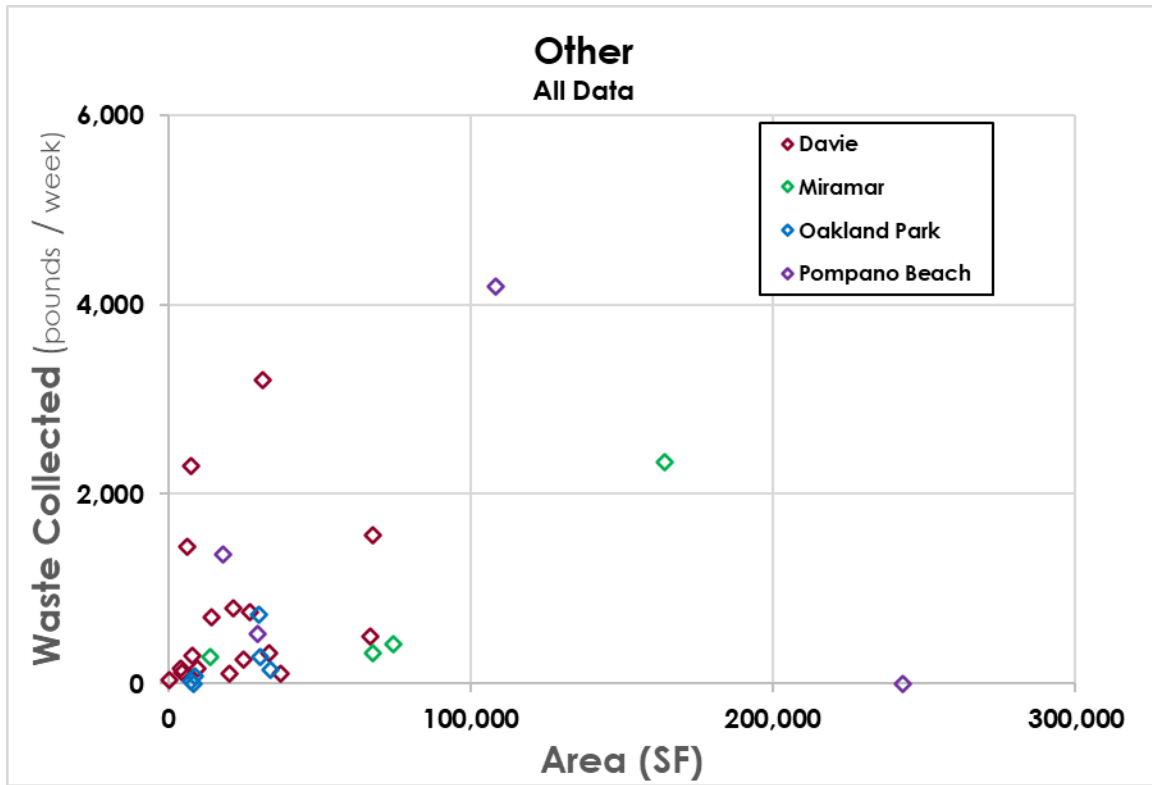




# Medical



# Other



# Parking

