# 2017 King County

# Targeted Business Characterization Report

## King County Waste Monitoring Program

King County
Department of
Natural Resources and Parks
**Solid Waste Division**

*Waste* **Prevention** | *Resource* **Recovery** | *Waste* **Disposal**

www.kingcounty.gov/solidwaste

**September 2017**

**FINAL**

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# Executive Summary

## Project Purpose and Background

In 2015, residents and businesses in King County disposed nearly 843,000 tons of garbage, also known as municipal solid waste (MSW).[1] What are people disposing, where does this waste come from, and where does it go? Since 1990, the King County Solid Waste Division (SWD) has conducted its Waste Monitoring Program to answer these questions and learn more about the County's disposed waste. The Waste Monitoring Program includes waste characterization studies, customer surveys, and other studies as needed to help King County provide efficient and effective services, plan for future needs, and track progress towards its recycling goals.

In 2017 King County completed a targeted business characterization study as part of the Waste Monitoring Program. The key objective of the study is to estimate the quantity of food waste being disposed by the commercial sector and further estimate the proportion of disposed food that is edible using the World Resources Institute (WRI) Food Loss and Waste (FLW protocol).

To achieve this objective the study proceeded in three phases:

1. Modeling the commercial waste stream
2. Updating key model assumptions for select business groups
3. Characterizing FLW at businesses in the selected business groups

## Summary of Methods

This study proceeded in three phases. Phase one included updated the existing SWD commercial sector model with more recent data collected as part of the extensive 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California.[2] Cascadia used the model data to select two business groups with a high food waste diversion potential for more detailed data collection in phase two. In consultation with the SWD, Cascadia selected the two business groups (restaurants and services-management) based on the total tons of organics waste, the tons of organics waste on a per-employee basis, and the proportion of generation that is organics waste.[3,4]

Phase two of the project involved recruiting and visiting 21 businesses from the selected groups and measuring the quantity of material being placed in each of their disposal and diversion containers. The project team recruited random businesses throughout the county, secured their participation, and made

[1] This figure excludes wastes originating within the City of Seattle, which manages its solid waste separately from the rest of King County, and the City of Milton, which is serviced by Pierce County, but includes the waste from Bothell (Snohomish County part) and Auburn and Pacific (Pierce County part)
[2] This study is available at http://www.calrecycle.ca.gov/Publications/Documents/1543/20151543.pdf
[3] Throughout this report waste refers to materials set out for curbside collection in a garbage, recycling, or organics container.
[4] The services – management group includes social services organization, professional societies, churches, daycares, and other businesses.

2-4 site visits over the course of several weeks to measure the accumulation of materials in each waste container. The measurements collected in phase two were used to further refine the generation estimates used in the model updated in phase one. Cascadia asked a subset of the business recruited in phase two to participate in a more detailed FLW measurement as part of phase three.

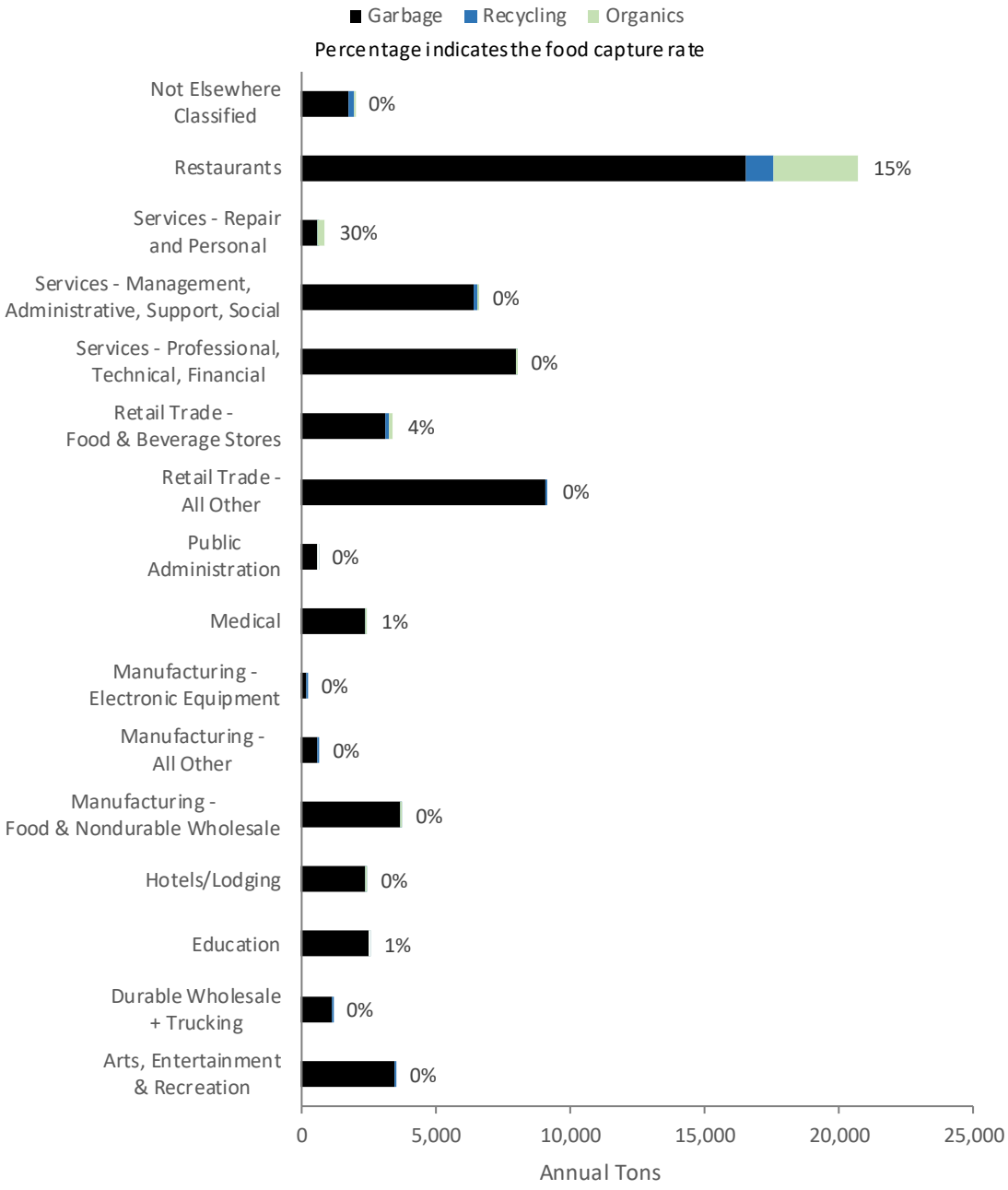
In phase three the project team hand sorted all material being disposed or diverted at eight businesses (four from each selected business group). The field crew collected all disposed and diverted waste for a typical "low waste" day and for a typical "high waste" day at each business (two days in total at each business). They hand sorted and weighed the collected material to estimate the edible food and inedible food generated by each business. The field team defined edible and inedible using the WRI FLW protocol:

> *Edible is defined as components of food that, in a particular food supply chain, are intended to be consumed by humans. What is considered edible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography.*

## Summary of Findings

The phase one modeling estimated that the largest organics waste generators in the county are restaurants (nearly 21,000 tons of food in 2016). Restaurants also have the second highest food diversion rate (15% of food waste is placed in an organics collection bin). Approximately 66% of the County's food waste is generated by businesses in four business groups: restaurants, services – professional, retail trade – other, and services – management. The remaining 33% is generated by businesses in the 12 remaining business groups. These findings are summarized in Figure 1. A complete list of the types of businesses included in each business groups is included in Appendix A: Business Group Detail.

**Figure 1. Food Waste by Waste Stream and Business Group**




Based on the accumulation measurements collected in phase two, restaurants in King County place a much larger proportion (24% vs 1%) of their waste in an organics bin than do restaurants in California. King County restaurants also place a much larger proportion (17% vs 8%) of their waste in a recycling bin than do restaurants in California. Similarly, services – management businesses in King County place a much larger proportion of their waste in a recycling bin than do services – management businesses in California. The phase two findings are summarized in Figure 2 and Figure 3.

**Figure 2. Proportion of Restaurant Waste in each Stream**

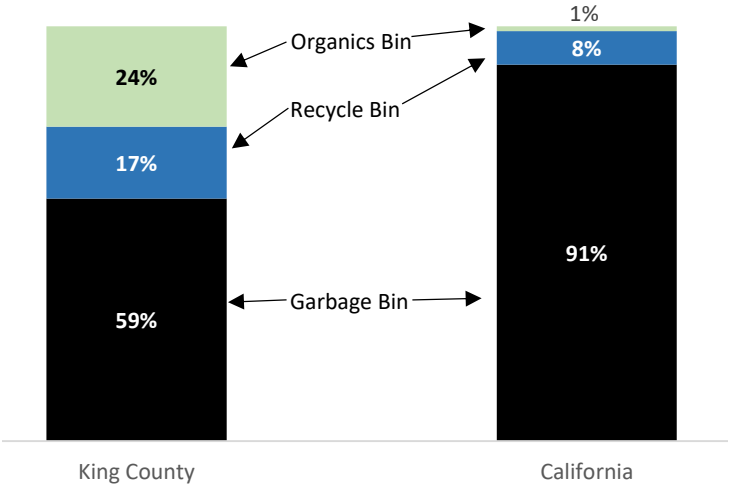
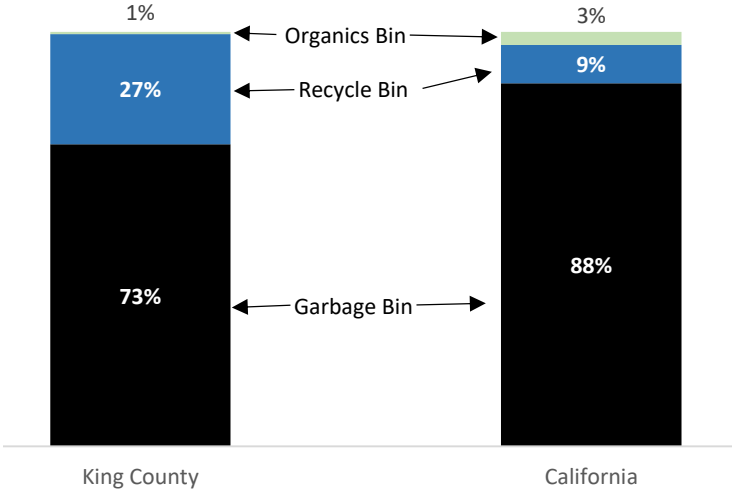



**Figure 3. Proportion of Services – Management Waste in each Stream**

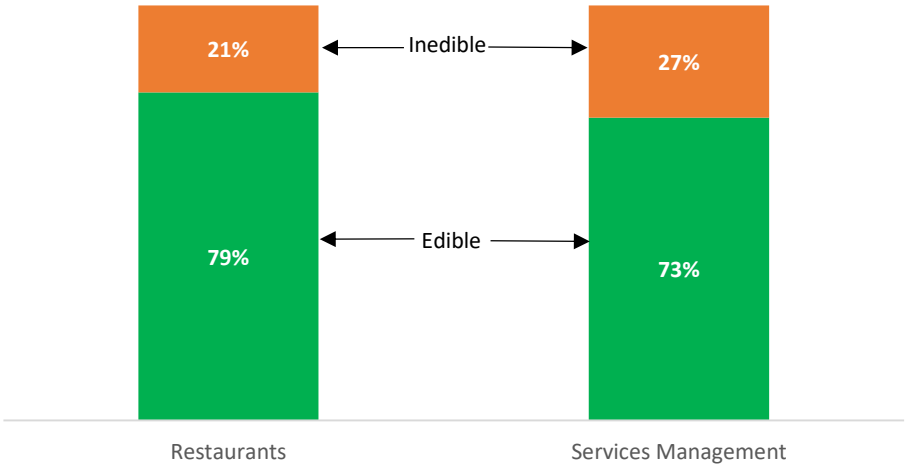



The primary purpose of phase three was to estimate the proportion of FLW that is edible vs. inedible. The WRI definition of edible is:

> *…the components of food that, in a particular food supply chain, are intended to be consumed by humans. What is considered edible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography.*[5]

For both selected business groups, edible food was approximately ¾ of the food waste. The phase three findings are summarized in Figure 4. This indicates that a great majority of the food disposed was intended for consumption and was wasted, either through inventory mismanagement, food prep wastage, or excessive portion sizes.

**Figure 4. Proportion of Edible and Inedible Food Loss and Waste (FLW)**




[5] The WRI protocol can be accessed at http://www.wri.org/sites/default/files/REP_FLW_Standard.pdf

## Organization of the Report

The remainder of this report is organized into the following four sections:

- A summary of the study methodology
- Key findings for each phase of the study
- Technical assistance best practices to increase diversion at businesses
- A user guide for the commercial sector model

# 1. Task Methodology

## Project Purpose and Background

In 2015, residents and businesses in King County disposed nearly 843,000 tons of garbage, also known as municipal solid waste (MSW).[6] What are people disposing, where does this waste come from, and where does it go? Since 1990, the King County Solid Waste Division (SWD) has conducted its Waste Monitoring Program to answer these questions and learn more about the County's disposed waste. The Waste Monitoring Program includes waste characterization studies, customer surveys, and other studies as needed to help King County provide efficient and effective services, plan for future needs, and track progress towards its recycling goals.

## Overview of Task

In 2017 King County completed a targeted business characterization study as part of the Waste Monitoring Program. The key objective of the study is to estimate the quantity of food waste being disposed by the commercial sector and further estimate the proportion of disposed food that is edible using the World Resources Institute (WRI) Food Loss and Waste (FLW protocol).

To achieve this objective the study proceeded in three phases:

1. Modeling the commercial waste stream
2. Updating key model assumptions for select business groups
3. Characterizing FLW at business in the selected business groups

Each phase is intended to build upon the findings of the previous phase. The results of the modeling phase (phase one) suggested which business groups to target for in phase two (updating assumptions). The phase three FLW characterizations were completed at a portion of the businesses recruited in phase two.

[6] This figure excludes wastes originating within the City of Seattle, which manages its solid waste separately from the rest of King County, and the City of Milton, which is serviced by Pierce County, but includes the waste from Bothell (Snohomish County part) and Auburn and Pacific (Pierce County part)

# Phase 1 Methodology

In this phase of the study Cascadia updated the existing SWD commercial sector model with data collected as part of the extensive 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California.[7] The assumption is that the total generation at a particular type of business is consistent, regardless of where the business is located. What changes based on location is the types of diversion programs available to the business and the level of participation in those programs. The modeling proceeded in the following six steps:

1. **Obtain Employment Data.** Cascadia obtained employment data from a private business listing service for all businesses in the County. The employment data is presented by jurisdiction. To ensure that these data are accurate, Cascadia will check this information against publicly available information from the U.S. Census, Washington Employment Security Department, and other sources.
2. **Model the Quantity of Waste by Business Group and Stream.** Cascadia multiplied the number of employees in each of 16 business groups in each jurisdiction by the associated tons-per-employee-per-year (TPEPY) factors. The TPEPY factors were calculated using data collected through dumpster-based sampling and extensive on-site interviews at more than 1,000 businesses across California, as part of the 2014 CalRecycle study.
3. **Create Waste Scaling Factors.** Cascadia summed the modeled waste for each business group and jurisdiction to calculate a waste estimates for each city and stream. We then compared this estimate to the commercial waste data provided by the SWD to calculate a scaling factor. This factor is used in a later step to adjust the modeled waste quantities to match the quantities provided by the SWD.
4. **Model the Composition of Waste by Business Group.** Cascadia multiplied the composition data for each business group (also calculated as part of the 2014 CalRecycle study) by the modeled waste quantities associated with each business group.
5. **Scale the Modeled Quantity and Composition.** The modeled quantities by material type in each business group were then multiplied by the scaling factor calculated in step 3. This created an estimated waste quantity (in tons) for each material type in each business group in each jurisdiction.
6. **Estimate Composition of Waste Countywide.** In the final step, the business-specific waste quantities calculated in Step 5 were summed across business groups and jurisdictions to generate total estimated quantities for each material type in each stream countywide.

A complete list of the types of businesses included in each business groups is included in Appendix A: Business Group Detail.

Based on the results of the modeling two business groups were selected for additional data collection. The business group selection considered several criteria including:

[7] This study is available at http://www.calrecycle.ca.gov/Publications/Documents/1543/20151543.pdf

1. The total tons of organics generated,
2. The organics tons generated on a per employee basis,
3. The proportion of generation that is organics, and
4. A subjective assessment of the group's suitability for the study.

Each business group's objective score (the first three criteria above) is summarized in Figure 5 (on the following page). The group's overall rank on the subject criteria is noted in the figure. Each colored portion of the bar indicates the group's rank on particular criteria, longer sections indicate the group ranked higher on that particular criteria. As shown, restaurants; arts, recreation, and entertainment; and services-management had the three highest objective scores. Based on Cascadia's experience recruiting businesses for other studies and the relatively small number of businesses in the arts, recreation, and entertainment group, the project team (in coordination with the SWD) elected to not include that group in phase two and instead chose to include businesses in restaurants and services-management groups.

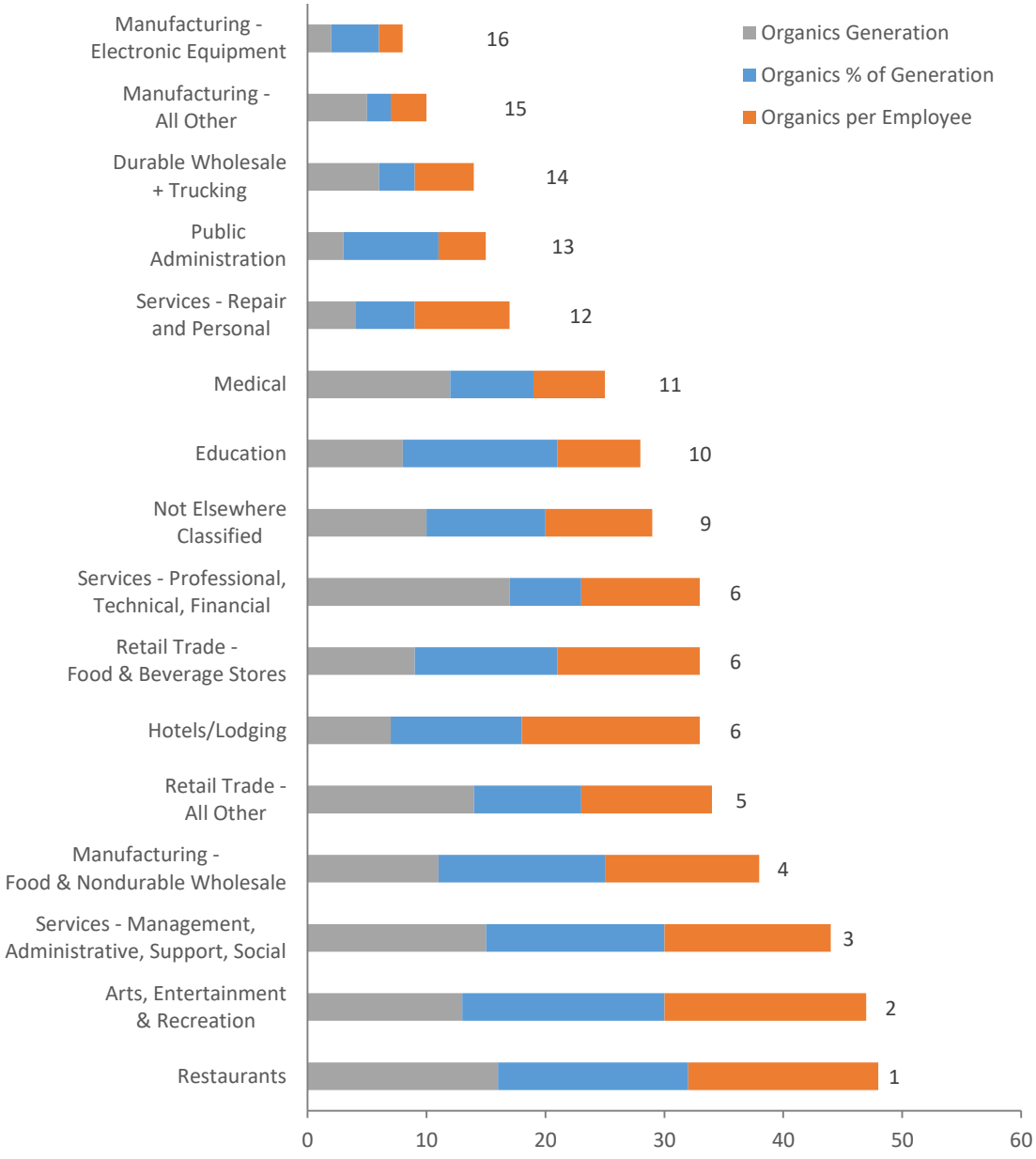
The business groups are based on North America Industrial Classification System (NAICS) codes. NAICS is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. The NAICS definition for each of the selected groups is:

> **Restaurants:** Industries in the restaurant group prepare meals, snacks, and beverages to customer order for immediate on-premises and off-premises consumption. This includes fast food and table service restaurants, food service contractors, caterers, and mobile food services; and drinking places.
>
> Food and beverage services at hotels and motels; amusement parks, theaters, casinos, country clubs, and similar recreational facilities; and civic and social organizations are included in this group only if these services are provided by a separate establishment primarily engaged in providing food and beverage services.
>
> **Services-Management:** This group includes many different kinds of businesses (see Appendix A: Business Group Detail for a list of the included NAICS codes). Examples include: agents, brokers, and business-to-business electronic markets; establishments that administer, oversee, and manage the strategic or organizational planning and decision making role of the company or enterprise (e.g., general management, personnel administration, clerical activities, cleaning activities, landscaping activities); social assistance services organizations (day-care and drug rehabilitation services); and churches, foundations, business associations, professional organizations, labor unions, and political organizations.

After selecting two business groups the study moved on to phase two. Additional modeling results are discussed in the Key Findings section.

**Figure 5. Business Group Objective Scores for Inclusion in Phase 2**

Number indicates the group's rank on the objective study criteria



# Phase 2 Methodology

Phase two proceeded in two steps: recruit businesses and quantify generation. The methods used for each step are detailed in the next two sections.

## Recruit businesses

Phase two included recruiting ten businesses from each of the selected business groups and measuring the quantity of material being placed in each of their disposal and diversion containers.

Our first step in the recruitment process was to compile lists of eligible sites for each business group using commercial sources, like Dun & Bradstreet or infoUSA. The lists were then queued in a randomized order in preparation for recruitment.

Our experienced staff made in person visits to generators to determine their eligibility and willingness to participate in the study. The recruiter attempted to speak with a manager or supervisor who could give permission for the site to participate in the study.

After each generator was confirmed as eligible and willing to participate, we collected additional information used in (1) determining how to arrange and conduct visits for data collection purposes, (2) quantifying disposal and diversion, and (3) correlating disposal and diversion information with other information about the generator (such as number of employees, participation in recycling programs, etc.). For logistical purposes we collected the following information:

- Number of distinct waste streams at the location
- Numbers, locations, and approximate sizes of containers for waste
- Days and times of scheduled pick-up of waste
- Times or ranges of time when waste is taken to the dumpsters.
- Name and contact information for all hauling companies that serve the location
- Number of full time equivalent (FTE) employees
- Tonnage information for businesses with compactors or roll-off containers for waste
- Hours during which it is possible for our team to schedule data collection visits
- Layout of the site (including a map if the location is large enough to merit it)
- Specific places to visit onsite in order to observe and quantify waste
- Specific procedures for accessing the waste, gaining assistance, taking measurements, taking samples, etc.

During the recruitment process, recruiters determined the best method for quantifying waste at each site. The choice of method depended on what information the site had available. The possible methods for quantifying waste, in order of preference, were:

- examination of records maintained by the generator or waste hauler
- measurement of the amounts of materials set out over time
- interviews with representatives of the generator or hauler
- other methods, to be described on a case-by-case basis

For this study the quantity of waste at each site was determined via direct field measurement of the amounts of materials set out over time.

Cascadia recruited a total of 21 businesses: 11 restaurants and 10 services-management businesses as shown in Table 1 and Table 2. As part of the phase one modeling, the estimated quantity of commercial waste is scaled to the hauler reported total quantity of commercial waste. Tonnages from businesses operated from a home (and thus have residential service) are not included in the hauler reported quantities. To ensure that the data collected in phase two is consistent with the modeling inputs recruited businesses were required to have commercial waste service to be eligible (which excluded businesses operated from a home).

**Table 1. Services Management Recruited Businesses by City**

| City | Recruited |
|---|---|
| Bellevue | 1 |
| Issaquah | 2 |
| Maple Valley | 2 |
| Newcastle | 1 |
| Normandy Park | 2 |
| Tukwila | 2 |
| TOTAL | 10 |

**Table 2. Restaurant Recruited Businesses by City**

| City | Recruited |
|---|---|
| Bellevue | 2 |
| Des Moines | 3 |
| Enumclaw | 2 |
| Renton | 2 |
| Sammamish | 2 |
| TOTAL | 11 |

## Quantify Waste

After recruiting a business, the field crew made 2-4 visits to the business over the course of several weeks to measure the quantity of material being placed in each of their disposal and diversion containers shortly before scheduled collection by the hauler. The quantification methodology is detailed below. This process was completed for each stream (garbage, recycling, and organics) present at each business.

- **Waste Volume Measurements:** Field staff recorded the length, width, and height to the nearest inch for all waste at each site. The volume of the waste at each site is the sum of all volumes for each waste container (if there is more than one container onsite), in cubic inches.
- **Waste Accumulation Time:** During initial recruitment, recruiters asked the responsible party at the site for information to determine waste accumulation time,

including: the business operating hours, the time the waste containers were last collected by the hauler (or regular collection schedule), and when material is regularly taken to containers.

- **Volume of Waste:** We used the above information to calculate (1) the hours of accumulation for the observed waste volume and (2) the total hours of waste accumulation time per year. We used these two numbers to calculate the annual volume of the waste at each business site.
- **Density of Waste:** Field staff measured the density of materials by measuring the volume and weight of samples collected in phase three. When the field staff extracted a sample, they place the sample in carts with known volumes, without compacting or fluffing the material and record the volume of the sample based on the fullness of the carts. The weight of the sample was the sum of all of its sorted material types. Using the sum of sample weights and sample volumes for all businesses within a business group we calculated the waste density (in pounds per yard$^3$).
- **Annual Waste Set out Rate per Group:** We used the calculated waste density to convert annual waste volume measurements into annual waste tons. After this step, we had a common unit of measurement of tons per year for the annual waste set out rate at each site.
- **Tons per Employee per Year:** We divided the annual waste set out rate for each group by the number of FTE at the selected businesses in that group to calculate tons per employee per year (TPEPY) figure for each group and each waste stream.

After completing the quantification measurements the phase one model was updated with the King County specific TPEPY data for the two selected business groups.

During the course of the recruitment and measurement visits the field crew engaged with the business staff in the hopes of securing their participation for the phase three field work (sampling and sorting). Four business from each group were selected to participate in phase three.

## Phase 3 Methodology

After completing approximately half of the phase two site visits and securing the participation of eight business, the field crew began scheduling and coordinating with the eight selected business to collect and sort samples of their waste (phase three). Phase two and phase three proceeded concurrently from this point to maximize the field work efficiency. Each business was visited twice for sampling, once on a busy day and once on a slow day. The sites designated which days of the week they considered busy and which they considered slow.

For each sampling visit the field crew sorted all materials that had accumulated during the previous 24 hours. To accomplish this the field crew visited each site the day prior to the sampling visit and placed a

large tarp in the waste containers. When the team returned 24 hours later (the scheduled sampling day) all material that had accumulated on the tarp was sorted. At businesses with multiple containers from the same stream, the field crew tarped all containers. In cases where the trash was inaccessible, unique arrangements were required for the sample collection to proceed. For example, if the site used a compactor, the team provided rolling carts for the site to deposit waste into for a 24 hour period, instead of into the compactor.

All samples were hand-sorted into three material types (edible food, inedible food, and other materials) using the following steps:

- A member of the field crew photographed the sample using a digital camera. A *Sample Placard* identifying the sample was positioned to be visible in each photo.
- The field crew sorted the sample into three material types into plastic laundry baskets, on material type per basket. The crew manager monitored the homogeneity of material in the baskets as they accumulated, rejecting any materials that were improperly classified.
- The Field Manager visually inspected the purity of each basket as it was weighed using a pre-calibrated scale, and recorded each material weight on the *Material Weight Tally Sheet*.

**Edible food** is defined as components of food that, in a particular food supply chain, are intended to be consumed by humans. What is considered edible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography.

**Inedible food** is defined as all components of food not included in the edible food (skins, pits, bones, eggshells, etc.)

**Other materials** included all non-food materials.

The sort data from each sample in a business groups was combined to estimate the proportion of food that is edible and inedible for the group. The edible and inedible proportions were used to update the composition data for the two selected business groups in the phase one model.

This phase followed the basic structure of the waste composition method as described in the World Resources Institute (WRI) Food Loss and Waste (FLW) Protocol. The components of the protocol are illustrated in Figure 6.

**Figure 6. WRI FLW Summary**

## Baseline Food Waste Assessment – Commercial (FLW Standard*)

**TIMEFRAME**

- One week (April 2017)

**MATERIAL TYPE**

- Edible Food ✓
- Inedible Parts ✓

**DESTINATION**

- Animal Feed
- Biomaterial/ processing
- Co/anaerobic digestion ✓
- Compost/aerobic ✓
- Controlled combustion
- Landfill ✓
- Land application
- Not harvested
- Refuse/discards ✓
- Sewer

**BOUNDARY**

- **Food category** = all food and beverage discarded at business
- **Lifecycle stage** = consumption
- **Geography** = King County, WA
- **Organization** = 8 Businesses

**RELATED ISSUES**

- Weight of lightweight packaging is included.
- Weight of heavy packaging excluded from analysis.

*The structure for this figure was developed by the Natural Resources Defense Council.

# 2. Key Findings

## Phase One: Waste Modeling

This section summarizes the key findings from the phase one modeling. The findings shown here include updates made to the model using the phase two and phase three data. Throughout this section the words "recyclable", "compostable", and "divertible" refer to materials that are included in traditional curbside diversion programs. The material types considered recyclable and compostable are listed in Table 3

**Table 3. Recyclable and Compostable Material Types**

| Recyclable | Compostable |
|---|---|
| OCC/Kraft | Compostable/Food Soiled Paper |
| Mixed Recyclable Paper | Food |
| PET Containers | Yard Debris |
| HDPE Containers | |
| #3-#7 Containers | |
| Glass Containers | |
| Tin/Steel Cans | |
| Other Ferrous Metal | |
| Aluminum Cans | |
| Other Non-Ferrous Metal | |

### Commercial Sector Generation

The modeled commercial sector generation is summarized in the following tables and figures. More than two-thirds (69%) of the commercial generation is set out in a garbage bin, nearly 29% in a recycling bin and the remaining 2% in an organics bin (see Figure 7). As shown in Figure 8, commercial generation is nearly evenly split between recyclable materials, compostable materials, and other materials (36%, 30%, and 34%, respectively). This implies that the maximum diversion potential of a traditional curbside diversion program is 66% (36% recyclable plus 30% compostable). This doesn't include the potential diversion from non-curbside programs (C&D recycling, tire recycling, etc.).

These two figures illustrate that compostable materials account for 30% of commercial sector generation yet only 2% of commercial sector generation is placed in organics bins. This suggest that most of the organics diversion potential is unrealized.

**Figure 7. Overall Commercial Generation by Waste Stream**

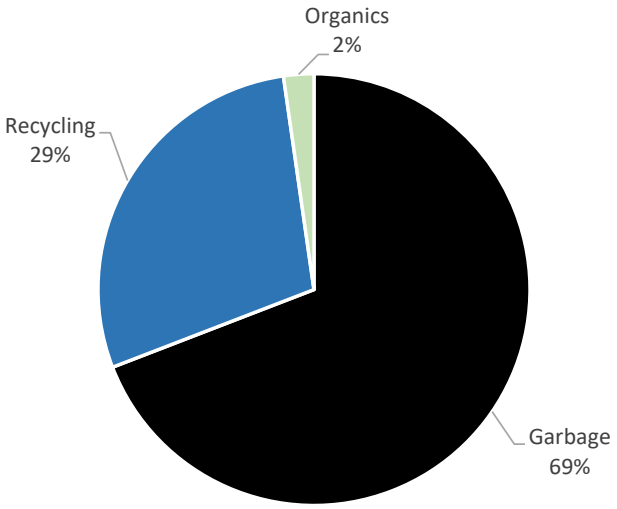
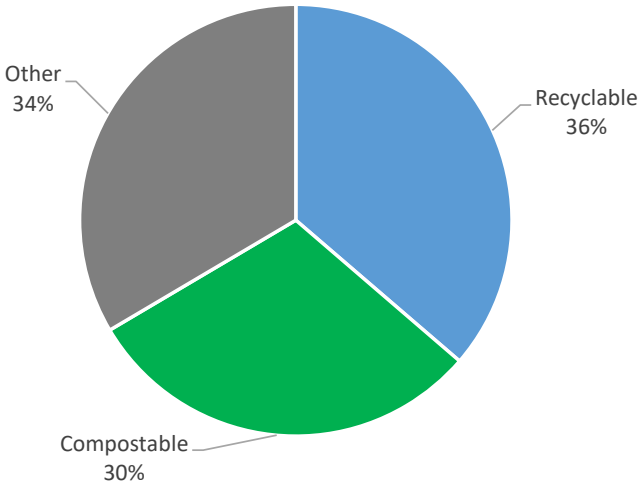


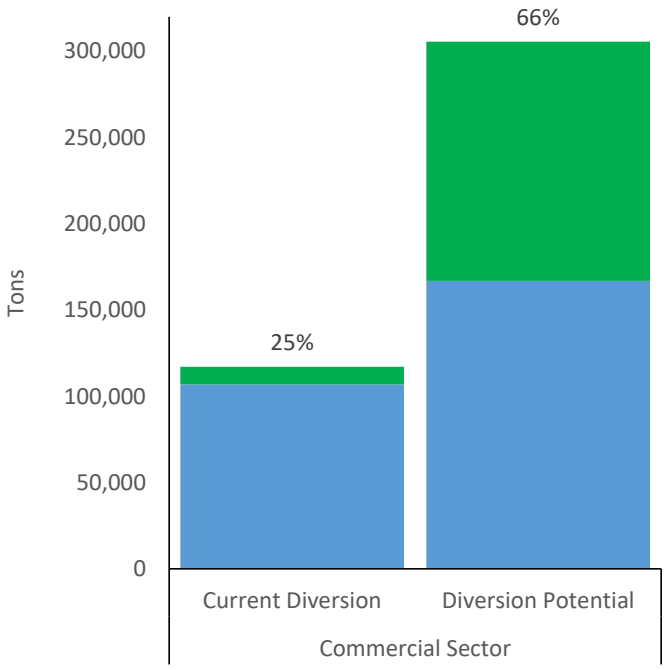

**Figure 8. Overall Commercial Generation by Recoverability**




The current commercial sector diversion rate and the potential commercial sector diversion rates are illustrated in Figure 9. The diversion rate is the proportion of total generation that is divertible material (either recyclable or compostable) placed in a diversion bin (either a recycling bin or an organics bin); the diversion rates calculated here don't consider the contamination in the recycling or organics bin as diversion. As shown, the current commercial sector diversion rate is approximately 25%. The maximum commercial sector diversion rate under current, typical, curbside diversion programs is 66%. The maximum diversion assumes that every business in the County is recycling or composting every scrap of divertible material. In practice, even the most widely recycled materials rarely exceed an 80% capture rate (the proportion of available material that makes it into a diversion container) which makes a 50% diversion rate a more achievable goal under current market and program conditions.

**Figure 9. Commercial Sector Current and Maximum Potential Diversion Rate**

Percentage indicates current or potential diversion rate, as appropriate




The five most prevalent material types in the commercial sector comprise more than half (54%) of the total generation as shown in Table 4. The two most prevalent, *OCC/Kraft* (18%) and *food* (12%) account for approximately 30% of generation. All of the five most prevalent materials are divertible in a traditional curbside program.

**Table 4. Five Most Prevalent Material Type in Commercial Generation**

| Material Type | Est. Comp. | Cum. % | Est. Tons |
|---|---|---|---|
| OCC/Kraft | 18.2% | 18.2% | 83,550 |
| Food | 11.9% | 30.1% | 67,733 |
| Mixed Recyclable Paper | 8.8% | 38.9% | 54,698 |
| Compostable/Food Soiled Paper | 8.1% | 47.0% | 37,273 |
| Yard Debris | 7.3% | 54.3% | 33,660 |
| ***Top Five Subtotal*** | ***54.3%*** | ***54.3%*** | ***276,915*** |
| All Other Materials | 45.7% | | 182,563 |
| **Total** | **100.0%** | | **459,478** |

The commercial sector generation is detailed by material type in Table 5.

**Table 5. Commercial Generation Detailed Composition**

| Material Type | Est. Comp. | Est. Tons | Material Type | Est. Comp. | Est. Tons |
|---|---|---|---|---|---|
| **Recyclable** | **36.3%** | **166,874** | **Other Materials** | **33.5%** | **153,938** |
| OCC/Kraft | 18.2% | 83,550 | Other Paper | 2.2% | 10,285 |
| Mixed Recyclable Paper | 11.9% | 54,698 | Clean Plastic Film | 1.0% | 4,383 |
| PET Containers | 0.8% | 3,714 | Durable Plastic Items | 1.2% | 5,427 |
| HDPE Containers | 0.6% | 2,816 | Other Plastic | 7.1% | 32,704 |
| #3-#7 Containers | 0.5% | 2,208 | Other Glass | 0.4% | 1,788 |
| Glass Containers | 2.2% | 10,281 | Other Metal | 1.0% | 4,691 |
| Tin/Steel Cans | 0.5% | 2,215 | Textiles | 1.9% | 8,857 |
| Other Ferrous Metal | 0.9% | 4,012 | Carpet | 0.7% | 3,319 |
| Aluminum Cans | 0.2% | 885 | Other Organic | 4.5% | 20,496 |
| Other Non-Ferrous Metal | 0.5% | 2,495 | Concrete | 0.7% | 3,308 |
| | | | Asphalt Paving | 0.3% | 1,245 |
| **Compostable** | **30.2%** | **138,666** | Asphalt Roofing | 0.3% | 1,311 |
| Compostable/Food Soiled Paper | 8.1% | 37,273 | Clean Wood | 6.6% | 30,376 |
| Food | 14.7% | 67,733 | Other C&D Debris | 3.3% | 15,085 |
| Yard Debris | 7.3% | 33,660 | E-waste | 0.7% | 3,162 |
| | | | Household Hazardous Waste | 0.2% | 891 |
| | | | Other Waste | 1.4% | 6,608 |
| | | | **Total** | **100%** | **459,478** |

# Key Findings for the Selected Business Groups

## Restaurants

The modeled restaurant generation is summarized in the following tables and figures. More than half (58%) of the restaurant generation is set out in a garbage bin, approximately 36% in a recycling bin and the remaining 6% in an organics bin (see Figure 10). As shown in Figure 11, commercial generation is nearly entirely recyclable materials and compostable materials (40% and 47% respectively). The remaining 13% is materials that aren't currently included in traditional curbside diversion programs. This implies that the maximum diversion potential of a traditional curbside diversion program is 87% (40% recyclable plus 47% compostable). This doesn't include the potential diversion from non-curbside programs (C&D recycling, tire recycling, etc.).

As for the commercial sector overall data, it is of interest that compostable materials account for 47% of restaurant group generation yet only 6% of restaurant group generation is placed in organics bins. This suggest that most of the organics diversion potential is unrealized.

**Figure 10. Restaurant Generation by Waste Stream**

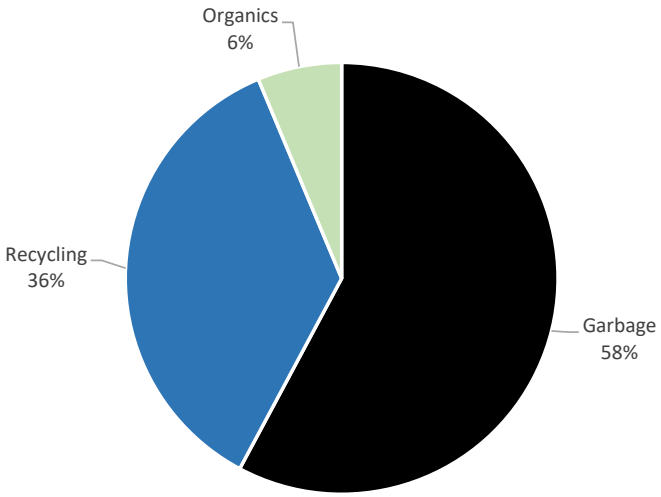
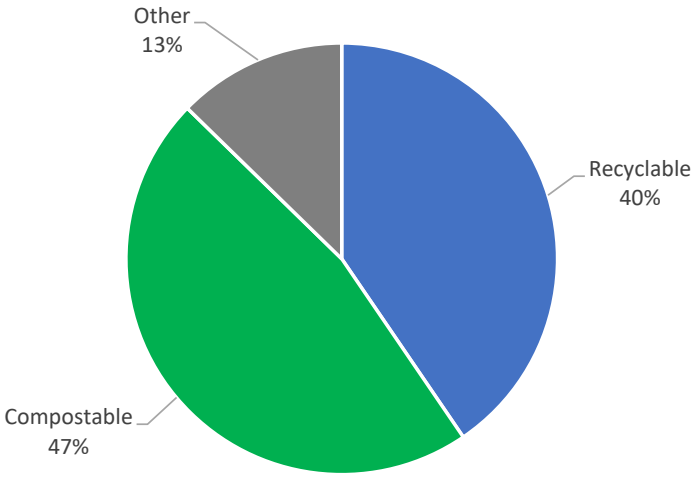
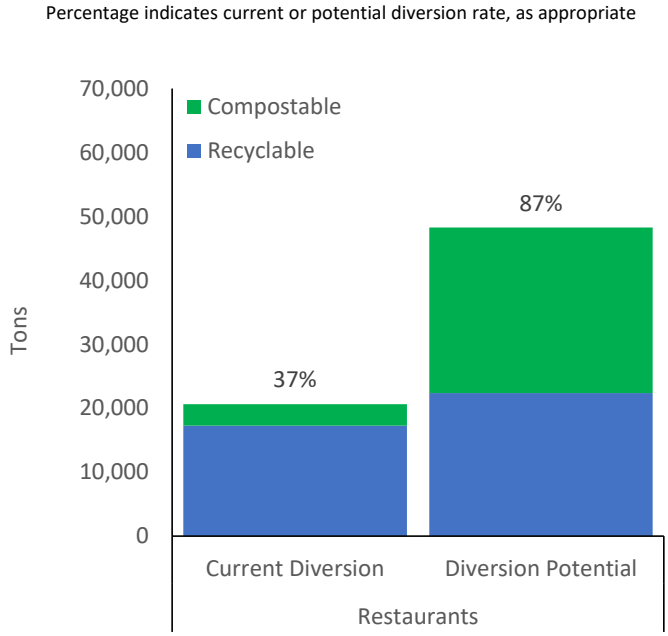



**Figure 11. Restaurant Generation by Recoverability**



The current restaurant group diversion rate and the potential restaurant group diversion rates are illustrated in Figure 12. The diversion rate is the proportion of total generation that is divertible material (either recyclable or compostable) placed in a diversion bin (either a recycling bin or an organics bin); the diversion rates calculated here don't consider the contamination in the recycling or organics bin as diversion. As shown, the current restaurant group diversion rate is approximately 37% and maximum potential curbside diversion is 87%. The maximum diversion assumes that every restaurant in the County is recycling or composting every scrap of divertible material. In practice, even the most widely recycled materials rarely exceed an 80% capture rate (the proportion of available material that makes it into a diversion container) which makes a 70% diversion rate a more achievable goal under current market and program conditions.

**Figure 12. Restaurant Current and Maximum Potential Diversion Rate**




The five most prevalent material types in the restaurant group comprise more than three quarters (76%) of the total generation as shown in Table 6. More than half (54%) of the restaurant group generation is composed of just the two most prevalent material types, *edible food* (30%) and *OCC/Kraft* (24%). Four of the five most prevalent materials are divertible in a traditional curbside program.

**Table 6. Five Most Prevalent Material Type in Restaurant Generation**

| Material Type | Est. Comp. | Cum. % | Est. Tons |
|---|---|---|---|
| Edible Food | 29.6% | 29.6% | 16,365 |
| OCC/Kraft | 24.0% | 53.6% | 13,295 |
| Non-edible Food | 7.9% | 61.5% | 4,346 |
| Compostable/Food Soiled Paper | 7.7% | 69.2% | 4,284 |
| Other Plastic | 6.6% | 75.8% | 3,653 |
| ***Top Five Subtotal*** | ***75.8%*** | ***75.8%*** | ***41,943*** |
| All Other Materials | 24.2% | | 13,357 |
| **Total** | **100.0%** | | **55,300** |

The restaurant group generation is detailed by material type in Table 7.

**Table 7. Restaurant Generation Detailed Composition**

| Material Type | Est. Comp. | Est. Tons | Material Type | Est. Comp. | Est. Tons |
|---|---|---|---|---|---|
| **Recyclable** | **40.5%** | **22,383** | **Other Materials** | **12.7%** | **7,023** |
| OCC/Kraft | 24.0% | 13,295 | Other Paper | 2.2% | 1,193 |
| Mixed Recyclable Paper | 5.8% | 3,197 | Clean Plastic Film | 0.2% | 84 |
| PET Containers | 1.4% | 748 | Durable Plastic Items | 0.5% | 273 |
| HDPE Containers | 1.3% | 742 | Other Plastic | 6.6% | 3,653 |
| #3-#7 Containers | 0.5% | 300 | Other Glass | 0.2% | 101 |
| Glass Containers | 5.5% | 3,058 | Other Metal | 0.2% | 92 |
| Tin/Steel Cans | 1.4% | 761 | Textiles | 0.5% | 258 |
| Other Ferrous Metal | 0.2% | 120 | Carpet | 0.0% | 0 |
| Aluminum Cans | 0.2% | 94 | Other Organic | 0.9% | 497 |
| Other Non-Ferrous Metal | 0.1% | 67 | Concrete | 0.0% | 0 |
| | | | Asphalt Paving | 0.0% | 0 |
| **Compostable** | **46.8%** | **25,895** | Asphalt Roofing | 0.0% | 0 |
| Compostable/Food Soiled Paper | 7.7% | 4,284 | Clean Wood | 0.7% | 394 |
| Edible Food | 29.6% | 16,365 | Other C&D Debris | 0.1% | 40 |
| Non-edible Food | 7.9% | 4,346 | E-waste | 0.0% | 10 |
| Yard Debris | 1.6% | 900 | Household Hazardous Waste | 0.0% | 4 |
| | | | Other Waste | 0.8% | 425 |
| | | | **Total** | **100%** | **55,300** |

## Services-Management

The modeled services-management group generation is summarized in the following tables and figures. More than half (51%) of the services-management generation is set out in a garbage bin, approximately 42% in a recycling bin and the remaining 7% in an organics bin (see Figure 13). As shown in Figure 14, services-management generation is nearly half compostable materials (45%) and the remainder is nearly evenly split between recyclable materials and other materials (29% and 26%, respectively). This implies that the maximum diversion potential of a traditional curbside diversion program is 74% (29% recyclable and 45% compostable). This doesn't include the potential diversion from non-curbside programs (C&D recycling, tire recycling, etc.).

Similar to the commercial group overall and the restaurant group, it appears that most of the services-management group organics diversion potential is unrealized. As illustrated in these two figures, compostable materials account for 45% of services-management group generation yet only 7% of services-management group generation is placed in organics bins.

**Figure 13. Services-Management Generation by Waste Stream**

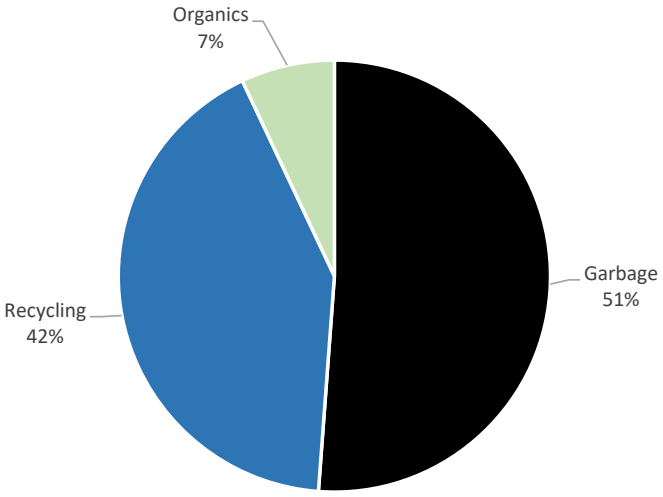
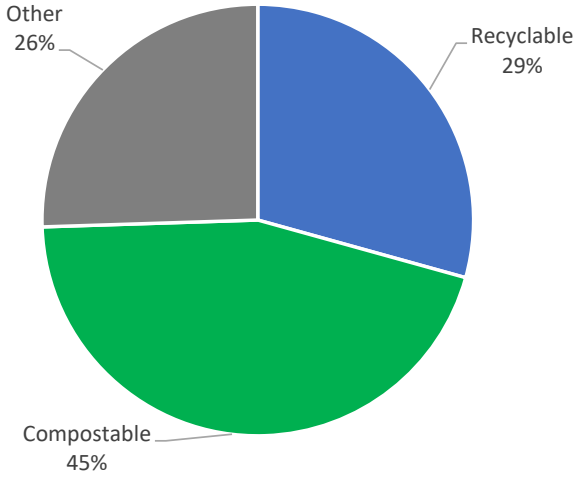
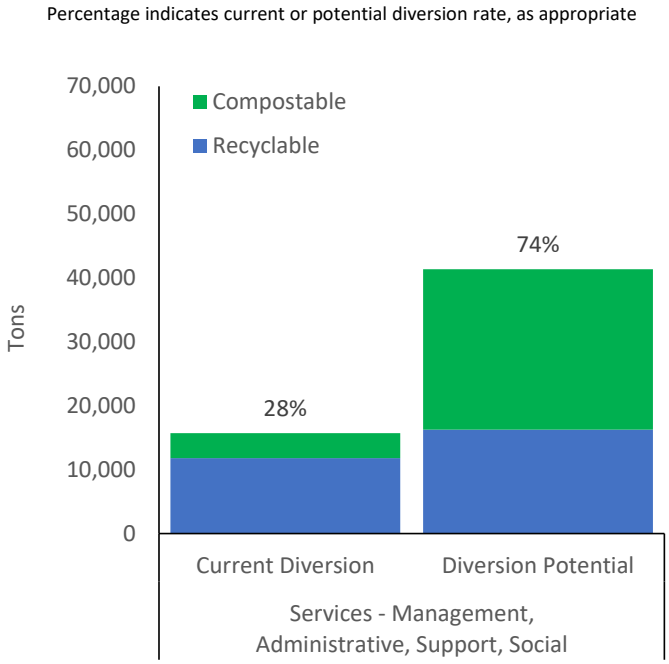



**Figure 14. Services-Management Generation by Recoverability**




The current services-management group diversion rate and the potential services-management group diversion rates are illustrated in Figure 15. The diversion rate is the proportion of total generation that is divertible material (either recyclable or compostable) placed in a diversion bin (either a recycling bin or an organics bin); the diversion rates calculated here don't consider the contamination in the recycling or organics bin as diversion. As shown, the current services-management group diversion rate is approximately 28% and maximum potential curbside diversion is 74%. The maximum diversion assumes that every services-management business in the County is recycling or composting every scrap of divertible material. In practice, even the most widely recycled materials rarely exceed an 80% capture rate (the proportion of available material that makes it into a diversion container) which makes a 60% diversion rate a more achievable goal under current market and program conditions.

**Figure 15. Services-Management Current and Maximum Potential Diversion Rate**




The five most prevalent material types in the Services-Management group comprise more than three-quarters (76%) of the total generation as shown in Table 8. More than half (53%) of the Services-Management group generation is composed of just the two most prevalent material types, *yard debris* (30%) and *mixed recyclable paper* (24%). Landscapers are included in this group which is the source of the unusually high proportion of *yard debris* in this business group. All of the five most prevalent materials are divertible in a traditional curbside program.

**Table 8. Five Most Prevalent Material Type in Services - Management Generation**

| Material Type | Est. Comp. | Cum. % | Est. Tons |
|---|---|---|---|
| Yard Debris | 29.5% | 29.5% | 13,853 |
| Mixed Recyclable Paper | 23.9% | 53.4% | 8,074 |
| OCC/Kraft | 7.8% | 61.2% | 5,787 |
| Edible Food | 7.7% | 68.9% | 4,784 |
| Compostable/Food Soiled Paper | 6.6% | 75.5% | 4,686 |
| ***Top Five Subtotal*** | ***75.5%*** | ***75.5%*** | ***37,184*** |
| All Other Materials | 24.5% | | 18,360 |
| **Total** | **100.0%** | | **55,544** |

The Services-Management group generation is detailed by material type in Table 9.

**Table 9. Services-Management Generation Detailed Composition**

| Material Type | Est. Comp. | Est. Tons | Material Type | Est. Comp. | Est. Tons |
|---|---|---|---|---|---|
| **Recyclable** | **29.3%** | **16,278** | **Other Materials** | **25.5%** | **14,168** |
| OCC/Kraft | 10.4% | 5,787 | Other Paper | 1.8% | 1,000 |
| Mixed Recyclable Paper | 14.5% | 8,074 | Clean Plastic Film | 1.1% | 586 |
| PET Containers | 0.8% | 466 | Durable Plastic Items | 1.1% | 634 |
| HDPE Containers | 0.4% | 196 | Other Plastic | 5.4% | 3,015 |
| #3-#7 Containers | 0.4% | 233 | Other Glass | 0.4% | 203 |
| Glass Containers | 0.9% | 526 | Other Metal | 0.8% | 466 |
| Tin/Steel Cans | 0.8% | 420 | Textiles | 2.8% | 1,580 |
| Other Ferrous Metal | 0.3% | 188 | Carpet | 0.2% | 101 |
| Aluminum Cans | 0.2% | 116 | Other Organic | 5.2% | 2,861 |
| Other Non-Ferrous Metal | 0.5% | 271 | Concrete | 0.1% | 59 |
| | | | Asphalt Paving | 0.0% | 0 |
| **Compostable** | **45.2%** | **25,099** | Asphalt Roofing | 0.0% | 1 |
| Compostable/Food Soiled Paper | 8.4% | 4,686 | Clean Wood | 3.1% | 1,738 |
| Edible Food | 8.6% | 4,784 | Other C&D Debris | 1.1% | 629 |
| Non-edible Food | 3.2% | 1,776 | E-waste | 1.5% | 838 |
| Yard Debris | 24.9% | 13,853 | Household Hazardous Waste | 0.1% | 43 |
| | | | Other Waste | 0.7% | 414 |
| | | | **Total** | **100%** | **55,544** |

## Phase Two: Quantify Generation

The field teams collected 210 container measurements from the 21 recruited businesses. All 21 businesses had garbage and recycling service, three of the businesses had organics service. The number of container measurements is summarized in Table 10.

**Table 10. Number of Accumulation Measurements by Group and Stream**

| | Garbage | Recycle | Organics | Total |
|---|---|---|---|---|
| **Restaurants** | 42 | 67 | 12 | **121** |
| **Services - Management** | 41 | 42 | 6 | **89** |
| **Total** | **83** | **109** | **18** | **210** |

Based on the accumulation measurements, restaurants in King County place a much larger proportion (24% vs 1%) of their waste in an organics bin than do restaurants in California. King County restaurants also place a much larger proportion (17% vs 8%) of their waste in a recycling bin than do restaurants in California. Similarly, services – management businesses in King County place a much larger proportion of their waste in a recycling bin than do services – management businesses in California. The phase two findings are summarized in Figure 16 and Figure 17.

**Figure 16. Proportion of Restaurant Waste in the Garbage, Recycle, and Organics Streams**

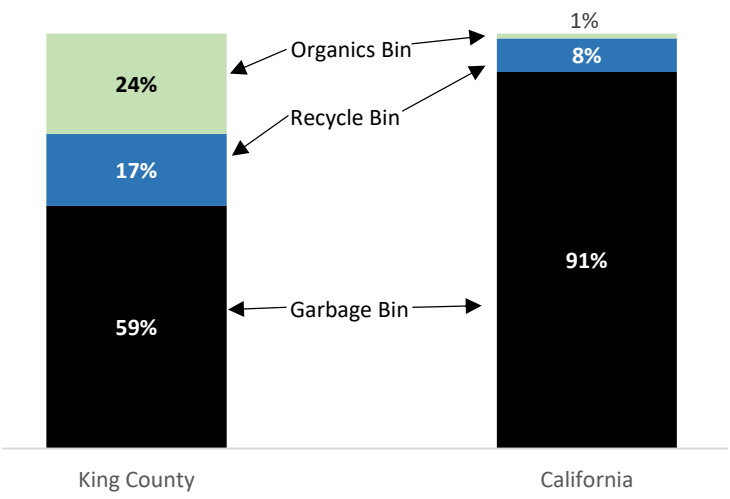
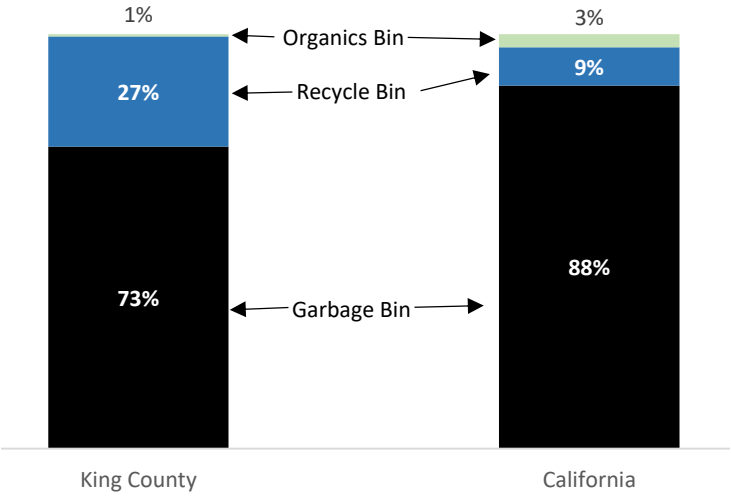



**Figure 17. Proportion of Services – Management Waste in the Garbage, Recycle, and Organics Streams**



# Phase Three: FLW Sorts

The field crew sorted the waste generated during two 24 hour periods from each of the eight businesses recruited to participate in phase three. The field crew sorted nearly 1,500 pounds of waste in total, primarily garbage. The quantity of waste sorted is summarized in Table 11.

**Table 11. Pounds sorted by Business Group and Stream**

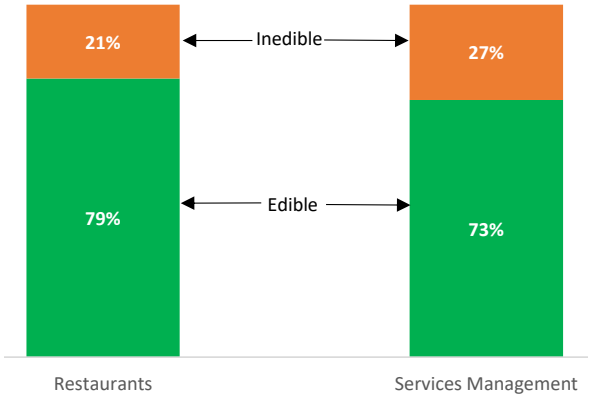
| | Garbage | Recycle | Organics | Total |
|---|---|---|---|---|
| **Restaurants** | 655 | 109 | 116 | **881** |
| **Services - Management** | 532 | 52 | 11 | **595** |
| **Total** | **1,187** | **161** | **127** | **1,476** |

The composition data for each business group and stream is summarized in Table 12. More than 55% of the disposed waste from restaurants is food. For both business groups, food was less than one percent of the recycling stream.

**Table 12. Composition by Business Group and Stream**

| | | GARBAGE | | RECYCLING | | ORGANICS | |
|---|---|---|---|---|---|---|---|
| | | Est. % | + / - | Est. % | + / - | Est. % | + / - |
| **Restaurants** | Edible Food | 45.6% | 10.5% | 0.0% | 0.0% | 40.2% | 61.1% |
| | Inedible food | 10.3% | 3.2% | 0.1% | 0.2% | 7.7% | 39.9% |
| | Other Materials | 44.1% | 9.6% | 99.9% | 0.2% | 52.2% | 21.2% |
| | *Sample Counts* | *8* | | *8* | | *2* | |
| **Services - Management** | Edible Food | 14.2% | 3.2% | 0.1% | 0.2% | 0.0% | NA |
| | Inedible food | 5.5% | 3.1% | 0.0% | 0.0% | 0.0% | NA |
| | Other Materials | 80.3% | 5.5% | 99.9% | 0.2% | 100.0% | NA |
| | *Sample Counts* | *8* | | *8* | | *1* | |

**Figure 18. Proportion of Edible and Inedible Food Loss and Waste**




The primary purpose of phase three was to estimate the proportion of FLW that is edible. Edible is defined by the WRI as *"… the components of food that, in a particular food supply chain, are intended to be consumed by humans. What is considered edible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography."*[8] For both selected business groups, edible food was approximately ¾ of the food waste. The phase three findings are summarized in Figure 18. This indicates that a great majority of the food disposed was intended for consumption and was wasted, either through inventory mismanagement, food prep wastage, or excessive portion sizes.

[8] The WRI protocol can be accessed at http://www.wri.org/sites/default/files/REP_FLW_Standard.pdf

# 3. Summary of Technical Assistance Best Practices

This section provides a summary of strategies King County businesses may take to start or improve recycling and organics diversion programs at their business. These strategies were identified through years of conducting technical assistance and outreach to improve recycling programs at thousands of businesses across the US. The strategies fall into these basic steps, outlined in the next section:

1. Choose a Recycling Program Coordinator
2. Research Collection Service and Select Materials to Include in Your Program
3. Select a Collection Service Provider and Determine Your Ideal Service Level
4. Set Up a Collection System
5. Educate your Team
6. Monitor, Evaluate, and Expand Your Program

There may be opportunities for the King County Solid Waste Division to work with local recycling coordinators and garbage, recycling, and organics collection service providers to support businesses with implementing these strategies. Implementation assistance may include offering onsite support, crafting community-based social marketing (CBSM) campaigns to promote specific steps or behaviors, or the development of incentive programs such as offering free collection bins or educational signage

## Choose a Recycling Program Coordinator

- **Select a program coordinator to lead the program.** The coordinator should be enthusiastic, organized, and have good rapport with the team. Previous recycling knowledge is useful, though not required. The coordinator will be responsible for ensuring that each of the following steps are assigned and completed.

## Research Collection Service and Select Materials to Include in Your Program

- **Review your current waste bills** to determine your current collection service provider, understand what services you are currently signed up for, and calculate the costs associated with those services.
- **Determine recycling service options** by contacting your current garbage collection service provider, your city's solid waste or public works department, King County Solid Waste Division, or your property manager. Your city may have specific requirements for recycling and organics collection and may work with one or multiple collection service providers.
- **Ask recycling collection service provider**(s) in your area about their service levels, costs of service, and which waste items could be included in a recycling program.
- **Conduct an inventory of items at your location** and where they are usually found in different areas of your facility. This will help you match your recycling needs with available services.
- **Decide which recyclable materials to include in your program**. You can discuss this list with the service provider you select to confirm that they will collect the materials you want to include.

## Select a Collection Service Provider and Determine Your Ideal Service Level

- **Select a collection service provider.** If possible, schedule an on-site meeting with your service provider to confirm which items can be included in the recycling and how to collect them (all together, in separate bins, etc.). Your service provider will also review the different sizes of containers available to collect waste outside your business.
- **Ask your service provider to conduct a visual waste audit** to estimate the volume of recyclable material in your waste stream to help you calculate the service levels you need to capture that material.
- **If they cannot provide an audit, conduct your own audit** using a free do-it-yourself audit tool such as the Seattle Public Utilities Business Waste Assessment tool.
- **Choose service levels that maximize the collection of recyclable and compostable material** found in your waste stream and minimize your collection costs. Collections services for recyclables and organics are almost always less expensive than garbage collection service costs in King County. The recycling and organics service level you request should accommodate the quantity and types of materials generated by any tenants, employees, contractors, and customers at your business. You can adjust your service level by changing the number or size of collection containers and the frequency of service for each stream.
- **Ask your service provider if they provide internal collection bins** and training for staff.

## Set Up a Collection System

- **Decide which areas to collect materials** for recycling inside your business.
- **Identify appropriate bin locations, types, and sizes** using these guidelines:
    - Identify places where waste is generated such as office workstations, staff or customer dining areas, conference or meeting rooms, loading docks, copy rooms, etc. Proper bin placement can increase diversion, reduce contamination, and maximize cost savings.
    - Establish an easy-to-understand color-coded system for bins and signage such as green for organics, blue for recycling, and gray or black for garbage.
    - Pair organics collection containers next to garbage and recycling containers to create a three-stream collection system.
- **Acquire bins from your service provider** or order needed bins and liners.
- **Label the individual containers** with visuals that show which items go into each bin and post visible signage above the containers at eye-level. Create custom signage using materials found onsite at your business wherever possible. Laminate the signage for easy cleaning.
- **Outline a plan and schedule for staff** responsible for maintaining bins and bin stations. This includes emptying bins and replacing liners, and cleaning up bin stations.

## Educate your Team

- **Schedule an initial training session**(s) to formally kick off the program. The training should cover bin labels and signage, internal bin placement and collection procedures, and external collection bin placement. Training materials should be available in all languages spoken by staff.
- **Create a regular training program** for employees and janitorial staff to address issues and questions about certain materials or other program components.

- **Include information on the collection program** in new employee orientation materials and in any customer areas that have collection bins.

## Monitor, Evaluate, and Expand Your Program

- **Review your recycling, organics, and garbage collection service bills** and track weights or volumes of each material stream.
- **Conduct basic visual waste audits regularly** after implementation to gauge success and gather information about materials that are still not being recycled.
- **Expand your program to include additional material**, or establish programs for other types of materials, including hazardous materials like fluorescent lamps and batteries.
- **Share your success with staff, customers, and any other business locations**. Sign up for recognition through EnviroStars.
- **Take steps to minimize or reduce waste** such as:
    - Reduce paper and maximize office efficiencies by using paper wisely. Set printers to default to double-sided (duplex) printing.
    - Stop junk mail.
    - Prevent food waste through better purchasing, storage, and food preparation practices.
    - Donate surplus food – It's legal, safe, and easy.
    - Select products that are reusable, refillable, and more durable or repairable.
    - Recycle, sell, or donate surplus materials through these regional groups: Take It Back Network, LinkUp, and Industry Materials Exchange (IMEX).
- **Adopt green-purchasing practices such as:**
    - Find Green Seal certified and EPA Safer Choice-labeled products and services.
    - Purchase recycled-content substitutes to close the loop by driving market demand for remanufacturing recyclable materials.
    - Buy less hazardous products to reduce regulatory liability, improve workers' safety, and lower disposal costs.

# 4. Model User Guide

## Data Sources

The model draws on several data sources. The composition for each stream and business group is based on the 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California.[9] The normalized tons-per-employee-per-year (TPEPY) is also based on the 2014 CalRecycle study. The number of employees in each business group and jurisdiction is based on employment data purchased from a private business data provider and correlated with data from the U.S. Census. Actual garbage, recycling, and organics tons are provided by the SWD.

For the two selected business groups, the CalRecycle composition and TPEPY data is supplemented with the additional data collected during the phase two and phase three field work.

[9] This study is available at http://www.calrecycle.ca.gov/Publications/Documents/1543/20151543.pdf

## User Defined Fields

When using the model the user may update which jurisdictions to include in the calculations and may update the actual waste quantities for each of the jurisdictions. In addition the user may change the recoverability group (recycle, organics, other) each material is assigned to. The model will automatically incorporate these updates when running the calculations.

## Hard Coded Data Elements

Most of the model data inputs are hard coded and not easily updated. The hard coded data elements include: the composition data, the TPEPY data, and the employment data.

## Calculations

The modeling involves five calculation steps. These are detailed in Phase 1 Methodology and an example of each calculation is presented below. These examples illustrate how the model would function with two jurisdictions, two business groups, three streams, and two material types. The actual model includes 38 jurisdictions, 16 business groups, three streams, and 30 material types.

1. **Model the Quantity of Waste by Business Group and Stream.** Cascadia multiplied the number of employees in each of 16 business groups in each jurisdiction by the associated tons-per-employee-per-year (TPEPY) factors. The TPEPYs used for the restaurant and services-management business groups are updated based the phase two data collected as part of this study.

$$TonsE \quad = TPEPY_{g,s} * Employment_{j,g}$$

where:

*g* represents a business group
*s* represents a waste stream
*j* represents a jurisdiction

**Table 13. Example Calculation for Estimating Tons by Jurisdiction, Business Group, and Stream**

| Jurisdiction | Business Group | Stream | TPEPY | # of Employees | Estimated Tons |
|---|---|---|---|---|---|
| A | 1 | Garbage | 2.74 | 5,630 | 15,426 |
| A | 1 | Recycling | 0.73 | 6,849 | 5,000 |
| A | 1 | Organics | 0.25 | 4,561 | 1,140 |
| A | 2 | Garbage | 1.42 | 2,472 | 3,510 |
| A | 2 | Recycling | 0.19 | 8,962 | 1,703 |
| A | 2 | Organics | 0.33 | 5,168 | 1,705 |
| B | 1 | Garbage | 2.74 | 3,599 | 9,861 |
| B | 1 | Recycling | 0.73 | 2,352 | 1,717 |
| B | 1 | Organics | 0.25 | 4,127 | 1,032 |
| B | 2 | Garbage | 1.42 | 3,876 | 5,504 |
| B | 2 | Recycling | 0.19 | 2,709 | 515 |
| B | 2 | Organics | 0.33 | 2,211 | 730 |

2. **Create Waste Scaling Factors.** Cascadia summed the modeled waste for each business group and jurisdiction to calculate a waste estimates for each city and stream. We then compared this estimate to the commercial waste data provided by the SWD to calculate a scaling factor. This factor is used in a later step to adjust the modeled waste quantities to match the quantities provided by the SWD.

$$Scaling\ Factor = \frac{TonsE}{TonsA}$$

**Table 14. Example Scaling Factors by Jurisdiction and Stream**

| Jurisdiction | Stream | Estimated Tons | Actual Tons | Scaling Factor |
|---|---|---|---|---|
| A | Garbage | 18,936 | 14,527 | 0.767 |
| A | Recycling | 6,703 | 5,124 | 0.765 |
| A | Organics | 2,846 | 3,664 | 1.287 |
| B | Garbage | 15,365 | 15,368 | 1.000 |
| B | Recycling | 2,232 | 2,939 | 1.317 |
| B | Organics | 1,761 | 1,760 | 0.999 |

3. **Model the Composition of Waste by Business Group.** Cascadia multiplied the composition data for each business group (also calculated as part of the 2014 CalRecycle study) by the modeled waste quantities associated with each business group. The food data is further broken into edible and inedible food for the restaurant and services-management business groups based on the data collected in phase three of this project.

$$TonsEM_{s,g,j} = TonsE_{s,g,j} * Composition_{m,s,g}$$

where:

*g* represents a business group
*s* represents a waste stream
*j* represents a jurisdiction

**Table 15. Estimate Composition by Jurisdiction, Stream, and Material Type**

| Jurisdiction | Business Group | Stream | Material Type | Composition | Estimated Tons |
|---|---|---|---|---|---|
| A | 1 | Garbage | A | 72% | 11,066 |
| A | 1 | Garbage | B | 28% | 4,360 |
| A | 1 | Recycling | A | 61% | 3,061 |
| A | 1 | Recycling | B | 39% | 1,938 |
| A | 1 | Organics | A | 55% | 632 |
| A | 1 | Organics | B | 45% | 508 |
| A | 2 | Garbage | A | 81% | 2,844 |
| A | 2 | Garbage | B | 19% | 666 |
| A | 2 | Recycling | A | 14% | 230 |
| A | 2 | Recycling | B | 86% | 1,473 |
| A | 2 | Organics | A | 72% | 1,232 |
| A | 2 | Organics | B | 28% | 474 |
| B | 1 | Garbage | A | 72% | 7,074 |
| B | 1 | Garbage | B | 28% | 2,787 |
| B | 1 | Recycling | A | 61% | 1,051 |
| B | 1 | Recycling | B | 39% | 666 |
| B | 1 | Organics | A | 55% | 572 |
| B | 1 | Organics | B | 45% | 460 |
| B | 2 | Garbage | A | 81% | 4,459 |
| B | 2 | Garbage | B | 19% | 1,045 |
| B | 2 | Recycling | A | 14% | 70 |
| B | 2 | Recycling | B | 86% | 445 |
| B | 2 | Organics | A | 72% | 527 |
| B | 2 | Organics | B | 28% | 203 |

4. **Scale the Modeled Quantity and Composition.** The modeled quantities by material type in each business group were then multiplied by the scaling factor calculated in step 2. This created an estimated waste quantity (in tons) for each material type in each business group in each jurisdiction.

$$TonsCM_{s,g,j} = TonsEM_{s,g,j} * Scaling\ Factor_{j,s}$$

where:

*g* represents a business group
*s* represents a waste stream
*j* represents a jurisdiction

**Table 16. Scaled Tons by Jurisdiction, Stream, and Material Type**

| Jurisdiction | Business Group | Stream | Material Type | Estimated Tons | Scaling Factor | Scaled Tons |
|---|---|---|---|---|---|---|
| A | 1 | Garbage | A | 11,066 | 0.767 | 8,489 |
| A | 1 | Garbage | B | 4,360 | 0.767 | 3,345 |
| A | 1 | Recycling | A | 3,061 | 0.765 | 2,341 |
| A | 1 | Recycling | B | 1,938 | 0.765 | 1,482 |
| A | 1 | Organics | A | 632 | 1.287 | 814 |
| A | 1 | Organics | B | 508 | 1.287 | 654 |
| A | 2 | Garbage | A | 2,844 | 1.000 | 2,844 |
| A | 2 | Garbage | B | 666 | 1.000 | 667 |
| A | 2 | Recycling | A | 230 | 1.317 | 303 |
| A | 2 | Recycling | B | 1,473 | 1.317 | 1,940 |
| A | 2 | Organics | A | 1,232 | 0.999 | 1,231 |
| A | 2 | Organics | B | 474 | 0.999 | 473 |
| B | 1 | Garbage | A | 7,074 | 1.528 | 10,809 |
| B | 1 | Garbage | B | 2,787 | 1.528 | 4,259 |
| B | 1 | Recycling | A | 1,051 | 0.831 | 874 |
| B | 1 | Recycling | B | 666 | 0.831 | 553 |
| B | 1 | Organics | A | 572 | 0.871 | 498 |
| B | 1 | Organics | B | 460 | 0.871 | 401 |
| B | 2 | Garbage | A | 4,459 | 1.946 | 8,676 |
| B | 2 | Garbage | B | 1,045 | 1.946 | 2,034 |
| B | 2 | Recycling | A | 70 | 0.984 | 68 |
| B | 2 | Recycling | B | 445 | 0.984 | 438 |
| B | 2 | Organics | A | 527 | 1.587 | 836 |
| B | 2 | Organics | B | 203 | 1.587 | 322 |

5. **Estimate Composition of Waste Countywide.** In the final step, the business-specific waste quantities calculated in Step 4 were summed across business groups and jurisdictions to generate total estimated quantities for each material type in each stream countywide.

$$TonsCM_s = \sum_{g,j} TonsCM_{s,g,j}$$

where:

*g* represents a business group
*s* represents a waste stream
*j* represents a jurisdiction

for:

*g*=1 to n, where n=the number of business groups in the model
*j*=1 to m, where m=the number of jurisdictions in the model

**Table 17. Scaled Tons Countywide by Stream, and Material Type**

| Jurisdiction | Stream | Material Type | Scaled Tons |
|---|---|---|---|
| Countywide | Garbage | A | 30,819 |
| Countywide | Garbage | B | 10,304 |
| Countywide | Recycling | A | 3,585 |
| Countywide | Recycling | B | 4,413 |
| Countywide | Organics | A | 3,379 |
| Countywide | Organics | B | 1,850 |

## Modeling Outputs

By default the model calculates the quantity by material type for each business group, jurisdiction, and waste stream and the sum waste streams (the generation). Using these standard outputs a myriad of visualizations can be readily created. Several are built into the model including a visualization of:

- the proportion of waste by stream for each business group,
- the proportion of waste by stream for each of the three defined recoverability groups, and
- the proportion of food waste by stream for each business group.

# 5. Appendices

## Appendix A: Business Group Detail

Each of the 16 business groups included in the model is based on the North America Industrial Classification System (NAICS) codes. The NAICS codes and industry name included in each business group are summarized in Table 18.

**Table 18. Business Groups and the included NAICS Codes**

| Group Number | Included NAICS Codes | Industry |
|---|---|---|
| **1** | | **Arts, Entertainment, & Recreation** |
| | 711 | Performing Arts & Spectator Sports |
| | 712 | Museums, Historical Sites & Similar |
| | 713 | Gambling, Recreation, Amusement |
| **2** | | **Durable Wholesale & Trucking** |
| | 423 | Durable Goods Wholesalers |
| | 484 | Truck Transportation |
| | 491 | Postal Service |
| | 492 | Couriers & Messangers |
| | 493 | Warehousing & Storage |
| **3** | | **Education** |
| | 611 | Educational Services |
| **4** | | **Hotels & Lodging** |
| | 721 | Accommodation |
| **5** | | **Manufacturing - Electronic Equipment** |
| | 334 | Computer & Electronic Products |
| | 335 | Electrical Equipment & Appliances |
| **6** | | **Manufacturing - Food & Nondurable Wholesale** |
| | 311 | Food Manufacturing |
| | 312 | Beverage & Tobacco Products |
| | 424 | Nondurable Goods Wholesalers |

**Table 18. Business Groups and the included NAICS Codes, continued**

| Group Number | Included NAICS Codes | Industry |
|---|---|---|
| **7** | | **Manufacturing - All Other** |
| | 313 | Textile Mills |
| | 314 | Textile Product Mills |
| | 315 | Apparel Manufacturing |
| | 316 | Leather & Allied Products |
| | 321 | Wood Products |
| | 322 | Paper Products |
| | 323 | Printing & Related Support Activities |
| | 324 | Petroleum & Coal Products |
| | 325 | Chemical Products |
| | 326 | Plastics & Rubber Products |
| | 327 | Nonmetallic Mineral Products |
| | 331 | Primary Metal Manufacturing |
| | 332 | Fabricated Metal Products |
| | 333 | Machinery |
| | 336 | Transportation Equipment |
| | 337 | Furniture & Related Products |
| | 339 | Miscellaneous Manufacturing |
| | 511 | Publishing Industries, except Internet |
| **8** | | **Medical & Health** |
| | 621 | Ambulatory Health Care Services |
| | 622 | Hospitals |
| | 623 | Nursing & Residential Care Facilities |
| **9** | | **Public Administration** |
| | 92X | Public Administration |
| **10** | | **Restaurants** |
| | 722 | Food Services & Drinking Places |
| **11** | | **Retail Trade - Food & Beverage Stores** |
| | 445 | Food & Beverage Stores |

**Table 18. Business Groups and the included NAICS Codes, continued**

| Group Number | Included NAICS Codes | Industry |
|---|---|---|
| **12** | | **Retail Trade - All Other** |
| | 441 | Motor Vehicle & Parts Dealers |
| | 442 | Furniture & Home Furnishings |
| | 443 | Electronics & Appliance Stores |
| | 446 | Health & Personal Care Stores |
| | 447 | Gasoline Stations |
| | 448 | Clothing & Clothing Accessories |
| | 451 | Sporting Goods, Hobby, Books, Music |
| | 452 | General Merchandise Stores |
| | 453 | Miscellaneous Store Retailers |
| | 454 | Nonstore Retailers |
| **13** | | **Services - Management, Administrative, Support, & Social** |
| | 425 | Electronic Markets, Agents, Brokers |
| | 551 | Management of Companies & Enterprises |
| | 561 | Administrative & Support Services |
| | 624 | Social Assistance |
| | 813 | Religious, Civic, Professional & Similar |
| **14** | | **Services - Professional, Technical, & Financial** |
| | 515 | Broadcasting, except Internet |
| | 517 | Telecommunications |
| | 518 | Data Processing, Hosting & Related |
| | 519 | Other Information Services |
| | 521 | Monetary Authorities - Central Bank |
| | 522 | Credit Intermediation & Related |
| | 523 | Financial Investment & Related |
| | 524 | Insurance Carriers & Related Activity |
| | 525 | Funds, Trusts, Other Financial Vehicles |
| | 531 | Real Estate |
| | 532 | Rental & Leasing Services |
| | 533 | Lessors of Nonfinancial Intangible Assets |
| | 541 | Professional & Technical Services |

**Table 18. Business Groups and the included NAICS Codes, continued**

| Group Number | Included NAICS Codes | Industry |
|---|---|---|
| **15** | | **Services - Repair & Personal** |
| | 811 | Repair & Maintenance |
| | 812 | Personal & Laundry Services |
| **16** | | **Not Elsewhere Classified** |
| | 111 | Crop Production |
| | 112 | Animal Production |
| | 113 | Forestry & Logging |
| | 114 | Fishing, Hunting & Trapping |
| | 115 | Agriculture & Forestry Support Activities |
| | 211 | Oil & Gas Extraction |
| | 212 | Mining, except Oil & Gas |
| | 213 | Support Activities for Mining |
| | 22X | Utilities |
| | 444 | Building Materials & Garden Supplies |
| | 481 | Air Transportation |
| | 482 | Rail Transportation |
| | 483 | Water Transportation |
| | 485 | Transit & Ground Passenger Transport |
| | 486 | Pipeline Transportation |
| | 487 | Scenic & Sightseeing Transportation |
| | 488 | Support Activities for Transportation |
| | 512 | Motion Picture & Sound Recording |
| | 562 | Waste Management & Remediation Services |