King County Solid Waste Division

Organics Study

Final Report

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King County

Department of
Natural Resources and Parks

Solid Waste Division

Prepared by:

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 2009 organics characterization study is intended to measure the composition of material collected by organics service programs throughout the county as well as estimate the set out rate, participation rate, and capture rate. This study uses a methodology refined from the 2007 study and provides limited comparability between the two studies.

In 2009 the consultant team surveyed 20 organics routes per season and collected more than 400 samples from areas of the County where combined yard waste/food scraps organics service is currently available. The data collection occurred over two seasons; the first sampling event occurred during the last week of April and the second occurred during the last week of August. Samples of material were sorted into 17 *material types* by a sorting crew at Cedar Grove in Maple Valley. The major change to the methods is a switch from collecting samples from route trucks to collecting samples directly from carts at the curbside.

The study estimated the proportion of subscribers putting a cart out for collection, the proportion of carts that contain food, and the average quantity of food scraps set out by each participating household, as well as characterized the contents of the carts.

Key Findings

Figure 1 and Table 1 provide a summary analysis of the organics material stream. Both seasons' samples were combined when calculating the findings.

Key findings include

- The majority (about 88%) of all organic material is *yard debris*.
- The Food and Compostable Paper material classes comprise more than 7% of all organic material.
- About two thirds (63%) of households in the county subscribe to organics service.
- Nearly half (49%) of subscribers set out a collection bin during the study period.
- Approximately 24% of subscribers include food scraps in their set out.
- The participation rate for all households in the county is approximately 15%.
- Approximately 50% of set outs contain food scraps.
- The average participant includes approximately 35 pounds of food scraps and compostable paper per month in their organics service container.
- The food scraps and compostable paper capture rate for participants is approximately 77%.

Figure 1: Organic Material Composition by Material Class

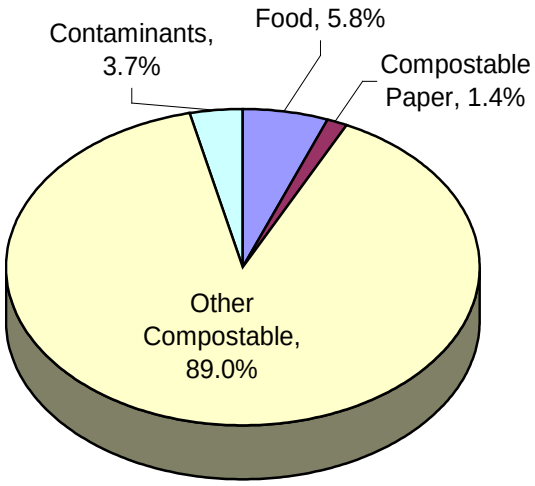


Table 1: Organics Analysis Summary

	Subscription Rate	Set Out Rate	Participation Rate	Pounds of Food Scraps and Compostable Paper Collected	Capture Rate
Per Household	63%	31%	15%	5.4	11.9%
Per Subscriber	100%	49%	24%	8.5	18.9%
Per Set Out	100%	100%	50%	17.3	38.5%
Per Participant	100%	100%	100%	34.9	77.4%

INTRODUCTION

In 2009, King County conducted a countywide composition study of the curbside organic service as part of its ongoing waste monitoring program. The study estimated the proportion of subscribers putting a cart out for collection, the proportion of carts that contain food, and the average quantity of food scraps set out by each participating household, as well as characterized the contents of the carts. The study is intended to update the baseline composition of material collected from organics routes throughout King County using a methodology refined from the 2007 study.

SUMMARY OF METHODS

This study collected route data and samples from 20 organics routes in each of two seasons from areas of the County with organics service. The data collection occurred during the last week of April and the last week of August. More than 400 samples were sorted at Cedar Grove in Maple Valley.

The methodology is organized into four sections.

1. Study Terms and Definitions—a list of several unique terms used throughout this document.
2. Route Selection—a description of the method used to define the universe of routes and the route selection process.
3. Route Data and Sample Collection—a description of the method in which data was collected along each of the selected routes and the method used to collect random, representative samples.
4. Sorting Procedures—a description of the method used to characterize samples.

Each section is described in more detail on the following pages.

Study Terms and Definitions

This study includes several unique terms and definitions. Definitions for these terms are provided below.

King County—Refers to King County, excluding Seattle.

Organics Service—For the purposes of this study, organics service only includes commercially collected curbside/alley programs where residents are permitted to include food scraps in the yard waste bin. Table 2 shows the King County cities and regions that have organics service, and those that do not.

Table 2: Cities and Regions With and Without Organics Service

Has Organics Service		
Algona	Kenmore	Snoqualmie
Auburn	Kent	Tukwila
Beaux Arts	Kirkland	Woodinville
Bellevue	Lake Forest Park	Yarrow Point
Black Diamond	Maple Valley	Unincorporated County (except as noted
Bothell	Medina	below)
Burien	Mercer Island	
Carnation	Newcastle	
Clyde Hill	Normandy Park	
Covington	North Bend	**Does Not Have Organics Service**
Des Moines	Pacific	Duvall
Enumclaw	Redmond	SeaTac (service began 10/1/09)
Federal Way	Renton	Town of Skykomish
Hunts Point	Sammamish	Unincorporated County-Vashon Island,
Issaquah	Shoreline	Snoqualmie Pass, Skykomish area

Households—A household is a single family garbage customer with organics service available to them. Ninety eight percent of all single family residences in King County have organics service available to them so the number of households in this study is nearly equal to the total number of single family garbage customers in the county.

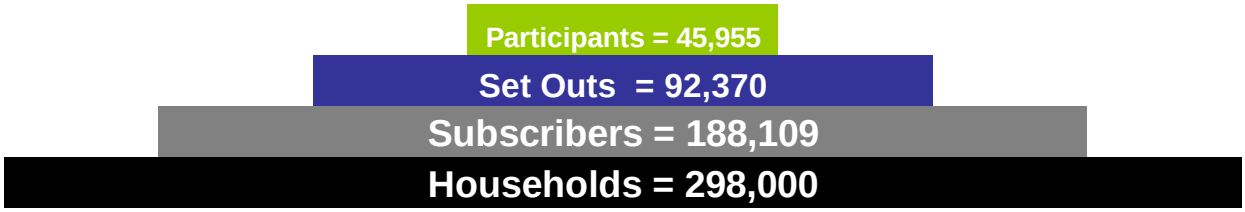
Subscriber—A subscriber is a King County household that pays an additional fee for organics service or is a household in a jurisdiction where organics service is embedded in the garbage collection rates.

Set Out—A set out is an organics service container actually placed out on the curb/alley for pick up by the collection company. It is important to distinguish between a subscriber (a household that pays an additional fee for organics service or has organics service embedded in their garbage collection rates) and a set out (where the resident uses the service and literally "sets out" the container for collection).

Food Scraps Participant—A food scraps participant is a household that places at least some food scraps in the organics service container.

The relationship between the number of households, subscribers, set outs, and participants can be visualized as in Figure 2.

Figure 2: Relationship between Defined Terms



Route Selection

All organics service routes in King County were included in the sampling universe. Waste Management, Allied Waste, the City of Enumclaw, and CleanScapes provided complete route lists for their respective service areas. All Wednesday routes were excluded as sampling occurred Monday, Tuesday, Thursday, and Friday. The remaining 231 routes were arranged by collection day and five routes per day were randomly selected for sampling. The same routes were used for both seasons. For each of the selected routes the haulers provided an approximate subscriber count and a map showing the route boundaries.

The routes selected for sampling are listed in Table 3.

Table 3: Routes Randomly Selected for Sampling in 2009

Monday	
Hauler	**Jurisdiction**
Allied	South Unincorporated County
Allied	North Unincorporated County
WM	Renton
WM	Redmond
CleanScapes	Shoreline

Tuesday	
Hauler	**Jurisdiction**
Allied	Mercer Island
Allied	South Unincorporated County
WM	Kirkland
WM	Burien
WM	Renton

Thursday	
Hauler	**Jurisdiction**
Allied	Bellevue
WM	Fairwood
Allied	Kent
WM	Bothell
Allied	Kenmore

Friday	
Hauler	**Jurisdiction**
WM	Bothell
Allied	Sammamish
Allied	Clyde Hill
WM	Federal Way
Allied	Bellevue

Route Data and Sample Collection

On Monday, Tuesday, Thursday, and Friday during each of the field seasons, Route Surveyors, using the route maps provided by the haulers, traversed the selected routes ahead of the regular collection vehicles to count the number of set outs on each route and collect samples. Each house along the route with organic material placed at the curb was considered a set out, whether the material was in a standard service cart or bundled and bagged in accordance with the hauler's collection guidelines. A household was considered a single set out regardless of the actual amount of material set out (multiple carts or bundles at a single address were a considered a single set out). The Route Surveyors tallied each set out on a Route Count Form (see Appendix D for examples of all field forms used) and collected samples from set outs along the route.

Samples from each route were collected from randomly selected set outs along the route. Using the subscriber counts provided by the haulers the consultant team calculated a sampling interval "*n*" for each route. For example; if *n*=20 then every 20th set out was collected as a sample. When the Route Surveyor reached the *nth* set out the Route Surveyor collected, wrapped in a tarp, labeled and stored for later sorting the entire set out (all bundled or bagged organics material plus all material in the organics service cart). An example sample label is shown in Appendix D. The sampling interval was calculated using the following three steps:

1. Multiply the hauler provided subscriber count by .5. The subscriber count is reduced by half based on previous experience that only about half of subscribers set out their carts in a given collection cycle. This is the expected number of set outs.
2. Divide the expected number of set outs by the number of samples to be collected from the route. This step calculates the expected "n", the expected sampling interval.
3. Multiply the expected "n" by .9. Since samples must be collected before the end of the route is reached, reducing "n" slightly provides the Route Surveyor a small cushion in case of unexpected issues with the route. This is the adjusted "n" used by the Route Surveyor to select set outs for sampling.

A total of 20 samples were collected from each route over two seasons. In total the Route Surveyors counted more than 12,000 set outs and collected more than 400 samples. The Route Surveyors transported collected samples to Cedar Grove in Maple Valley for sorting.

Sorting Procedures

The sorting crew hand-sorted samples at Cedar Grove's compost facility in Maple Valley. The sorting proceeded according to the following four steps.

1. Review methodology and sorting categories with the crew. To provide consistent sorting, the sort crew used trained crewmembers throughout the project. Before the sorting began, all crewmembers studied procedures, forms, and material definitions in detail. The material definitions are included in Appendix A.
2. Sort the sample. The sample material was sorted by hand into the prescribed material categories. The sorting crewmembers typically specialized in groups of materials, such as food or compostable paper, while the Field Crew Manager monitored the homogeneity of the sorted material, rejecting materials which may be improperly classified.
3. Weigh the sample. The Field Crew Manager verified the purity of each material as it was weighed and recorded the data on the Sample Tally Sheet. An example Sample Tally Sheet is included in Appendix D.
4. Review the data. At the conclusion of each sorting day, the Field Crew Manager conducted a quality control review of the data recorded.

Changes from Previous Study

While the objectives of the current study and the 2007 study of organic materials have similar objectives the methodologies are significantly different. Changes, and the reason for those changes, include:

- In 2007 sampling and sorting occurred over single week in early summer. For this study sampling occurred twice, once in late spring and once in late summer. The change was made to better capture any seasonal variation in set out rate, participation rate, sample size, and sample composition.
- In 2007 samples were collected from route trucks as they tipped their load at the end of their route. For this study, samples were collected directly from organics service carts at the curbside. Collecting samples directly from the curb allowed for a better estimation of the level of participation (i.e., how much food was in each cart), and a better estimation of the participation rate. It also led to a much larger number of samples being sorted (more than 400, compared to 40 in the previous study)
- In 2007 participation rate was using data collected during the route surveys. The Route Surveyors looked in every set out and noted whether the set out contained food. In this study the participation rate was calculated based on the proportion of sampled carts that contained food. It is likely that Route Surveyors missed the presence of food using the old method: perhaps because food was present in small quantities or buried too deeply in the cart, or because there was limited light available before sunrise when the route surveys were conducted. For this reason, the County and consultant team altered the method to more accurately estimate the participation rate.
- The percentage of total garbage customers with organics service (households) has increased from 57% in 2007 to 98% in 2009.

RESULTS

This section presents the results broken out into 5 sections:

1. The countywide composition of material set out in organics service carts.
2. The food scraps and compostable paper capture rate.
3. The countywide set out and participation rate.
4. A comparison among the various service types and collections schedules.
5. A comparison to previous studies.

Organic Material Composition

From September 2008 through August 2009 single family residents in King County set out more than 130,000 tons of material in their organics service carts. Table 4 details the average amount of food scraps and compostable paper collected per month. Figure 3 summarizes the composition by material class of the organic material stream for King County jurisdictions that have implemented food scraps collection. Table 5 presents the detailed material composition data for each of the 17 material types. The quantity and composition data are valid only for King County jurisdictions with yard waste/food scraps collection programs.

Key Findings

- The average participant includes approximately 35 pounds of food scraps and compostable paper in their container per month.
- The most prevalent material type is yard debris which comprises about 88% of the collected material.
- The second largest compostable material category is fruits and vegetables (5,812 tons), which accounts for approximately four percent of all collected material.
- Contaminants (4,961 tons) account for almost four percent of the collected material.

Table 4: Pounds of Food Scraps and Compostable Paper Collected per Month

	Pounds of Food Scraps and Compostable Paper Collected
Per Household	5.4
Per Subscriber	8.5
Per Set Out	17.3
Per Participant	34.9

Figure 3: Organic Material Composition by Material Type

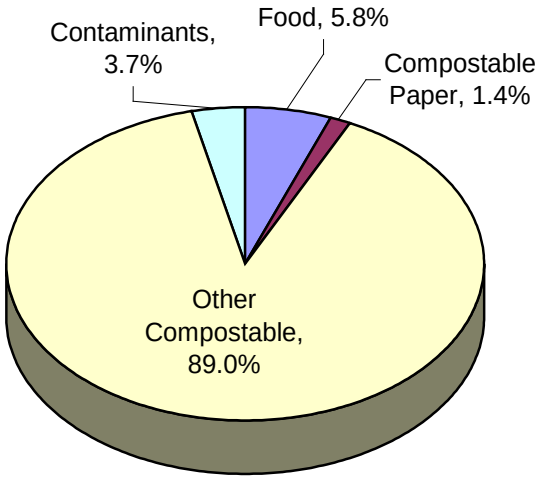


Table 5: Detailed Organic Material Composition

Material	Est. Percent	+ / -	Est. Tons
Food	**5.8%**		**7,705**
Fruits and Vegetables	4.4%	0.9%	5,812
Meat	0.4%	0.1%	486
Dairy	0.0%	0.0%	55
Mixed/Other Food Scraps	1.0%	0.3%	1,352
Compostable Paper	**1.4%**		**1,909**
Uncoated Paper Bags	0.2%	0.1%	219
Pizza Boxes	0.3%	0.1%	337
Other Compostable Paper	1.0%	0.3%	1,353
Other Compostable	**89.0%**		**117,890**
Yard Debris	88.4%	1.6%	117,035
Biodegradable Plastic Bags	0.1%	0.0%	70
Other Compostables	0.6%	0.6%	785
Contaminants	**3.7%**		**4,961**
Difficult to Compost Materials	0.2%	0.2%	330
Milk/Ice Cream Cartons	0.0%	0.0%	41
Paper Cups	0.0%	0.0%	29
Other Plastic Coated Papers	0.0%	0.0%	53
Other Recyclable Materials	0.2%	0.0%	200
Plastic Bags	0.0%	0.0%	17
Other Materials	3.2%	0.9%	4,291
Totals	**100.0%**		**132,465**
Sample Count: 402			

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

The material type *other materials* is catch all material type for materials not defined elsewhere that do not belong in organics service carts. Examples of *other materials* include: animal waste, kitty litter, treated wood, construction materials, rocks, Styrofoam, and plastic trash bags.

Capture Rate

The food scraps and compostable paper capture rate is the proportion of total food scraps and compostable paper generated that is collected for composting. It is calculated by dividing the tons of food scraps and compostable paper collected in organics service programs by the tons of food scraps and compostable paper generated. King County residents generate an estimated 45 pounds of food scraps and compostable paper per household per month[1]. The average food scraps participant sets out for collection approximately 35 pounds per month per household, thus the participant capture rate is 77%. The food scraps and compostable paper capture rate analysis is summarized in Table 6.

Table 6: Capture Rates

	Pounds of Food Scraps and Compostable Paper, Collected	Pounds of Food Scraps and Compostable Paper, Generated	Capture Rate
Per Household	5.4	45	11.9%
Per Subscriber	8.5	45	18.9%
Per Set Out	17.3	45	38.5%
Per Participant	34.9	45	77.4%

Set Out and Participation Rate

The set out and participation rates were calculated using the subscriber, set out, and composition data presented in Table 7. This data was collected through the following methods.

- The number of subscribers on a route was provided by the haulers.
- The set outs and participant numbers were collected by the Route Surveyors.
- The set out rate is the number of set outs divided by the number of subscribers.
- The participation rate is the number of samples containing food divided by the total number of samples.

Table 7: Route Data

Subscribers	24,504
Set Outs	12,033
Samples Collected	402
Samples with Food Scraps	200
Set Out Rate (for Subscribers)	49%
Participation Rate (for Subscribers)	24%

Key Findings

- Approximately 49% of subscribers set out during the study period.
- About 50% of set outs contained food scraps during the study period.
- About 24% of subscribers include food scraps in their organics service carts (about half of subscribers set out and about half of set outs contain food).
- The participation rate among all subscribers varies route to route from a high of 46% to a low of 9%.

[1] Per household food scraps and compostable paper generation figure provided by King County Solid Waste Division and is based on the 2007 King County Waste Characterization Study available at http://your.kingcounty.gov/solidwaste/about/documents/waste-characterization-study-2007.pdf.

Comparisons Among Service Types and Collection Schedules

Using information provided by the hauler every sampled routes can be classified by its service type and collection schedule. The two service types are:

- Subscription Service—Cities where households have the option to pay an extra fee on top their regular garbage service for organics service.
- Embedded Service—Cities where the cost of organics service is embedded the regular service fee households pay for their garbage service. In embedded programs households receive organics service automatically.

Haulers provide organics service to each jurisdiction on one of two collection schedules. Organics service is provided either weekly or every other week. Some jurisdictions have weekly service during the summer months (typically April through October) then switch to an every other week service for the winter months. For this study jurisdictions with this split service were considered weekly as they had weekly service during the study period. Table 8 summarizes the service type and collection schedule information for each jurisdiction.

Table 8: Service Type and Collection Schedules

Jurisdiction	Schedule	Service Type
Bellevue	Weekly	Embedded
Bothell	Weekly	Embedded
Burien	Weekly	Subscription
Clyde Hill	Weekly	Subscription
Fairwood (Unincorporated)	Weekly	Subscription
Federal Way	Weekly	Subscription
Kenmore	EOW	Subscription
Kent	EOW	Subscription
Kirkland	Weekly	Embedded
Mercer Island	EOW	Embedded
North Unincorporated County	EOW	Subscription
Redmond	Weekly	Embedded
Renton	Weekly	Embedded
Sammamish	Weekly	Subscription
Shoreline	EOW	Subscription
South Unincorporated County	EOW	Subscription

To maximize the amount of food and yard waste collected under organics service programs it is of interest whether service type or collection schedule has an effect on set out rate, participation rate, average cart weight (the amount of material set out), or the quantity of food and compostable paper placed in organics service carts. Table 9 compares these metrics for each of the service types. The set out rate is higher for households with a subscription service as is the average amount of material set out for collection. The participation rate and average pounds of food and compostable paper are higher for households with an embedded service.

Table 9: Comparison of Key Metrics by Service Type

	Number of Samples	Set Out Rate	Participation Rate	Average Cart Weight	Average Pounds Food & Compostable Paper*
Embedded	179	45%	55%	51.5	8.2
Subscription	223	54%	45%	60.9	7.9
Combined	402	49%	50%	56.7	8.1

**Calculated using only set outs with food or compostable paper, the average excludes non participating set outs.*

The set out rate, average amount of material set out for collection, and average pounds of food and compostable paper are higher for subscribers with every other week service (see Table 10).

Table 10: Comparison of Key Metrics by Collection Schedule

	Number of Samples	Set Out Rate	Participation Rate	Average Cart Weight	Average Pounds Food & Compostable Paper*
Weekly	261	46%	52%	56.4	7.9
Every Other Week	141	61%	46%	57.2	8.6
Combined	402	49%	50%	56.7	8.1

**Calculated using only set outs with food or compostable paper, the average excludes non participating set outs.*

Comparisons to Previous Studies

There have been marked changes to curbside organics service throughout King County since the 2007 study. Residents in nearly every jurisdiction within the county can now include food scraps in their carts (98% of households in 2009 compared to 57% in 2007). Many programs have had two years to mature and attract new users. Additionally the methodological changes between the 2007 study and the current are significant. For example, the most significant change to the methods is a switch from collecting samples from route trucks as the complete their route to collecting samples directly from carts at the curbside. Because of these reasons direct comparisons of the results between the two studies is difficult. However, the same metrics are reported for both studies and they can be studied side by side with the caveat that some of the differences in the results are methodological, some are programmatic, and some are due to behavior changes on the part of King County residents.

Table 11 compares several key metrics between the two studies. As shown the set out rate, participation rate, and capture rate all increased. The subscription rate, however, decreased.

Table 11: Comparison of Key Data between 2007 and 2009

	2007	2009
Subscription Rate	68%	63%
Set Out Rate (per subscriber)	38%	49%
Participation Rate (per subscriber)	7%	24%
Capture Rate (for participants)	32%	77%

The decrease in the subscription rate is likely due to an increase in jurisdictions implementing paid subscription based rather than embedded organics service programs. The total number of King County residents with organics service available to them has increased faster than the number of residents who subscribe to the service. The other metrics likely increased due to a combination of methodological changes, programmatic changes (increased outreach and education on the part of haulers and the County), and behavior changes on the part of County residents.

APPENDIX A: SAMPLING MATERIAL DEFINITIONS

The following lists each material type and its associated definition.

Food

1. Fruits and Vegetables—perishable food that comes from a plant. Examples include vegetables and fruit like bananas, cucumbers, and rutabagas. Includes fruit and vegetables in the original or another container when the container weight is less than 10% of the total weight.
2. Meat—perishable food that comes from an animal. Examples include eggs, fresh meat, bones, cooked meat, and meat scraps. Does not include dairy products such as cheese and milk. Includes meat in the original or another container when the container weight is less than 10% of the total weight.
3. Dairy—perishable food that comes from an animal's milk. Examples include cheese, milk, and yogurt. Includes dairy products in the original or another container when the container weight is less than 10% of the total weight.
4. Mixed/Other Food Scraps—any food that cannot be put in the above categories. Examples include food items that are a combination of the above categories, as well as coffee grounds, tea packets, grains, crackers, bread, and cereal. Includes food in the original or another container when the container weight is less than 10% of the total weight.

Compostable Paper

5. Uncoated Paper Bags—any uncoated bag made of paper. Examples include paper grocery bags, soiled and unsoiled fast food bags, and department store bags if made entirely from paper.
6. Pizza Boxes—boxes without a plastic or foil liner that have been used for carrying pizza.
7. Other Compostable Paper—includes paper products, not included above, that do not contain a plastic coating. Examples include waxed cardboard boxes, uncoated or waxed paper plates, uncoated or waxed paper containers (such as for fast food), napkins, coffee filters, shredded paper, newspaper (if used to contain food scraps), and paper towels.

Other Compostables

8. Yard Debris—includes leaves, grass clippings, sod, garden wastes, brush, prunings, and logs.
9. Biodegradable Plastic Bags—plastic bags that are made of materials such as corn starch or soy and are designed to biodegrade or compost. The bags will most likely have the companies' logo including BioBag, Biocorp, Natu-Ur, BioSource, Eco Film/Eco Works, and Bio Tuf.
10. Other Compostables—other compostable organic materials, not included above, such as hair, Popsicle sticks, and toothpicks.
11. Difficult to Compost Materials—organic items whose durability makes them hard to compost. Examples include wine corks, burlap sacks, pallets, wood crates, and rope.

Contaminants

12. Milk/Ice Cream Cartons—bleached polycoated paperboard cartons of various sizes and shapes that contained milk, ice cream, or other liquids. Does not include paper containers with a foil liner or aseptic containers (these will be considered *other recyclable materials)*.
13. Paper Cups—all cups designed to be used for beverages or food. Examples include to-go coffee cups, fast food soda cups, and paper picnic cups.
14. Other Plastic Coated Papers—food service papers coated with plastic. Examples include some types of fast food wrapping, plastic coated take-out containers, and plastic coated paper plates and bowls.
15. Other Recyclable Materials—includes materials normally recycled in curbside collection programs that are not significantly contaminated. Examples include newspapers (not used to contain food scraps), newspaper inserts, corrugated cardboard, magazines, phone books, junk mail, chipboard, boxboard, egg cartons, printing and writing paper, scrap iron, aluminum cans, tin cans, plastic tubs, plastic bottle and jars, and glass bottles.
16. Plastic Bags—plastic bags that are not made of materials that compost or biodegrade.

17. Other Materials—any material that does not fit into the above categories. Examples include textiles, grease, foil lined paper products, Styrofoam, gypsum waste, treated wood, pet waste, soil, rocks, stumps, demolition debris, hazardous wastes, and non-recyclable metals, glass, and plastics.

APPENDIX B: GREENHOUSE GAS AND COST IMPLICATIONS OF ORGANICS DIVERSION

Cities and counties around Puget Sound have implemented organics service for many reasons including reductions in greenhouse gas (GHG) emissions and costs. This appendix quantifies current and potential GHG reductions and cost savings associated with organics diversion. It is divided into two sections, the first covering current organics programs and the second covering future programs with increased diversion of organics from the disposed waste stream to compost. Each section considers the estimated GHG reductions and cost savings. All GHG reduction calculations are performed using MEBCalc™, an LCA model for measuring the environmental footprint of a community's solid waste management system, from collection through final disposition of each discarded product or packaging material.

CURRENT ORGANICS SERVICE

Greenhouse Gas Emissions Estimates

Measuring or calculating GHG reductions is complicated, however the United Nations Intergovernmental Panel on Climate Change (IPCC) provides some methodological guidelines. This analysis follows the IPCC guidelines and takes into account local conditions (such as local landfill gas management practices and the local power grid) when data are available. Factors incorporated in the GHG analysis include the following:

- Emissions from organics collection vehicles compared to garbage collection vehicles.
- Emissions from equipment used to process organics into compost compared to equipment used to manage garbage wastes delivered to the landfill.
- Emissions from hauling organics to Cedar Grove composting facility compared to hauling garbage to Cedar Hills landfill.
- Carbon sequestration in landfills.
- Emissions from petroleum-based fertilizers. (Compost provides a replacement for these fertilizers, decreasing demand and associated embodied emissions.)
- Carbon sequestration in compost and from applications of compost.
- Fugitive emissions of methane from landfills.
- Emissions from landfill gas (LFG) flares and LFG to energy projects.

Some of these factors tend to support the case for increasing diversion of organics to compost (increased diversion reduces the use of petroleum based fertilizers, for instance) and some support reduced diversion of organics to compost (landfilling organics can increase electricity generation from captured LFG thus displacing other petroleum based fuels in the power grid).

As shown in Table 5, organics service programs collected more than 9,600 tons of food and compostable paper and 117,000 tons of yard waste during the study period. Compared to landfilling the material, curbside organics service programs reduce emissions by more than 52,700MTCO2E with current landfill operations (LFG is flared). This is summarized in Table 12.

Table 12. Estimated GHG reductions from Composting vs. Landfilling, Flaring LFG

	Curbside Tons Collected	GHG Reduction (MTCO2E)
Yard Waste	117,035	46,070
Food/Paper	9,614	6,633
Total	126,649	52,704

Notes: Assumes 90% landfill gas capture

When Cedar Hills landfill begins producing energy from LFG instead of flaring it, organics diversion will yield a more limited reduction of 44,200MTCO2E, as shown in Table 13. This estimate assumes that in creating energy from LFG, the Cedar Hills landfill is decreasing demand for energy produced by natural gas combustion.

Table 13. Estimated GHG reductions from Composting vs. Landfilling, LFG to Energy

	Curbside Tons Collected	GHG Reduction (MTCO2E)
Yard Waste	117,035	38,691
Food/Paper	9,614	5,507
Total	126,649	44,199

Notes: Assumes 90% landfill gas capture

For perspective, more practical measures of the importance of composting include the following:[2]

- The average participant household approximately 1,663 pounds of organics annually. The GHG reductions from this are equivalent to reducing gas consumption by 5%.
- Assuming substantial food scraps diversion, setting out a full 96-gallon cart reduces GHG emissions by 66 pounds of CO2E.

Cost Savings Estimates

Calculating the costs of garbage service and organics service is another very complicated task with a variety of complex variables including subsidies, penalties, incentives, hauling costs, transfer costs, disposal costs, material management costs, product revenues, moisture content, and a host of other factors. A simplified model comparing the tipping costs of organics and garbage makes the following assumptions:

- Hauling costs are the same for both organics and garbage. Whether the material is placed into an organics service cart or a garbage cart, the same total volume and weight of material needs to be hauled requiring the same amount of labor, equipment, and driving.
- Different transfer costs, disposal costs, material management costs, and product revenues for the garbage and organics are captured in the different tipping fees charged for those materials.
- The tipping fee for garbage is $95/ton; the tipping fee for organics varies between $60/ton and $82.50/ton.
- The effects of subsidies, penalties, and incentives are marginal.

Under these assumptions the cost savings to the solid waste system vary between $1.6 million and $4.6 million, as shown in Table 14, under the current organics programs.

Table 14. Current Organics Program Cost Savings

	Organics Tip Fees	
	$60.00	**$82.50**
Current program cost savings	$4,636,260	$1,655,807

FUTURE POTENTIAL

In 2007 King County residents landfilled more than 86,000 tons of yard waste, food, and compostable paper. [3] If subscription rates, set out rates, and participation rates increase, the quantity of these materials captured in curbside organics programs will likely increase as well. Table 15 shows the additional quantities of these materials composted

[2] Calculations for these two comparisons can be found in Appendix C: Calculations and are based on data contained in this report and in MEBCalc™, an LCA model for measuring the environmental footprint of a community's solid waste management system, from collection through final disposition of each discarded product or packaging material.

at Cedar Grove assuming an additional 25%, 50% or 75% of these materials can be diverted from curbside residential garbage. Cascadia estimated the additional GHG reductions and costs savings from diverting these additional quantities of materials in the following sections.

Table 15. Single Family Residential Disposed Tons, 2007[4]

	Tons Disposed	Tons Diverted at 25% Diversion	Tons Diverted at 50% Diversion	Tons Diverted at 75% Diversion
Yard Waste	8,266	2,066	4,133	6,199
Food/Paper	78,154	19,538	39,077	58,615
Total	**86,419**	**21,605**	**43,210**	**64,815**

Greenhouse Gas Emissions Estimates

Under current landfill operations (LFG flared), diverting additional quantities from the landfill reduces GHG emissions by nearly 13,800MTCO2E to nearly 41,300MTCO2E depending on the level of additional diversion. Table 16 summarizes these results.

Table 16. Estimated GHG reductions from Additional Composting vs. Landfilling, Flaring LFG

	GHG Reduction (MTCO2E)		
	25% Diversion	50% Diversion	75% Diversion
Yard Waste	813	1,627	2,440
Food/Paper	12,937	25,875	38,812
Total	**13,751**	**27,502**	**41,252**

Notes: Assumes 90% landfill gas capture

As shown in Table 17 the additional emissions reductions will drop by approximately 18% to between nearly 11,300MTCO2E and nearly 33,900MTCO2E depending on the additional diversion level when Cedar Hills landfill begins generating electricity from captured LFG instead of flaring it as is the current practice.

Table 17. Estimated GHG reductions from Additional Composting vs. Landfilling, LFG to Energy

	GHG Reduction (MTCO2E)		
	25% Diversion	50% Diversion	75% Diversion
Yard Waste	683	1,366	2,049
Food/Paper	10,601	21,202	31,803
Total	**11,284**	**22,568**	**33,852**

Notes: Assumes 90% landfill gas capture

[3] From the 2007 King County Waste Characterization Study available at http://your.kingcounty.gov/solidwaste/about/documents/waste-characterization-study-2007.pdf

[4] Food waste is the sum of packaged bakery items, opened/unpackaged/scrap bakery items, packaged vegetative items, opened/unpackaged/scrap vegetative items, packaged non-vegetative items, and opened/unpackaged/scrap non-vegetative items from the 2007 waste characterization study. Yard waste is the sum of yard wastes and large prunings from the 2007 waste characterization study. Compostable paper is as defined in the 2007 waste characterization study.

Cost Savings Estimates

If additional organics material is captured from the garbage and diverted to compost the cost savings will increase by between $0.27 million and $2.3 million, depending on organics tipping fees and the amount of increased capture. See Table 18 for a summary of these results.

Table 18. Cost Savings at Various Levels of Increased Organics Diversion

	Organics Tip Fees	
	$60.00	**$82.50**
Cost savings at 25% increased diversion	$756,169	$270,060
Cost savings at 50% increased diversion	$1,512,338	$540,121
Cost savings at 75% increased diversion	$2,268,508	$810,181

APPENDIX C: CALCULATIONS

Composition Calculations

The composition estimates represent the ratio of the material categories' weight to the total weight for each noted substream. They are derived by summing each material's weight across all of the selected records and dividing by the sum of the total weight of material, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

c = weight of a particular material
w = sum of all material weights
for i =1 to n
where n = number of selected samples
for j = 1 to m
where m = number of material categories

The confidence interval for this estimate is derived in two steps. First, the variance around the estimate is calculated, accounting for the fact that the ratio includes two random variables (the material and total sample weights). The variance of the ratio estimator equation follows:

$$\hat{V}_{r_j} = \left(\frac{1}{n}\right) \times \left(\frac{1}{\overline{w}^2}\right) \times \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n - 1}\right)$$

where:

$$\overline{w} = \frac{\sum_i w_i}{n}$$

Second, precision levels at the 90% confidence interval are calculated for a material's mean as follows:

$$r_j \pm \left(t \times \sqrt{\hat{V}_{r_j}}\right)$$

where:

t = the value of the t-statistic (1.645) corresponding to a 90% confidence level

For more detail, please refer to Chapter 6 "Ratio, Regression and Difference Estimation" of Elementary Survey Sampling by R.L. Scheaffer, W. Mendenhall and L. Ott (PWS Publishers, 1986).

Subscription Rate

The subscription rate is calculated by dividing the monthly average number of King County residents with garbage service in the included jurisdictions by the monthly average number of organic service customers in the included jurisdictions. The King County Solid Waste Division (KCSWD) provided customer number data for the period from September 2008 through August 2009.

$$average\ monthly\ organics\ customers \div\ average\ monthly\ garbage\ customers = subscription\ rate$$

$$188{,}109 \div 298{,}000 = 63\%$$

Set Out Rate

The set out rate is calculated by dividing the total number of subscribers along surveyed routes by the total number of carts set out for collection along surveyed routes. The haulers provided the number of subscribers on a route and the Route Surveyors counted the number of set outs on a route.

$$number\ of\ set\ outs\ on\ routes \div number\ of\ subscribers\ on\ routes = set\ out\ rate$$

$$12{,}033 \div 24{,}504 = 49\%$$

Participation Rate

The participation rate is calculated per subscriber and per set outs. The per subscriber participation rate is a measure of the people who have signed up for organics service (not all households subscribe to organics service even if it's available) that place food scraps in their cart. The per set out participation rate is a measure of the number of carts set out for collection that contain food scraps.

The per set out participation rate is calculated by dividing the total number of samples collected by the number that contained food scraps.

$$200(samples\ with\ food) \div 402(total\ samples) = 50\%$$

The per subscriber participation rate is calculated by multiplying the per set out participation rate by the set out rate. The premise is that we know what percent of set outs have food scraps and we know what percent of subscribers set out so the percent of subscribers who participate is the product of those two numbers.

$$49\%(set\ out\ rate) \times 50\%(per\ set\ out\ participaton\ rate) = 24\%$$

Capture Rate

The capture rate is a measure of the amount of food scraps and compostable paper collected per participant per month in organics service programs divided by the amount of food scraps and compostable paper generated per participant per month. The amount of food scraps and compostable paper generated is the sum of food scraps and compostable paper disposed and food scraps and compostable paper collected in organics service programs.

The amount of food scraps and compostable paper collected per participant per month in organics service programs is calculated from the composition data and tonnage information provided by the KCSWD. The amount of food scraps and compostable paper disposed per participant per month is provided by the KCSWD.

The capture rate is

$$c \div (c + d)$$

where:

c = food scraps and compostable paper collected in organics service programs per participant per month
d = food scraps and compostable paper disposed per participant per month

GHG Calculations

The following several tables illustrate the calculations and sources used in Appendix B: Greenhouse Gas and Cost Implications of Organics Diversion.

As shown in Table 19 the average organics service participant composts approximately 418 pounds per year of food scraps and compostable paper. The data in this table is compiled from elsewhere in this report.

Table 19. Annual Pounds of Food Scraps and Paper Composted per Participant

Annual tons food scraps and paper composted	9,614
Number of participants	45,955
Annual pounds food scraps and paper composted per participant	**418**

As shown in Table 20 the average organics service subscriber composts approximately 1,244 pounds per year of yard debris. The data in this table is compiled from elsewhere in this report.

Table 20. Annual Pounds of Yard Waste Composted per Subscriber

Tons yard debris composted annually	117,035
Number of subscribers	188,109
Pounds yard debris composted annually per subscriber	**1,244**

Table 21 shows the sum of materials composted per participant per year, 1,663 pounds. This is the sum of the composted food scrap, compostable paper, and yard debris amounts.

Table 21. Annual Pounds of Diverted Compostables per Participant

Annual pounds of compostables per participant	**1,663**

Table 22 illustrates the pounds of emitted CO2E organics participants avoid each year. Data used in this calculation is from Table 19, Table 20, and MEBCalc™, an LCA model for measuring the environmental footprint of a community's solid waste management system, from collection through final disposition of each discarded product or packaging material.

Table 22. Pounds of CO2E Avoided Annually from Composting

	Pounds Composted per Family per Year	Pounds CO2E Avoided per Ton Composted	Pounds CO2E Avoided Annually from Composting
Yard Debris	1,244	868	540
Food Scraps and Compostable Paper	418	1,807	378
Totals	**1,663**		**918**

A s shown in Table 23 the average King County family emits more than 20,200 pounds of CO2E annually from their vehicles. Data in this table come from the US Census and MEBCalc™.

Table 23. Average CO2E Emitted from Vehicle Fuel Consumption

Per capita annual MTCO2E emitted from vehicle fuel consumption	4.0
Average King Co. family size	2.3 people
Average per family MTCO2E emitted from vehicle fuel consumption	9.2
Average per family pounds CO2E emitted from vehicle fuel consumption	**20,283**

As shown in Table 24 the CO2E emissions avoided through composting by the average participant are equivalent to a family reducing their annual fuel consumption by five percent. Data in this table is compiled from Table 22 and Table 23.

Table 24. Vehicle Emission Reduction Equivalency

Pounds CO2E avoided by composting	918
Average per family pounds CO2E emitted from vehicle fuel consumption	20,283
Percent emissions reduction equivalent	**5%**

As shown in Table 25 each participant's full organics service cart avoids 66 pounds of CO2E annually. Data in this table is compiled from elsewhere in this report and from MEBCalc™.

Table 25. Pounds CO2E Avoided per Organics Service Cart

	Average Full Organics Cart Weight (pounds)	Pounds CO2E Avoided per Ton Composted	Pounds CO2E Avoided per Full Organics Service Cart
Yard Debris	90	868	39
Food Scraps and Compostable Paper	30	1,807	27
Totals	**120**		**66**

King County Waste Monitoring Study
Sample Label

Day:

_____

Hauler:

_____

Jurisdiction:

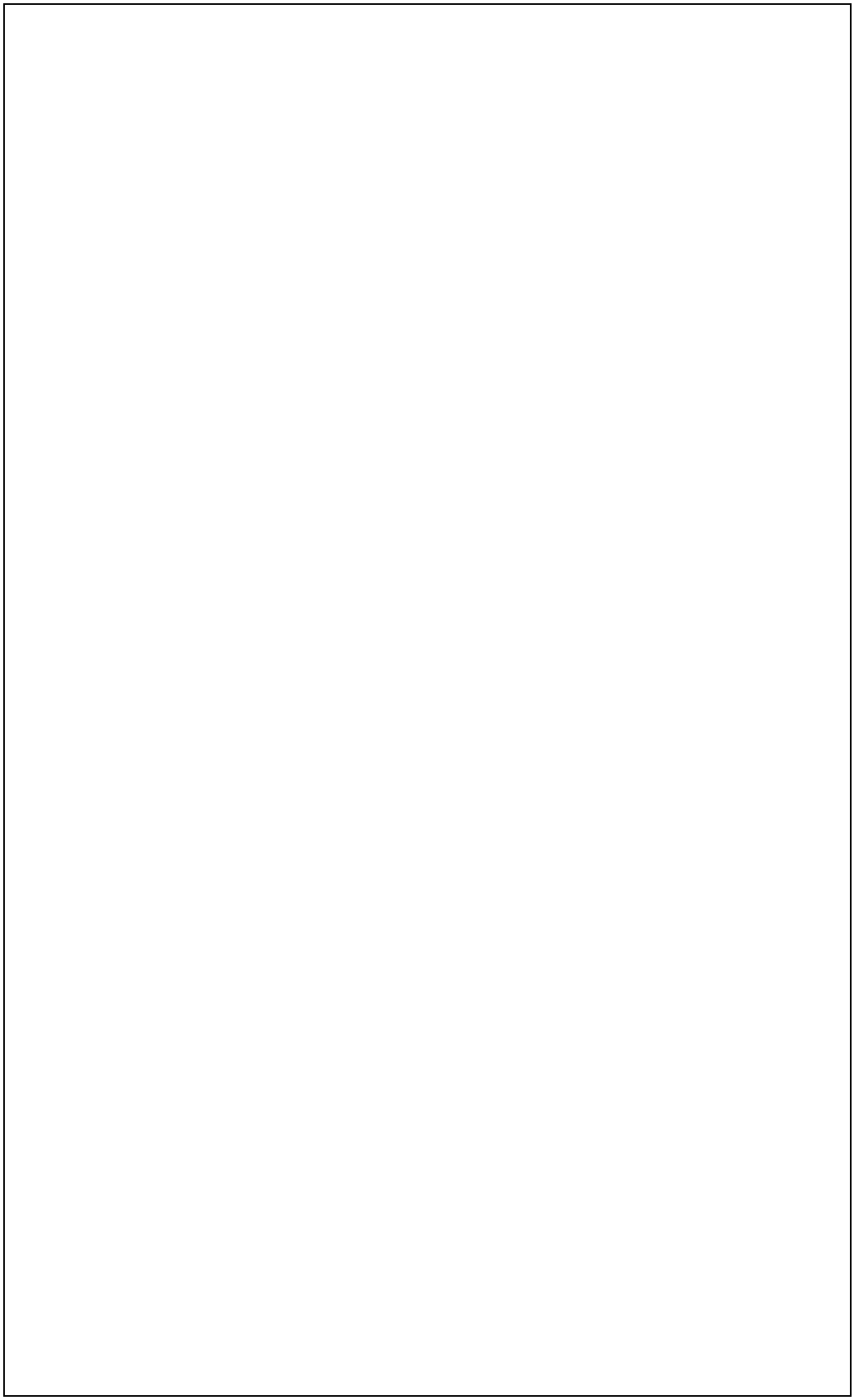
_____

Route:

_____

Item Number:

_____OF_____



King County Waste Monitoring Study
Sample Tally Sheet

Food	Wt.1	Wt.2	Wt.3	Wt.4
Fruits and Vegetables				
Meat				
Dairy				
Mixed/Other Food Scraps				

Compostable Paper	Wt.1	Wt.2	Wt.3	Wt.4
Uncoated Paper Bags				
Pizza Boxes				
Other Compostable Paper				

Other Compostable	Wt.1	Wt.2	Wt.3	Wt.4
Yard Debris				
Biodegradable Plastic Bags				
Other Compostables				
Difficult to Compost Materials				

Contaminants	Wt.1	Wt.2	Wt.3	Wt.4
Milk/Ice Cream Cartons				
Paper Cups				
Other Plastic Coated Papers				
Other Recyclable Materials				
Plastic Bags				
Other Materials				

Sample ID: _____

Day: _____

Hauler: _____

Jurisdiction: _____

Route: _____

Sampler: _____

Notes: