Seattle Public Utilities

2005
Residential Recycling Composition Study
Final Report

prepared by

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in cooperation with

Seattle Public Utilities Staff

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Table of Contents

Table of Tables

Table of Figures

1 OVERVIEW

1.1 Introduction

In 1988, Seattle Public Utilities (formerly Seattle Solid Waste Utility) launched an ongoing waste composition study. This basic information is essential to effective solid waste management and affects all aspects of policy and program implementation, such as meeting the city's goal of 60% recycling by 2008. As part of this ongoing study, the City of Seattle included a recycling composition study in 1993, 1998/99, 2000/01 to better understand the types and quantities of recyclables set out by Seattle residents.[1] Recycling composition estimates obtained from this study are also used to determine payment from the City to the private company that processes Seattle's residential recycling.[2]

Composition estimates are made by sampling recyclables – sorting and weighing samples – from randomly selected loads brought to the City's contracted recycling facility. This report summarizes estimates from samples taken between January and December 2005. Cascadia Consulting Group served as the primary contractor for this research; Sky Valley Associates conducted the sorting of recyclables.

This report is organized into four sections. Section 1 briefly summarizes the project, including a description of the sampling populations. An overview of the results is presented in Section 2. Section 3 presents a comparison of results from the current study with those of the 2000/01 study. Lastly, Section 4 provides the complete composition results, by *service area*, *generator type*, and by *generator type for each service area*, for samples taken during the 2005 study. Detailed appendices follow the main body of the report.

1.2 Sampling Populations

This study was designed to determine the composition of recycling setouts for both single-family and multifamily residences within the City. Recyclable materials that were either self-hauled to the City's two transfer stations or hauled from Seattle's commercial substream were excluded from this study.[3]

In order to facilitate more accurate analysis, the recyclables set out by residences in Seattle were divided into four subpopulations based on *generator type* and *service area*. The two generator types included *single-family* and *multifamily*, which were defined as follows:

[1] For the purposes of this study, "recyclables" were defined by the manner in which they were set out by residents, and not by the composition of the material itself. For example, if a resident placed a piece of cardboard in a garbage can, it would not have been included in this study's recycling sorts; however, the same piece of cardboard placed in a recycling container could have been sampled.

[2] These payments partly depend on the amount of each material collected and also on current market prices.

[3] At the start of the 2005 study, small business recycling was collected with residential recycling. Since April 2001, eligible small businesses have been able to participate for free in SPU's *Small Business Recycling Program*. This program was absorbed into a larger commercial program in March of the study year. In January and February, approximately 700 businesses participated in the program, accounting for 0.5% of the subscribers in those months and less than 0.1% of the collections for the year.

- ***Single-family***: Residences using a toter-based collection system: one toter with an accompanying insert for glass. Typically, these residences are detached single-family, duplex, triplex and four-plex homes.
- ***Multifamily***: Residences using a dumpster-based collection system: Generally, one or more dumpsters with accompanying glass toter(s). Typically, these residences are apartments and condominiums with five or more units.

Seattle's residential recyclables were collected in two service areas: *north* and *south*. The Lake Washington Ship Canal was the physical boundary that divided the north and south service areas.

Figure 1-1 depicts each of the four residential recycling subpopulations, according to generator type and service area.

Figure 1-1. Subpopulation Definitions

		Generator Type	
		Single-family	*Multifamily*
Service Area	*North*	Single-family North	Multifamily North
	South	Single-family South	Multifamily South

Each of these four subpopulations contributed a portion of the approximately 83,200 total tons of recyclables collected from Seattle residents from January to December 2005. About 41% (or about 33,800 tons) was collected from single-family generators in the south service area. Single-family generators in the north service area set out approximately 38% (31,600 tons) of these recyclables. The remaining 21% was collected from multifamily generators: almost 14%, or 11,400 tons, from the south and nearly 8%, or 6,400 tons, from the north.

2 SUMMARY OF SAMPLING RESULTS

For this study, a total of 266 samples were taken from single-family and multifamily loads between January and December 2005. An equal number of samples were apportioned to the north and south service areas since roughly equal amounts of recyclables are collected from each service area.

Recycling samples were sorted by hand into 29 component categories for the 2005 study. Composition estimates are presented in the following order in this report. First, a pie chart depicts the composition percentages of the six broad material categories: *paper, metal, plastic, glass, recyclable glass (commingled compartment)* and *contaminants.* Next, a table presents the top ten components, by weight, and finally, a table lists the full composition results of all 29 components[4]. Please refer to Appendix A for a list and definitions of the 29 components.

Seattle has a two-stream recycling process in which glass is collected separately from other recyclables. Collectively, the other recyclables are referred to as *commingled*. Occasionally glass is mixed in with the *commingled* recyclables. In the 2000/01 study recyclable glass in the *commingled* compartment was classified as a contaminant. In 2005 recyclable glass in the *commingled* compartment was recovered as a recyclable, although not with the same efficiency as separated glass. Consequently, in this study *recyclable glass (commingled compartment)* is treated as a separate broad material category.

The overall composition results are illustrated in Figure 2-1. At approximately 76%, *paper* made up the largest portion of residential recycling from January to December 2005. *Glass* was also prominent, comprising about 16% of the total, by weight.

[4] When interpreting the results presented in the tables and figures in this report, it is important to consider the effect of rounding. To keep waste composition tables and figures readable, estimated tonnages are rounded to the nearest ton, and estimated percentages are rounded to the nearest tenth of a percent. For this reason, when added together, estimates may not match the subtotals or totals shown. Please see Appendix E for more detail regarding the calculations.

Figure 2-1. Overview of Composition Estimates: Overall
(January 2005 – December 2005)

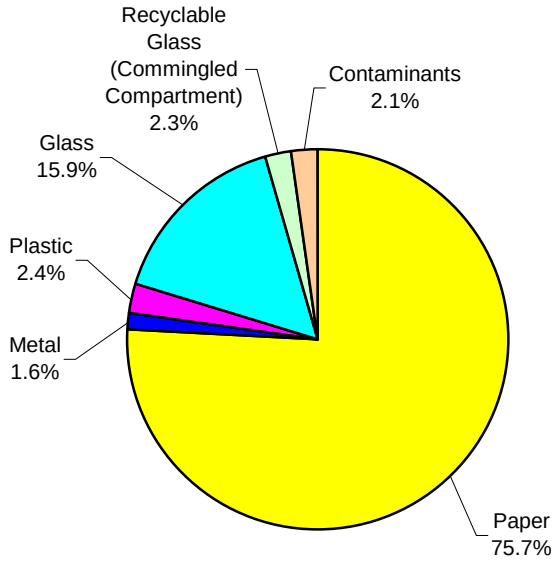


Table 2-1 lists the mean percent, by weight, cumulative percent, and tons of the top ten components found in residential recycling samples from January to December 2005. *Newsprint* (33.0%) was the largest single component, followed by *mixed low-grade paper* and *unwaxed OCC/Kraft paper*, which comprised 24% and 16%, respectively. Please see Table 2-2 for the complete composition results for the overall residential recycling stream.

Table 2-1. Top Ten Components: Overall
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	33.0%	33.0%	27,445
Mixed Low-grade Paper	23.9%	56.9%	19,901
Unwaxed OCC/Kraft Paper	15.7%	72.7%	13,107
Green Glass Bottles	5.9%	78.5%	4,870
Brown Glass Bottles	4.1%	82.6%	3,422
Clear Glass Bottles	3.3%	85.9%	2,746
Phone Books	2.7%	88.6%	2,231
Mixed Cullet	2.4%	91.0%	1,967
Recyclable Glass (Commingled Compartment)	2.3%	93.3%	1,904
Tin Food Cans	0.8%	94.1%	675
Total	**94.1%**		**78,266**

Table 2-2. Composition by Weight: Overall
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**63,005**	**75.7%**		
Newsprint	27,445	33.0%	32.1%	33.9%
OCC/Kraft, Unwaxed	13,107	15.8%	14.9%	16.6%
Phone Books	2,231	2.7%	2.2%	3.2%
Mixed Low-grade	19,901	23.9%	23.1%	24.8%
Polycoat Containers	289	0.3%	0.3%	0.4%
Aseptic Containers	33	0.0%	0.0%	0.0%
Metal	**1,342**	**1.6%**		
Aluminum Cans	419	0.5%	0.5%	0.6%
Tin Food Cans	675	0.8%	0.7%	0.9%
Other Ferrous	248	0.3%	0.2%	0.4%
Plastic	**1,957**	**2.4%**		
Small PET Bottles (24 oz or smaller)	351	0.4%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	426	0.5%	0.5%	0.5%
PET Jars, Tubs, and Other Containers	29	0.0%	0.0%	0.1%
HDPE Bottles	556	0.7%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	88	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	66	0.1%	0.1%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	101	0.1%	0.1%	0.1%
Plastic Bags and Packaging	339	0.4%	0.4%	0.5%
Glass	**13,216**	**15.9%**		
Clear Bottles	2,746	3.3%	3.2%	3.4%
Green Bottles	4,870	5.9%	5.6%	6.1%
Brown Bottles	3,422	4.1%	3.9%	4.3%
Clear Container Glass	140	0.2%	0.1%	0.2%
Other Glass Containers and Bottles	72	0.1%	0.1%	0.1%
Mixed Cullet	1,967	2.4%	2.2%	2.5%
Recyclable Glass (Commingled Compartment)	**1,904**	**2.3%**		
Recyclable Glass (Commingled Compartment)	1,904	2.3%	1.8%	2.8%
Contaminants	**1,774**	**2.1%**		
Non-conforming Paper (Commingled Compartment)	475	0.6%	0.5%	0.7%
Non-conforming Metal (Commingled Compartment)	130	0.2%	0.1%	0.2%
Non-conforming Plastic (Commingled Compartment)	577	0.7%	0.6%	0.8%
Non-conforming Glass (Glass Compartment)	37	0.0%	0.0%	0.1%
Other Non-recyclables	554	0.7%	0.5%	0.8%
Total Tons	**83,197**			
Sample Count	**266**			

3 SUMMARY OF RESULTS COMPARED TO PREVIOUS STUDIES

In this section, the results of the 2005 study are compared to those from the 2000/01 study. The two studies followed the same basic methodology.[5] Changes in the composition percentages and the total amount of waste disposed of each broad waste category were analyzed to compare findings between study periods.[6] Section 3.1 provides an overview of the changes in the last 5 years. Section 3.2 provides detailed results of the comparisons.

3.1 Trends in Recycling

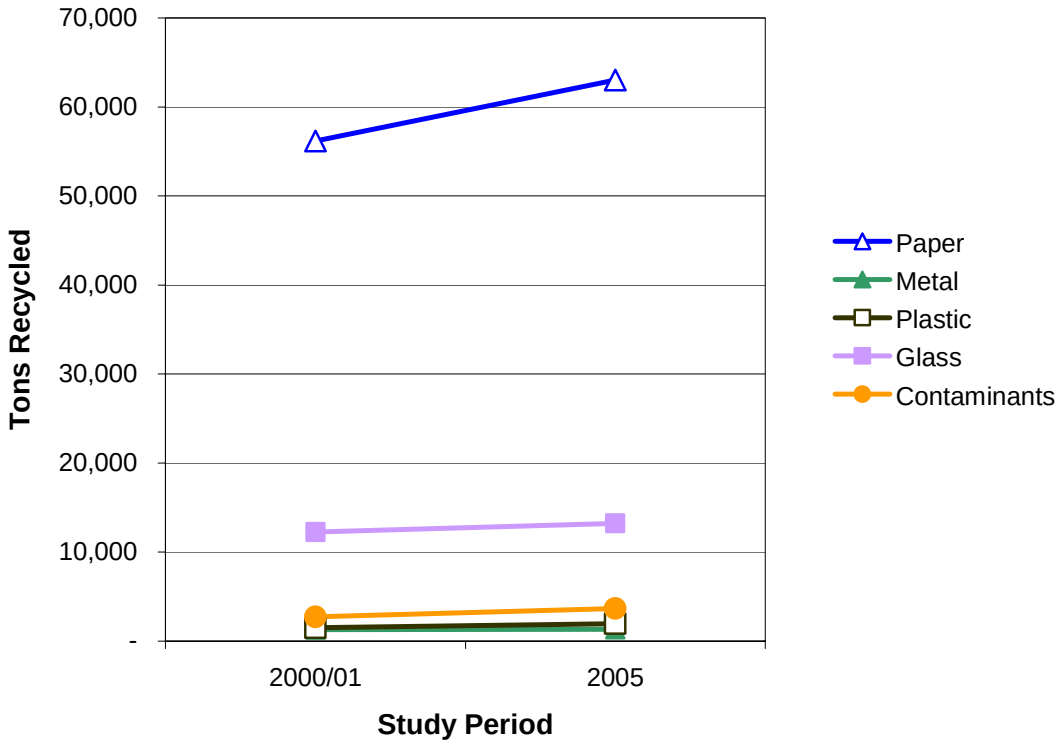
Figure 3-1 illustrates the changes in residential recycling tons over the last five years. Overall, the quantity of residential recyclables has increased from about 74,000 tons in 2000/01 to approximately 83,200 tons in 2005. The *paper* broad material category showed the greatest increase since 2000/01.[7]

[5] The methodologies used in the 1993 and 1998/99 resulted in findings that are not comparable to the more recent studies.

[6] The composition percentages used to analyze the differences in disposed tonnage, and to perform statistical tests were calculated using unweighted averages. Please Appendix D for more detail.

[7] For the purposes of comparisons with the previous study, material components in this section are organized into five broad material categories: *paper*, *metal*, *plastic*, *glass*, and *contaminants*. Because of changes in the category definitions since 2000/01, such as the addition of the material category *recyclable glass (commingled compartment)*, the numbers reported in this section differ slightly from those in other parts of this report. Appendix A shows the history of how materials have changed since the initial study.

Figure 3-1. Changes in Residential Recycling Tons, 2000/01 to 2005



3.2 Changes in Recycling: 2000/01 to 2005

In Table 3-1, broad material categories that are bolded showed significant differences between the 2000/01 and 2005 study periods. *Plastic* was the only broad material category that showed a significant change. Although not significant changes, *glass* decreased as a percentage of total residential recycling by almost 1%, and contaminants increased as percentage of the total by nearly 1%.

Table 3-1. Changes in Recycling: 2000/01 to 2005[8]

	Percent		Change in	Disposed Tons	
	2000	2005	Composition %	2000	2005
Paper	76.0%	75.7%	-0.3% ⬇	56,180	63,005
Metal	1.8%	1.6%	-0.1% ⬇	1,303	1,342
Plastic	**2.0%**	**2.4%**	**0.3%** ⬆	**1,493**	**1,957**
Glass	16.6%	15.9%	-0.7% ⬇	12,239	13,216
Contaminants	3.7%	4.4%	0.8% ⬆	2,710	3,678
Total	**100%**	**100%**		**73,926**	**83,197**

* Bold type indicates statistically significant changes.

[8] There is no change to measure for *recyclable glass (commingled compartment)*, because it was not sorted for the entire 2000/01 study. For the purposes of this section, *recyclable glass (commingled compartment)* is represented in the *contaminants* broad material category.

4 COMPOSITION RESULTS, BY SUBPOPULATION

Table 4-1 summarizes the sample information for each subpopulation. Approximately 70,200 pounds (or about 35 tons) were sampled. Of those vehicles sampled, the average weight of material collected in the *glass* compartment was approximately 1,900 pounds; the material collected in the *commingled* compartment weighed, on average, about 9,500 pounds. The total weight of all the glass samples was approximately 9,000 pounds with an average sample weight of about 40 pounds. The material sorted from *commingled* compartments totaled approximately 61,000 pounds and the average sample was about 230 pounds.

Table 4-1. Description of Samples for each Subpopulation[9]
(January 2005 – December 2005)

Subpopulation	Sample Count	Total Sample (lbs)	Avg Net Load Wt (lbs)	
			(Glass)	*(All Other Recyclables)*
Service Area				
North	133	35,775.9	1,882.3	8,127.4
South	133	34,452.0	2,012.3	10,933.5
Generator Type				
Single-family	178	46,612.9	1,846.8	9,397.7
Multifamily	88	23,615.0	2,140.0	9,781.6
Service Area and Generator Type				
Single-family North	88	23,125.2	1,641.4	7,226.0
Single-family South	90	23,487.7	2,040.0	11,544.9
Multifamily North	45	12,650.7	2,305.3	9,890.2
Multifamily South	43	10,964.3	1,954.0	9,667.9
Overall	**266**	**70,227.9**	**1,947.3**	**9,525.2**

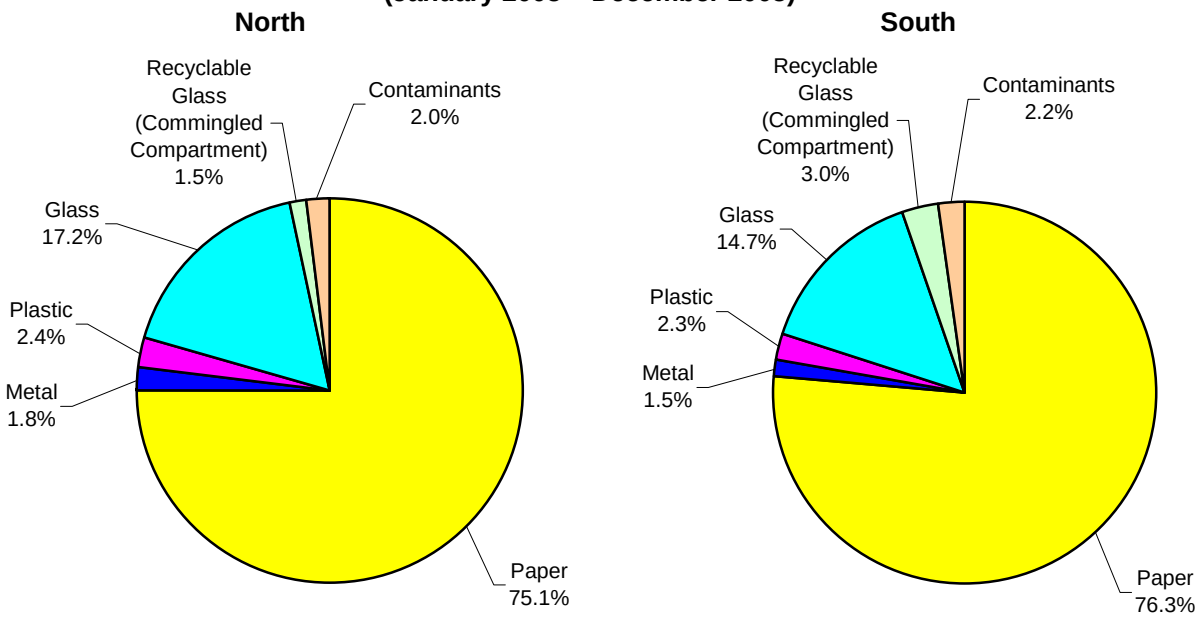
Section 4.1 presents detailed composition estimates for the north and south service areas while Section 4.2 provides single-family and multifamily estimates. Finally, composition by generator type for each of the two service areas is given in Section 4.3.

[9] Not all loads in the study were weighed and not all samples included a glass component. See Appendix C for details.

4.1 By Service Area

Figure 4-1 depicts the composition results of residential recycling collected from the north and south service areas. For both service areas, *paper* made up about three-quarters of the total, by weight. *Glass* was the second largest broad material category in both service areas, accounting for about 17% in the north and 15% in the south service area. *Recyclable glass (commingled compartment)* comprised a higher percentage (3.0%) in the south than in the north (1.5%).

Figure 4-1. Overview of Composition Estimates, by Service Area
(January 2005 – December 2005)



4.1.1 North

A total of 133 loads of recyclables were sampled from the north service area between January and December 2005. Table 4-2 lists the top ten components set out by residents in the north, by weight. As shown, *newsprint* accounted for approximately 34% while *mixed low-grade paper* comprised an additional 23%. *Unwaxed OCC/Kraft paper* and *green glass bottles* made up about 16% and 6% respectively. The full composition results are listed in Table 4-4.

Table 4-2. Top Ten Components: North
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	33.6%	33.6%	12,753
Mixed Low-grade Paper	22.9%	56.5%	8,688
Unwaxed OCC/Kraft Paper	15.5%	72.0%	5,880
Green Glass Bottles	6.0%	78.0%	2,273
Brown Glass Bottles	4.7%	82.7%	1,798
Clear Glass Bottles	3.6%	86.3%	1,371
Phone Books	2.7%	89.0%	1,033
Mixed Cullet	2.6%	91.6%	984
Recyclable Glass (Commingled Compartment)	1.5%	93.1%	554
Tin Food Cans	0.9%	93.9%	328
Total	**93.9%**		**35,663**

4.1.2 South

For this study, 133 recycling loads from the south service area were sampled. As shown in Table 4-3, *newsprint* and *mixed low-grade paper* are the largest two components, at almost 33% and 25%, respectively. *Unwaxed OCC/Kraft paper* was the next largest component at about 16% of the total, by weight. Please see Table 4-5 for the complete results for recycling setouts collected from the south service area.

Table 4-3. Top Ten Components: South
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	32.5%	32.5%	14,692
Mixed Low-grade Paper	24.8%	57.3%	11,213
Unwaxed OCC/Kraft Paper	16.0%	73.3%	7,226
Green Glass Bottles	5.7%	79.0%	2,597
Brown Glass Bottles	3.6%	82.6%	1,624
Clear Glass Bottles	3.0%	85.6%	1,375
Recyclable Glass (Commingled Compartment)	3.0%	88.6%	1,350
Phone Books	2.6%	91.3%	1,197
Mixed Cullet	2.2%	93.4%	983
Tin Food Cans	0.8%	94.2%	347
Total	**94.2%**		**42,603**

4.1.3 Comparison between Service Areas

The same materials made up the top ten components for the north and south service areas. With the exception of *recyclable glass (commingled compartment)*, they appeared in the same order in both top ten tables. The proportion of *recyclable glass (commingled compartment)* was twice as much, by weight, and was the seventh largest component in the south service area compared to the ninth largest component in the north.

Table 4-4. Composition by Weight: North
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**28,514**	**75.1%**		
Newsprint	12,753	33.6%	32.2%	35.0%
OCC/Kraft, Unwaxed	5,880	15.5%	14.3%	16.6%
Phone Books	1,033	2.7%	2.0%	3.5%
Mixed Low-grade	8,688	22.9%	21.7%	24.0%
Polycoat Containers	144	0.4%	0.3%	0.4%
Aseptic Containers	15	0.0%	0.0%	0.1%
Metal	**680**	**1.8%**		
Aluminum Cans	209	0.6%	0.5%	0.6%
Tin Food Cans	328	0.9%	0.8%	0.9%
Other Ferrous	142	0.4%	0.2%	0.6%
Plastic	**915**	**2.4%**		
Small PET Bottles (24 oz or smaller)	159	0.4%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	208	0.5%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	20	0.1%	0.0%	0.1%
HDPE Bottles	269	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	32	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	32	0.1%	0.1%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	53	0.1%	0.1%	0.2%
Plastic Bags and Packaging	142	0.4%	0.3%	0.4%
Glass	**6,546**	**17.2%**		
Clear Bottles	1,371	3.6%	3.4%	3.8%
Green Bottles	2,273	6.0%	5.7%	6.3%
Brown Bottles	1,798	4.7%	4.4%	5.1%
Clear Container Glass	80	0.2%	0.1%	0.3%
Other Glass Containers and Bottles	41	0.1%	0.1%	0.1%
Mixed Cullet	984	2.6%	2.4%	2.8%
Recyclable Glass (Commingled Compartment)	**554**	**1.5%**		
Recyclable Glass (Commingled Compartment)	554	1.5%	0.8%	2.2%
Contaminants	**756**	**2.0%**		
Non-conforming Paper (Commingled Compartment)	213	0.6%	0.4%	0.7%
Non-conforming Metal (Commingled Compartment)	43	0.1%	0.1%	0.1%
Non-conforming Plastic (Commingled Compartment)	254	0.7%	0.6%	0.8%
Non-conforming Glass (Glass Compartment)	26	0.1%	0.0%	0.1%
Other Non-recyclables	219	0.6%	0.4%	0.7%
Total Tons	**37,965**			
Sample Count	**133**			

Table 4-5. Composition by Weight: South
(January 2005 – December 2005)

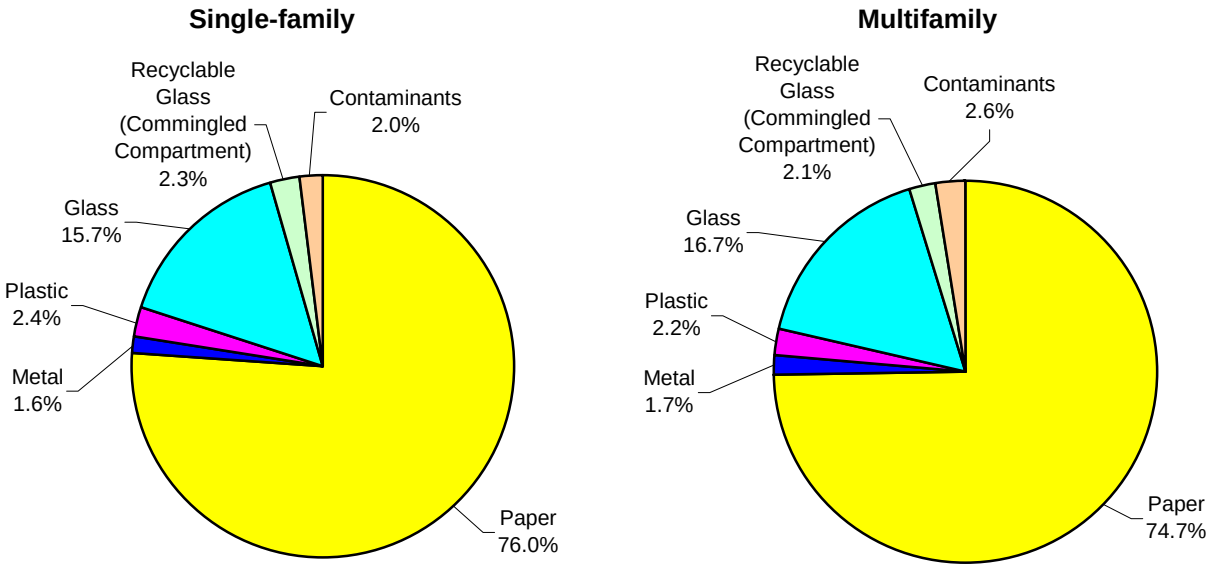
Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**34,491**	**76.3%**		
Newsprint	14,692	32.5%	31.3%	33.7%
OCC/Kraft, Unwaxed	7,226	16.0%	14.7%	17.2%
Phone Books	1,197	2.6%	2.0%	3.3%
Mixed Low-grade	11,213	24.8%	23.5%	26.1%
Polycoat Containers	145	0.3%	0.3%	0.4%
Aseptic Containers	17	0.0%	0.0%	0.1%
Metal	**662**	**1.5%**		
Aluminum Cans	210	0.5%	0.4%	0.5%
Tin Food Cans	347	0.8%	0.7%	0.9%
Other Ferrous	105	0.2%	0.1%	0.4%
Plastic	**1,041**	**2.3%**		
Small PET Bottles (24 oz or smaller)	192	0.4%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	218	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	10	0.0%	0.0%	0.0%
HDPE Bottles	287	0.6%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	56	0.1%	0.0%	0.2%
Other Plastic Bottles (#3-7, excluding #6)	34	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	48	0.1%	0.1%	0.1%
Plastic Bags and Packaging	198	0.4%	0.4%	0.5%
Glass	**6,670**	**14.7%**		
Clear Bottles	1,375	3.0%	2.9%	3.2%
Green Bottles	2,597	5.7%	5.4%	6.0%
Brown Bottles	1,624	3.6%	3.4%	3.8%
Clear Container Glass	60	0.1%	0.1%	0.2%
Other Glass Containers and Bottles	31	0.1%	0.0%	0.1%
Mixed Cullet	983	2.2%	2.0%	2.4%
Recyclable Glass (Commingled Compartment)	**1,350**	**3.0%**		
Recyclable Glass (Commingled Compartment)	1,350	3.0%	2.2%	3.7%
Contaminants	**1,018**	**2.2%**		
Non-conforming Paper (Commingled Compartment)	262	0.6%	0.5%	0.7%
Non-conforming Metal (Commingled Compartment)	87	0.2%	0.1%	0.3%
Non-conforming Plastic (Commingled Compartment)	323	0.7%	0.6%	0.8%
Non-conforming Glass (Glass Compartment)	11	0.0%	0.0%	0.1%
Other Non-recyclables	334	0.7%	0.5%	1.0%
Total Tons	**45,232**			
Sample Count	**133**			

4.2 By Generator Type

Composition estimates for single-family and multifamily recycling are summarized in Figure 4-2. As depicted, *paper* accounted for about three-quarters while *glass* made up between 16-17% of recycling from both single-family and multifamily generators. *Contaminants*, *recyclable glass (commingled compartment)*, *plastic*, and *metal* each made up less than 5% of the total for each generator type.

Figure 4-2. Overview of Composition Estimates, by Generator Type
(January 2005 – December 2005)



4.2.1 Single-family Composition

A total of 178 single-family recycling loads were sampled between January and December 2005. Table 4-6 lists the top ten components, by weight, of single-family recycling. *Newsprint* was the largest single component at about 34%, followed by *mixed low-grade paper* (24.5%) and *unwaxed OCC/Kraft paper* (14.7%). *Green glass bottles* was the next most prominent component, making up about 6% of this generator type's recycling. Table 4-8 lists the detailed composition results for the single-family recycling.

Table 4-6. Top Ten Components: Single-family
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	34.0%	34.0%	22,219
Mixed Low-grade Paper	24.5%	58.4%	15,996
Unwaxed OCC/Kraft Paper	14.7%	73.1%	9,594
Green Glass Bottles	5.8%	78.9%	3,785
Brown Glass Bottles	4.1%	82.9%	2,650
Clear Glass Bottles	3.3%	86.3%	2,175
Phone Books	2.5%	88.8%	1,636
Recyclable Glass (Commingled Compartment)	2.3%	91.1%	1,523
Mixed Cullet	2.3%	93.4%	1,485
Tin Food Cans	0.8%	94.2%	545
Total	**94.2%**		**61,609**

4.2.2 Multifamily Composition

A total of 88 samples were captured and sorted from multifamily recycling loads for this study. As shown in Table 4-7, *newsprint* was the single largest component at nearly 30% of the total, by weight. *Mixed low-grade paper* and *unwaxed OCC/Kraft paper* together comprised approximately 40%. *Green glass bottles* accounted for about 6% of the total for this generator type. Table 4-9 lists the full composition results for multifamily recycling.

Table 4-7. Top Ten Components: Multifamily
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	29.4%	29.4%	5,225
Mixed Low-grade Paper	22.0%	51.3%	3,906
Unwaxed OCC/Kraft Paper	19.7%	71.1%	3,512
Green Glass Bottles	6.1%	77.2%	1,085
Brown Glass Bottles	4.3%	81.5%	772
Phone Books	3.3%	84.9%	595
Clear Glass Bottles	3.2%	88.1%	571
Mixed Cullet	2.7%	90.8%	481
Recyclable Glass (Commingled Compartment)	2.1%	92.9%	381
Other Non-recyclables	1.0%	94.0%	186
Total	**94.0%**		**16,714**

4.2.3 Comparison between Generator Types

Nine out of ten of the top ten components are the same for single-family and multifamily recycling. The top five components appear in the same order in both top ten tables.

The one component that differed between the two generator types was *tin food cans* for single-family recycling and *other non-recyclables* was for multifamily recycling. *Other non-recyclables* includes items such as food, construction waste, and non-glass recyclables in the *glass* compartment.

Table 4-8. Composition by Weight: Single-Family
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**49,715**	**76.0%**		
Newsprint	22,219	34.0%	32.9%	35.0%
OCC/Kraft, Unwaxed	9,594	14.7%	13.7%	15.6%
Phone Books	1,636	2.5%	1.9%	3.1%
Mixed Low-grade	15,996	24.5%	23.5%	25.4%
Polycoat Containers	242	0.4%	0.3%	0.4%
Aseptic Containers	28	0.0%	0.0%	0.1%
Metal	**1,041**	**1.6%**		
Aluminum Cans	340	0.5%	0.5%	0.6%
Tin Food Cans	545	0.8%	0.8%	0.9%
Other Ferrous	156	0.2%	0.1%	0.3%
Plastic	**1,573**	**2.4%**		
Small PET Bottles (24 oz or smaller)	289	0.4%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	337	0.5%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	26	0.0%	0.0%	0.1%
HDPE Bottles	443	0.7%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	56	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	55	0.1%	0.1%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	84	0.1%	0.1%	0.2%
Plastic Bags and Packaging	283	0.4%	0.4%	0.5%
Glass	**10,247**	**15.7%**		
Clear Bottles	2,175	3.3%	3.2%	3.5%
Green Bottles	3,785	5.8%	5.5%	6.0%
Brown Bottles	2,650	4.1%	3.8%	4.3%
Clear Container Glass	92	0.1%	0.1%	0.2%
Other Glass Containers and Bottles	60	0.1%	0.1%	0.1%
Mixed Cullet	1,485	2.3%	2.1%	2.4%
Recyclable Glass (Commingled Compartment)	**1,523**	**2.3%**		
Recyclable Glass (Commingled Compartment)	1,523	2.3%	1.7%	2.9%
Contaminants	**1,313**	**2.0%**		
Non-conforming Paper (Commingled Compartment)	346	0.5%	0.4%	0.6%
Non-conforming Metal (Commingled Compartment)	101	0.2%	0.1%	0.2%
Non-conforming Plastic (Commingled Compartment)	478	0.7%	0.6%	0.8%
Non-conforming Glass (Glass Compartment)	21	0.0%	0.0%	0.1%
Other Non-recyclables	367	0.6%	0.4%	0.7%
Total Tons	**65,413**			
Sample Count	**178**			

Table 4-9. Composition by Weight: Multifamily
(January 2005 – December 2005)

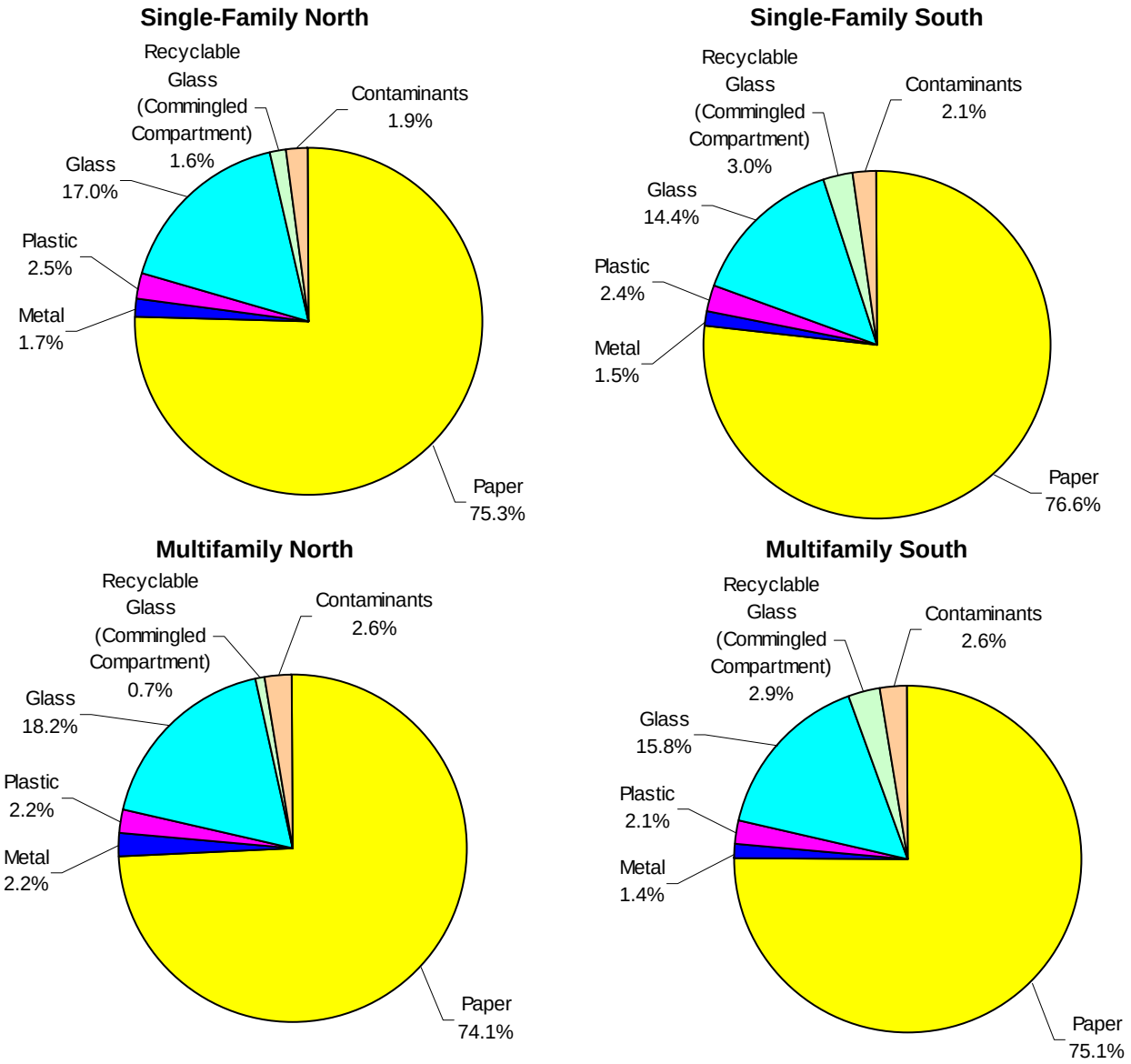
Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**13,290**	**74.7%**		
Newsprint	5,225	29.4%	27.6%	31.1%
OCC/Kraft, Unwaxed	3,512	19.7%	17.7%	21.8%
Phone Books	595	3.3%	2.6%	4.1%
Mixed Low-grade	3,906	22.0%	20.1%	23.9%
Polycoat Containers	47	0.3%	0.2%	0.3%
Aseptic Containers	5	0.0%	0.0%	0.0%
Metal	**301**	**1.7%**		
Aluminum Cans	79	0.4%	0.4%	0.5%
Tin Food Cans	130	0.7%	0.6%	0.9%
Other Ferrous	92	0.5%	0.1%	0.9%
Plastic	**384**	**2.2%**		
Small PET Bottles (24 oz or smaller)	62	0.3%	0.3%	0.4%
Large PET Bottles (greater than 24 oz)	89	0.5%	0.4%	0.6%
PET Jars, Tubs, and Other Containers	3	0.0%	0.0%	0.0%
HDPE Bottles	113	0.6%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	32	0.2%	0.0%	0.4%
Other Plastic Bottles (#3-7, excluding #6)	11	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	18	0.1%	0.1%	0.1%
Plastic Bags and Packaging	57	0.3%	0.2%	0.4%
Glass	**2,969**	**16.7%**		
Clear Bottles	571	3.2%	3.0%	3.4%
Green Bottles	1,085	6.1%	5.7%	6.5%
Brown Bottles	772	4.3%	4.0%	4.7%
Clear Container Glass	48	0.3%	0.1%	0.4%
Other Glass Containers and Bottles	12	0.1%	0.0%	0.1%
Mixed Cullet	481	2.7%	2.4%	3.0%
Recyclable Glass (Commingled Compartment)	**381**	**2.1%**		
Recyclable Glass (Commingled Compartment)	381	2.1%	1.2%	3.1%
Contaminants	**461**	**2.6%**		
Non-conforming Paper (Commingled Compartment)	130	0.7%	0.5%	0.9%
Non-conforming Metal (Commingled Compartment)	29	0.2%	0.1%	0.2%
Non-conforming Plastic (Commingled Compartment)	100	0.6%	0.4%	0.7%
Non-conforming Glass (Glass Compartment)	16	0.1%	0.0%	0.2%
Other Non-recyclables	186	1.0%	0.5%	1.6%
Total Tons	**17,785**			
Sample Count	**88**			

4.3 By Generator Type and Service Area

Figure 4-3 summarizes the composition by generator type and service area. *Paper* accounted for between 74-77% of recycling set out by each of these subpopulations. *Glass* comprised between 14% and 18% of each of the four subpopulations. *Recyclable glass (commingled compartment)* made up a slightly smaller portion of recycling in the north service area, between 0.7% and 1.6%, than in the south service where it comprised about 3% of the total residential recycling. The three remaining broad material categories: *contaminants*, *plastic* and *metal* each accounted for less than 3% of the total for all four subpopulations.

Figure 4-3. Overview of Composition Estimates, by Generator Type and Service Area (January 2005 – December 2005)



4.3.1 Single-family North

A total of 88 samples were captured and sorted from single-family north recycling loads between January and December 2005. As illustrated in Table 4-10, the three largest components, *newsprint*, *mixed low-grade paper*, and *unwaxed OCC/Kraft paper*, comprised more than 70% of the total recycling for this subpopulation, by weight. Please see Table 4-14 for full composition results for single-family north recycling.

Table 4-10. Top Ten Components: Single-Family North
(January – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	34.0%	34.0%	10,750
Mixed Low-grade Paper	23.9%	58.0%	7,559
Unwaxed OCC/Kraft Paper	14.4%	72.3%	4,544
Green Glass Bottles	6.0%	78.4%	1,903
Brown Glass Bottles	4.6%	83.0%	1,465
Clear Glass Bottles	3.7%	86.7%	1,161
Phone Books	2.5%	89.2%	802
Mixed Cullet	2.4%	91.6%	767
Recyclable Glass (Commingled Compartment)	1.6%	93.2%	509
Tin Food Cans	0.9%	94.1%	280
Total	**94.1%**		**29,740**

4.3.2 Single-family South

Ninety loads were sampled from the single-family south subpopulation. Table 4-11 lists the top ten components, by weight, for this recycling. *Newsprint* was the largest component, at nearly 34%, followed by *mixed low-grade paper* at about 25%, and *unwaxed OCC/Kraft paper*, which made up about 15% of the total, by weight. Please see Table 4-15 for the full composition results for single-family south recycling.

Table 4-11. Top Ten Components: Single-Family South
(January – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	33.9%	33.9%	11,469
Mixed Low-grade Paper	24.9%	58.9%	8,436
Unwaxed OCC/Kraft Paper	14.9%	73.8%	5,050
Green Glass Bottles	5.6%	79.4%	1,883
Brown Glass Bottles	3.5%	82.9%	1,185
Recyclable Glass (Commingled Compartment)	3.0%	85.9%	1,015
Clear Glass Bottles	3.0%	88.9%	1,014
Phone Books	2.5%	91.3%	834
Mixed Cullet	2.1%	93.4%	719
Tin Food Cans	0.8%	94.2%	265
Total	**94.2%**		**31,869**

4.3.3 Multifamily North

A total of 45 samples were captured and sorted from multifamily north recycling loads. *Newsprint* was the largest single component, at about 31% of the total (Table 4-12). *Unwaxed OCC/Kraft paper* and *mixed low-grade paper* made up about 40%, combined. *Green glass bottles* and *brown glass bottles* each comprised between 5% and 6% of the total, by weight. Table 4-16 lists the full composition results for multifamily north recycling.

Table 4-12. Top Ten Components: Multifamily North
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	31.4%	31.4%	2,003
Unwaxed OCC/Kraft Paper	21.0%	52.4%	1,336
Mixed Low-grade Paper	17.7%	70.1%	1,129
Green Glass Bottles	5.8%	75.9%	370
Brown Glass Bottles	5.2%	81.1%	333
Phone Books	3.6%	84.8%	231
Mixed Cullet	3.4%	88.2%	217
Clear Glass Bottles	3.3%	91.5%	210
Other Ferrous Metal	1.0%	92.4%	61
Other Non-recyclables	0.9%	93.4%	58
Total	**93.4%**		**5,949**

4.3.4 Multifamily South

Forty-three samples were captured from multifamily south loads during the 2005 study. As illustrated in Table 4-13, *newsprint* and *mixed low-grade paper* comprised about half of this recycling, when combined. *Unwaxed OCC/Kraft paper* accounted for approximately 20%, by weight. The detailed composition results for multifamily south recycling are listed in Table 4-17.

Table 4-13. Top Ten Components: Multifamily South
(January 2005 – December 2005)

Component	Mean	Cum. %	Tons
Newsprint	28.2%	28.2%	3,223
Mixed Low-grade Paper	24.3%	52.6%	2,777
Unwaxed OCC/Kraft Paper	19.1%	71.6%	2,176
Green Glass Bottles	6.3%	77.9%	715
Brown Glass Bottles	3.8%	81.7%	439
Phone Books	3.2%	84.9%	363
Clear Glass Bottles	3.2%	88.1%	361
Recyclable Glass (Commingled Compartment)	2.9%	91.0%	335
Mixed Cullet	2.3%	93.3%	264
Other Non-recyclables	1.1%	94.5%	128
Total	**94.5%**		**10,780**

4.3.5 Comparison between Subpopulations

Many components can be found in the top ten tables for all four residential recycling subpopulations. *Newsprint* (28.2% - 34.0%) is the largest component for each subpopulation. The next two prevalent components were *mixed low-grade paper* and *unwaxed OCC/Kraft paper*, although they appeared in different orders for different subpopulations. The fourth largest component, *green glass bottles*, made up about 6% in all four subpopulations, and *brown glass bottles*, the fifth largest component, accounted for between 3% and 6% of the total, by weight.

There were several differences between the top ten tables for the subpopulations. First, *tin food cans* only appeared in the top ten components for the two single-family subpopulations. *Recyclable glass (commingled compartment)* was a top ten component for all subpopulations except for multifamily north. Next, *other non-recyclables* was only in the top ten for the two multifamily subpopulations. Lastly, *other ferrous metal* only appeared in the top ten table for multifamily north.

Table 4-14. Composition by Weight: Single-Family North
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**23,793**	**75.3%**		
Newsprint	10,750	34.0%	32.5%	35.6%
OCC/Kraft, Unwaxed	4,544	14.4%	13.1%	15.7%
Phone Books	802	2.5%	1.7%	3.4%
Mixed Low-grade	7,559	23.9%	22.6%	25.3%
Polycoat Containers	123	0.4%	0.3%	0.4%
Aseptic Containers	14	0.0%	0.0%	0.1%
Metal	**539**	**1.7%**		
Aluminum Cans	179	0.6%	0.5%	0.7%
Tin Food Cans	280	0.9%	0.8%	1.0%
Other Ferrous	81	0.3%	0.1%	0.4%
Plastic	**775**	**2.5%**		
Small PET Bottles (24 oz or smaller)	135	0.4%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	176	0.6%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	17	0.1%	0.0%	0.1%
HDPE Bottles	221	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	24	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	28	0.1%	0.1%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	47	0.1%	0.1%	0.2%
Plastic Bags and Packaging	127	0.4%	0.3%	0.5%
Glass	**5,385**	**17.0%**		
Clear Bottles	1,161	3.7%	3.5%	3.9%
Green Bottles	1,903	6.0%	5.7%	6.3%
Brown Bottles	1,465	4.6%	4.2%	5.0%
Clear Container Glass	51	0.2%	0.1%	0.2%
Other Glass Containers and Bottles	38	0.1%	0.1%	0.2%
Mixed Cullet	767	2.4%	2.2%	2.7%
Recyclable Glass (Commingled Compartment)	**509**	**1.6%**		
Recyclable Glass (Commingled Compartment)	509	1.6%	0.8%	2.4%
Contaminants	**592**	**1.9%**		
Non-conforming Paper (Commingled Compartment)	164	0.5%	0.4%	0.6%
Non-conforming Metal (Commingled Compartment)	33	0.1%	0.1%	0.1%
Non-conforming Plastic (Commingled Compartment)	222	0.7%	0.6%	0.8%
Non-conforming Glass (Glass Compartment)	12	0.0%	0.0%	0.1%
Other Non-recyclables	161	0.5%	0.4%	0.7%
Total Tons	**31,593**			
Sample Count	**88**			

Table 4-15. Composition by Weight: Single-family South
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**25,923**	**76.6%**		
Newsprint	11,469	33.9%	32.5%	35.3%
OCC/Kraft, Unwaxed	5,050	14.9%	13.6%	16.3%
Phone Books	834	2.5%	1.6%	3.3%
Mixed Low-grade	8,436	24.9%	23.6%	26.3%
Polycoat Containers	119	0.4%	0.3%	0.4%
Aseptic Containers	15	0.0%	0.0%	0.1%
Metal	**502**	**1.5%**		
Aluminum Cans	162	0.5%	0.4%	0.6%
Tin Food Cans	265	0.8%	0.7%	0.9%
Other Ferrous	75	0.2%	0.1%	0.4%
Plastic	**797**	**2.4%**		
Small PET Bottles (24 oz or smaller)	154	0.5%	0.4%	0.5%
Large PET Bottles (greater than 24 oz)	161	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	9	0.0%	0.0%	0.0%
HDPE Bottles	222	0.7%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	32	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	28	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	36	0.1%	0.1%	0.1%
Plastic Bags and Packaging	156	0.5%	0.4%	0.5%
Glass	**4,863**	**14.4%**		
Clear Bottles	1,014	3.0%	2.8%	3.2%
Green Bottles	1,883	5.6%	5.2%	5.9%
Brown Bottles	1,185	3.5%	3.2%	3.8%
Clear Container Glass	41	0.1%	0.1%	0.2%
Other Glass Containers and Bottles	21	0.1%	0.0%	0.1%
Mixed Cullet	719	2.1%	1.9%	2.3%
Recyclable Glass (Commingled Compartment)	**1,015**	**3.0%**		
Recyclable Glass (Commingled Compartment)	1,015	3.0%	2.1%	3.9%
Contaminants	**721**	**2.1%**		
Non-conforming Paper (Commingled Compartment)	182	0.5%	0.4%	0.7%
Non-conforming Metal (Commingled Compartment)	68	0.2%	0.1%	0.3%
Non-conforming Plastic (Commingled Compartment)	256	0.8%	0.6%	0.9%
Non-conforming Glass (Glass Compartment)	9	0.0%	0.0%	0.1%
Other Non-recyclables	207	0.6%	0.4%	0.8%
Total Tons	**33,820**			
Sample Count	**90**			

Table 4-16. Composition by Weight: Multifamily North
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**4,721**	**74.1%**		
Newsprint	2,003	31.4%	28.8%	34.1%
OCC/Kraft, Unwaxed	1,336	21.0%	18.2%	23.7%
Phone Books	231	3.6%	2.4%	4.8%
Mixed Low-grade	1,129	17.7%	16.0%	19.4%
Polycoat Containers	20	0.3%	0.3%	0.4%
Aseptic Containers	2	0.0%	0.0%	0.0%
Metal	**140**	**2.2%**		
Aluminum Cans	30	0.5%	0.4%	0.6%
Tin Food Cans	49	0.8%	0.6%	0.9%
Other Ferrous	61	1.0%	0.0%	2.0%
Plastic	**140**	**2.2%**		
Small PET Bottles (24 oz or smaller)	24	0.4%	0.3%	0.4%
Large PET Bottles (greater than 24 oz)	32	0.5%	0.4%	0.6%
PET Jars, Tubs, and Other Containers	2	0.0%	0.0%	0.1%
HDPE Bottles	48	0.8%	0.6%	0.9%
HDPE Jars, Tubs, and Other Containers	9	0.1%	0.1%	0.2%
Other Plastic Bottles (#3-7, excluding #6)	4	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	6	0.1%	0.1%	0.1%
Plastic Bags and Packaging	15	0.2%	0.2%	0.3%
Glass	**1,161**	**18.2%**		
Clear Bottles	210	3.3%	3.0%	3.6%
Green Bottles	370	5.8%	5.0%	6.6%
Brown Bottles	333	5.2%	4.7%	5.8%
Clear Container Glass	29	0.5%	0.1%	0.8%
Other Glass Containers and Bottles	3	0.0%	0.0%	0.1%
Mixed Cullet	217	3.4%	3.0%	3.8%
Recyclable Glass (Commingled Compartment)	**46**	**0.7%**		
Recyclable Glass (Commingled Compartment)	46	0.7%	0.5%	0.9%
Contaminants	**164**	**2.6%**		
Non-conforming Paper (Commingled Compartment)	50	0.8%	0.5%	1.1%
Non-conforming Metal (Commingled Compartment)	10	0.2%	0.1%	0.2%
Non-conforming Plastic (Commingled Compartment)	32	0.5%	0.4%	0.6%
Non-conforming Glass (Glass Compartment)	14	0.2%	0.0%	0.4%
Other Non-recyclables	58	0.9%	0.4%	1.4%
Total Tons	**6,373**			
Sample Count	**45**			

Table 4-17. Composition by Weight: Multifamily South
(January 2005 – December 2005)

Calculated at a 90% confidence level

	Tons	Mean	Low	High
Paper	**8,568**	**75.1%**		
Newsprint	3,223	28.2%	25.9%	30.6%
OCC/Kraft, Unwaxed	2,176	19.1%	16.3%	21.9%
Phone Books	363	3.2%	2.3%	4.1%
Mixed Low-grade	2,777	24.3%	21.5%	27.1%
Polycoat Containers	27	0.2%	0.2%	0.3%
Aseptic Containers	3	0.0%	0.0%	0.0%
Metal	**161**	**1.4%**		
Aluminum Cans	48	0.4%	0.3%	0.5%
Tin Food Cans	82	0.7%	0.5%	0.9%
Other Ferrous	30	0.3%	0.1%	0.5%
Plastic	**244**	**2.1%**		
Small PET Bottles (24 oz or smaller)	38	0.3%	0.3%	0.4%
Large PET Bottles (greater than 24 oz)	57	0.5%	0.4%	0.6%
PET Jars, Tubs, and Other Containers	1	0.0%	0.0%	0.0%
HDPE Bottles	65	0.6%	0.5%	0.7%
HDPE Jars, Tubs, and Other Containers	23	0.2%	0.0%	0.5%
Other Plastic Bottles (#3-7, excluding #6)	6	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	12	0.1%	0.1%	0.1%
Plastic Bags and Packaging	41	0.4%	0.2%	0.5%
Glass	**1,808**	**15.8%**		
Clear Bottles	361	3.2%	2.9%	3.4%
Green Bottles	715	6.3%	5.7%	6.8%
Brown Bottles	439	3.8%	3.4%	4.3%
Clear Container Glass	19	0.2%	0.0%	0.4%
Other Glass Containers and Bottles	10	0.1%	0.0%	0.2%
Mixed Cullet	264	2.3%	2.0%	2.7%
Recyclable Glass (Commingled Compartment)	**335**	**2.9%**		
Recyclable Glass (Commingled Compartment)	335	2.9%	1.5%	4.4%
Contaminants	**297**	**2.6%**		
Non-conforming Paper (Commingled Compartment)	80	0.7%	0.4%	1.0%
Non-conforming Metal (Commingled Compartment)	20	0.2%	0.1%	0.3%
Non-conforming Plastic (Commingled Compartment)	67	0.6%	0.4%	0.8%
Non-conforming Glass (Glass Compartment)	2	0.0%	0.0%	0.0%
Other Non-recyclables	128	1.1%	0.3%	1.9%
Total Tons	**11,412**			
Sample Count	**43**			

Appendix A RECYCLING COMPONENTS

For the 2005 study, a sample generally consisted of two parts, corresponding to two separate collection compartments within a truck: one for *glass* recyclables, and the other for *all other recyclables* (e.g. mixed paper, aluminum cans, and plastic bottles). A small number of trucks combined these materials in one compartment or mixed the materials accidentally. See Appendix B for more information.

Samples from *glass* compartments were sorted into eight of the 30 categories listed below: the seven *glass* components and *garbage (glass compartment)*. Samples from *all other recyclables* compartments were sorted into the remaining 22 categories. Detailed definitions of all component categories for the 2005 study are listed below and are followed by component changes between the 2000/01 and 2005 studies.

Paper

1. NEWSPRINT: Printed newsprint. (Advertising "slicks" (glossy paper) were included in this category if found mixed with newspaper; otherwise, ad slicks are included with mixed low grade paper.)

2. OCC/KRAFT, UNWAXED: Unwaxed/uncoated old corrugated container boxes and Kraft paper, and brown paper bags. Clean bags and boxes only; soiled are "non-conforming."

3. PHONE BOOKS: Telephone directories.

4. MIXED LOW GRADE: Mixed recyclable papers, including junk mail, magazines, colored papers, bleached Kraft, boxboard, mailing tubes, and paperback books. May also contain white or lightly colored sulfite/sulfate bond, copy papers, computer printouts, hard-back books, and envelopes.

5. POLYCOAT CONTAINERS: Bleached polycoated milk, ice cream, and frozen food containers. Clean containers only; soiled are "non-conforming."

6. ASEPTIC CONTAINERS: Juice, soy/rice milk, and soup broth containers. Clean containers only; soiled are "non-conforming."

Metal

7. ALUMINUM CANS: Aluminum beverage cans (UBC) and bi-metal cans made mostly of aluminum.

8. TIN FOOD CANS: Tinned steel food containers, including bi-metal cans mostly of steel.

9. OTHER FERROUS: Ferrous and alloyed ferrous scrap metals to which a magnet adheres and which are not significantly contaminated with other metals or materials.

Plastic

10. SMALL PET BOTTLES: Polyethylene terephthalate bottles (containers with a narrow neck), such as soda pop and other beverage less than or equal to 24 ounces.

11. LARGE PET BOTTLES: Polyethylene terephthalate bottles (containers with a narrow neck), such as soda pop and other beverage bottles greater than 24 ounces.

12. PET JARS, TUBS, AND OTHER CONTAINERS: Polyethylene terephthalate containers bearing a #1 in the triangular recycling symbol. Does not include any lids.

13. HDPE BOTTLES: High-density polyethylene bottles (containers with a narrow neck), such as milk, juice, and detergent containers.

14. HDPE JARS, TUBS, AND OTHER CONTAINERS: High-density polyethylene items bearing a #2 in the triangular recycling symbol. Does not include any lids.

15. OTHER PLASTIC BOTTLES (#3-7, EXCLUDING #6): Plastic bottles made of types of plastic other than HDPE or PETE. When marked for identification, these items may bear the number "3," "4," "5," or "7" in the triangular recycling symbol, but excludes all bottles marked with a "6," and all lids.

16. OTHER JARS, TUBS, AND CONTAINERS (#3-7, EXCLUDING #6): Clean plastic items made of types of plastic other than HDPE or PETE. When marked for identification, these items may bear the number "1," "2," "3," "4," "5," or "7" in the triangular recycling symbol. Excludes all containers marked with a "6" (i.e. take out/fast food containers), and all lids.

17. PLASTIC BAGS AND PACKAGING: Clean plastic retail, grocery, garbage, newspaper, drycleaner bags, and plastic shrink-wrap. Excludes all food and freezer bags, bags that are soiled or contain other items (i.e. paper advertisement, cosmetic samples, computer disks), and plastic kitchen wrap. Bags with non-plastic handles (e.g. string) are also excluded.

Glass

18. CLEAR BOTTLES: Includes clear pop, liquor, wine, juice, beer, and vinegar bottles.

19. GREEN BOTTLES: Includes green pop, liquor, wine, beer, and lemon juice bottles.

20. BROWN BOTTLES: Includes brown pop, beer, liquor, juice, vanilla extract bottles.

21. CLEAR CONTAINER GLASS: All glass containers that are clear-colored and hold materials such as mayonnaise and non-dairy creamer.

22. OTHER GLASS CONTAINERS AND BOTTLES: All glass containers (of colors except clear) holding materials such as facial cream. All bottles of colors other than clear, green or brown. Examples include blue wine and liquor bottles.

23. MIXED CULLET. Glass bottles and containers that are broken into pieces less than one square inch and of multiple colors.

Recyclable Glass (Commingled Compartment)

24. RECYCLABLE GLASS (COMMINGLED COMPARTMENT): Glass bottles and containers meeting the requirements for Seattle's recycling program and located in a recycling truck's commingled compartment; such as pop and beer bottles, and glass containers holding materials such as facial cream.

Contaminants

25. NON-CONFORMING PAPER (COMMINGLED COMPARTMENT): Any paper not described in the paper category and not meeting the requirements for Seattle's recycling program, such as tissue, photographs, soiled paper, food-soiled polycoat containers, waxed cardboard, and paper bags with plastic lining (i.e. dog or cat food bags).

26. NON-CONFORMING METAL (COMMINGLED COMPARTMENT): Any metal not described in the metals category and not meeting the requirements for Seattle's recycling program, such as products containing a mixture of metals, all foil wrapping, foil pie tins, aerosol containers, and other materials.

27. NON-CONFORMING PLASTIC (COMMINGLED COMPARTMENT): Any plastic not described in the plastics category and not meeting the requirements for Seattle's recycling program such as toys, tarps, bubble wrap, bags with plastic or rope handles, and all plastic lids.

28. NON-CONFORMING GLASS (GLASS COMPARTMENT): Any glass from glass loads not described in the glass category and not meeting the requirements for Seattle's recycling program, such as window glass, light bulbs and glassware.

29. (COMMINGLED COMPARTMENT)OTHER NON-RECYCLABLES: Non-glass recyclables in a recycling truck's glass compartment or any item that does not meet the requirements for Seattle's recycling program in either compartment, such as organic wastes, construction debris, soil, and hazardous wastes.

Table A-1 summarizes the changes to component categories made since 1998/99. (An "X" signifies that the component remains the same from the previous study; an outline border reflects how components were split apart or combined.)

Table A-1. Changes to Recycling Component Categories, 1998/99 to Present

	1998/99	2000/01	2005
PAPER			
Newsprint	X	X	X
Corrugated/Kraft, Unwaxed	X	X	X
Phone Books	X	X	X
Mixed Low Grade	X	X	X
PLASTICS			
PET Bottles	X	Small PET Bottles (24 oz or smaller)	X
		Large PET Bottles (greater than 24 oz)	X
HDPE Bottles	X	X	X
GLASS			
Clear Beverage	X	Clear Glass Bottles	X
Green Beverage	X	Green Glass Bottles	X
Brown Beverage	X	Brown Glass Bottles	X
Container Glass	X	Clear Container Glass	X
		Other Glass Containers and Bottles	X
Mixed Cullet	X	X	X
METALS			
Aluminum Cans	X	X	X
Tin Food Cans	X	X	X
Other Ferrous	X	X	X
CONTAMINANTS			
Non-conforming Paper	X	X	X
		Polycoat Containers; moved to *Paper*	X
		Aseptic Containers; moved to *Paper*	X
Non-conforming Plastic	X	X	X
		PET Plastic Jars, Tubs, and Other Containers; moved to *Plastic*	X
		HDPE Plastic Jars, Tubs, and Other Containers; moved to *Plastic*	X
		Other Plastic Bottles (#3-7, excluding #6); moved to *Plastic*	X
		Other Plastic Jars, Tubs, and Containers (#3-7, excluding #6); moved to *Plastic*	X
		Plastic Bags and Packaging; moved to *Plastic*	X
Non-conforming Glass (Glass Compartment)	X	X	X
Non-conforming Metal	X	X	X
Garbage	X	X	Other Non-Recyclables
			Recyclable Glass (Commingled Compartment)

Appendix B SAMPLING METHODOLOGY

Overview

The objective of the 2005 Residential Recycling Stream Composition Study was to provide statistically significant data on the composition of recycling setouts for both single-family and multifamily residences within the City of Seattle. [1] Residential recycling was sampled in 1993, 1998/99, and 2000/01. This study follows the same basic methodology as the 2000/01 study.

Sampling Populations

This study is designed to determine the composition of recycling setouts for both single-family and multifamily residences within the city.[2] Recyclable materials that are either self-hauled to the city's two transfer stations or hauled from Seattle's commercial substream will be excluded from this study.

The recyclables set out by residences in Seattle can be divided into four subpopulations based on generator type and service area. The two generator types include single-family and multifamily and are defined as follows:

- ***Single-family***: Residences using a toter system and a separate container for glass. Typically, these residences are detached single-family, duplex, triplex, and four-plex homes.

- ***Multifamily***: Typically apartments and condominiums with five or more units. A variety of systems may be used for collecting recyclables from this generator type. Generally includes a dumpster system with accompanying toters for glass.

Seattle's residential recyclables are collected in two service areas, north and south. The Lake Washington Ship Canal is the physical boundary that divides the north and south service areas.[3]

Figure B-1 depicts each of the four residential recycling subpopulations, according to generator type and service area.

[1] For the purposes of this study, "recyclables" are defined by the manner in which they are set out by residents, and not by the composition of the material itself. For example, if a resident places a piece of cardboard in a garbage can, it will not be included in this study's recycling sorts; however, the same piece of cardboard placed in a recycling container could potentially be sampled.

[2] At the start of the 2005 study, small business recycling was collected with residential recycling. Since August 2001, eligible small businesses have been able to participate for free in SPU's *Small Business Recycling Program*. This program was absorbed into a larger commercial program in March of the study year. In January and February, approximately 700 businesses participated in the program, accounting for 0.5% of the subscribers in those months and less than 0.1% of the collections for the year.

[3] Waste Management collected recycling setouts from the city's north service area while U.S. Disposal collected recyclables set out in the south service area. Both private hauling companies delivered recyclables to the City's contracted recycling facility, Third & Lander.

Figure B-1. Subpopulations, by Generator Type and Service Area

		Generator Type	
		Single-family	*Multifamily*
Service Area	*North*	Single-family North	Multifamily North
	South	Single-family South	Multifamily South

Sample Allocation & Schedule

Identify the "Universe"

The recyclables set out by single-family and multifamily residences are collected by two private hauling companies, Waste Management, Inc. in the north service area and U.S. Disposal and Recycling in the south service area. Both companies then take these recyclables to the Third & Lander Recycling & Transfer Station, which is owned by Rabanco.

One of the key steps in developing the sampling plan for the 2005 study is to identify the *universe* of collection routes for recycling setouts in Seattle. The *universe* is a list of every collection route for single and multifamily residences. It also includes the truck that is expected to service each route, the total number of loads picked up from the route on each collection day, and whether the route is in the north or south service area.

The recycling setouts from each of the four residential recycling subpopulations are collected separately. A brief description of each subpopulation is presented below:

- ***Single-family North***: Waste Management, Inc. and J & M (a subcontractor) pick up recycling setouts from single-family residences in the north service area. Each household is serviced every other week. On a typical day, a total of 12-15 trucks are in operation. These trucks service specific routes and collect both commingled and glass recyclables in separate compartments.[4]

- ***Single-family South***: U.S. Disposal operates 14-15 trucks per day to service single-family residences in the south service area on a biweekly basis. All trucks collect both commingled and glass recyclables and haul them in separate compartments.

- ***Multifamily North***: Nuts 'n' Bolts, another subcontractor of Waste Management, Inc., operates three trucks per day to pick up all recycling setouts from multifamily residences in the north service area. Residences are serviced at least one time per month and as much as once per week. All three trucks pick up both commingled and glass recyclables and store them in separate compartments.

[4] Commingled recycling includes all recyclables that are set out, except glass (i.e. mixed paper, aluminum cans, and plastic bottles).

- ***Multifamily South***: U.S. Disposal operates four trucks per day. Additionally, West Seattle Recycling, a subcontractor, operates one truck per day in West Seattle. Multifamily setouts in the south service area are picked up once every two weeks. All trucks pick up both commingled and glass recyclables separately.

Determine Number of Samples

This study was designed to capture a total of 270 samples – 180 single-family and 90 multifamily – between January and December 2005.[5] These samples were divided evenly between the north and south service areas. Table B-1 outlines the number of samples that were apportioned among the four subpopulations in this study.

Table B-1. Planned Number of Samples, by Subpopulation[6]
(January – December 2005)

	Planned Number of Samples
Single-family	
North	90
South	90
Multi-family	
North	45
South	45
Total	**270**

An additional 2 routes (1 single-family and 1 multifamily) were added to the list of routes scheduled on each sampling day. The additional collection routes provided "contingency samples" which were sorted in the event that one of the vehicles for the regularly planned collection routes failed to arrive on time or was not intercepted in time to get a sample.

Develop Sampling Calendar and Apportion Samples to Days

Since the field crew could sort approximately 22 samples per day; 12 sampling days were required to meet the sampling goals. In order to capture seasonal variations, one sampling day was assigned to each month of a 12-month period.

Working around major holidays and weekends (since residential recyclables are not collected on those days) and the sorting crew's availability, sampling dates were selected at random. This was accomplished by assigning all potential sampling days a computer-generated random

[5] In this study a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for glass recyclables and the other for *all other recyclables* (e.g. mixed paper, aluminum cans, and plastic bottles).
[6] The actual number of samples collected was 266, falling two short of the number of planned samples for single-family loads from the North service area and two short of the number of planned samples for multi-family loads from the South service area. See Appendix C for a month-by-month comparison of the plan with actual sampling.

number. The date with the lowest random number for each month was selected for sampling, unless the selected date was on or shortly after a major holiday.[7]

Single-family setouts are collected once every other week in both the north and the south service areas. Multifamily recycling in the south service area also operates on a two week schedule, although some accounts are picked up less frequently. Multifamily recycling in the north operates on a four-week schedule. Therefore the collection schedule for the entire city repeats itself every four weeks.

The sampling schedule was designed to ensure an even distribution across days of the week and weeks of the four-week collection cycle. This distribution allows for samples to be captured from a representative portion of all residential recyclables collected within the city.

The year's calendar is provided in Table B-2. Sampling was planned for one day every month. However, it was necessary to reschedule twice during the year (please see Appendix C for more detail). For this reason, only multifamily north recycling was sampled on May 23rd and the other three subpopulations were rescheduled for May 31st. Similarly, November's sampling event was moved to December. Beginning in May, the multifamily north samples were collected early in the morning from the previous day's loads.

On a typical sampling day, 15 single-family loads, including 7 or 8 from each service area, and 7 or 8 multifamily loads, including 3 or 4 from each service area, were scheduled for sampling.

Table B-2. Sampling Calendar[8]
(January – December 2005)

Date	Season	Day of Week	Single-family North Week	South Week	Multi-family North Week	Multi-family North Day
January 31	Winter	Monday	A	B	A	Monday
February 1	Winter	Tuesday	A	B	A	Tuesday
March 4	Spring	Friday	A	B	A	Friday
April 14	Spring	Thursday	A	B	C	Thursday
May 23	Spring				D	Friday
May 31	Spring	Tuesday	B	A		
June 14	Summer	Tuesday	B	A	D	Monday
July 11	Summer	Monday	B	A	D	Friday
August 10	Summer	Wednesday	B	A	D	Tuesday
September 22	Fall	Thursday	B	A	B	Wednesday
October 25	Fall	Tuesday	A	B	C	Monday
December 14	Winter	Wednesday	B	A	B	Tuesday
December 19	Winter	Monday	A	B	A	Friday

Table B-3 displays the resulting allocation of sampling days for each subpopulation by day and across the collection cycle.

[7] A day between Christmas and New Year's Day was rejected due to its proximity to the holidays.
[8] The May sampling event was interrupted so that only mutlifamily north loads were sampled on May 23rd and all other subpopulations were sampled on May 31st.

Table B-3. Sampling Day Distribution, by Generator Type
(January – December 2005)

	Number of Sampling Days					
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Overall**
SINGLE-FAMILY NORTH	***3***	***4***	***2***	***2***	***1***	***12***
Spring (Mar-May)	***0***	***1***	***0***	***1***	***1***	***3***
Week A				1	1	2
Week B		1				1
Summer (June - August)	***1***	***1***	***1***	***0***	***0***	***3***
Week A						0
Week B	1	1	1			3
Fall (September - November)	***0***	***1***	***0***	***1***	***0***	***2***
Week A		1				1
Week B				1		1
Winter (January, February, December)	***2***	***1***	***1***	***0***	***0***	***4***
Week A	2	1				3
Week B			1			1

	Number of Sampling Days					
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Overall**
SINGLE-FAMILY & MULTIFAMILY SOUTH	***3***	***4***	***2***	***2***	***1***	***12***
Spring (Mar-May)	***0***	***1***	***0***	***1***	***0***	***2***
Week A				1		1
Week B		1				1
Summer (June - August)	***0***	***1***	***0***	***1***	***1***	***3***
Week A		1				1
Week B				1	1	2
Fall (September - November)	***1***	***1***	***1***	***0***	***0***	***3***
Week A	1	1	1			3
Week B						0
Winter (January, February, December)	***2***	***1***	***1***	***0***	***0***	***4***
Week A			1			1
Week B	2	1				3

	Number of Sampling Days					
	Monday	Tuesday	Wednesday	Thursday	Friday	Overall
MULTIFAMILY NORTH	***3***	***3***	***1***	***1***	***4***	***12***
Spring (Mar-May)	***0***	***0***	***0***	***1***	***2***	***3***
Week A					1	1
Week B						0
Week C				1		1
Week D					1	1
Summer (June - August)	***1***	***1***	***0***	***0***	***1***	***3***
Week A						0
Week B						0
Week C						0
Week D	1	1			1	3
Fall (September - November)	***1***	***0***	***1***	***0***	***0***	***2***
Week A						0
Week B			1			1
Week C	1					1
Week D						0
Winter (January, February, December)	***1***	***2***	***0***	***0***	***1***	***4***
Week A	1	1			1	3
Week B		1				1
Week C						0
Week D						0

Select Loads for Sorting

On each day, the number of single-family loads from each service area arriving at Third & Lander was greater than the quotas to be sampled. Therefore, it was necessary to select which specific loads were to be sampled on each sampling day. In order to select which loads were to be sampled, a random number was assigned to every load that was expected to arrive at the Third & Lander facility. These random numbers were sorted, and the loads with the lowest random numbers were selected in sequence until the quota was met for both the single-family north and single-family south subpopulations. For subsequent sampling days, a new random number was assigned to each load, and the process was repeated.

A total of eight trucks delivered multifamily recycling to the Third & Lander transfer station each day, with each truck bringing in approximately one load per day. Three of these trucks collected from the north service area, and five collected recyclables from the south service area. Loads collected in the south service area were randomly selected according to the steps outlined above. For the north service area, all three trucks were sampled. When four samples were needed, two samples were taken from one of these three trucks. The truck that was sampled twice was randomly selected.

Coordinate Sampling

Before the sampling began, each hauler and the Third & Lander transfer station manager were given an annual schedule that listed the sampling dates and number of samples to be captured per generator type. Then, a few days prior to each sampling day, the affected haulers were sent a notice that listed each route to be included in the upcoming sort. This notice requested that each hauler confirm the correct truck and route numbers, and that the trucks listed would deliver loads on the upcoming sampling day. The appropriate drivers were to be alerted that their loads would be sampled.

Field Procedures

Net Weights

A *gatekeeper* was present at the Third & Lander facility for each sampling day to coordinate the details of weighing procedures and truck diversion in conjunction with the transfer station manager, scalehouse staff, and sorting crew.

All trucks selected for sampling were required to weigh three times at the scalehouse – once upon entering the facility, once after dumping the commingled portion of their load, and a final time after dumping the glass portion of their load.[9] The net weights for both the commingled and glass compartments were needed to get accurate weights for each portion of the load.

The gatekeeper recorded net weights for all sampled loads by viewing net weight tickets at the Third & Lander scalehouse at the end of each sampling day. The particular vehicles that were sampled were identified according to truck number, hauler, and time of day.

Extract Samples

Trucks were designated for sampling by the gatekeeper with a sample placard on the windshield. The Field Supervisor managed the sample extraction, sorting area, and recycling of sorted materials with the transfer station manager. Each sample consisted of approximately 200 – 250 pounds of material.

Samples were captured from the *glass* and *all other recyclables* compartments according to the following steps.

1. The compartment containing *all other recyclables* was emptied, and about 1-2 cubic yards (approximately 200 pounds) of the material was placed onto a tarp for sorting. (Each sample was selected with care in order to ensure a representative cross-section of the load's top, bottom, and sides.)
2. Immediately after emptying its first compartment, the truck was instructed to weigh again at the scalehouse.
3. Next, a glass sample (approximately 30-50 pounds) was captured from the truck's *glass* compartment. The same sampling procedure that was used for the *all other recyclables* load was repeated for the *glass* compartment.

Sorting Procedures

Each sample was sorted by hand into the component categories defined in Appendix A. Samples from *glass* compartments were sorted into eight component categories and *all other recyclables* were sorted into 22 component categories. Glass was separated from other contaminants in compartments that contained *all other recyclables*.

The weights of all materials were recorded on tally sheets (shown in Appendix F). Pieces of broken glass were sorted into the C*lear Glass Bottles, Green Glass Bottles, Brown Glass Bottles, Clear Container Glass,* or O*ther Glass Containers and Bottles* categories if the pieces were either

- Uniform in color and type, or
- Larger than one square inch and the type could be determined.

[9] The few trucks that did not have separate compartments for *glass* and *all other recyclables* materials only weighed twice: once upon entering the facility and once before exiting.

If the type of glass (container or bottle) could not be determined then it was recorded as *mixed cullet. Mixed cullet* also included glass bottles or containers that were broken into pieces less than one square inch and of multiple colors.

Comparisons to Previous Studies

The 2005 study was conducted using the same methodology as the 2000/01 study, with one exception. In the 2000/01 study, single-family routes were sampled one day every other month and two days during the months when multifamily routes were sampled, for a total of 18 sample days. In the 2005 study, both single-family and multifamily routes were sampled together on one day each month, for a total of 12 sample days.[10] Reducing the number of sampling events to only one day per month reduced expenses associated with mobilizing the sorting crew and reduced the impact of the sampling operation on the drivers and transfer station.

[10] Since the May sampling event was split between two days, the study included 13 sampling days.

Appendix C COMMENTS ON MONTHLY SAMPLING EVENTS

The net weight of some trucks of some of the trucks in the study was not measured, either because the driver forgot to weigh the loads or chose not to participate. Also, some trucks did not have glass in their glass compartments or had glass in their compartments that was not sampled. The table below summarizes these occurrences:

	Planned Samples	Actual Samples	Missing Glass Sample	Missing Net Weights for Sample Vehicle	
				Commingled	*Glass*
North					
Single-family	90	88	9	0	0
Multi-family	45	45	0	0	0
South					
Single-family	90	90	5	2	2
Multi-family	45	43	3	4	4

Details of the missed samples are included in the monthly sampling notes below.

January

On January 31st, 19 samples were sorted: 17 from single-family vehicles and 2 from multifamily vehicles. We missed the Waste Management multifamily vehicles this day due to a misunderstanding regarding the numbering scheme on the trucks. Two additional Waste Management single-family samples were captured, including 1 from an unscheduled vehicle, in place of the multifamily loads. Two multifamily and 4 single-family USD loads were missed and 3 single-family trucks were selected instead. All of the samples had corresponding glass samples with the exception of 1 truck that wasn't able to open the glass compartment and another truck that did not have a separate glass compartment. The breakdown of samples per day is listed below.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	8	2
Waste Management	7	4	9	0
Total	**15**	**8**	**17**	**2**

February

Twenty-two samples, 11 single-family and 11 multifamily, were collected and sorted on February 1st, as shown in the table below. Four multifamily trucks were double-sampled to make up for a shortage from the previous sampling event. Several USD trucks did not arrive as planned and others were sampled in their place. All samples included both commingled and glass samples.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	3	4	5
Waste Management	8	4	7	6
Total	**15**	**7**	**11**	**11**

March

Twenty-three vehicles were sampled: 13 single-family and 10 multifamily vehicles. Four single-family USD samples were missed: we didn't see 3 of the USD single-family trucks and 1 driver did not expect to return for a second trip. One contingency single-family and 1 contingency multifamily USD load was selected instead. All of the pre-selected Waste Management vehicles arrived as expected. All of the samples had corresponding glass samples with the exception of 1 multifamily truck that did not have any glass in the glass compartment. The breakdown of samples is below.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	6	5
Waste Management	7	4	7	5
Total	**15**	**8**	**13**	**10**

April

Twenty-two vehicles were sampled: 15 single-family and 7 multifamily vehicles. We did not see 3 USD single-family trucks that we expected and, as a result, selected 3 contingencies. Two Waste Management trucks did not arrive as expected and we selected 2 in their place. Four samples did not have corresponding glass samples:

- one glass sample was missed,
- one driver did not dump the glass compartment,
- one driver had difficulty opening the back door in order to empty the glass,
- and one driver forgot to close the door between the 2 compartments prior to collection.

One sample only consisted of the glass portion as the loader driver was not able to collect the commingled portion. The breakdown of samples is below.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	4	8	3
Waste Management	8	3	7	4
Total	15	7	15	7

May

In May, we began sampling multifamily loads from Waste Management early in the morning. Those loads are actually from the day prior to sampling. This change helped alleviate congestion at the facility in the afternoon.

On May 23rd, 3 Waste Management multifamily loads were sampled. One truck was double-sampled, resulting in a total of 4 samples for the day. Third & Lander was overwhelmed with material and did not have room for us to complete a full day of sampling. We left early and rescheduled for May 31st.

On May 31st, 21 vehicles (17 single-family and 4 multifamily) were sampled. We did not see 2 USD single-family trucks that we expected and, as a result, selected 1 contingency. One sample did not have corresponding glass sample as that driver accidentally dumped the glass compartment at the same time as the commingled.

The breakdown of samples from both May sampling events is below.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	9	4
Waste Management	7	3	8	4
Total	**15**	**7**	**17**	**8**

June

Twenty-three samples were captured from 16 single-family and 6 multifamily vehicles on June 14th. One Waste Management multifamily load was double-sampled, making a total of 7 multifamily samples. Two additional USD vehicles were selected in place of 1 truck that did not arrive and 1 that arrived much later than expected. Two trucks did not have separate glass due to mechanical issues. The summary of the June sampling event is presented in the following table.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	4	9	3
Waste Management	8	3	7	4
Total	**15**	**7**	**16**	**7**

July

Twenty-three vehicles were sampled: 16 single-family and 7 multifamily. One USD multifamily contingency was selected in place of 1 vehicle that did not arrive as expected. All Waste Management trucks arrived as planned. Two USD samples did not have corresponding glass samples due to truck mechanical issues.

Once again, the Waste Management multifamily samples were captured early in the morning from their previous day's loads. Since the sampling event occurred on a Monday, these samples were from Friday's routes. This is tracked in the database as the route number is unique to the day of the week.

The breakdown of samples is below.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	9	4
Waste Management	7	3	7	3
Total	**15**	**7**	**16**	**7**

Because we were able to capture 1 extra single-family sample, we are now on track with our sampling goals.

August

Fourteen single-family and 8 multifamily commingled samples were captured and sorted. All 4 multifamily trucks were double-sampled in place of other vehicles that did not arrive as expected. One Waste Management truck did not arrive as planned so 1 single-family sample was not collected. Three USD samples did not have corresponding glass samples due to truck mechanical issues.

Once again, the Waste Management multifamily samples were captured early in the morning from their previous day's loads. Since the sampling event occurred on a Wednesday, these samples were from Tuesday's routes. This is tracked in the database as the route number is unique to the day of the week.

The breakdown of samples is below.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	4	7	4
Waste Management	8	4	7	4
Total	**15**	**8**	**14**	**8**

September

Sixteen single-family and 8 multifamily commingled samples were captured and sorted. One Waste Management multifamily truck was double-sampled in order to meet the sampling goals. One Waste Management truck arrived at the facility but the sample was missed so another single-family truck, not included in the day's sampling plan, was selected instead. Similarly, 1 USD truck was not seen and an additional truck was selected in its place.

One USD and 1 Waste Management single-family sample did not have accompanying glass samples. The Waste Management truck had had the glass door open during the route so all the material was mixed together. The USD sample came from a spare USD truck that does not have a separate glass compartment.

Once again, the Waste Management multifamily samples were captured early in the morning from their previous day's loads. Since the sampling event occurred on a Thursday, these samples were from Wednesday's routes. This is tracked in the database as the route number is unique to the day of the week.

The breakdown of samples is below.

Hauler	**Planned**		**Actual**	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	8	4
Waste Management	7	4	8	4
Total	**15**	**8**	**16**	**8**

October

Fourteen single-family and 8 multifamily commingled samples were captured and sorted. Two Waste Management multifamily trucks were double-sampled in order to meet the sampling goals. Two USD single-family trucks did not arrive and a multifamily truck, a contingency on the day's sampling plan, was selected.

One USD sample did not have an accompanying glass sample. This sample was captured from a spare USD truck that does not have a separate glass compartment.

Once again, the Waste Management multifamily samples were captured early in the morning from their previous day's loads. Since the sampling event occurred on a Tuesday, these samples were from Monday's routes. This is tracked in the database as the route number is unique to the day of the week.

The breakdown of samples is below. As described above, 1 fewer single-family sample and 1 additional multifamily sample were collected from USD trucks.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	3	6	4
Waste Management	8	4	8	4
Total	**15**	**7**	**14**	**8**

December

Wednesday, December 14th

Sixteen single-family and 7 multifamily commingled samples were captured and sorted on December 14th. All the selected trucks were sampled; an additional single-family USD sample was captured in place of a multifamily sample to correct for October's sampling event.

One USD truck was selected for sampling in the first trip but did not empty the glass compartment until the second trip. A glass sample was captured from the second trip. We will not have net weights for this truck on this day.

Once again, the Waste Management multifamily samples were captured early in the morning from the previous day's loads. Since the sampling event occurred on a Wednesday, these samples were from Tuesday's routes. This is tracked in the database as the route number is unique to the day of the week.

The breakdown of samples is below.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	8	4	9	3
Waste Management	7	4	7	4
Total	**15**	**8**	**16**	**7**

Monday, December 19th

On December 19th, 13 single-family and 5 multifamily samples were sorted. This total was 4 short of the day's sampling goal. When the sorting area became overwhelmed with recyclable material in the afternoon, it was no longer a safe work area and the crew was asked to leave.

Two selected trucks arrived when there was not space for more samples in the sorting area, so an alternate single-family USD truck was sampled that was not included in the day's plan. With the exception of this sample, all other samples were captured from trucks included in the list for that day.

The Waste Management multifamily samples were captured early in the morning from Friday's loads.

The planned versus actual samples for this day are presented below.

Hauler	Planned		Actual	
	Single-family	*Multifamily*	*Single-family*	*Multifamily*
USD	7	4	7	2
Waste Management	8	3	6	3
Total	**15**	**7**	**13**	**5**

Appendix D COMPOSITION CALCULATIONS

Composition Calculations

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

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

where:

c = weight of particular component

w = sum of all component weights

for i 1 to n

where n = number of selected samples

for j 1 to m

where m = number of components

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 component and total sample weights). The **variance of the ratio estimator** equation follows:

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

where:

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

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

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

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).

Weighted Averages

The overall recycling composition estimates were calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from each of the four subpopulations: single-family north and south, and multifamily north and south.[11]

North and south service area composition was calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* collected from each of the two generator types. Single-family and multifamily estimates were calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* collected from each of the two service areas. Lastly, composition was calculated for the four subpopulations by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from the relevant generator and service area.

Seattle Public Utilities provided the estimate of tonnage for each of the four subpopulations, and sample vehicle net weights were used to estimate the tonnage split between the *glass* and *all other recyclables* compartments.[12] Net weights of vehicles with a missing glass sample were excluded from the calculation. The composition estimates were applied to the relevant tonnages to estimate the amount for each component category.

The **weighted average for a composition estimate** is performed as follows:

$$E_j = (p_1 * r_{j1}) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + ...$$

where:

p = the proportion of tonnage contributed by the noted group

r = ratio of component weight to total sample weight in the noted group

for j 1 to m
where m = number of components

The **variance of the weighted average** is calculated:

$$VarE_j = (p_1^2 * \hat{V}_{rj1}) + (p_2^2 * \hat{V}_{rj2}) + (p_3^2 * \hat{V}_{rj3}) + ...$$

The weighting percentages that were used to perform the composition calculations for the 2005 study are listed in Table D-1 through Table D-9 below.

[11] In this study a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for *glass* recyclables, and the other for *all other recyclables* (e.g. mixed paper, aluminum cans, and plastic bottles). A few vehicles did not have separate compartments, or accidentally mixed, *glass* and *all other recyclables* in the same compartment. See Appendix C for more details.

[12] For example, multifamily trucks from the north that were sampled during the study collected approximately 445,060 pounds of recycling in *all other recyclables* compartments and 103,740 pounds in *glass* compartments. These weights translate into approximately 81% and 19% of the multi-family north tonnage for the study period. Applying these percentages to the total multi-family north tonnage, supplied by SPU, results in overall percentages of about 6% and 1%, respectively, for multi-family north *all other recyclables* and for *glass*.

Table D-1. Weighting Percentages: Overall
(January – December 2005)

		(Service Area)	
Generator	**Material**	**North**	**South**
Multi-Family	Other	6.21%	11.53%
Multi-Family	Glass	1.45%	2.19%
Single-Family	Other	31.43%	34.77%
Single-Family	Glass	6.54%	5.89%

Table D-2. Weighting Percentages: North
(January – December 2005)

	(Service Area)	
Material	**Other**	**Glass**
Multi-family	13.29%	3.10%
Single-family	69.22%	14.40%

Table D-3. Weighting Percentages: South
(January – December 2005)

	(Service Area)	
Material	**Other**	**Glass**
Multi-family	20.73%	3.94%
Single-family	64.43%	10.91%

Table D-4. Weighting Percentages: Single-Family
(January – December 2005)

	(Service Area)	
Material	**North**	**South**
Other	39.98%	44.22%
Glass	8.32%	7.49%

Table D-5. Weighting Percentages: Multifamily
(January – December 2005)

	(Service Area)	
Material	**North**	**South**
Other	29.08%	53.90%
Glass	6.78%	10.24%

Table D-6. Weighting Percentages: Single-Family North
(January – December 2005)

Material	**Pct of Total**
Other	82.78%
Glass	17.22%

Table D-7. Weighting Percentages: Single-Family South
(January – December 2005)

Material	Pct of Total
Other	85.52%
Glass	14.48%

Table D-8. Weighting Percentages: Multifamily North
(January – December 2005)

Material	Pct of Total
Other	81.10%
Glass	18.90%

Table D-9. Weighting Percentages: Multifamily South
(January – December 2005)

Material	Pct of Total
Other	84.04%
Glass	15.96%

Appendix E YEAR-TO-YEAR COMPARISON CALCULATIONS

This section outlines the technical issues involved with the year-to-year comparison calculations. The calculation formulae are outlined in Appendix D.

Background

In an ongoing effort to monitor the types and amounts of residential recycling, Seattle has performed several residential recycling composition studies. Differences are often apparent between study periods. In this appendix, results from the year 2005 study are compared to 2000/01 findings.[13] Composition variations in the percentage of each broad material category were measured for the two study years.

In order to control for population changes and other factors that may influence the total amount of waste disposed from year to year, the tests described in this appendix measure waste proportions, and not actual tonnage. For example, if newspaper accounts for 5% of a particular substream's disposed waste each year, and that substream disposed a total of 1,000 tons of waste in one year and 2,000 tons of waste in the next, while the amount of newspaper increased from 50 to 100 tons, the percentage remained the same. Therefore, the tests would indicate that there had been no change.

The purpose of conducting these comparison tests is to identify statistically significant changes in the percentage of broad material categories of waste disposed in each substream over time. One specific example is stated as follows:

Hypothesis: "There is no statistically significant difference, between the 2000/01 and 2005 study periods, in the percentage of paper recycled."

Statistics are then employed to look for evidence disproving the hypothesis. A "significant" result means that there is enough evidence to disprove the hypothesis, and it can be concluded that there is a true difference across years. "Insignificant" results indicate that either a) there is no true difference, or b) even though there may be a difference, there is not enough evidence to prove it.

The purpose of these tests is to identify changes across years. However, the study did not attempt to investigate *why* or *how* these changes occurred. The changes may be due to a variety of factors. For example, a decrease in paper recycled could be due to any combination of the following:

- Consumer preferences might have shifted so that electronic media might have captured some of the market previously held by paper.
- Technology might have changed so that manufacturers might use thinner paper than in the past, which would decrease the weight of paper, even if the same number of paper was recycled.
- Fewer residents may participate in paper recycling programs.

[13] The 2000/01 study was also conducted by Cascadia Consulting Group and followed the same basic methodology as the 2005 study. Conversely, the methodologies used in the 1993 and 1998/99 resulted in findings that are not comparable to the more recent studies.

- An increase in the recycling of another, non-paper material which would cause the percentage of recycling that is paper to decrease, even if there was no change in the tons of paper that were recycled.

Statistical Considerations

The analyses are based on the component percentages, by weight, for each selected substream. As described in Appendix D, these percentages are calculated by dividing the sum of the selected component weights by the sum of the corresponding sample weights. T-tests (modified for ratio estimation) were used to examine the year-to-year variation.

Normality

The distribution of some of the broad waste categories (particularly the hazardous materials) is skewed and may not follow a normal distribution. Although t-tests assume a normal distribution, they are very robust to departures from this assumption, particularly with large sample sizes. In addition, the broad waste categories are sums of several individual waste components, which improves our ability to meet the assumptions of normality.

Dependence

There may be dependence between waste components (if a person disposes of component A, they always dispose of component B at the same time).

There is certainly a degree of dependence between the calculated percentages. (Since the percentages sum to 100, if the percentage of component A increases, the percentage of some other component must decrease). This type of dependence is somewhat controlled by choosing only a portion of the waste categories for the analyses.

Multiple T-Tests

In all statistical tests, there is a chance of incorrectly concluding that a result is significant. The year-to-year comparison required conducting several t-tests, (one for each waste category within each set of substreams) **each** of which carries that risk. However, we were willing to accept only a 2% chance for each individual test of making an incorrect conclusion.

Interpreting the Calculation Results

The following tables include detailed calculation results of the comparison calculations. The comparisons are shown for all five tests; an asterisk indicates the statistically significant differences. *For the purposes of this study, only those calculation results with a p-value of less than 2.00% are considered to be statistically significant.*

The t-statistic is calculated from the data; according to statistical theory, the larger the absolute value of the t-statistic, the less likely that the two populations have the same mean. The p-value describes the probability of observing the calculated t-statistic if there were no true difference between the population means.

For example, in Table E-1 the proportion of *plastic* in the disposed commercial substream increased from 1.4% to 1.7% across the study periods. The t-statistic is relatively large (2.9620) and the probability (p-value) of observing that t-statistic if there had been no true difference between years is approximately 0.32%. This value is less than the study's pre-determined threshold for statistically significant results (alpha-level of 2.00%); thus the increase in *plastic* is considered to be a true difference. On the other hand, the p-value corresponding to the increase in *paper* is very large. The chance of observing the 78.2% to 78.3% increase when the

actual proportion had not changed is approximately 96% - much too high to be considered a true difference.

Changes in Residential Recycling

In Table E-1, *paper*, *metal*, *glass*, and *contaminants* broad material categories did not show a significant change across study periods. The proportion of *plastic* was the only broad material category that showed a significant increase or decrease.

Table E-1. Changes in Commercial Waste Composition: 1988/89 to 2004

	Mean Ratio *(Material Wt/Total Wt)*		**t-Statistic**	**p-Value** *(Cut-off for statistically valid difference = 0.02)*
	2000	*2005*		
Paper	78.2%	78.3%	0.0469	0.9626
Metal	1.8%	1.8%	0.5208	0.6027
Plastic	**1.4%**	**1.7%**	**2.9620**	**0.0032 ***
Glass	13.3%	12.7%	0.4399	0.6602
Contaminants	5.2%	5.6%	0.8872	0.3752
Number of Samples	*549*	*515*		

Appendix F FIELD FORM

The field forms are included in the following order:

- Vehicle selection sheet
- Sample Placard
- Tally sheet

Vehicle Selection Sheet Sampling Date: **Tuesday, October 25, 2005**

Seattle Residential Recycling Composition Study Hauler: **Waste Management**

Time In	SF/MF	Truck No.	Driver	Route	Load	ETA	Notes	Inbound Commingled	Outbound Commingled	Inbound Glass (if different)	Outbound Glass
	SF	151500		37A	1	10am-noon					
	SF	151501		34A	1	10am-noon					
cont. 1	SF	151503		33A	1	10am-noon					
	SF	151505		31A	1	10am-noon					
	SF	151506		29A	1	10am-noon					
	SF	151509		36A	2	2-4pm					
	SF	151512		21A	1	10am-noon					
	SF	151513		24A	2	2-4pm					
	SF	151514		27A	2	2-4pm					
	MF	506717/6		t30	1	7-8am	*sample this truck twice*				
	MF	506718/7		t31	1	7-8am					
	MF	506272/8		t31	1	7-8am					

Today's Sampling Plan: 8 SF, 4 MF

sf count: _____

mf count: _____

SAMPLE

2005 City of Seattle Recycling Composition Study

Paper				
Corrugated/Kraft, Unwaxed				
Newsprint				
Mixed Low Grade				
Polycoat Containers				
Aseptic Containers				
Phone Books				
NonConforming Paper				
Plastic				
Small PET Bottles (24 oz or smaller)				
Large PET Bottles (greater than 24 oz)				
PET Plastic Jars, Tubs and Other Containers				
HDPE Bottles				
HDPE Plastic Jars, Tubs, and Other Containers				
Other Plastic Bottles (#3-7, excluding #6)				
Other Jars, Tubs, and Containers (#3-7, excluding #6)				
Plastic Bags and Packaging				
NonConforming Plastic				
Metal				
Aluminum Cans				
Tin Food Cans				
Other Ferrous				
NonConforming Metal				
Glass				
Glass (Commingled compartment)				
Garbage				
Garbage (Commingled compartment)				

Sample ID:

Sorting Date:

Generator Type:

Single-family

Multi-family

Hauler:

Waste Mgt. (North)

U.S. Disposal (South)

Truck #:

Route #:

Load:

Material:

Commingled Only

Glass Only

Sep. Commingled & Glass

Mix. Commingled & Glass

Vehicle Net. Wt.

Inbound:

Middle:

Outbound:

FOR GLASS SAMPLE:

Glass				
Clear Glass Bottles				
Green Glass Bottles				
Brown Glass Bottles				
Clear Container Glass				
Other glass containers and bottles				
Mixed Cullet				
NonConforming Glass				
Garbage				
Garbage (Glass compartment)				

If found, please call Cascadia Consulting Group at 206/343-9759. Reward offered.