

SWMP APPENDIX D
WASTE CHARACTERIZATION FIELD STUDY

TABLE OF CONTENTS

1.0	Executive Summary	p. 3
2.0	Purpose and Scope	p. 6
3.0	Methodology	
3.1	Sampling Preparation	p. 7
3.2	Solid Waste Sampling and Sorting at the Rapp Road Landfill	p. 8
3.3	Recyclable Materials Sampling and Sorting and the Rapp Road Landfill	p. 9
4.0	Data Analysis and Results	
4.1	Data Processing	p. 11
4.2	Solid Waste Characterization Results	p. 13
4.3	Recyclable Materials Characterization Results	p. 16
4.4	Comparison with Other Studies	p. 17
5.0	Conclusions and Recommendations	p. 19
	References	p. 20

Appendices

- Appendix A: Material Category Definitions
- Appendix B: Collection Vehicle Driver Interview
- Appendix C: Collection Vehicle Data Sheets
- Appendix D: Solid Waste Sorting Protocol

LIST OF TABLES

Table 1 – Sampling Distribution

Table 2 – Solid Waste Composition Summary

Table 3 – Largest Single Material Categories in the Solid Waste Stream

Table 4 – DGS and Commercial Collection Vehicles Summary

Table 5 – Designated Recyclable Materials within the Solid Waste Stream

Table 6 – Recyclable Materials Composition Summary

Table 7 – Solid Waste Composition in Other Studies

LIST OF FIGURES

Figure 1 – Total Waste Stream Composition

Figure 2 – DGS Solid Waste Summary

Figure 3 – Commercial Waste Summary

Figure 4 – SUNY Solid Waste Summary

Figure 5 – Recyclables: Paper Stream

Figure 6 – Recyclables: Metals, Glass, and Plastic

1.0 EXECUTIVE SUMMARY

CHA has been retained by the City of Albany for preparation of a new Solid Waste Management Plan (SWMP) for the Capital Region Solid Waste Management Partnership (the Planning Unit). As part of the SWMP, a field study was conducted to characterize the solid waste stream and recyclable stream of the Planning Unit. This study will assist with development of improvements to the current solid waste management and recycling practices. Characterization of the solid waste and recyclables stream will also assist the development of future practices and the consideration of new technologies for use by the Planning Unit. To this end, CHA designed and conducted a field study to determine the percent composition of a variety of material components within the solid waste and recyclables stream within the Planning Unit.

Randomly selected samples were collected from solid waste collection vehicles arriving at the Rapp Road Landfill in Albany over a five-day period at the end of February 2009. Vehicles were selected based upon collection routes within the Planning Unit. Each of the representative solid waste samples was then sorted into 39 material categories, and the weight of each material category was recorded. Samples were collected from City of Albany Department of General Services (DGS) vehicles, commercial waste haulers, and collection vehicles from several other municipalities and organizations.

Representative samples of recyclable materials were obtained from collection vehicles re-routed from the Sierra Fibers recycling facility to the Rapp Road Landfill, where sampling and sorting occurred. All of the recyclable samples collected were from Albany DGS vehicles. These vehicles are compartmentalized into two recyclable streams: one for mixed paper, and another for metals, glass and plastic (MGP). Two samples were collected from each vehicle containing recyclables: one from each category as above, and the paper stream and MGP stream were sorted and analyzed separately. Each sample was sorted using the same material categories used for the solid waste sampling, and the data was also recorded and calculated in a similar manner.

The sampling and sorting program was generally conducted and analyzed according to Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, ASTM D5231-92 (Reapproved 2003). The mean mass fraction and average composition percentages were calculated for each material component for each sample, and then a mean mass fraction for each material category was calculated across multiple samples. The standard

deviation for each material category was also calculated. Results for the solid waste sampling are presented with the combined total of all samples, as well as separate results for the DGS vehicles only and the commercial vehicles only.

The largest single material component in the solid waste stream as sampled is food waste, at an average of 19% of the total mass sampled. All paper categories combined represent 31% of the waste deliveries, but this includes eight separate categories of paper. The largest single paper category is classified as other paper, at 11% of the total mass sampled. The combined plastics category was the third largest major component of the solid waste stream with approximately 13% of the total mass of the sample. The largest single plastics category was film plastic and plastic bags totaling 4% of the solid waste stream. The proportional share of all of the material components measures are presented in Table 2 – Solid Waste Composition Summary.

The solid waste composition data was also analyzed to compare waste delivered by DGS to waste delivered by commercial haulers. The data for all vehicles, as indicated above, was divided by vehicle operator into subsets to obtain the solid waste composition of the DGS waste stream and commercial hauler stream separately, and determine differences between these two waste streams. For these subsets, the combination of all paper categories is the largest material component category from the commercial waste vehicles at 41% composition by weight, and from the DGS vehicles at 25% by weight. For both the DGS and Commercial waste streams, the largest paper category was other paper, with approximately 7% and 17% of the total mass of the sample, respectively. Food wastes were the largest single material category from both waste streams, with compositions of approximately 23% and 21%, each for DGS and commercial vehicles. As above, film plastic and plastic bags were the largest single plastics category. This material category constituted 6% of the DGS waste stream, and 4.5% of the commercial waste stream. Other significant waste component categories varied between the DGS samples and the commercial samples; these included textiles and leather, disposable diapers, and wood, with the DGS samples, and dirt/fines, and glass, for the commercial samples. Table 4 presents the comparison of the composition of the DGS collected waste with the commercial collection vehicles.

The solid waste stream contained a significant number of designated recyclable materials, as indicated in Table 5 – Designated Recyclable Materials within the Solid Waste Stream. This is particularly true of paper products in the commercial vehicles sampled, where the mixed office paper and corrugated categories each consisted of more than 5% of the total waste stream; the

DGS solid waste stream contained significant amounts of recyclable paper as well, particularly paperboard.

For the recyclable materials, a majority of the paper stream consisted of newspaper, at over 52% of the total sample, followed by books (including telephone directories) and magazines, at 13% and 11%, respectively. Other significant categories included paperboard, mixed office paper, and corrugated (see Table 6 – Recyclable Materials Composition Summary). Only 1.4% of the paper stream consisted of non-paper products. Nearly 60% of the MGP stream consisted of glass. The largest fraction of the glass material category was comprised of clear glass bottles, which accounted for 29% of the total MGP sample. Green glass bottles were also a significant fraction at 17% of the entire MGP sample. Ferrous metals consisted of approximately 12%, and all plastic categories combined included 19% of the MGP stream. Various paper products constituted 7.9% of the MGP stream, which could be viewed as a contaminant in this recyclable material stream.

The data from the waste characterization field study for the Planning Unit were compared to data from a similar 2005 study for the Onondaga County Resource Recovery Agency (OCRRA), as well as from national data collected by the United States Environmental Protection Agency (USEPA) for the year 2007. Table 7 – Solid Waste Composition in Other Studies presents the Capital Region data alongside the OCRRA and USEPA data. The data are consistent across several material categories such as food wastes, and textiles and leather; however, the waste stream composition of other material categories reflects differences between the solid waste stream of the Capital Region, and the OCRRA and USEPA data. These differences include a higher percentage of paper products, and other material categories such as electronics, and dirt/fines, and lower percentages of categories such as yard waste and rubber. Comparison of the Capital Region results with other studies will also assist in the planning and preparation of the future management of solid waste and recyclable materials.

Yard waste only represented 1.2% of the solid waste discarded during this study. While there are numerous yard waste composting programs in place within the planning unit, the waste characterization study was conducted during the low season for yard waste generation. Therefore, an upward adjustment might be needed to reflect an annual average percentage of yard waste that is discarded. This should be examined further in the context of the overall waste stream analysis being conducted for the new SWMP.

2.0 PURPOSE AND SCOPE

The purpose and objective of this field study is to characterize the constituents of the solid waste and recycled materials stream for the Capital Region Solid Waste Planning Unit. Characterizing the local waste stream will provide valuable information for planning future improvements to local recycling efforts as well as for evaluating the feasibility of alternative solid waste management systems. Another purpose of the study is to examine differences in solid waste composition collected by a municipal agency (such as the City of Albany DGS) and commercial haulers servicing commercial, industrial or institutional customers as well as multi-family dwellings.

In order to categorize the solid waste and recyclable materials stream within the Planning Unit, CHA developed a field study involving the sampling of solid waste and recyclables collection vehicles, and sorting the materials contained in each sample to determine the mass percentage composition. The field study was conducted between February 23-27, 2009, for solid waste and from March 2-4, 2009, for recyclable materials. Both solid waste deliveries to the Rapp Road Landfill as well curbside recyclables collected by the City of Albany DGS were sampled and characterized during this time period. Detailed methodology and results for this field study are presented in the following sections.

3.0 METHODOLOGY

3.1 SAMPLING PREPARATION

The solid waste and recyclables sampling and sorting program generally followed procedures established by the American Society of Testing Materials *Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste*, ASTM D5231-92 (Reapproved 2003). The solid waste sampling and sorting program took place at the Rapp Road Landfill between February 23 and February 27, 2009. The sampling and sorting of recyclables took place also at the Rapp Road Landfill between March 2, and March 4, 2009.

Prior to beginning the waste sorting program, a protocol was developed for the procedure with a total of 39 material sort categories used, based upon knowledge of the potential waste stream at the landfill. Appendix A presents a definition of each material category. Forms and data sheets to assist with the solid waste sampling data collection were also prepared for use in the field. These data sheets included driver interview forms for each of the collection trucks that were sampled, as well as tables containing listings of each material category to facilitate the input of solid waste information during field sampling. The driver interview forms were prepared for both the solid waste sampling and recyclables sampling, while the data tables utilized the same material categories for both solid waste and recyclables. The completed driver interview forms and sampling data sheets are presented in Appendix B and Appendix C, respectively.

Additional preparations prior to the solid waste and recyclables sampling in the field included obtaining appropriate bins for each of the material categories to be sorted. Based upon the proposed sample size, and potential volume of waste for each category from other similar studies, plastic garbage containers were obtained in a sufficient size to be used for the sorting.

A sorting table was also constructed using a wire screen over a box constructed of plywood. The sorting table helped to contain the dirt and fines so that a measurable quantity of this waste category could be determined.

3.2 SOLID WASTE SAMPLING AND SORTING AT THE RAPP ROAD LANDFILL

Solid waste sampling and sorting at the Rapp Road Landfill was conducted by a crew of 7 people, including a Site Manager and a Crew Chief. The Site Manager was responsible for the selection of appropriate collection vehicles from which to sample, and for interviewing the drivers of the vehicles regarding the geographic origin and type of waste contained in the collection vehicle. The Site Manager and Crew Chief communicated via two-way radio, so that once the sorting of one collection vehicle was nearly completed, another vehicle could be selected for sampling. The Crew Chief was responsible for leading the crew during the manual sorting effort pertaining to general sorting operations and any issues regarding material sort categories. Generally, the procedure for sampling and sorting occurred as follows:

Solid waste collection vehicles arriving at the landfill facility were randomly selected by the Site Manager. Selection was based on the communications between the Site Manager and the Crew Chief, who advised if the sort crew was ready to accept another load. Upon selection of the next available vehicle, eligibility for the waste sampling and sorting study was determined through driver interviews, which were conducted by the Site Manager from the scale house. Vehicles were determined to be eligible for sampling based upon collections or a collection route within the Planning Unit. Vehicles that did not have a collection route within the Planning Unit were ineligible for sampling, and were sent to empty their loads in accordance with regular operating procedure. Collection vehicles that were delivering industrial solid wastes or construction and demolition debris were also ineligible for the sampling program. Eligible trucks from within the Planning Unit were then diverted to the processing building where the waste sampling and sorting occurred. The selected eligible collection vehicle load was emptied onto the floor of the processing building. A front-end loader operated by DGS personnel was used to scrape a load of waste from one edge of the discharged waste. This waste was mixed and divided into quarters. The waste sample to be sorted was collected from a randomly selected quarter using the front-end loader. The sample size was approximately 1 cubic yard of waste by volume, with a target sample size of approximately 200-300 pounds by weight. The sample was emptied onto the sorting table, and then the waste was sorted into the bins for each of the 39 material categories. The bins were weighed before and after the sort to determine the net weight composition of the solid waste sample; the weight of material for each waste category was entered into the prepared data sheets for each vehicle. One data sheet was used for each collection vehicle/sample. The data sheets with results for each vehicle are presented in Appendix C.

The landfill facility closed early due to high winds on both Monday and Friday, thereby decreasing the number of samples obtained during the week due to time considerations. During the course of the week, a total of 36 waste samples were collected, as follows:

2/23/09 Monday – 5 samples

2/24/09 Tuesday – 8 samples

2/25/09 Wednesday – 8 samples

2/26/09 Thursday – 8 samples

2/27/09 Friday – 7 samples

The average sample weight for these 36 waste samples was approximately 215 lbs.

3.3 RECYCLABLE MATERIALS SAMPLING AND SORTING AT THE RAPP ROAD LANDFILL

The original intention of the sampling and sorting program was to characterize both the solid waste and recyclables in the waste stream at separate facilities. The solid waste was sampled at the Rapp Road Landfill, and the recyclables were to be sampled and sorted at the Sierra Fibers facility. However, the Sierra Fibers facility was not able to be used for the sampling and sorting; therefore, sampling and sorting of the recyclable waste stream was also completed at the Rapp Road Landfill. The procedure for the selection of collection vehicles for sampling was different from the procedure used for the solid waste sorting. Instead of the procedure outlined above, DGS recyclable collection vehicles were diverted en route from the Sierra Fibers facility to the Rapp Road Landfill by the City of Albany dispatcher. Collection vehicles were diverted at various points along the collection route to ensure a continuous stream of vehicles arrived at the landfill for sampling and sorting. There were no driver interviews conducted as part of the recyclables sampling program, as all vehicles sampled were DGS vehicles from within the Planning Unit.

The collection vehicles used for the recyclables were internally divided into two compartments: paper, and metals, glass and plastic (MGP). Therefore, two samples were taken from each vehicle: a paper sample, and an MGP sample based upon the contents of each compartment. The samples were then collected with the same procedure as outlined above for the solid waste sampling and sorting, and sorted into the same material categories. Also as above, the material bins were weighed before and after the sorting to obtain the weight of each material component in the sample of recyclables.

A total of 46 recycling samples were collected during the sampling period, as follows:

3/2/09 Monday –	7 Paper samples	7 MGP samples
3/3/09 Tuesday –	8 Paper samples	8 MGP samples
3/4/09 Wednesday –	8 Paper samples	8 MGP samples

The sampling and sorting protocol developed prior to the field study is presented in Appendix D. The average sample weight for these 46 waste samples was 136 lbs.

4.0 DATA ANALYSIS AND RESULTS

4.1 DATA PROCESSING

In order to determine the percentage of each waste or recyclable component in the sample, and in the waste stream or recyclable stream, the mass fraction of each component was calculated for each sample. That is, the net weight of each material component was divided by the total weight of the sample. The mass fraction of each component for the entire waste stream was obtained by taking the mean of each of the mass fractions of each sample for a given material component. The standard deviation for each mass fraction was calculated both on an individual sample level, and on an aggregate waste/recyclable stream level. These calculation methods are outlined in the *Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste*, ASTM D5231-92.

Solid waste collection vehicles were randomly sampled during the 5-day field operations. Sampled vehicles included City of Albany Department of General Services (DGS), as well as from a variety of commercial and institutional haulers and other municipalities. A total of 36 samples were collected over the course of the week to represent the solid waste stream. Table 1: Sampling Distribution presents the number of samples from each waste hauler, shown below.

Table 1: Sampling Distribution

<i>Vehicle</i>	<i>Number of samples</i>
Albany Department of General Services (DGS)	9
County Waste	4
Allied Waste	6
Waste Management	5
Accurate Disposal	1
City of Rensselaer	2
Village of Green Island	1
Town of Knox	2
Town of Guilderland	1
Town of Rensselaerville	1
Albany County	1
Salvation Army	2
SUNY- University of Albany	1
Total	36

In addition to the summary of results for the total aggregate waste stream, results were also tabulated separately for both the DGS collection vehicles and the commercial waste haulers. The commercial solid waste haulers included the vehicles from County Waste, Allied Waste, Waste Management, and Accurate Disposal. The vehicles from the municipalities and other organizations were not included in the commercial waste results.

As indicated in the methodology, all of the collection vehicles sampled to characterize the recyclable stream were DGS vehicles. Therefore, the analysis of the recyclable stream presented below represents primarily the residential component of the recyclable stream within the City of Albany. An analysis of the commercial recyclable stream was not studied.

We offer the following about the limitations of the study:

- A total of 36 samples were sorted from collection vehicles within the planning unit for the solid waste portion of the study
- A total of 46 samples of recyclables were sorted, including 23 samples each of the paper stream and metals, glass and plastic (MGP) stream
- Vehicles delivering municipal solid waste to the Rapp Road Landfill were randomly selected and were interviewed to determine that the waste originated on a collection route within the planning unit. Industrial solid waste, and construction and demolition debris (C&D), was not included as part of this study.
- Differences in types of commercial solid waste were not studied (ie. waste streams specific to restaurants, the retail sector, offices, etc.)
- As indicated above, solid waste characterization results are from a single week of sampling and sorting, and recyclable characterization results are from a three-day period of sampling and sorting. Therefore, the results presented herein may not be indicative of seasonal, monthly, or other time-dependent variations in the solid waste or recyclable stream.

Notes on the Results

In the analysis of the results for the solid waste stream, some categories may show differing percentages between the DGS component, commercial component, and aggregate total. For example, the fraction of food waste averages 18.7% for all samples, but 23% for DGS, and 21% for the commercial samples. Note that the results for the vehicles from municipalities or other organizations were not included in either the DGS or commercial category. Therefore, the addition of samples from these vehicles adjusts the total average composition for each material component.

As can be seen from the tables of results, the standard deviation of some of the material categories is greater than the mean percent composition. This indicates a high degree of variability and large range in percent composition within the samples for these material categories. This may also be due to the limited number of samples and timeframe of the study: greater numbers of samples may have led to greater precision and a lower standard deviation for some of these material categories. It may also be due to the variety of commercial waste generators, as explained above.

It is important to note that this study analyzed the components of both the solid waste stream and the recyclables stream by weight and not by volume; therefore, items of relatively low weight may not appear significant to the results, but may have been present in large quantity in the waste stream by volume. A typical example of this is seen in the recyclables stream with glass and plastics. Anecdotally, plastic bags and film plastics appeared to be abundant during the waste sorting. However, the total weight of these items was insignificant in comparison to items of greater density, such as glass jars. Incidentally, the glass constituted the greatest fraction of the MGP recyclables stream; however, glass is also significantly denser and heavier than the plastics in the waste stream. This may also occur with the solid waste stream, with differences in densities between food waste, paper products, metals, or other categories.

4.2 SOLID WASTE CHARACTERIZATION RESULTS

Table 2 – Solid Waste Composition Summary provides each material component and the mean composition percentage (mean mass fraction), and the standard deviation for each material category. In order of greatest to least mean composition percentage, the largest individual categories of the solid waste stream are as follows: food waste, other paper, dirt/fines, textiles and leather, corrugated, film plastic and plastic bags, paperboard, mixed office paper, miscellaneous, and wood. Table 3 below presents each of these material categories and the corresponding component fraction in the solid waste stream.

Capital Region Solid Waste Management Plan - Waste Characterization Field Study
Table 2 - Solid Waste Composition Summary

Material Components	Average Composition (%)	Mass Fraction Standard Deviation (%)
PAPER		
Newspaper	2.0%	2.6%
Magazines	2.1%	4.2%
Corrugated	4.5%	3.6%
Gable Top Cartons & Drink Boxes	0.4%	0.7%
Paper Board	4.2%	2.7%
Books (including phone directories)	2.8%	4.2%
Mixed Office Paper	4.1%	7.2%
Other Paper	11.1%	13.5%
SUBTOTALS	31.3%	16.7%
PLASTICS		
Plastic Containers (PET) #1 Non-Bottle Bill	1.7%	3.0%
Plastic #1 (Bottle Bill Containers)	0.3%	0.4%
Plastic Containers (HDPE) #2	0.8%	0.7%
Other Plastic Containers	2.5%	2.1%
Film Plastic & Plastic Bags	4.4%	2.4%
Other Plastics	2.8%	2.9%
SUBTOTALS	12.5%	5.1%
FOOD WASTE		
	18.7%	19.9%
TEXTILES & LEATHER		
	5.7%	7.2%
RUBBER		
	0.5%	1.3%
DISPOSABLE DIAPERS		
	2.3%	3.3%
FERROUS METALS		
Ferrous Metal/Bimetal Cans	0.7%	1.0%
Aerosol Cans	0.1%	0.1%
Other Ferrous Metal	1.9%	3.2%
SUBTOTALS	2.8%	3.2%
NON-FERROUS METALS		
Aluminum Cans (Non-Bottle Bill)	0.2%	0.2%
Aluminum Cans (Bottle Bill)	0.2%	0.4%
Other Non-Ferrous Metal	1.0%	1.4%
SUBTOTALS	1.3%	1.4%
ELECTRONICS		
	2.7%	3.8%
GLASS		
Glass Bottles (Bottle Bill)	0.5%	1.0%
Glass Bottle - Clear	1.8%	5.1%
Glass Bottle - Amber	0.9%	3.8%
Glass Bottle - Green	0.1%	0.3%
Flat Glass & Other Glass	1.4%	3.4%
SUBTOTALS	4.7%	9.2%
WOOD		
	3.6%	6.5%
RUBBLE		
	0.6%	2.7%
YARD WASTE		
	1.2%	4.3%
DIRT/FINES		
	7.9%	16.9%
HAZARDOUS WASTE		
Household Hazardous Waste (HHW)	0.0%	0.0%
Lead Acid Batteries	0.0%	0.0%
Other Batteries	0.0%	0.1%
SUBTOTALS	0.1%	0.1%
MEDICAL OR PHARMACEUTICAL WASTE		
	0.2%	0.8%
MISCELLANEOUS		
	3.8%	4.3%
TOTAL	100%	0.0%

Table 3: Largest Single Material Categories in the Solid Waste Stream

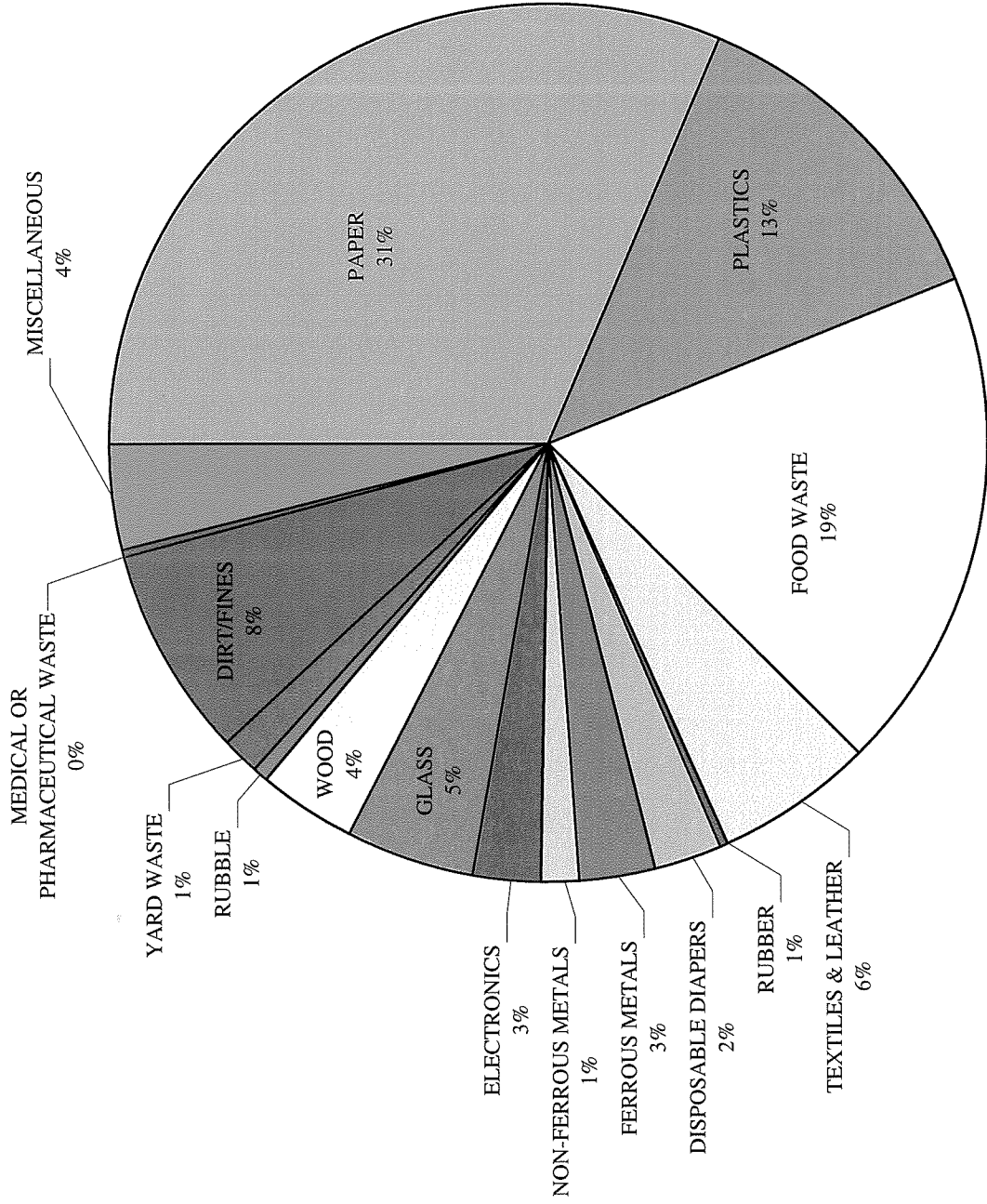
<i>Material</i>	<i>Component Fraction</i>
Food Waste	18.7%
Other Paper	11.1%
Dirt/Fines	7.9%
Textiles & Leather	5.7%
Corrugated	4.5%
Film Plastic & Plastic Bags	4.4%
Paper Board	4.2%
Mixed Office Paper	4.1%
Miscellaneous	3.8%
Wood	3.6%

Food wastes constitute the largest single component percentage for a single material component category, with a fraction of 18.7%. Paper products constitute a significant portion of the solid waste stream sampled in the study, with a component fraction greater than 30%. This fraction is for all paper categories combined, including: newspaper, magazines, corrugated, gable top cartons and drink boxes, paperboard, books (including telephone directories), mixed office paper, and other paper. The largest paper category consisted of other paper, at 11.1% of the total waste stream. This is a non-recyclable paper component containing tissue paper and paper towels. Approximately 20% of the discarded solid waste stream consisted of recyclable paper categories, the largest of which were corrugated, paperboard, and mixed office paper, which constituted 4.6%, 4.2% and 4.1% respectively. Figure 1 – Total Waste Stream Composition presents the total waste stream by major material category or individual material category, as applicable.

Plastics also constitute a significant portion of the waste stream at 12.5% mean composition for all plastic categories, the largest of which is film plastic and plastic bags at 4.4% of the total waste stream.

Recyclable glass, metal, and plastic containers in the solid waste stream include Plastic Containers #1 and #2, ferrous metal cans, aluminum cans, and the various colors of glass bottles. Combined, these categories account for an average of about 7.2 % of the discarded solid waste stream.

Figure 1 - Total Waste Stream Composition



Comparison of DGS and Commercial Samples

The compositions of the DGS and Commercial collection vehicles were evaluated separately to examine any differences from the overall waste stream composition. Table 4 – DGS and Commercial Collection Vehicles Summary presents the composition of each of the 39 material categories in each of these two sample subsets. The DGS is responsible for municipal curbside pick-up of solid waste in residential areas in the City of Albany: single family homes, and dwellings up to four units per building. Therefore, these vehicles largely represent the residential waste stream component. The percentages of paper and food waste in the DGS vehicles are similar, at 25% and 23%, respectively, followed by the plastics category at 15%. Within the paper fraction, the largest category of paper waste was other paper, with a fraction of 7.4% of the total DGS waste stream. The largest single plastics category was film plastic and plastic bags, at 6.4% of the total DGS waste stream. Textiles and leather, disposable diapers, and wood also constitute significant fractions at 6%, 5%, and 5%, respectively. The six categories of paper, food waste, plastics, textiles and leather, disposable diapers, and wood, comprise nearly 80% of the DGS waste stream, with smaller categories filling in the remaining 20% including glass, dirt/fines, miscellaneous, ferrous metals, and electronics as indicated in Figure 2 – DGS Solid Waste Summary.

By contrast, the solid waste sampled from the commercial vehicles contains a greater percentage of paper products, at 41% of the total waste stream composition across all paper categories. Like the DGS vehicles, and the aggregate total of all samples, the largest single paper category is other paper, at 16.6% of the commercial waste stream. This is the largest single paper category by a significant margin, as the next largest category of mixed office paper represents 6.3% of the total commercial waste stream. The composition of food waste and plastics remains relatively consistent with the DGS vehicles at 21% and 12%, respectively. Within the plastics fraction, the largest single category was film plastic and plastic bags, at 4.5% of the total waste stream. This result is also consistent with the composition of plastics in the DGS waste stream and overall for all vehicles sampled. The paper, food waste, and plastics categories comprise nearly 75% of the commercial solid waste stream, with additional categories including dirt/fines (6%), glass (5%), and textiles and leather (3%) as indicated in Figure 3 – Commercial Waste Summary.

There was less designated recyclable paper in the discarded solid waste delivered by the DGS than was present in the commercial solid waste discards. Designated recyclable paper consisted of 17.6% of the DGS waste compared to 24.2% in the commercial waste stream. Both the DGS and commercial waste streams contained similar amounts of recyclable plastic, metal, and glass containers, although these was slightly less metal in the commercial waste samples. Table 5 –

Capital Region Solid Waste Management Plan - Waste Characterization Field Study
Table 4 - DGS and Commercial Collection Vehicles Summary

Material Components	DGS Mean Mass Fraction	Mean Mass Fraction Std. Dev.	Commercial Mean Mass Fraction	Mean Mass Fraction Std. Dev.
PAPER				
Newspaper	2.7%	2.4%	2.1%	3.4%
Magazines	1.4%	1.1%	3.5%	6.0%
Corrugated	3.4%	2.9%	5.6%	4.2%
Gable Top Cartons & Drink Boxes	0.3%	0.2%	0.5%	1.1%
Paper Board	5.3%	2.2%	3.9%	3.1%
Books (including phone directories)	2.5%	3.8%	2.4%	4.2%
Mixed Office Paper	2.1%	1.5%	6.3%	10.3%
Other Paper	7.4%	2.8%	16.6%	19.1%
SUBTOTALS	25.0%	6.4%	40.8%	21.1%
PLASTICS				
Plastic Containers (PET) #1 Non-Bottle Bill	2.0%	1.6%	2.2%	4.4%
Plastic #1 (Bottle Bill Containers)	0.3%	0.3%	0.3%	0.4%
Plastic Containers (HDPE) #2	1.0%	1.0%	0.6%	0.5%
Other Plastic Containers	2.7%	1.2%	2.6%	2.8%
Film Plastic & Plastic Bags	6.4%	1.9%	4.5%	2.4%
Other Plastics	2.7%	2.6%	2.0%	2.4%
SUBTOTALS	15.2%	4.8%	12.2%	5.8%
FOOD WASTE	23.2%	15.0%	20.5%	24.4%
TEXTILES & LEATHER	6.2%	4.9%	3.4%	4.2%
RUBBER	0.2%	0.4%	0.5%	0.9%
DISPOSABLE DIAPERS	4.9%	4.2%	1.0%	1.6%
FERROUS METALS				
Ferrous Metal/Bimetal Cans	0.9%	0.5%	0.5%	0.5%
Aerosol Cans	0.1%	0.2%	0.1%	0.2%
Other Ferrous Metal	2.4%	5.1%	1.9%	2.8%
SUBTOTALS	3.5%	4.9%	2.5%	3.0%
NON-FERROUS METALS				
Aluminum Cans (Non-Bottle Bill)	0.3%	0.4%	0.1%	0.1%
Aluminum Cans (Bottle Bill)	0.2%	0.2%	0.3%	0.5%
Other Non-Ferrous Metal	1.2%	1.3%	0.2%	0.3%
SUBTOTALS	1.8%	1.3%	0.6%	0.7%
ELECTRONICS	2.6%	3.2%	2.1%	3.6%
GLASS				
Glass Bottles (Bottle Bill)	1.5%	1.7%	0.2%	0.3%
Glass Bottle - Clear	1.8%	2.1%	2.6%	7.6%
Glass Bottle - Amber	0.4%	0.5%	1.6%	5.7%
Glass Bottle - Green	0.1%	0.3%	0.1%	0.3%
Flat Glass & Other Glass	0.5%	0.4%	0.5%	0.8%
SUBTOTALS	4.3%	3.8%	4.9%	13.2%
WOOD	5.2%	5.4%	0.2%	0.4%
RUBBLE	0.0%	0.0%	0.2%	0.9%
YARD WASTE	0.7%	1.1%	1.0%	4.0%
DIRT/FINES	4.1%	4.5%	6.0%	17.9%
HAZARDOUS WASTE				
Household Hazardous Waste (HHW)	0.0%	0.1%	0.0%	0.0%
Lead Acid Batteries	0.0%	0.0%	0.0%	0.0%
Other Batteries	0.1%	0.2%	0.0%	0.0%
SUBTOTALS	0.1%	0.2%	0.0%	0.0%
MEDICAL OR PHARMACEUTICAL WASTE	0.0%	0.1%	0.5%	1.3%
MISCELLANEOUS	3.4%	3.1%	3.5%	4.3%
TOTAL	100.0%	0.0%	100.0%	0.0%

Figure 2 - DGS Solid Waste Summary

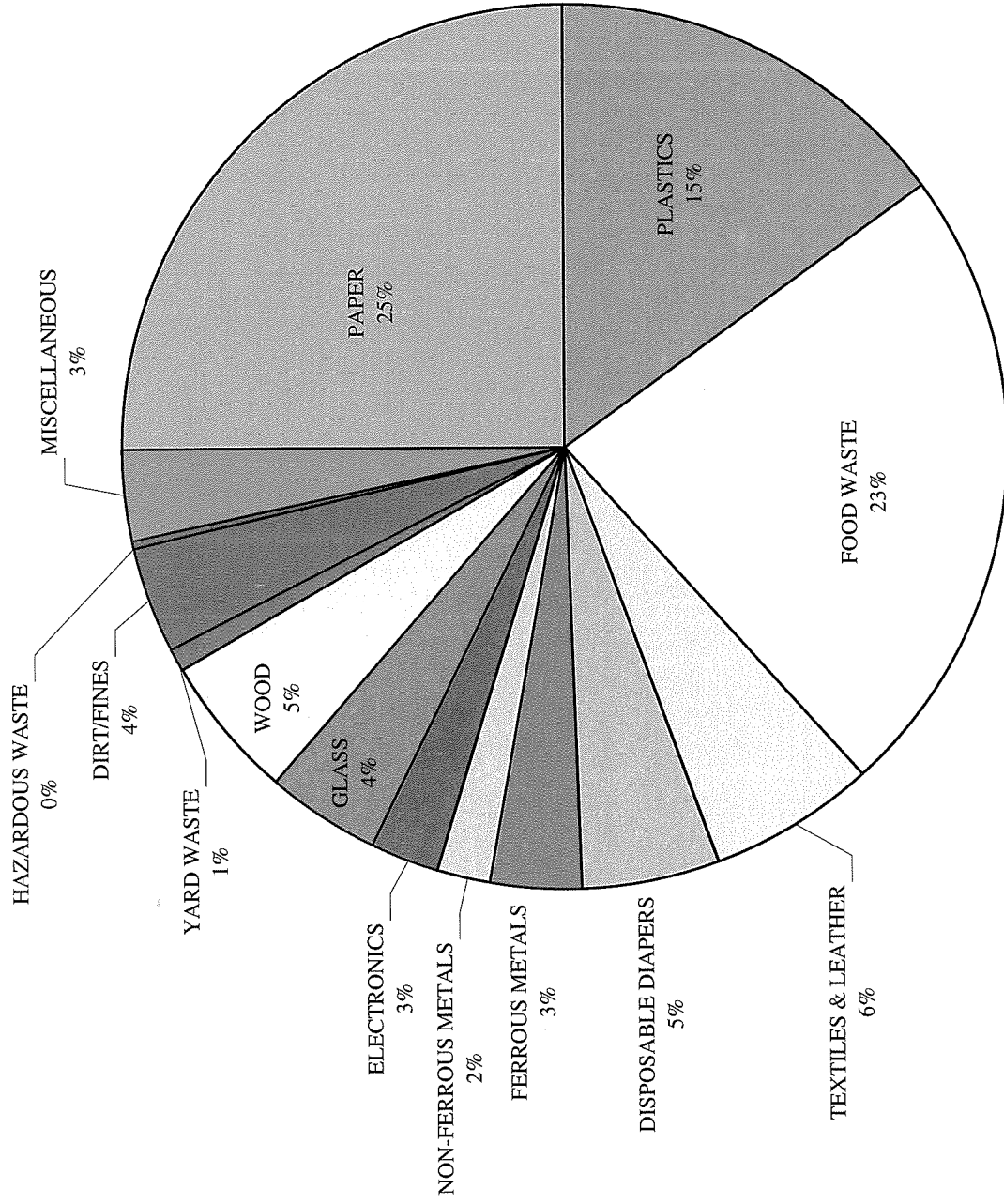
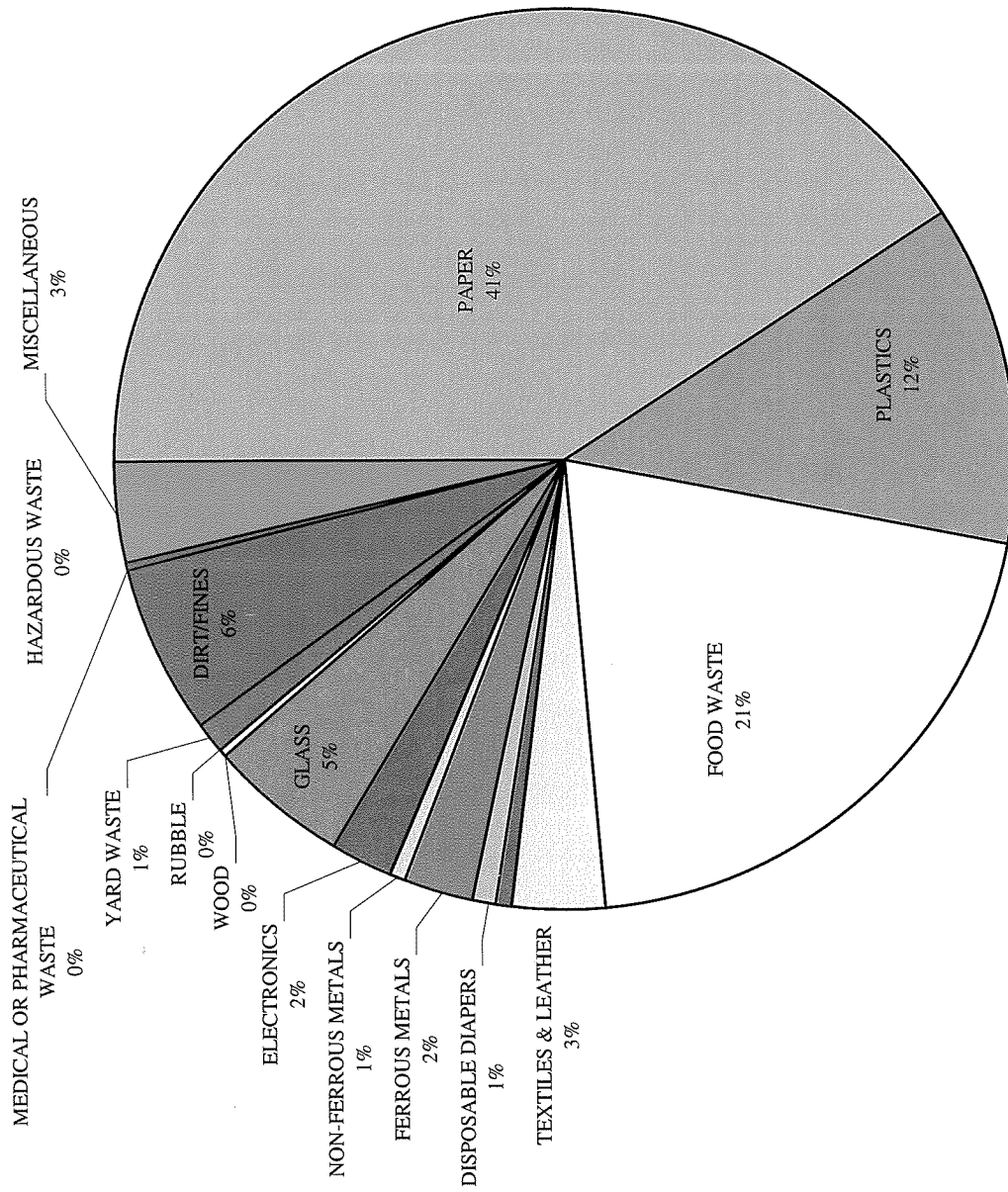


Figure 3 - Commercial Waste Summary



Designated Recyclable Materials within the Solid Waste Stream presents the percentage of each recyclable material category found in the solid waste stream for the following classifications: all solid waste samples, DGS samples, commercial samples, and the SUNY Albany sample.

For comparison, the solid waste composition of one of the independent vehicles was also examined separately. The waste composition of the commercial collection vehicles contrasts with the waste composition of the vehicle from SUNY Albany. From the SUNY vehicle, the paper composition and plastics composition was similar to the DGS results, at 21% paper composition (12% other paper), and 12% for plastics composition (4% film plastic and plastic bags), as presented in Figure 4 – SUNY Solid Waste Summary. The main difference, however, between the SUNY sample and the DGS and commercial waste streams, is in the quantity of food waste, which represents the single largest material category at 49% of the SUNY waste stream. In addition, multiple material categories had no waste from the SUNY vehicle, including: disposable diapers, non-ferrous metals, electronics, rubble, yard waste, dirt/fines, hazardous waste, medical/pharmaceutical waste, and miscellaneous. The waste stream of the SUNY vehicle contained primarily food waste, paper, and plastics, as indicated, wood at 9% of the waste stream, and ferrous metals at 6% of the waste stream. Ferrous metal/bimetal cans comprised the entire ferrous metals category. Glass, rubber, and textiles and leather were each represented at 1%. It is important to note, however, that only a single SUNY Albany vehicle was sampled. Therefore, this analysis does not provide a waste composition analysis for SUNY Albany; however, it represents contrast in waste composition between different commercial waste generators, and hence accounts for some of the large standard deviations present with some of the material categories.

4.3 RECYCLABLE MATERIALS CHARACTERIZATION RESULTS

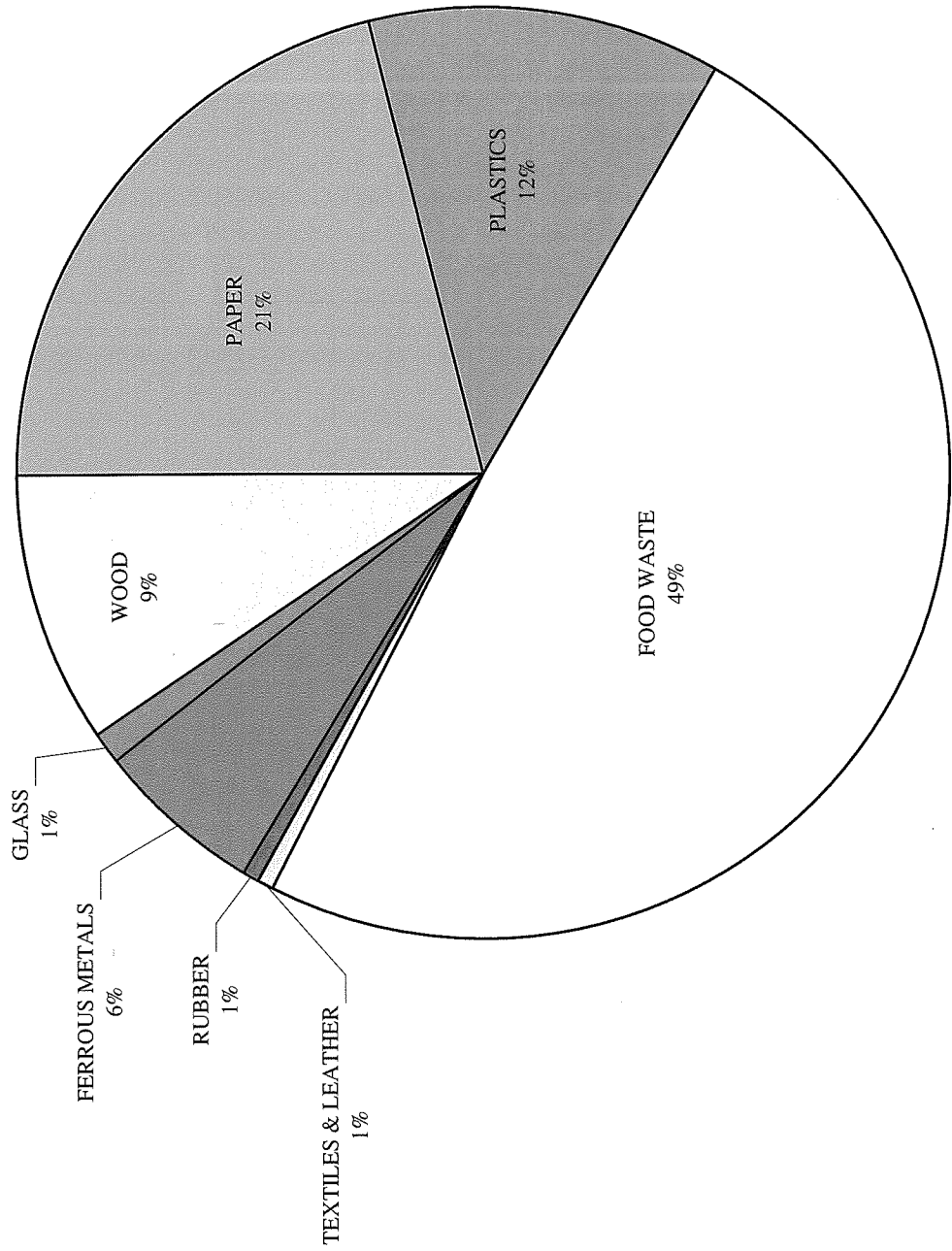
The collection vehicles for recyclable materials were divided into two compartments: paper, and metals, glass and plastic (MGP). The composition of each recyclable stream was analyzed in the same manner as described above, including calculating the mass fraction of each component, the mean mass fraction for a particular component in the recyclable stream from an aggregate total of all of the samples, and the standard deviation of each component percentage. In the paper stream, total paper products comprised an average of 98.56% of the paper stream; however, most samples contained trace amounts of plastics (with an average composition of 0.5%), ferrous metals (0.2%) and glass (0.6%), as indicated in Table 6 – Recyclable Materials Composition Summary. Within the paper stream, the largest component of recyclable paper was newspaper at

Capital Region Solid Waste Management Plan - Waste Characterization Field Study

Table 5 - Designated Recyclable Materials within the Solid Waste Stream

Material Components	Total Mean Mass Fraction for All Samples	DGS Mean Mass Fraction	Commercial Mean Mass Fraction	SUNY Albany Mass Fraction
<u>PAPER</u>				
Newspaper	2.0%	2.7%	2.1%	1.0%
Magazines	2.1%	1.4%	3.5%	0.0%
Corrugated	4.5%	3.4%	5.6%	1.1%
Gable Top Cartons & Drink Boxes	0.4%	0.3%	0.5%	0.1%
Paper Board	4.2%	5.3%	3.9%	6.2%
Books (including phone directories)	2.8%	2.5%	2.4%	0.0%
Mixed Office Paper	4.1%	2.1%	6.3%	0.7%
SUBTOTAL	20.2%	17.6%	24.2%	9.0%
<u>PLASTICS</u>				
Plastic Containers (PET) #1 Non-Bottle Bill	1.7%	2.0%	2.2%	2.6%
Plastic #1 (Bottle Bill Containers)	0.3%	0.3%	0.3%	0.6%
Plastic Containers (HDPE) #2	0.8%	1.0%	0.6%	0.7%
SUBTOTAL	2.8%	3.3%	3.1%	3.9%
<u>FERROUS METALS</u>				
Ferrous Metal/Bimetal Cans	0.7%	0.9%	0.5%	5.8%
Other Ferrous Metal	1.9%	2.4%	1.9%	0.0%
SUBTOTAL	2.7%	3.3%	2.4%	5.8%
<u>NON-FERROUS METALS</u>				
Aluminum Cans (Non-Bottle Bill)	0.2%	0.3%	0.1%	0.0%
Aluminum Cans (Bottle Bill)	0.2%	0.2%	0.3%	0.1%
Other Non-Ferrous Metal	1.0%	1.2%	0.2%	0.3%
SUBTOTAL	1.3%	1.8%	0.6%	0.4%
<u>GLASS</u>				
Glass Bottles (Bottle Bill)	0.5%	1.5%	0.2%	0.3%
Glass Bottle - Clear	1.8%	1.8%	2.6%	0.5%
Glass Bottle - Amber	0.9%	0.4%	1.6%	0.0%
Glass Bottle - Green	0.1%	0.1%	0.1%	0.0%
SUBTOTAL	3.2%	3.7%	4.4%	0.8%
<u>YARD WASTE</u>	1.2%	0.7%	1.0%	0.0%
Grand Total	31.4%	30.4%	35.7%	19.9%

Figure 4 - SUNY Solid Waste Summary



53%, followed by books (including phone directories) at 13%, and magazines at 11% (Figure 5 – Recyclables: Paper Stream). Other significant components included paperboard at 8%, mixed office paper at 7%, and corrugated at 6%. The component percentage of gable top cartons and drink boxes was minimal at an average of 0.24%.

The majority of the MGP stream included plastic, ferrous metals, non-ferrous metals, and glass; however, the mean mass fraction of all samples included approximately 8% paper (all paper categories combined). This paper fraction included newspaper, gable top cartons and drink boxes, paperboard, and books. The paper fraction has been included within the analysis of the MGP stream, below.

Greater than half of the MGP stream, at 58.8%, consisted of glass (Figure 6 – Recyclables: Metals, Glass and Plastic). Within this material category, the largest components of glass were clear glass bottles and green glass bottles. These two categories comprised 29% and 17%, respectively, of the total MGP stream. The second largest major material category within the MGP stream was plastics at 18.9%; the largest material categories within the plastics family were PET #1 plastic containers at 8% of the total MGP stream, HDPE #2 plastic containers at 6% of the total MGP stream, and other plastic containers at 3% of the total MGP stream. The remaining plastic categories were present in smaller quantities. The third largest MGP component fraction consisted of ferrous metals (12%), of which nearly all were ferrous metal/bimetal cans (11.52%). The MGP stream also has approximately 2% non-ferrous metals, more than half of which was the material category of other non-ferrous metal.

4.4 COMPARISON WITH OTHER STUDIES

Table 7 – Solid Waste Composition in Other Studies compares the solid waste composition obtained in this study of the Capital Region with data from two other sources: the Onondaga County Resource Recovery Agency (OCRRA), and the United States Environmental Protection Agency (USEPA). OCRRA conducted a similar study in 2005 for the characterization of the solid waste and recyclable stream within the county (OCRRA, 2005). USEPA collects and publishes data on the generation, recovery, and disposal of municipal solid waste (MSW) on an annual basis. This data is collected for the entire United States; therefore, the percentages provided represent a national average across all regions and areas. The USEPA data for the year 2007 were collected from Tables 14, 17, and 23 in *Municipal Solid Waste in the United States: 2007 Facts and Figures* (USEPA, 2008). It is important to note that some material categories

Capital Region Solid Waste Management Plan - Waste Characterization Field Study
Table 6 - Recyclable Materials Composition Summary

Material Components	Mean mass fraction - Paper	Standard deviation - Paper	Mean mass fraction - Metals, Glass & Plastics	Standard Deviation - Metals, Glass & Plastics
PAPER				
Newspaper	52.7%	13.8%	2.0%	2.9%
Magazines	10.8%	4.7%	0.5%	0.6%
Corrugated	6.2%	3.5%	0.2%	0.4%
Gable Top Cartons & Drink Boxes	0.2%	0.3%	1.3%	0.8%
Paper Board	7.5%	3.6%	1.6%	1.0%
Books (including phone directories)	12.8%	7.3%	1.7%	2.9%
Mixed Office Paper	6.6%	4.8%	0.2%	0.3%
Other Paper	1.7%	0.8%	0.4%	0.4%
SUBTOTALS	98.6%	1.4%	7.9%	5.2%
PLASTICS				
Plastic Containers (PET) #1 Non-Bottle Bill	0.1%	0.2%	7.9%	4.4%
Plastic #1 (Bottle Bill Containers)	0.0%	0.1%	0.8%	0.7%
Plastic Containers (HDPE) #2	0.1%	0.1%	6.1%	4.2%
Other Plastic Containers	0.1%	0.2%	2.7%	0.9%
Film Plastic & Plastic Bags	0.1%	0.1%	0.4%	0.2%
Other Plastics	0.1%	0.1%	1.0%	0.9%
SUBTOTALS	0.5%	0.4%	18.9%	9.1%
FOOD WASTE	0.1%	0.2%	0.0%	0.2%
TEXTILES & LEATHER	0.1%	0.2%	0.1%	0.2%
RUBBER	0.0%	0.0%	0.0%	0.0%
DISPOSABLE DIAPERS	0.0%	0.1%	0.0%	0.0%
FERROUS METALS				
Ferrous Metal/Bimetal Cans	0.2%	0.2%	11.5%	4.1%
Aerosol Cans	0.0%	0.0%	0.3%	0.8%
Other Ferrous Metal	0.0%	0.0%	0.1%	0.4%
SUBTOTALS	0.2%	0.2%	12.0%	4.4%
NON-FERROUS METALS				
Aluminum Cans (Non-Bottle Bill)	0.0%	0.1%	0.3%	0.2%
Aluminum Cans (Bottle Bill)	0.0%	0.0%	0.6%	0.3%
Other Non-Ferrous Metal	0.0%	0.1%	1.2%	0.9%
SUBTOTALS	0.0%	0.1%	2.1%	0.9%
ELECTRONICS	0.0%	0.0%	0.0%	0.1%
GLASS				
Glass Bottles (Bottle Bill)	0.1%	0.1%	5.3%	3.4%
Glass Bottle - Clear	0.4%	0.8%	29.2%	7.5%
Glass Bottle - Amber	0.0%	0.0%	5.9%	3.7%
Glass Bottle - Green	0.1%	0.2%	16.9%	9.7%
Flat Glass & Other Glass	0.0%	0.0%	1.5%	2.1%
SUBTOTALS	0.6%	0.9%	58.8%	13.5%
WOOD	0.0%	0.1%	0.0%	0.0%
RUBBLE	0.0%	0.0%	0.0%	0.0%
YARD WASTE	0.0%	0.0%	0.0%	0.0%
DIRT/FINES	0.0%	0.0%	0.0%	0.0%
HAZARDOUS WASTE				
Household Hazardous Waste (HHW)	0.0%	0.0%	0.0%	0.0%
Lead Acid Batteries	0.0%	0.0%	0.0%	0.0%
Other Batteries	0.0%	0.0%	0.0%	0.1%
SUBTOTALS	0.0%	0.0%	0.0%	0.1%
MEDICAL OR PHARMACEUTICAL WASTE	0.0%	0.0%	0.2%	0.8%
MISCELLANEOUS	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	0.0%	100.0%	0.0%

Figure 5 - Recyclables: Paper Stream

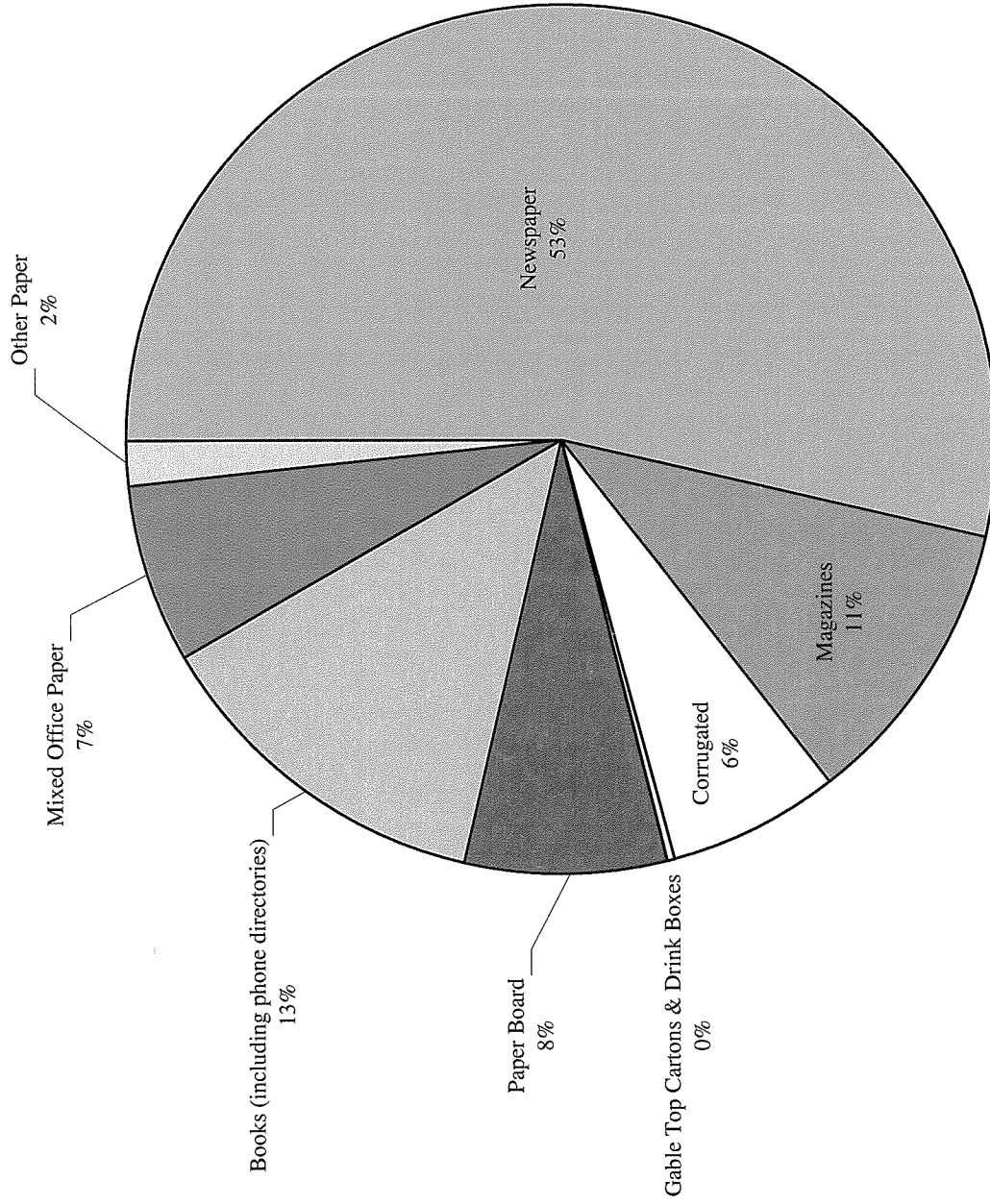
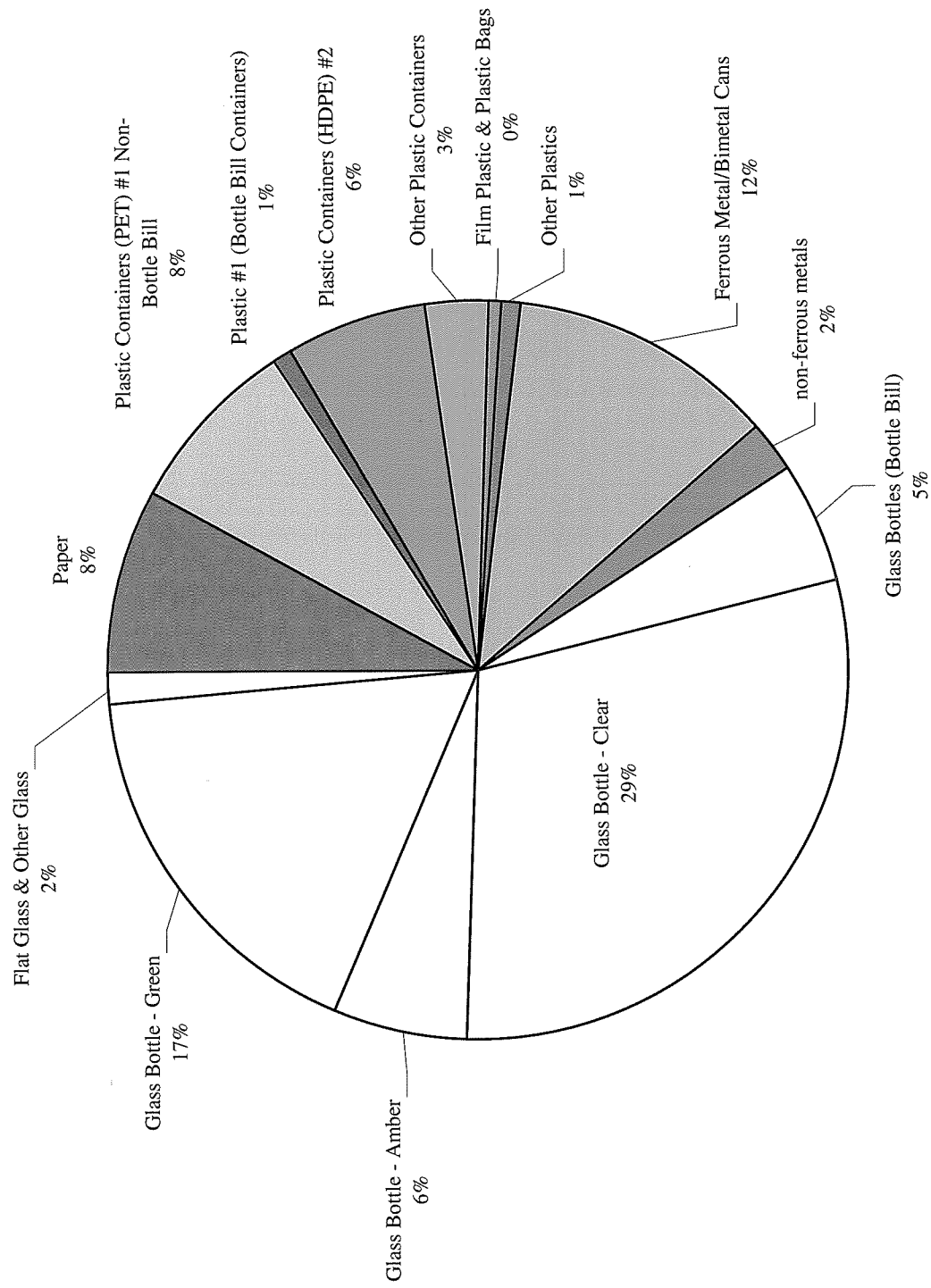


Figure 6 - Recyclables: Metals, Glass and Plastic



have been combined with other categories, or were not used for the particular study. Therefore, some of the “other” categories have been used to categorize multiple materials not otherwise listed.

Several of the material categories were consistent across the three studies, including food wastes, textiles and leather, disposable diapers, non-ferrous metals, electronics, wood, and rubble. In several more of the material categories, two of the three studies indicate similar fractions of a particular material category, with the third study as the exception with a greater or lesser component fraction. This is true of the ferrous metals category, glass, and yard waste, as indicated in Table 7. The Capital Region and OCRRA studies contained larger fractions of ferrous metals, at 2.8% and 2.5% of the waste stream, than in the USEPA data, at 0.6% of the waste stream. Yard wastes, while not a significant fraction of the Capital Region or OCRRA studies, at 1.2% and 1.1%, respectively, constituted 6.9% of the discarded waste stream based upon USEPA data. The glass fraction was also significantly higher in the Capital Region and USEPA studies than in the OCRRA study, with component percentages of 4.7%, 4.9%, and 1.8%, respectively.

As the table indicates, the total combined paper fraction is higher in the Capital Region than in the OCRRA study and the USEPA data, but only by several percentage points. This increase is due to larger fractions of paperboard, books, and other paper present in the Capital Region waste stream. The OCRRA solid waste stream contained larger fractions of plastic than both the Capital Region and USEPA data. The largest single plastics category in the OCRRA data was other plastic containers, which comprised 11% of the total waste stream.

The comparison with these studies indicates that the data obtained in the Capital Region waste characterization field study is relatively consistent with other studies on a regional and national level, while still retaining some differences specific to the Capital Region. As noted above, knowledge of the area’s waste stream composition and recyclable materials composition will assist the Planning Unit in the further development of solid waste and recyclables management, as well a present and future practices.

Capital Region Solid Waste Management Plan - Waste Characterization Field Study
Table 7 - Solid Waste Composition in Other Studies

Material Components	Capital Region Average Composition 2009 (%)	Onondaga County Waste Characterization Study 2005 - Exhibit 3-1 (%)	USEPA Products Discarded in the Municipal Waste Stream 2007: Tables 14, 17, & 23 (%)
PAPER			
Newspaper	2.0%	3.4%	1.4%
Magazines	2.1%	1.6%	0.9%
Corrugated	4.5%	4.6%	4.9%
Gable Top Cartons & Drink Boxes	0.4%	0.2%	0.3%
Paper Board	4.2%	1.7%	4.0%
Books (including phone directories)	2.8%	0.6%	0.9%
Mixed Office Paper	4.1%	3.3%	4.7%
Other Paper	11.1%	12.8%	6.7%
SUBTOTALS	31.3%	28.2%	23.8%
PLASTICS			
Plastic Containers (PET) #1 Non-Bottle Bill	1.7%	1.1%	n/a
Plastic #1 (Bottle Bill Containers)	0.3%	0.3%	n/a
Plastic Containers (HDPE) #2	0.8%	2.1%	0.0%
Other Plastic Containers	2.5%	11.0%	2.6%
Film Plastic & Plastic Bags	4.4%	n/a	3.2%
Other Plastics	2.8%	4.6%	3.1%
SUBTOTALS	12.5%	19.1%	8.9%
FOOD WASTE	18.7%	14.6%	18.2%
TEXTILES & LEATHER	5.7%	5.8%	4.7%
RUBBER	0.5%	1.0%	1.9%
DISPOSABLE DIAPERS	2.3%	2.4%	2.2%
FERROUS METALS			
Ferrous Metal/Bimetal Cans	0.7%	1.0%	0.5%
Aerosol Cans	0.1%	n/a	0.0%
Other Ferrous Metal	1.9%	2.4%	0.0%
SUBTOTALS	2.8%	3.5%	0.6%
NON-FERROUS METALS			
Aluminum Cans (Non-Bottle Bill)	0.2%	0.1%	0.4%
Aluminum Cans (Bottle Bill)	0.2%	0.2%	0.0%
Other Non-Ferrous Metal	1.0%	0.8%	0.2%
SUBTOTALS	1.3%	1.1%	0.7%
ELECTRONICS	2.7%	1.2%	1.5%
GLASS			
Glass Bottles (Bottle Bill)	0.5%	0.3%	3.0%
Glass Bottle - Clear	1.8%	0.7%	n/a
Glass Bottle - Amber	0.9%	0.1%	n/a
Glass Bottle - Green	0.1%	0.2%	n/a
Flat Glass & Other Glass	1.4%	0.5%	1.9%
SUBTOTALS	4.7%	1.8%	4.9%
WOOD	3.6%	3.2%	4.3%
RUBBLE	0.6%	0.6%	n/a
YARD WASTE	1.2%	1.1%	6.9%
DIRT/FINES	7.9%	4.3%	n/a
HAZARDOUS WASTE			
Household Hazardous Waste (HHW)	0.0%	0.4%	n/a
Lead Acid Batteries	0.0%	0.0%	0.0%
Other Batteries	0.0%	0.1%	n/a
SUBTOTALS	0.1%	0.5%	0.0%
MEDICAL OR PHARMACEUTICAL WASTE	0.2%	n/a	n/a
MISCELLANEOUS	3.8%	11.7%	21.4%
TOTAL	100%	100%	100%

5.0 CONCLUSIONS

Significant quantities of designated recyclables are present in the discarded solid waste stream, as indicated in Table 5 – Designated Recyclable Materials within the Solid Waste Stream. While this is evident in all the waste streams delivered, it is most evident in the commercial waste stream.

Yard waste only represented 1.2% of the solid waste discarded during this study. While there are numerous yard waste composting programs in place within the planning unit, the waste characterization study was conducted during the low season for yard waste generation. Therefore, an upward adjustment might be needed to reflect an annual average percentage of yard waste that is discarded. This should be examined further in the context of the overall waste stream analysis being conducted for the new SWMP.

Food waste is the largest single component of the discarded solid waste stream, totaling almost 19%. When combined with the yard waste and other compostable elements of the some other waste material categories, the compostable organic waste fraction may equal or exceed 30% of the MSW discarded.

REFERENCES

United States Environmental Protection Agency. *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007*. Tables 14, 17, and 23. EPA-530-F-07-030. November 2007. Reviewed on October 30, 2008, from <http://www.epa.gov/osw/nonhaz/municipal/msw99.htm>

Onondaga County Resource Recovery Agency. 2005 Onondaga County Waste Quantification and Characterization Study. Dvirka and Bartilucci Consulting Engineers. Syracuse, NY. 2005

Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, ASTM D5231-92 (Reapproved 2003)