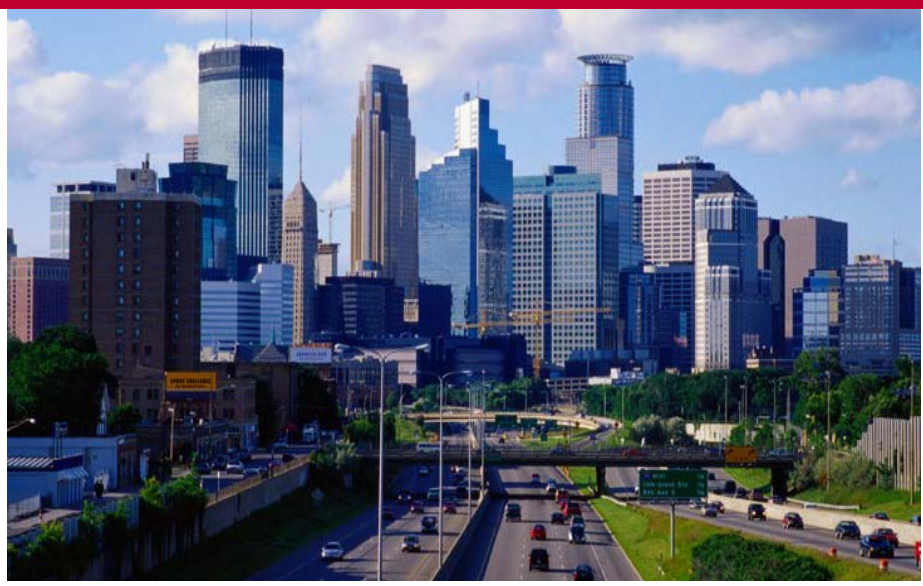
Louis Berger



Multifamily Waste Study

Hennepin County, Minnesota
September 2017

louisberger.com

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1.0 INTRODUCTION

Hennepin County's Environment and Energy Department (County) initiated this Multifamily Waste Study (Study) to capture data specific to Hennepin County in an effort to meet the following objectives:

- Determine the recycling potential at multi-unit dwellings; and
- Establish baseline waste and diversion information for long-term monitoring of programs.

Approximately one-third of all households in Hennepin County live in multifamily units and the County is seeking to collect data on multifamily waste generation and recycling rates, among other waste-related data. It is assumed that multifamily households generate less waste per household and recycle less than single-family dwelling households, however there are very few studies (locally or nationally) that have analyzed the waste generation of multifamily households specifically. The County retained the Louis Berger Group, Inc. (Louis Berger) to conduct this Study and produce an analysis of waste generation and recycling from multifamily households (apartment buildings, condominiums and townhome developments of five or more units) in Hennepin County.

This report describes the three components to the Study:

1. Waste Sort;
2. Waste Generation Research; and
3. Service Level and Cost Research.

Additional information is included in the appendices, as referenced in the report.

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2.0 WASTE SORT

2.1 BACKGROUND

For the waste sort, initially the County requested that Louis Berger coordinate with at least two haulers the delivery of municipal solid waste (MSW) one week and recyclables one week from the same multi-unit properties for sorting at the Hennepin County Brooklyn Park Transfer Station (BPTS). The loads were to be separate from commercial collections to confirm that the materials came from multi-unit properties only. However, this plan would not be economically or logistically possible for the haulers.

Louis Berger contacted multiple private haulers and while some agreed to collect from multifamily properties only, they all stated it would not be possible to collect from the same addresses for trash and recycling because some multifamily properties have different types of collection containers for recycling (i.e., some have wheeled carts and others have dumpsters) so it would not be possible for a hauler to dispatch one truck to collect all recyclables from a variety of addresses. (Carts are typically collected with side-load or rear-load trucks with cart tippers, while dumpsters are collected with front-load or rear-load trucks.) In addition, not all haulers that collect MSW are the same haulers that collect the recycling at certain buildings.

The City of Minneapolis did agree to collect from the same multifamily addresses each week for MSW and recyclables, however it was a limited number of properties on two collection days.

No hauler would commit two full weeks to the collection of multifamily properties. Because most of these properties are collected on commercial routes by the private haulers, it would be too disruptive to their operations to run separate multifamily and commercial routes, as most haulers do not have the staff to operate separate or additional routes.

Ultimately three[1] private haulers agreed to deliver a limited amount of multifamily MSW and recyclables to the BPTS for the waste sort. With the understanding that it would not be possible to obtain MSW and recyclables from the same addresses each week, the County agreed to this revised task in which Louis Berger would calculate an average "pounds per multifamily unit generated per day" based on the number of units and collection frequencies of the properties collected for each load and the MSW loads would not correlate to the recycling loads.

The field sorting event was held April 10 through April 21, 2017. Typically waste sorts are not conducted during a week with a major holiday, however Easter Sunday happened to fall on the weekend in between sorting weeks. In the project kick-off meeting, a lengthy discussion was held regarding the date of the waste sort. Because the targeted materials were multifamily MSW and recyclables, the County wanted to avoid the first and last weeks of the month to prevent any skewed data associated with residents moving in or moving out. In addition, the County and Louis Berger

[1] One hauler delivered both MSW and recycling, one hauler delivered MSW only, and one hauler delivered recyclables only.

agreed that Easter does not considerably affect the waste stream compared to other holidays. Therefore, it was decided to conduct the field sorting event during the two middle weeks in April.

2.2 METHODOLOGY

To estimate the amount and composition of MSW and recyclable materials generated from multifamily units within the County, Louis Berger developed a waste sort methodology that includes the following key elements:

1. Field Sort Planning;
2. MSW and Recycling Field Sorting Event; and
3. Data Analysis.

2.2.1 Field Sort Planning

On March 9, 2017, Louis Berger staff met with County staff and a facility operations representative at the Brooklyn Park Transfer Station for a facility orientation and to discuss logistics, health and safety concerns, schedule, and personnel (assistance from BPTS loader operator during the sort). The sorting locations and cart storage locations were determined and evaluated for space and safety. Louis Berger made arrangements with the County as well as the City of Minneapolis for the delivery of 90-gallon wheeled carts to be used during the waste sort to contain and stage samples waiting to be sorted.

Prior to any waste sort, information is gathered to execute the field sorting event. For this Study, the following components to the Study were pre-determined by the County:

- Generators;
- Origin of Waste and Recyclables; and
- Material Categories.

Each of these key elements to the Study are discussed below.

2.2.1.1 Generators

The waste and recyclables to be sorted were generated by households living in buildings of five or more units. These included condos and apartments located in small, medium, and large properties. From the address lists provided by the haulers to Louis Berger, the properties collected ranged in size from 5 units[2] to 466 units.

It is assumed that the generators represented a range of household sizes and incomes, based on the diverse geographic area in which multifamily properties were collected (13 suburban cities plus the City of Minneapolis). To accurately obtain data on household size and income, residents living

[2] Of the 111 properties collected by the haulers, five addresses were multi-family buildings with four units. It was not possible to exclude those properties from the total load weight so they are included in this analysis.

in the multifamily properties collected for this Study would have had to be individually surveyed and that was beyond the scope of this Study. (From the address lists provided by the haulers, Louis Berger noted two properties that are eligible to receive Section 8 low income housing subsidies: one property with 105 units and one with 38 units, both on recycling routes.)

2.2.1.2 Origin of Waste and Recyclables

The Study targeted multifamily MSW and recyclable materials generated throughout Hennepin County, in both urban and suburban locations. As indicated in Section 2.1, three private haulers and the City of Minneapolis agreed to deliver multifamily MSW and recyclable materials for the field sorting event. The haulers provided Louis Berger with address lists of the properties they collected for this Study, which totaled 111 addresses (70 MSW and 41 recycling) representing 5,203 units (2,681 MSW and 2,522 recycling). The geographic ranges of these addresses are shown in Figures 2-1 and 2-2 below and larger maps are attached in Appendix A. The areas least represented include the southern portion of the County, south of Interstate 394; the area north of the City of Minneapolis; and the central section between I-494 and Highway 169. Because the waste sort was conducted in Brooklyn Park, in the northern part of the County, many haulers declined to bring in loads from the southern suburbs because of the distance.

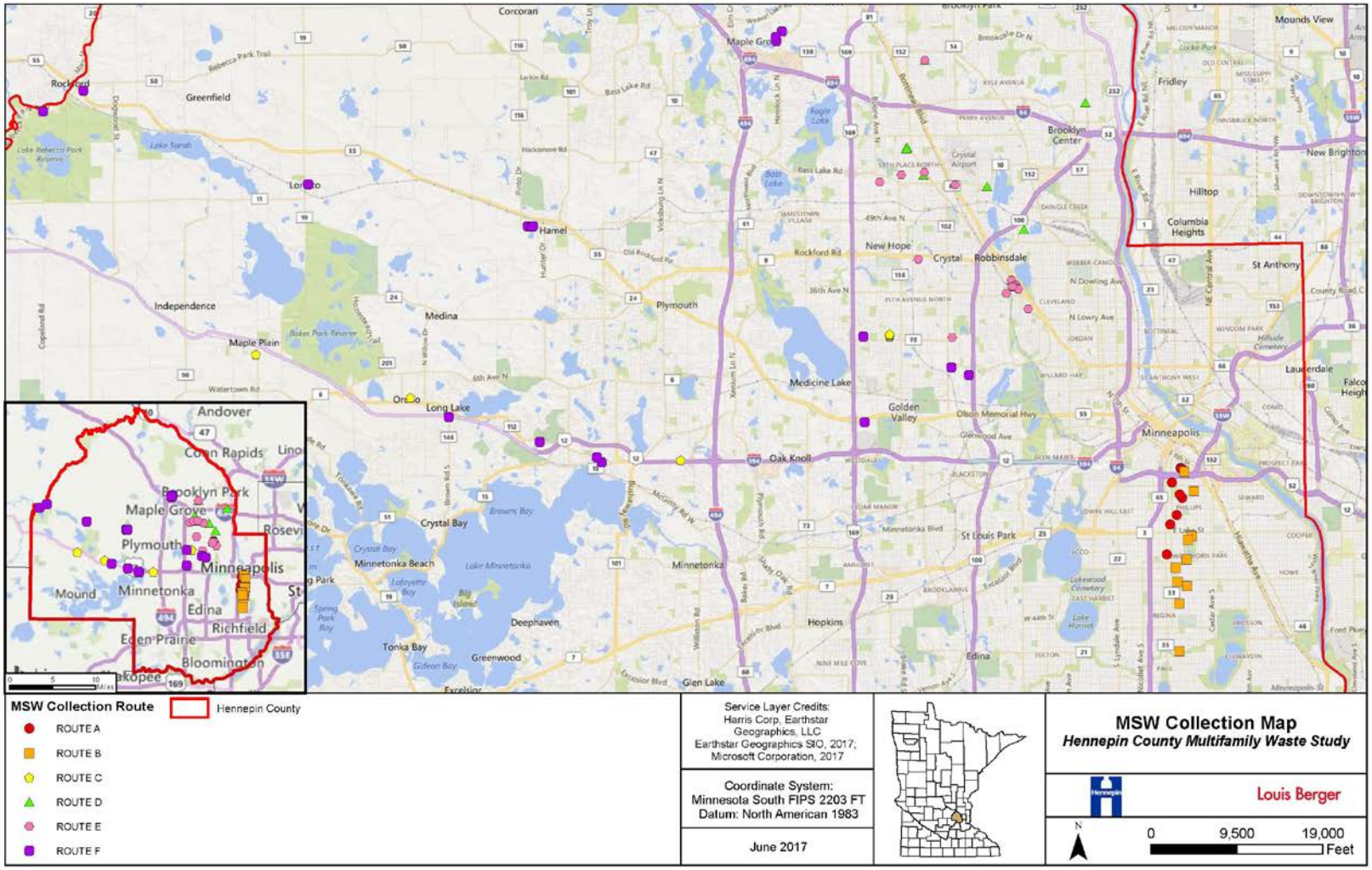

Figure 2-1: MSW Collection Map

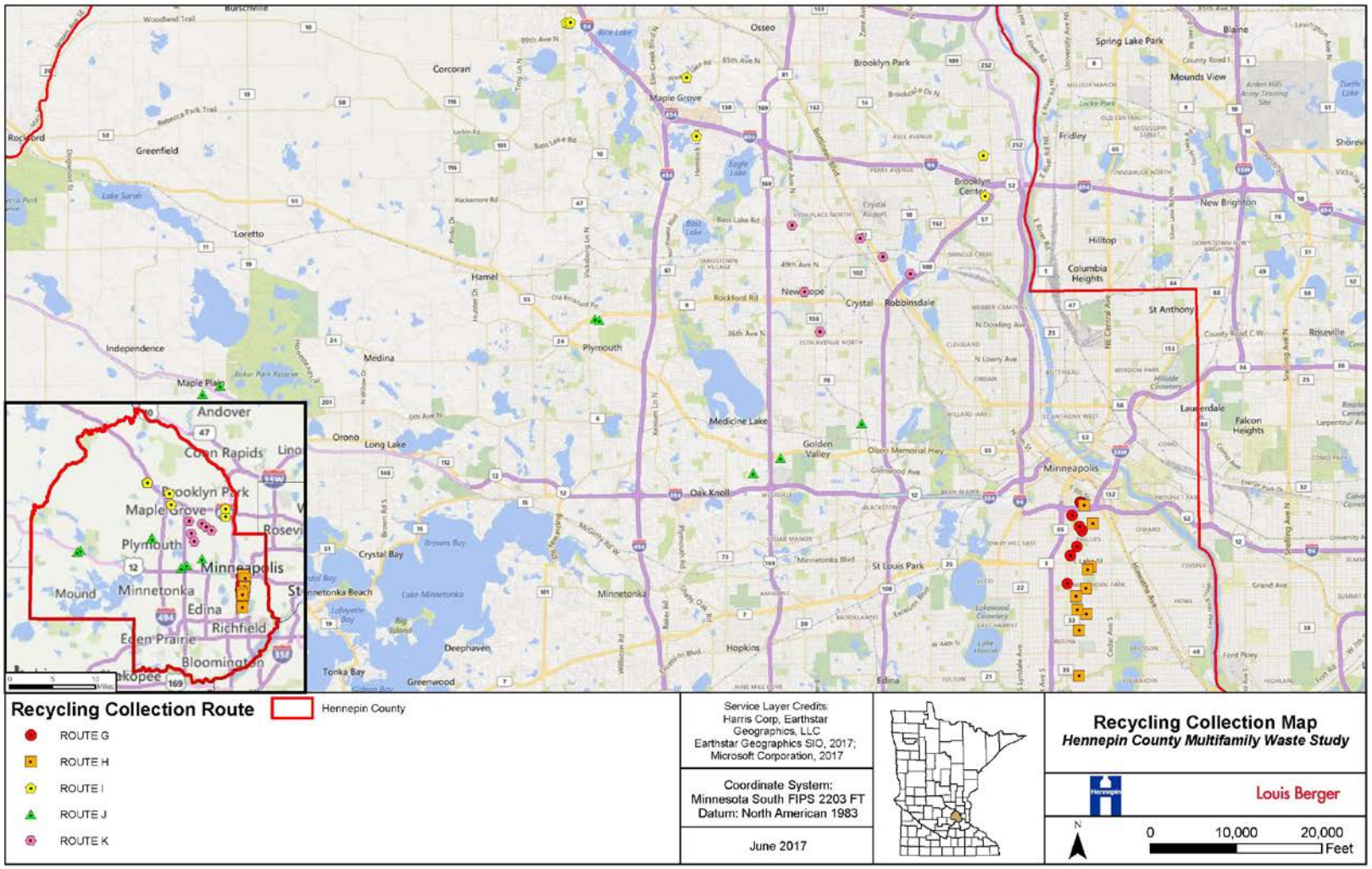

Figure 2-2: Recycling Collection Map

2.2.1.3 Material Categories

The County requested the following six materials be sorted from the multifamily MSW and recycling loads delivered for the waste sort:

1. Trash
2. Recyclables
3. Organics
4. Household Hazardous Waste (HHW) & Electronics
5. Bulky Waste
6. Textiles

County staff were interested in a qualitative assessment of how much recoverable plastic film and bags were found in the recycling stream. Louis Berger offered to create a seventh category, "Recoverable Film/Bags," for the recyclable materials characterization. Recoverable film and bags were sorted, weighed, and counted to provide a quantitative assessment of this material category.

A full material category list, including definitions, is included in Appendix B. The list originated from the County's 2016 waste sort study completed by Foth Infrastructure and Environment. For this Study, each material in the category list was placed in one of the six categories listed above.

Louis Berger also created data collection sheets to record the weights of each category for each sample. A copy of the data collection sheets is included in Appendix C.

2.2.2 MSW and Recycling Field Sorting Event

The field sorting consisted of two main elements: sample selection and sample sorting. The procedures used for each are described below.

2.2.2.1 Sample Selection

MSW Sample Selection

At the transfer station, the driver of a multifamily MSW load was directed to unload on the tipping floor, near the sort table. Louis Berger's project manager walked around the load and counted the number of mattresses and large pieces of furniture that were visible in each load. Louis Berger staff, along with sub-consultant GRG Analysis (together referenced hereafter as the Sort Team) randomly selected samples weighing a minimum of 200 pounds. The goal was to take ten samples from each load. Sampling was accomplished by systematically treating the tipped load as a clock face. For example, if the tipped pile was viewed from the top as a clock face with 12 o'clock being the part of the load closest to the front of the truck, the first sample was taken at the 12 o'clock position. Subsequent samples were collected from 3 o'clock, 6 o'clock, and 9 o'clock, and then from 1, 4, 7, and 10 o'clock and so on. Systematic "grabs" were taken by working from the perimeter into the middle of the load for each sample, ensuring that material was taken from the top, middle, and bottom of each section. The MSW was shoveled into 90-gallon carts which were wheeled to a scale to be weighed and tagged. When a minimum of 200 pounds was obtained, the

carts were tagged with placards indicating the date, hauler, and sample number, and wheeled to a staging area. Once all the samples were obtained from the load, the area was cleared by a BPTS loader operator. A total of fifty (50) MSW samples were collected for sorting.

Recyclable Materials Sample Selection

Similar to the MSW sampling procedure, the driver of a multifamily recycling load was directed to unload on the tipping floor, however the loads were emptied near the push wall, away from the MSW. A BPTS loader operator then scooped up the recyclables and brought them over to the recycling side of the building where the sorting took place. The sample selection was conducted similar to the MSW sample selection, using the clock face method. Most of the recycling loads were light in weight so the Sort Team ended up using all of the material from each load to obtain as many 200-pound samples as possible. A total of 33 samples were collected for sorting.

2.2.2.2 Sorting Procedures

The MSW samples were sorted in the transfer station, in a designated space on the tipping floor. The recycling samples were sorted in the old Rational Energies section of the recycling building at the BPTS. The sorting area consisted of a sorting table, containers for each sorted material type, and a digital scale. Prior to sorting the first sample, each container was labeled with the material category and weighed to obtain the tare weight of the empty container. The materials were then hand sorted by the Sort Team into individual containers representing the six material categories (seven categories for recycling, to include Recoverable Film/Bags). Then, each container was weighed to determine the quantity of materials by material type in each sample. The gross weight (the container plus its contents) were recorded to the nearest tenth of a pound on individual data sheets to document the sorting process. (To save time, the tare weights were subtracted later, during the data analysis, to obtain the net weight.) After each sample of MSW was sorted and weighed, any HHW and electronic waste was set aside for proper disposal and the post-sorted MSW was disposed in the "pit" with the other transfer station waste waiting to be loaded into transfer trailers. After each recyclable sample was sorted and weighed, any HHW and electronic waste was set aside for proper disposal, the recyclables were placed in wheeled carts and emptied into a recycling compactor located in the building, and the remaining post-sorted material (trash, organics, bulky, and textiles) was disposed with the transfer station waste.

Photos from the waste sort are included in Appendix D.

2.2.3 Data Analysis

The data collected from the ten-day sorting event was analyzed to estimate the composition of the multifamily MSW and recycling streams. The mean and the 90 percent upper and lower confidence intervals for each individual material category were calculated using JMP[3] statistical software. In

[3] JMP is a computer program for statistics created by analytics software developer SAS.

addition, the software program identified where specific samples could be considered statistical outliers.

The mean represents the mathematical average or average percent of material composing each stream by weight. The confidence interval is an expression of accuracy. It provides the upper and lower limits of the "actual" mean for the sampled materials. For example, the 90 percent confidence interval indicates that there is a 90 percent level of confidence that the true mean falls within the upper and lower bounds of the confidence interval. The 90 percent confidence interval is the generally accepted industry standard for solid waste composition studies. In general, the more samples that are sorted, the narrower the confidence interval becomes for a given reported value. The narrower the intervals, the less variability in the data. It is critical when evaluating the composition results that the confidence intervals are considered along with the mean percentages to ensure the range is taken into consideration.

2.2.3.1 MSW Analysis

A total of fifty samples representing 10,874 pounds of MSW were sorted during the field sorting event. The aggregated results of all fifty MSW samples are shown in Table 2-1.

Table 2-1
Hennepin County Multifamily Waste Study
MSW Composition (by Weight)

			90% Confidence Interval	
Material	**Mean (%)**	**+/-**	**Lower Bound**	**Upper Bound**
Trash	29.7%	2.0%	27.6%	31.7%
Recycling	23.0%	1.2%	21.8%	24.2%
Organics	30.2%	1.6%	28.6%	31.9%
HHW and Electronics	2.0%	0.8%	1.2%	2.8%
Bulky Waste	8.0%	1.7%	6.3%	9.8%
Textiles	7.0%	1.4%	5.6%	8.5%
Grand Total	**100%**			

Note: Sums may not total due to rounding.

The results show that Organics are the most prevalent material in the multifamily MSW stream at 30.2 percent, just slightly higher than Trash at 29.7 percent. Recyclable materials comprise approximately 23 percent of the MSW stream. Bulky Waste and Textiles are similar in percentages at 8 and 7 percent respectively. The category that included both HHW and Electronics made up only 2 percent of the multifamily waste stream.

Figure 2-3 presents a graph of the aggregated composition of the MSW collected from multifamily properties.

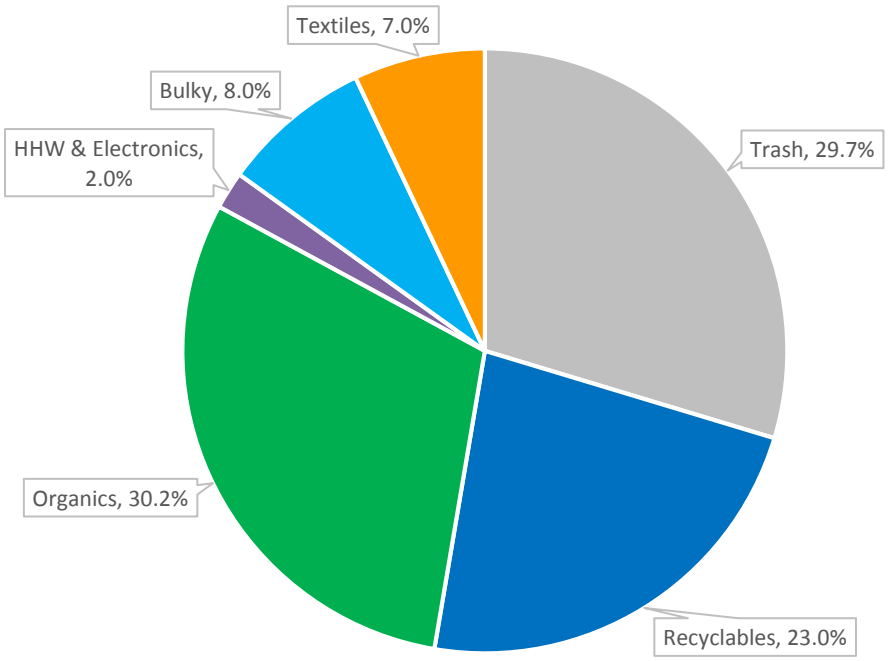

Figure 2-3: Hennepin County Multifamily MSW Composition

2.2.3.2 Recyclable Materials Analysis

A total of 33 samples representing 6,911 pounds of recyclable materials were sorted during the field sorting event. The aggregated results of all 33 recycling samples are shown in Table 2-2.

Table 2-2
Hennepin County Multifamily Waste Study
Recycling Composition (by Weight)

			90% Confidence Interval	
Material	**Mean (%)**	**+/-**	**Lower Bound**	**Upper Bound**
Trash	8.7%	1.0%	7.8%	9.7%
Recycling	76.0%	2.9%	73.1%	78.9%
Organics	9.5%	2.3%	7.2%	11.8%
HHW and Electronics	1.0%	0.9%	0.1%	1.9%
Bulky Waste	2.5%	0.7%	1.8%	3.2%
Textiles	1.5%	0.5%	1.0%	2.0%
Recoverable Film/Bags	0.8%	0.2%	0.7%	1.0%
Grand Total	**100%**			

The recycling stream contained 76 percent recyclable materials. Trash and Organics comprised similar percentages of the total quantity of materials present at 8.7 and 9.5 percent respectively. The quantity of the other materials – HHW & Electronics, Bulky Waste, Textiles, and Recoverable Film/Bags was minimal, ranging from 0.8 to 2.5 percent.

Figure 2-4 presents a graph of the aggregated composition of the recyclable materials collected from multifamily properties.

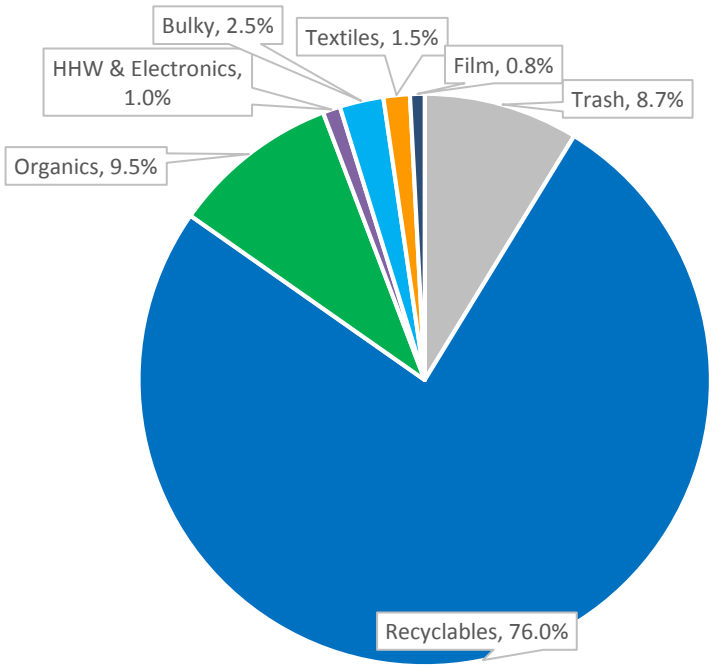

Figure 2-4: Hennepin County Multifamily Recycling Composition

For the recyclable materials field sorting event, recoverable[4] film/bags were separated into their own category in an attempt to determine how prevalent these items are in the recycling stream. (See Figure D-10 in Appendix D for a photo of the recoverable film/bags category after sorting a recycling sample.) Because film plastic has very little weight, the mean percentage is less than one percent. The weight of all Recoverable Film/Bags sorted from the 33 samples totaled 57 pounds or 1.7 pounds per sample, on average. Louis Berger counted the number of recoverable bags/pieces of film in random samples and on average, there were approximately 64 plastic bags and film items in one pound. Using the average of 1.7 pounds per sample, that equates to approximately 109 bags/pieces of film per sample. From the estimate of contamination in multifamily recyclables

[4] To define "recoverable" film plastic for this Study (as listed in the Material Categories and Definitions in Appendix B), the County referenced the Recycling Association of Minnesota's accepted materials in its "It's in the Bag" program. Available at: http://recycleminnesota.org/work/its-in-the-bag/.

shown in Table 3-8, it is extrapolated that approximately 153 tons of Recoverable Film is collected each year with multifamily recyclable materials. At an estimated 64 bags per pound, that equates to more than 19.6 million pieces of film and recoverable bags being disposed with multifamily recyclables each year.

2.2.3.3 Bulky Waste Analysis

Mattresses and large pieces of furniture were counted in each load delivered for the waste sort. A total of four mattresses, two box springs, and one recliner chair were observed in the six MSW loads delivered for the waste sort. No mattresses or large pieces of furniture were found in the recycling loads.

The County was interested in an estimate of the percentage of the Bulky Waste category that was made up of reusable items because it has a reuse diversion program for move-out waste at multifamily buildings. The material category list (see Appendix B) included a category under Bulky Waste for "Usable Household Goods" defined as "Items that appear to be in usable condition and not otherwise listed - dishes, lamps, art, cookware, sports equipment, toys." During the waste sort, Louis Berger's Project Manager recorded on the data collection sheet any reusable household items and their weight for each sample. A total of 123 pounds of reusable household goods were recorded in the MSW samples, which equates to 14 percent of the 879 pounds of Bulky Waste sorted from MSW loads. A total of 24 pounds of reusable household goods were recorded in the recycling samples, which equates to 14 percent of the 172 pounds of Bulky Waste sorted from the recycling loads. It is possible that the quantity of reusable items in the MSW stream could have been higher had those items been diverted for reuse rather than set out as trash. Reusable items that were originally placed in the garbage most likely became broken or unusable during the collection process.

Many of the items found in the MSW and recycling samples that were categorized as Bulky Waste appeared to be broken when the resident placed them in a collection container. Examples included: broken fans, vacuum cleaners, coffee makers, a playpen, a mop, a toaster, and broken furniture. The Bulky Waste category included small household appliances and the Sort Team came across several items such as a crock pot, iron, curling iron, electric fry pan, and several vacuum cleaners. These small appliances were not tested or plugged into an electrical socket to see if they were in working order; they were assumed non-reusable.

Photos of reusable household goods found in MSW and recycling samples are included as Figures D-8 and D-9 in Appendix D. The reusable items found in the MSW and recycling samples are listed below in Tables 2-3 and 2-4 respectively.

Table 2-3
Quantity and Weight of Reusable Household Goods Disposed with Multifamily MSW

Reusable Household Item	Weight (pounds)
Rake	2.5
Wooden head board	9.2
Bowling ball	14.0
Apple corer, ice cube trays	3.7
Christmas ornaments, wreath, artificial tree	9.4
Platter, bowl, vase	3.6
Closet organizer	3.2
Toys, cups, ash tray	2.9
Meat grinder	3.7
Wooden head board, toy	31.7
Picture frame, dish	1.8
Plastic shipping container/box	5.0
Luggage	15.1
Dishes, silverware	8.0
Silverware, flexible (soft-sided) cooler	3.0
Broiler pan, 5-gallon bucket	1.3
Closet organizer	4.5
Saucepan and cover	0.8
Total	**123.4**

Table 2-4
Quantity and Weight of Reusable Household Goods Disposed with Multifamily Recyclables

Reusable Household Item	Weight (pounds)
Shower caddy	1.0
Knives, china, Tupperware, colander/strainer	3.5
Laundry drying rack	3.5
Dishes	0.9
Pots and pans	3.3
Ironing board	11.5
Total	**23.7**

3.0 WASTE GENERATION ANALYSIS

The second task of this Study was to calculate the total waste generation and recycling rate for the multifamily sector in the County. Waste generation is defined by the U.S. Environmental Protection Agency (EPA) as "the total amount of MSW recycled plus the total amount of MSW disposed of, in tons."[5]

As part of the waste sort in Task 1, Louis Berger requested that the participating haulers provide an address list (including collection frequency) for each load delivered to the Brooklyn Park Transfer Station (BPTS). In addition, the County provided Louis Berger with a property list of all multi-unit properties in the County including the number of units at each address. With this data, Louis Berger determined the total number of units represented in each MSW and recycling load delivered for the waste sort. Using the weight of each load (provided by the BPTS scale house), and the collection frequency of each address, Louis Berger estimated the weight per week for each address. The sum of all the weekly weights was divided by the total number of units represented in that load to determine the pounds per unit per week and then pounds per unit per day for each multifamily unit. The results for each load were then aggregated to calculate an average pounds per unit per day for MSW (4.13) and recycling (0.63) generated in Hennepin County as shown in Tables 3-1 and 3-2.

Table 3-1
MSW Generated in Pounds per Multifamily Unit per Day

Route	Pounds/Unit/Day
A	2.21
B	4.88
C	5.93
D	4.16
E	4.31
F	3.27
Average	**4.13**

[5] Source: U.S. EPA. 1997. Measuring Recycling - A Guide for State and Local Governments. Available at: https://archive.epa.gov/wastes/conserve/tools/recmeas/web/html/index.html.

Table 3-2
Recyclable Materials Generated in Pounds per Multifamily Unit per Day

Route	Pounds/Unit/Day
G	0.67
H	0.25
I	0.64
J	0.84
K	0.75
Average	**0.63**

Therefore, the overall waste generation (MSW + Recycling) is estimated to be 4.76 pounds per multifamily unit per day for Hennepin County.

Figures 2-1, 2-2, and Appendix A of this report include maps depicting the geographic locations of the routes where MSW and recyclable materials were collected for the waste sort.

Using the estimated pounds per unit per day, and the composition results from the waste sort, Louis Berger calculated the following metrics:

1. Annual Amount of Total Waste Generation and by Category;
2. Annual Amount per Unit Waste Generation and by Category;
3. Multifamily Recycling Rate;
4. Capture Rate for Recyclables;
5. Percent of Total Waste Disposed and by Category; and
6. Percent of Contamination in Multifamily Recyclables.

3.1 ANNUAL AMOUNT OF TOTAL WASTE GENERATION AND BY CATEGORY

There are 161,761 multifamily units in Hennepin County as estimated by County staff. Utilizing this number, Louis Berger calculated annual waste generation by multiplying 4.76 pounds per unit/day (the sum of MSW and recycling pounds/unit/day as presented in Tables 3-1 and 3-2) by 161,761 to yield a total of 769,249 total pounds/day. This quantity converts to 140,388 tons of multifamily waste generated in Hennepin County each year.

The annual amount of multifamily waste generated by category is shown in Table 3-3.

Table 3-3
Annual Tons of Multifamily Waste Generated by Category

Category	Annual Tons (est)	Percentage
Trash	37,918	27.0%
Recycling	42,126	30.0%
Organics	38,603	27.5%
HHW and Electronics	2,627	1.9%
Bulky Waste	10,265	7.3%
Textiles	8,849	6.3%
Total	**140,388**	

Note: Sums may not total due to rounding.

3.2 ANNUAL AMOUNT PER UNIT WASTE GENERATION AND BY CATEGORY

The annual quantity of total waste generated per multifamily unit is estimated to be 1,736 pounds/year (0.87 tons/year). This was calculated by multiplying the total pounds/unit/day generated (4.76 pounds), by 365 days per year.

The estimated annual amount of multifamily waste generated per multifamily unit, by category, is shown in Table 3-4.

Table 3-4
Annual Pounds of Multifamily Waste Generated per Unit, by Category

Category	Annual Pounds (est)
Trash	469
Recycling	521
Organics	477
HHW and Electronics	32
Bulky Waste	127
Textiles	109
Total	**1,736**

Note: Sums may not total due to rounding.

3.3 MULTIFAMILY RECYCLING RATE

Per the EPA,[6] the standard recycling rate is determined using the following equation:

$$MSW\ Recycling\ Rate\ (\%) = \frac{Total\ MSW\ Recycled}{Total\ MSW\ Generated\ *} \times 100$$

$$*\ Total\ MSW\ Generated\ =\ Total\ MSW\ Recycled\ +\ Total\ MSW\ Disposed\ of$$

The annual quantity of multifamily waste recycled is estimated to be 18,542 tons/year. This was calculated by multiplying the estimated pounds/unit/day generated (0.63 pounds), by 365 days per year, by 161,761 multifamily units in the County.

The annual quantity of MSW disposed is estimated to be 121,846 tons per year. This was calculated by multiplying the estimated pounds/unit/day generated (4.13 pounds), by 365 days per year, by 161,761 multifamily units in the County.

Applying the EPA standard recycling rate equation, the Hennepin County multifamily recycling rate equates to 13.2 percent.

$$13.2\% = \frac{18{,}542}{18{,}542 + 121{,}846} \times 100$$

3.4 CAPTURE RATE FOR RECYCLABLES

The capture rate (also called recovery rate) for recyclable materials is the percentage of recyclable materials diverted from disposal and captured through a recycling program. Using the same method that was used in the County's 2016 waste sort, the capture rate is determined by the following calculation:

$$Capture\ Rate\ (\%) = \frac{Tons\ of\ Specified\ Material\ Diverted}{Tons\ of\ Specified\ Material\ Diverted + Tons\ of\ Specified\ Material\ Disposed}$$

Based on the quantities of recyclable materials found in the MSW and recycling samples sorted during the waste characterization, Louis Berger calculated Hennepin County's multifamily capture rate for recyclable materials at 33.4 percent as shown in Table 3-5.

[6] Ibid.

Table 3-5
Capture Rate for Multifamily Recyclable Materials

	Tons in MSW[(1)]	Tons in Recycling[(2)]	Annual Generated (tons)	Capture Rate
Recyclable Materials	28,036	14,090	42,126	33.4%

(1) For MSW tons calculation, see Section 3.5.
(2) For Recycling tons calculation, see Section 3.6.

$$33.4\% = \frac{14{,}090}{14{,}090 + 28{,}036}$$

The capture rate for organics cannot be calculated because the quantities of organics found in the MSW and recycling loads delivered for the waste sort were not source-separated for diversion. Multifamily residents on these routes disposed of their organics primarily in the trash (and a small portion in the recycling stream), not into a source-separated organics (SSO) stream. As a result, the "Tons of Specified Material Diverted" could not be determined for the calculation. However, for the County's reference, the tons of organics estimated in the MSW and recycling streams are shown below in Table 3-6.

Table 3-6
Estimated Annual Quantities of Organics
in Multifamily MSW and Recyclable Materials

	Tons in MSW[(1)]	Tons in Recycling[(2)]	Annual Tons Disposed (not including SSO collection)
Organic Materials	36,845	1,759	38,603

(1) For MSW tons calculation, see Section 3.5.
(2) For Recycling tons calculation, see Section 3.6.

Only one address from the 111 addresses collected for the MSW and recycling sort offered organics collection at its property.

3.5 PERCENT OF TOTAL MSW DISPOSED BY CATEGORY

Using the estimate of 4.13 pounds per multifamily unit per day from Table 3-1, and the estimated 161,761 number of multifamily units in the County, Louis Berger estimated 121,846 tons of MSW are disposed per year from multifamily units in Hennepin County.

The waste characterization percentages derived from the MSW sort were applied to the estimated 121,846 annual tons of multifamily MSW to determine the tons of MSW disposed by category, as shown in Table 3-7.

Table 3-7
Percent and Tons of Multifamily MSW Disposed by Category

Material	Mean (%)	Annual Tons (est)
Trash	29.7%	36,144
Recyclables	23.0%	28,036
Organics	30.2%	36,845
HHW and Electronics	2.0%	2,444
Bulky Waste	8.0%	9,806
Textiles	7.0%	8,572
Grand Total	**100.0%**	**121,846**

3.6 PERCENT OF CONTAMINATION IN MULTIFAMILY RECYCLABLES

From the recyclable materials characterization conducted as part of Task 1 (Waste Sort), the percentages, by material type, in the recycling stream are shown in Table 3-8. The quantity of acceptable recyclables totaled 76 percent or an estimated 14,090 annual tons. The percent contamination is estimated to be 24 percent or 4,452 out of 18,542 tons.

Table 3-8
Percent and Tons of Contamination in Multifamily Recyclable Materials

Material	Mean (%)	Annual Tons (est)
Trash	8.7%	1,621
Recyclables	76.0%	14,090
Organics	9.5%	1,759
HHW and Electronics	1.0%	183
Bulky Waste	2.5%	459
Textiles	1.5%	276
Recoverable Film/Bags	0.8%	153
Grand Total	**100.0%**	**18,542**

4.0 WASTE SERVICE LEVEL AND COST RESEARCH

MSW and recycling service levels and costs were obtained from a sample of multi-unit dwelling properties throughout Hennepin County. The County provided Louis Berger with a property list of all multi-unit addresses in the County. The list included a limited number of email addresses for property managers and multifamily building owners. Louis Berger developed an on-line survey using Survey Monkey® (see Appendix E for a copy of the survey questions) and emailed surveys to 162 multifamily property managers/owners. The total number of fully completed surveys returned was 25.[7] From the survey results, Louis Berger obtained information on the following services: 1) trash collection; 2) recycling collection; 3) organics collection; and 4) bulky waste collection. Of the completed surveys, only one property provides organics collection and the cost was included in the trash collection cost, so a separate analysis was not conducted on organics collection services.

The methodology used to gather service levels and cost information is summarized below.

- Emailed survey and called multi-unit dwelling property owners, building managers, and property management firms;
- Gathered data and information from multifamily property owners, building managers, and property management firms;
- Compiled the data according to the type of collection services provided, container sizes, number of collection containers, collection frequency, and costs for services; and
- Analyzed the data to determine the low, high, and average costs by service level for trash and recycling as well as the mean per unit cost.

In analyzing the cost of service data, there was a high degree of variability between properties (as expected) due to property size (number of units) and space constraints (locations with limited space for dumpsters/carts may have fewer containers but increased collection frequency).

The survey results included the following variations:

- Trash containers ranged in size from 2-yard to 20-yard; recycling dumpsters ranged from 2- to 6-yard, plus 90-gallon carts.
- The number of containers at each property ranged from 1 to 11 for trash and recycling dumpsters, and from 4 to 27 for 90-gallon carts used for recycling.
- The frequency of collection ranged from once per week to six times per week for both trash and recycling, plus one property with every-other-week collection for recycling.
- The collection costs included bundled and unbundled services – trash and recycling were either billed together as one cost (i.e., recycling is included in the cost for trash service), or the services were billed separately. In addition, bulky waste was most commonly billed

[7] Fully completed surveys included container sizes and cost information. Table 4-3 lists data for 26 properties because 26 respondents provided container sizes, but only 25 provided cost information.

separately, however one property stated that bulky waste was included in the cost for bundled trash and recycling collection service.

Appendix F provides a table of the survey results, showing the number of units per location and the service levels and costs per month for trash and recycling collection service.

In order to normalize such varied data for comparison, Louis Berger broke the costs down to a monthly cost per yard[8] (for dumpster service) and per cart (for wheeled cart recycling service) per collection event for each property to then determine the average, lowest, and highest costs as shown in Table 4-1. (All costs provided by survey respondents include taxes and fees.)

Table 4-1
Multifamily Properties' Average Monthly Cost per Yard or Cart per Collection Event

Collection Service	Average	Lowest	Highest
Trash Only	$52.50	$17.67	$148.00
Trash including Recycling	$67.86	$6.91	$166.67
Recycling Only - Dumpsters (per yard)	$23.31	$4.17	$57.75
Recycling Only - Carts (per cart)	$21.56	$14.63	$28.49

The cost per household or multifamily unit was calculated by dividing the total invoiced amount for collection service by the number of units for each property. The results are shown below in Table 4-2, by invoice type, and aggregated.

Table 4-2
Multifamily Properties' Average Monthly Cost per Unit(1)

Invoiced Collection Service	Average	Lowest	Highest
Trash Only	$8.57	$3.31	$25.21
Trash w/Recycling Included	$9.57	$5.02	$27.55
Recycling Only (Dumpsters)	$2.33	$1.03	$6.00
Recycling Only (Carts)	$4.18	$3.24	$5.11
Trash & Recycling Combined Invoices	$10.33	$4.92	$30.32

(1) Does not include bulky waste collection.

To calculate the average multifamily unit service level by volume, the service level data received from each survey (container size, number of containers, and frequency) was used, along with the number of units at each location, to calculate the total yards available per month and the number of yards available per unit for each property. For trash collection, the average volume is 1.06 yards per

[8] Because the haulers charge by the size of the dumpster and not by the weight, the standard of measurement used was volume (yards) rather than weight (pounds or tons).

month per multifamily unit with a range of 0.21 to 3.14 yards per month, as shown in Table 4-3 below.

Table 4-3
Multifamily Properties' Service Levels by Volume for Trash Collection Service

Number of Units	Total Yards per Month	Number of Yards/Unit/Month
36	48	1.33
39	96	2.46
47	32	0.68
51	24	0.47
56	176	3.14
56	144	2.57
58	72	1.24
60	16	0.27
77	16	0.21
90	144	1.60
93	32	0.34
108	24	0.22
108	72	0.67
119	32	0.27
122	96	0.79
129	64	0.50
132	144	1.09
135	72	0.53
138	128	0.93
156	184	1.18
192	144	0.75
200	64	0.32
200	320	1.60
238	432	1.82
259	608	2.35
324	96	0.30
	Average:	**1.06**

For recycling dumpster service, the average volume per month is 0.49 yards per multifamily unit (with a range of 0.16 to 1.24 yards) as shown in Table 4-4.

Table 4-4
Multifamily Properties' Service Levels
by Volume for Recycling Dumpster Collection Service

Number of Units	Total Yards per Month	Number of Yards/Unit/Month
36	16	0.44
47	8	0.17
51	24	0.47
56	16	0.29
56	16	0.29
58	72	1.24
77	32	0.42
90	24	0.27
93	16	0.17
108	48	0.44
108	72	0.67
119	32	0.27
129	32	0.25
132	144	1.09
135	144	1.07
138	128	0.93
156	32	0.21
192	126	0.66
200	80	0.40
200	32	0.16
238	96	0.40
259	144	0.56
	Average:	**0.49**

The data received from multifamily properties using carts for recycling was limited, with just four survey respondents, as shown in Table 4-5. The average volume per month is 45 gallons per unit for cart service (with a range of 22 to 65 gallons).

Table 4-5
Multifamily Properties' Service Levels
by Volume for Recycling Cart Collection Service

Number of Units	Total Gallons per Month	Number of Gallons/ Unit/Month
39	2,520	64.62
60	3,240	54.00
122	4,860	39.84
324	7,200	22.22
	Average:	**45.17**

The survey results for the cost to collect bulky waste are provided in Table 4-6 below. The costs per item are fairly consistent when the cost "ranges" are excluded. For example, the average cost to dispose of a mattress or box spring is $30 when the $50-$100 range is excluded. Haulers invoice multifamily property owners for bulky waste removal in a variety of ways including per item, per pound, per collection event, per hour, and per yard so it is not feasible to make comparisons, however the data provided in Table 4-6 offers the County a snapshot of bulky waste collection fees reported by the survey respondents.

Table 4-6
Survey Results for Cost of Bulky Waste Collection at Multifamily Properties, per Item

Bulky Waste Item	Cost
Door	$10
Chair	$ 8
Chair	$15
Upholstered Chair	$22
Small Table	$11
Table	$20
Couch	$30
Couch	$35
Couch	$45
Couch	$50-100
Mattress/Box Spring	$20
Mattress/Box Spring	$22
Mattress/Box Spring	$22
Mattress/Box Spring	$25
Mattress/Box Spring	$25
Mattress/Box Spring	$25
Mattress/Box Spring	$25
Mattress/Box Spring	$30
Mattress/Box Spring	$35
Mattress/Box Spring	$40
Mattress/Box Spring	$45
Mattress/Box Spring	$50
Mattress/Box Spring	$50-100
Electronics	$0.50/lb
Electronics	$150
Furniture	No charge(1)
Misc. Bulky	$25-35
Misc. Bulky	$20 per item
Misc. Bulky	$35 per collection
Misc. Bulky	$50 per collection
Bulky Service	$110/hour
Christmas tree	$10
Extra Refuse	$25-$35/yard
Extra Recycling	$12-$13/yard

(1) Mattresses and home furnishings included in contract.

5.0 SUMMARY

This section of the report summarizes the three tasks of this Study and provides a discussion of the results.

5.1 WASTE SORT

Because this is the County's first multifamily waste and recycling characterization study, it can serve as a baseline from which future waste sorts can be benchmarked.

There are a few limitations to the waste sort that should be noted:

- The results of the waste sort provide a sampling of all multifamily properties in the County. The combined MSW and recycling loads represented in this Study totaled 5,203 units. This equates to three percent of the estimated 161,761 multifamily units in Hennepin County.
- The geographic range of the multifamily properties collected for the waste sort was limited due to the haulers' availability to provide a portion of their multifamily collection routes during the time of this Study.
- The weights of the recycling loads delivered by the haulers were light. Louis Berger's Sort Team collected as many 200-pound samples as possible from each load. Although only 33 samples were collected for sorting, the narrow confidence intervals of the recycling data (as shown in Table 2-2), indicate minimal variability around the mean. The results of the 33 samples provide a realistic depiction of the composition of the County's multifamily recyclables.

Key findings of the MSW and recycling waste sort results are provided below along with potential diversion options.

5.1.1 MSW Analysis

- Organics were the most prevalent material in the multifamily MSW stream at 30.2 percent, just slightly higher than Trash at 29.7 percent. Most of the sorted material consisted of food waste and compostable paper, however the Sort Team did come across several bags of yard waste. There is potential to divert organics from multifamily properties through a SSO collection program, especially now that more haulers are offering organics collection to residential single-family homes, and to a lesser degree, to multifamily properties.
- Recyclable materials comprised approximately 23 percent of the MSW stream. As mentioned in Section 3.4, the capture rate for recyclable materials is 33 percent which means that 67 percent of recyclables are being disposed as trash. Suggested methods for educating multifamily residents about proper recycling include signage on or near the recycling containers, posters inside the building, and hand-delivered brochures.
- Bulky Waste (not including mattresses, box springs, and large pieces of furniture) totaled 8 percent of the MSW stream. Most of the items in this category were broken pieces of furniture or small, broken household appliances such as clocks, fans, coffee pots, vacuum cleaners, etc. However, a portion of this waste stream contains usable household goods. As

discussed in Section 2.2.3.3, approximately 14 percent of the bulky waste category contained items that could potentially be reused. In addition to encouraging residents to donate reusable items to a charity or thrift store, the County has a reuse diversion program in place for move-out waste at multifamily buildings.

- Textiles made up 7 percent of the MSW stream. The Sort Team observed that most of the clothing and shoes disposed in the MSW stream were in good condition and could have been reused by donating to a charity or thrift store.
- HHW & Electronics made up the smallest portion of the MSW stream at 2 percent. The small quantities found in the MSW samples demonstrates the County's successful drop-off programs to divert these materials from the waste stream.

5.1.2 Recyclable Materials Analysis

- The recycling stream contained 76 percent recyclable materials. Trash and Organics comprised similar percentages of the total quantity of materials present at 8.7 and 9.5 percent respectively. HHW & Electronics were one percent of the recycling stream; Bulky Waste was 2.5 percent; and Textiles were 1.5 percent.
- As discussed in Section 2.2.3.2, Recoverable Film/Bags were separated into their own category to provide the County with a sense of how prevalent these items are in the recycling stream. Because the waste sort analysis is weight-based, Recoverable Film and Bags comprised only 0.8 percent of the total recycling stream. By counting the number of recoverable bags and pieces of film in random samples, Louis Berger was able to estimate that 153 tons or 19.6 million pieces of Recoverable Film and Bags are being placed in the recyclables from multifamily residents in Hennepin County each year. There is a need to divert more of this material from the mixed recycling stream into a source-separated recycling collection program. When commingled with recyclables, plastic bags create problems at the materials recovery facility (MRF) because they get tangled in the separation equipment. Most MRFs have to shut down their processing operation several times per day in order to cut the plastic that wraps around the sorting equipment. In addition, plastic bags can become litter if they unintentionally get loose during collection while dumpsters and carts are being emptied into a truck.

  Plastic bags and certain types of film are recyclable when collected separately from other commingled recyclable materials. Through increased public education, multifamily residents should be encouraged to drop off plastic film and bags for recycling at one of the County's drop-off facilities or at a local grocery or other retail store.[9]

There are inherent challenges associated with multifamily recycling/waste diversion that can make it difficult to achieve a high recycling rate including:

- **High Turnover Rates.** Frequent turnover of residents and building managers make recycling program consistency difficult.

[9] Example: The website https://www.plasticfilmrecycling.org/ provides an easy way to find the nearest plastic drop off location to any zip code.

- **Space.** Many multifamily buildings were not designed with adequate space for recycling containers. Adding additional containers for organics collection may be an issue at certain properties. However, by diverting more organic materials, the size and/or number of MSW containers could potentially be reduced, freeing up space for organics collection containers.
- **Education and Outreach.** Because of the high turnover rate of multifamily residents and building managers, providing recycling information can be difficult. Ensuring that recycling education is provided to new tenants can be an ongoing effort. Many times education materials reach only the property owner if delivered as a bill insert or through a hauler's communication with the building owner or property management company.

The waste sort task of this Study is unique because there has not been a prior waste characterization study conducted solely on the multifamily waste stream in Minnesota.[10] For comparison, Louis Berger compiled the results of seven waste characterization studies (that had a multifamily component) conducted in other cities, counties, and states, to compare to the results of the MSW portion of this Study. Because each study is unique in its design and has different material categories, definitions, number of samples, etc., it is not feasible to perform a statistically defensible comparison, however it is possible to conduct a high level review. Louis Berger grouped other studies' material categories as close as possible to the County's categories and summed the means to obtain estimated percentages for each category. The biggest discrepancy among the studies was the bulky waste category. Some studies did not have specific categories for bulky waste so items such as small household appliances or furniture were placed in the general trash category. When the mean percentages for each category from the seven studies are averaged, the County appears to have less recyclables in its multifamily waste stream (23% compared to 27.5%), slightly more organics (30.2% compared to an average 28.4%), similar HHW & electronics quantities (2% compared to 2.4%), and more bulky waste (8%) and textiles (7%) compared to the 3.9% and 4.8% averages respectively (most likely due to the differences in material categories). The comparison table is provided in Appendix G.

5.2 WASTE GENERATION

The data gathered from the waste sort provides valuable waste generation information and can be used by the County as a baseline going forward as it monitors its waste diversion programs.

On average, every multifamily unit in the County generates 4.76 pounds of waste per day (4.13 pounds of MSW and 0.63 pounds of recyclables). This equates to a recycling rate of 13 percent or 229 pounds of recyclables per year, per multifamily unit. That is the portion of the overall waste generated by multifamily residents that was separated out for recycling. As a reference point, in the County's Solid Waste Management Master Plan adopted in April of 2012, municipalities that applied for County funding had to demonstrate a reasonable effort to increase residential recycling to at least 725 pounds per household or a minimum recovery rate of 80 percent by December 2015.

[10] In 2014 a Waste Composition Study was conducted for the Ramsey/Washington County Resource Recovery Project Board in which a total of 4 samples of multifamily waste were sorted.

Another metric from the waste generation analysis is the capture rate, which is the portion of all the multifamily recyclables generated that was actually separated out for recycling. The County's multifamily capture rate is estimated at 33 percent. That means 67 percent of recyclables generated by multifamily residents were placed in a trash container rather than a recycling container for collection. The capture rate is based on all of the categories deemed recyclable from the Material Category List (Appendix B) such as paper, plastic, metal, and glass that were found in the MSW and recycling samples sorted during the waste sort. The "Tons of Specified Material Disposed" used in the equation did not include any potentially recyclable/reusable items such as HHW, Electronics, Bulky Waste, and Textiles that residents could divert through other programs.

Very few studies have been conducted on apartment building waste generation and recycling to compare Hennepin County's Study results. However the City of Iowa City, Iowa published a Best Management Practices Manual for Apartment and Condominium Recycling in 2012.[11] In a pilot study, each multifamily unit generated approximately 28 pounds of trash and 16 pounds of recyclables per week. The results of this Study indicate Hennepin County's multifamily units generate a similar amount of trash, at 29 pounds per week, however the County's recycling generation is much lower at 4 pounds of recyclables per week. Iowa City's multifamily recycling rate was 36 percent compared to Hennepin County's estimated 13 percent.

In 2016, Iowa City passed a resolution requiring all multifamily properties provide recycling for their tenants. Hennepin County has a similar ordinance, however it requires its cities (not the County) to ensure all multifamily properties provide recycling. One task in this Study was to determine the number of multifamily units without recycling service. Louis Berger contacted the County's largest city, the City of Minneapolis, and they do not track which multifamily properties have recycling and which do not. The Cities of Brooklyn Center, New Hope, and Crystal do not track this information either. One city that does keep track of this information is the City of Brooklyn Park and that is because the City contracts for recycling collection service for all its residents - single-family and multifamily. Of its approximately 6,372 multifamily units, the City of Brooklyn Park has 504 units that have been offered recycling service (and are paying for it as a line item on their utility bill) that have voluntarily decided not to enroll in the City's recycling program. Louis Berger recommends the County enforce its ordinance that requires cities to ensure all multifamily properties have recycling collection service.

5.3 SERVICE LEVEL AND COSTS

The results of the waste service level and cost survey provided data representing 2,843 multifamily units, less than two percent of the County's estimated 161,761 multifamily units. Although this is a small sampling, the data collected covers a range of multifamily property sizes (36 to 324 units) with varying levels of MSW and recycling collection service (container sizes, number of containers, and collection frequency).

[11] Source: https://www.icgov.org/recyclepilot

The cost for services are varied because of the open-market system for commercial collection in the County (most haulers consider multifamily properties commercial, rather than residential accounts). The total fee that a hauler charges often takes into consideration additional factors besides the number of containers and frequency of service. Other factors affecting cost may include location, maneuverability at the site, discounted rates for long-term contracts, etc. Therefore the survey results related to cost may be more comprehensive than just equipment and labor.

Louis Berger estimates the combined cost for trash and recycling collection services per multifamily unit is approximately $10.33 per month, based on survey results. However the range is wide with the lowest cost reported at $4.92/month and the highest cost at $30.32/month.

The service level by volume for trash collection is also varied among multifamily properties, averaging one yard per unit/month and ranging from 0.21 to 3.14 yards per unit/month.

For recycling dumpster service, the service level by volume is not as varied as the trash service. The service level per multifamily unit ranged from 0.16 to 1.24 yards per month with the average volume estimated at 0.49 yards per multifamily unit/month.

For recycling cart service, the service level by volume ranged from 22 to 65 gallons per unit per month, with the average estimated at 45 gallons per multifamily unit/month. Although there were only four properties reporting cart service, the service levels for recycling carts showed a correlation between the number of units and the gallons available for recycling per month, as shown in Table 4-5 (i.e., the volume increased as the number of units increased). In contrast, the number of yards/unit/month for both recycling and trash dumpster service were more varied and did not indicate a pattern correlating the number of units to the service level. The variation in monthly container volumes by building/location could be due to any number of factors that affect the quantity of waste generated per unit and the level of recycling participation per unit. These factors are often linked to economic or social demographic variables such as median household income, age, education level, or culture.

Each location has its own particular needs for service, but it is possible that some multifamily buildings with high trash volumes or frequent collection service levels could potentially downsize their capacity or reduce the number of weekly collections with increased recycling participation from their tenants.

In addition to its public education efforts aimed at multifamily residents to increase recycling, Hennepin County should also work to increase awareness among building managers/owners about “right-sizing” their container sizes and monitoring their buildings’ collection frequency as a cost-saving measure.

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6.0 Next Step Options

This Study indicates three relevant takeaways:

1. Contamination of the multifamily recycling stream is high, at 24 percent. The majority of the contaminants are made up of Trash (8.7%) and Organics (9.5%).

2. There is a significant amount of divertible material in the MSW stream. Recyclables totaled 23 percent and Organics totaled 30 percent of the multifamily MSW disposed. In addition, it is possible that some of the 8 percent of Bulky Waste and 7 percent of Textiles that were reusable could have been diverted if recovered through other programs.

3. The service levels (container sizes and collection frequency) at some multifamily properties may not be adequate for the volumes generated. As shown in Table 3-3, multifamily residents generate, on average, more Recyclables (30%) than Trash (27%), yet the volume of space available for Recyclables is 0.49 cubic yards per unit per month compared to 1.06 yards/unit/month for Trash (Tables 4-4 and 4-3 respectively). The fact that only 33 percent of recyclable materials generated by multifamily residents is set out for recycling, while 67 percent is discarded as trash could be because 1) multifamily residents are not recycling as much as they could, or 2) the recycling bins may be full so residents are placing recyclables in the trash.

The County can use the data provided in this report as a baseline to compare multifamily waste and recycling data collected in the future. Options for next steps may include:

- **Increase source-separated organics collection at multifamily buildings.** The results of the multifamily MSW sort indicate that 30 percent of multifamily waste disposed is made up of food waste, yard waste, and compostable paper. Adding organics collection to multifamily collection services may be a challenge logistically for some properties, but by diverting organics from the MSW stream, it may be possible to reduce the size and/or number of trash containers to make room for organics containers. In addition, other opportunities exist to divert this material from the waste stream including increased outreach and education on organics waste reduction (e.g., discourage over-buying perishable food, encourage proper food storage, offer resources for donating food, etc.). The County should also continue to make multifamily residents aware of the organics drop-off locations in the County.
- **Work with multifamily buildings regarding service levels.** Some multifamily properties may need adjustments to their current service levels to better contain the quantities of recyclable materials generated so that residents have adequate space to place recyclables. If cost or space is an issue, it may be resolved by discussing options with their hauler. As recycling participation increases, the service levels would most likely need to be adjusted to accommodate increases in the volume of recyclable materials set out for collection. Simultaneously, trash container sizes could be reduced as recycling increases and/or

organics are diverted through a SSO collection program. Building managers/owners should be made aware of "right-sizing" their container sizes and monitoring their buildings' collection frequency as a cost-saving measure.

- **Continue collecting multifamily data.** Consider conducting a multifamily waste sort annually or every other year to monitor the effects of increased education on the multifamily waste stream. The results from this waste sort provide a benchmark for which the County can measure its progress in the future. Waste sort results also provide insight to contamination issues, giving the County customized data which can be used to tailor its recycling message in an effort to address a specific issue or material category.

  For future waste sorts, it is recommended to attempt to include other geographic regions of the County that were not included in this waste sort.

- **Remind municipalities of multifamily recycling requirements.**
  - Hennepin County Resolution No. 90-8-592R1 requires that "municipalities must adopt ordinances that require property owners of multifamily housing to provide recycling services by July 1, 1991."[12] During this Study, Louis Berger learned that most cities, including the County's largest city, do not track which multifamily properties have recycling service. Assuming all cities have adopted a multifamily recycling ordinance, the County may need to inquire with each city to ensure the ordinances are being enforced.

  - The State of Minnesota's commercial recycling requirement went into effect January 1, 2016 and requires that owners of commercial buildings in the seven-county metro area that contract for four cubic yards or more of trash per week, must collect "at least three recyclable materials, such as, but not limited to, paper, glass, plastic, and metal" and "transfer all recyclable materials collected to a recycler."[13] Multifamily residential buildings are included in this statute because they fall into the range of North American Industrial Classification System (NAICS) codes 42 through 81 referenced in the Statute. NAICS code 53 covers apartment buildings, rental houses, and town houses.

  A concerted effort to increase access to recycling for all multifamily residents will move the County closer to reaching its goal of recycling 75 percent of its waste by 2030.

- **Continue/increase/improve public education efforts targeting multifamily residents.** Because of the high turnover rate of multifamily residents and building managers, it can be difficult to reach this audience and may be costly to continuously disseminate recycling information, however certain outreach efforts may have an effect on diversion rates. Included in Appendix H of this report, is a case study that shows the effects of increased

[12] Source: Hennepin County Resolution No. 90-8-592R1, August 7, 1990.
[13] Statute 115A.151 Recycling Requirements; Public Entities; Commercial Buildings; Sports Facilities (2016).

outreach efforts on the diversion rate for a group of multifamily buildings in Alameda County, California when organics recycling was promoted.

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APPENDIX A

MSW AND RECYCLING COLLECTION MAPS

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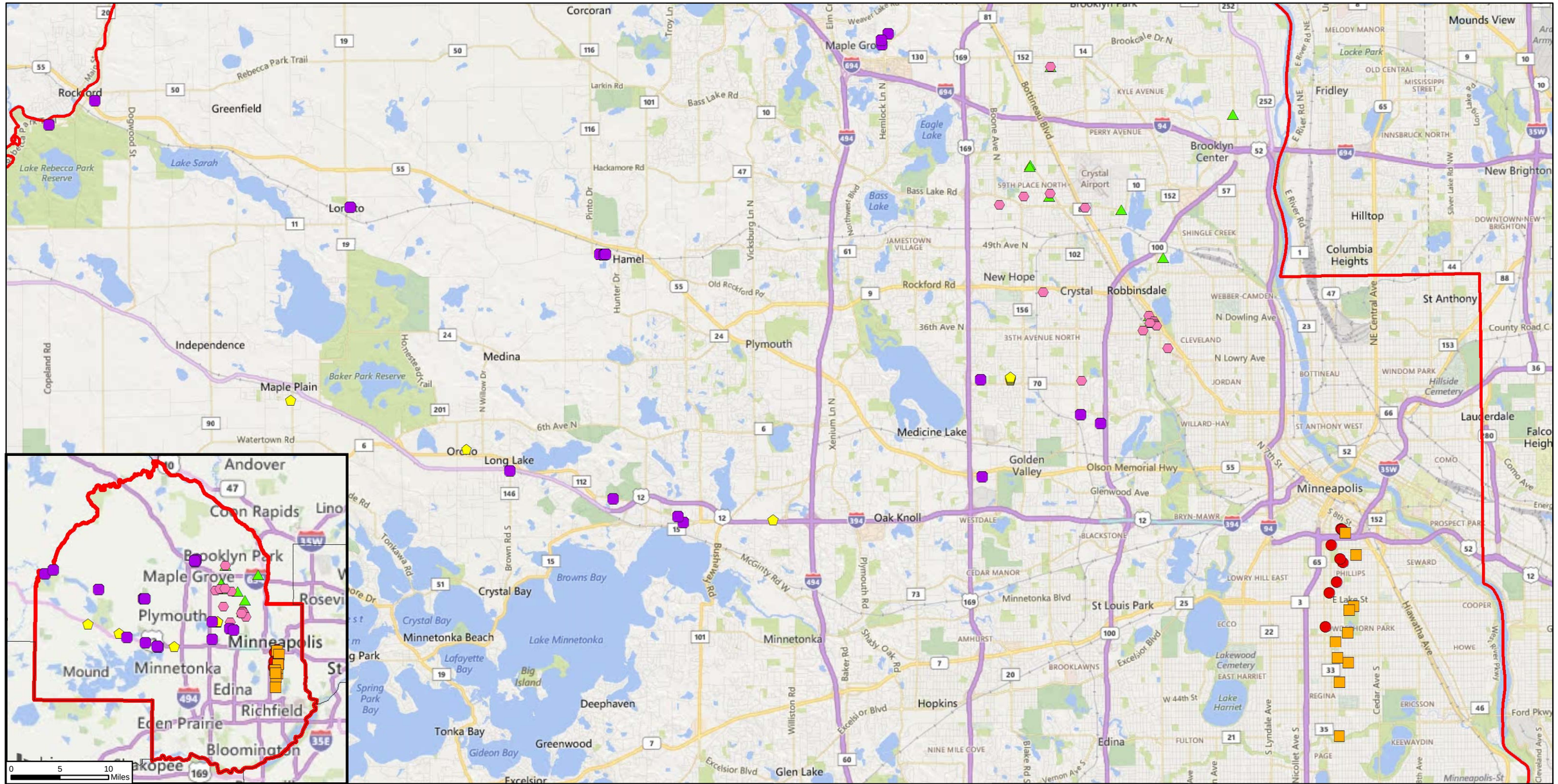


MSW Collection Route

Hennepin County

- ROUTE A
- ROUTE B
- ROUTE C
- ROUTE D
- ROUTE E
- ROUTE F

Service Layer Credits:
Harris Corp, Earthstar Geographics, LLC
Earthstar Geographics SIO, 2017;
Microsoft Corporation, 2017

Coordinate System:
Minnesota South FIPS 2203 FT
Datum: North American 1983

June 2017

MSW Collection Map

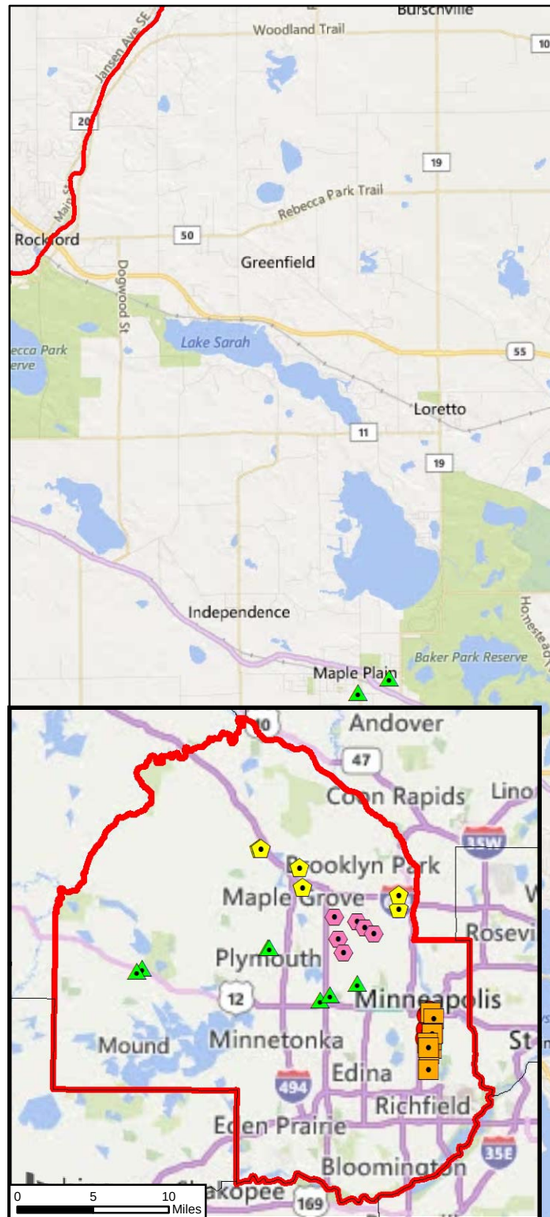
Hennepin County Multifamily Waste Study

Hennepin

Louis Berger

N

0 9,500 19,000 Feet



Recycling Collection Route

Hennepin County

- ROUTE G
- ROUTE H
- ROUTE I
- ROUTE J
- ROUTE K

Service Layer Credits:
Harris Corp, Earthstar Geographics, LLC
Earthstar Geographics SIO, 2017;
Microsoft Corporation, 2017

Coordinate System:
Minnesota South FIPS 2203 FT
Datum: North American 1983

June 2017

Recycling Collection Map

Hennepin County Multifamily Waste Study

Hennepin

Louis Berger

N

0 10,000 20,000 Feet

APPENDIX B

MATERIAL CATEGORIES AND DEFINITIONS

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Hennepin County
Multifamily Waste Sort
April 10-21, 2017
Material Categories and Definitions

PAPER		
Material	**Definition**	**Category**
Newspaper	Printed groundwood newsprint, including glossy advertisements and inserts typically found in newspapers.	recycable
Office paper	High grade continuous form computer paper, white paper including bond, photocopy, notebook paper, index cards, computer cards, notebook paper, xerographic, typing paper, tablets (yellow and with clear glue binding), manila file folders, nonglossy fax paper, and colored ledger paper primarily found in offices.	recycable
Magazines/catalogs	Magazines and Catalogs including any "seasonal circular" catalog clearly recognized as such from direct mail (e.g., LL Bean, Nordstrom's, etc.)	recycable
Cartons	Gable top and aseptic containers. Made mainly from paper in the form of paperboard as well as thin layers of polyethylene. The shelf stable cartons also have a thin layer of aluminum. Products in refrigerated cartons include milk, juice, cream, egg substitutes, soy and grain milk. Products in shelf-stasble cartons include juice, milk, soy and grain milk, soup and broth, and wine. **Does NOT include plastic pouches.**	recycable
Cardboard / Kraft paper	Corrugated cardboard usually has three layers. The center wavy layer is sandwiched between the two outer layers. It does not have any wax coating on the inside or outside. Examples include entire cardboard containers such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. This subcategory includes Kraft paper that are not excessively contaminated with food or liquid. This category does not include chipboard boxes such as cereal and tissue boxes.	recycable
Boxboard / paperboard	Uncoated boxboard such as cereal, cracker, shoes boxes, and paper cores (from paper towel, toilet paper, wrapping paper, aluminum foil, and plastic wrap). **Does NOT include heavily soiled, food contaminated, or wet boxes such as refrigerated and frozen food boxes.**	recycable
Mixed recyclable paper	Low grade recyclable paper is a broad category of paper that includes things like mail, phone books, all envelopes (with and without windows), glossy coated paper, paper-back books, construction paper, etc. **Does NOT include hardcover books or books that light up or play music.**	recycable
Plastic-coated paper	Refrigerated boxes (butter), pop and beer cases, etc. **Does NOT include frozen food boxes.**	recycable
Non-recyclable paper	All other paper that is not recyclable or compostable. Examples include coffee cups, frozen food boxes, plastic-coated take-out containers not accepted for composting, plastic Tyvek envelopes padded with bubble wrap, gift wrap (with glitter, foil, reflective areas or velvet), contaminated paper craft projects (with paint, glue, glitter, etc.), thermal receipt paper, loose shredded paper, blueprint paper, carbon paper, paper used to dispose of chewing gum, hard cover books, paper sprayed with paint heavy glue or tape, cigarette packages, photographs, cardboard with styrofoam glued to side(s), and paper coated with plastic or metal.	trash

PLASTICS		
Material	**Definition**	**Category**
#1 PET bottles	Narrow necked clear and colored plastic containers that bear the label #1 PET or PETE (polyethylene terephthalate).	recycable
#1 PET non-bottles	Other thermoform jars, trays, or clam shells that bear the label #1 PET or PETE (polyethylene terephthalate).	recycable
#2 HDPE bottles	Natural and pigmented bottles and jars that bear the label #2 HDPE (high-density polyethylene). Examples include dairy products, detergent, fabric softener, bleach, etc.	recycable
#2 HDPE non-bottles	Plastic #2 HDPE plastics. This subcategory excludes bottles and jars.	recycable
#3 PVC	Includes rigid plastic coded #3 (PVC) such as rigid plastic piping, fencing, etc., and flexible PVC such as tubing.	trash
#4 LDPE bottles and non-bottles	Includes rigid plastic packaging coded #4 (LDPE) such as rigid plastic lids and squeezable bottles	recycable
#5 PP containers	This subcategory includes all bottles, jars, tubs, lids, cups, clamshells, trays, etc. that bears the label #5 or "PP".	recycable
#6 EPS	Plastic products made of #6 PS expanded polystyrene (Styrofoam). Examples are cold and hot drink cups, packing peanuts, molded shipping packaging, coolers, takeout food trays and clamshells, etc. This excludes rigid #6 PS packaging.	trash
#6 PS and #7 packaging containers	Means plastic containers that are made of types of plastic other than #1 PET, #2 HDPE, #3 PVC, #4 HDPE, or #5 PP. Items may be made of rigid #6 PS, Other, dual labeled or unlabeled. When marked for identification, these items may bear the number “4,” “6,” “7” or Dual Label #5 - #7 in the triangular recycling symbol. This subcategory includes Keurig coffee containers and plastic containers that do not have the triangular recycling symbol. This excludes #7 compostable packaging	trash
Recoverable film/bags	This category includes shrink film and plastic bag recycling accepted by recycling program run by the Recycling Association of Minnesota. Includes plastic grocery bags, retail bags, dry cleaning bags, newspaper sleeves, cereal bags, bread bags, produce bags, plastic wrap from paper products (pack of paper towels), salt bags, ice bags, stretch/shrink wrap, and 6-pack holder rings. Does not include frozen food bags, bags with strings or rigid handles, soil or mulch bags, zipper bags, bubble wrap, food containers, bottles, bags with plant-based additives or compostable bags. Do not include material that is significantly wet or contaminated with residue.	trash
Film: trash bags	Plastic bags used as trash receptables, to collect and contain trash.	trash
Film: other	Other film means all other plastic film that is not categorized as recoverable film/bags or trash bags. Also includes recoverable film/bags that are highly contaminated. Examples include flexible plastic pouches (containing food, sauces, soup, drinks), pouches with laundry products, frozen vegetable bags, food wrappers such as candy bar wrappers, potato chip bags, yogurt tubes, cheese wrappers, mailing pouches, bank bags, X-ray film, metallized film (such as balloons).	trash
Durable plastic items	Plastic items other than bottles, containers, or film. These items are made to last for more than one use. Includes bulky items and other smaller items. Examples of bulky items include: crates, buckets (including 5-gallon buckets), baskets, totes, large plastic garbage cans, large tubs, large storage tubs/bins (usually with lids) that don't have sharp corners, flexible (non-brittle) flower pots of 1 gallon size or larger, lawn furniture, large plastic toys, tool boxes, first aid boxes, and some sporting goods. Examples of other durable items include CDs and their cases, plastic housewares such as dishes, cups, and cutlery.	trash
All other plastic	Plastic that cannot be put in any other type. These items are usually recognized by their optical opacity. This type includes items made mostly of plastic but combined with other materials. Examples include auto parts made of plastic attached to metal, plastic drinking straws, unlabeled plastic cups, produce trays, unlabeled cookie trays found in cookie packages, plastic strapping, plastic lids, some kitchen ware, toys, window blinds, plastic lumber, insulating foam, imitation ceramics, handles and knobs, plastic string, plastic rigid bubble/foil packaging (as for medications), small (less than 1 gal) plant containers such as nursery pots and plant sixpacks, any unlabeled plastic products, and new Formica, vinyl, or linoleum.	trash

Material	Definition	Category
METAL		
Steel cans	Steel or tin food & beverage containers means rigid containers made mainly of steel that are Bimetal Cans. These items will stick to a magnet and may be tin-coated. This subtype is used to store food, and beverages. Also includes cardboard cans with a steel bottom.	recycable
Aluminum cans and foil	Containers such as used beverage containers (UBC) and other cans made from aluminum used for containing soda, fruit, juice, sports drinks, iced tea, beer, food, pet food, etc. Also includes clean aluminum foil, trays, and tins (with no food residue).	recycable
Other scrap steel	Metal composed primarily of iron, plus other scrap ferrous including clothes hangers, sheet metal products, pipes, miscellaneous metal scraps, and other magnetic metal items. This category excludes food and beverage containers.	trash
Non-ferrous metal	Other non-ferrous means any metal item, other than aluminum cans and foil, that is neither stainless steel nor magnetic. These items may be made of aluminum, copper, brass, bronze, lead, or zinc. Examples include aluminum window frames, aluminum siding, copper wire, brass pipe.	trash
Mixed metal	Metal that cannot be put in any other type. This subcategory includes items made mostly of metal but combined with other materials and items made of both ferrous metal and non-ferrous metal combined. Examples include insulated wire and finished products that contain a mixture of metals, plastic, and other materials, whose weight is derived significantly from the metal portion of its construction.	trash
GLASS		
Food & beverage glass	Glass such as clear, brown, green, and blue containers for food, beverage, wine, liquor, and beer.	recycable
Non-recyclable glass	All other glass that was not originally used for food or beverage containers. Examples including ceramics or pottery, drinking glasses or bowls, glass plates, Pyrex, glass vases or decorative glass items, cooking utensils, ash trays, mirrors, incandescent light bulbs, window glass, plate glass, and fragments. If the glass is broken and not 100% identifiable as food or beverage glass, it belongs to Other Glass.	trash
ORGANICS		
Food waste	Food preparation wastes, food scraps, and spoiled food. Fruits and vegetables; meat, fish and bones; bakery and dry goods; eggs and eggshells; dairy products; coffee grounds, filters, and tea bags. When feasible, food waste will be removed from containers (e.g., Tupperware, carry-out containers, etc.) and the food waste will be placed in the Food Waste category and the container will be placed in the appropriate category.	organics
Compostable paper	Non-recyclable compostable paper. Includes certified compostable paper products; napkins, paper towels, and tissues; uncoated paper plates, cups, and food containers; paper egg cartons; pizza boxes; paper bags and waxed/parchment paper. **Does NOT include fast food wraps, plastic coated paper, coffee cups, cartons, or freezer boxes.**	organics
Other compostable	Includes certified compostable plastics. Also includes houseplant trimmings, cotton balls, hair and nail clippings, Q-tips with paper stems, wood chopsticks, popsicle sticks, toothpicks.	organics
Yard waste	Yard waste means grass clippings, leaves, branches, sticks, garden waste, brush, stumps, and non-woody plant material such as cut flowers.	organics
HHW		
HHW	Batteries, paints and solvents, automotive products, mercury-containing items, and other household hazardous waste.	HHW
Electronics	Electronics include TVs, cable boxes, CD players/stereos, computer monitors and CPUs (towers), computer peripherals (keyboard, mouse, speakers, cables), DVD/Blu-ray players, fax machines, phones, printers and copy/print/fax/scan combination units, radios, receivers, satellite dishes, scanners, and VCRs.	HHW

TRASH		
Material	**Definition**	**Category**
Clean lumber, pallets, crates	Clean dimensional lumber means unpainted new or demolition dimensional lumber. Includes materials such as 2 x 4s, 2 x 6s, 2 x 12s, and other residual materials from framing and related construction activities. May contain nails or other trace contaminants. This subcategory also includes clean pallets and crates made of lumber used for shipping and packaging.	trash
Treated wood, plywood	Wood treated with adhesive, paint, stain, fire retardant, pesticide or preservative. Examples are painted or stained lengths of wood from construction or woodworking activities, particle board, OSB, and plywood.	trash
Gypsum board	Interior wall covering made of a sheet of gypsum sandwiched between paper layers. Examples include used or unused broken or whole sheets. Gypsum board may also be called sheetrock, drywall, plasterboard, gypboard, gyproc, or wallboard. Includes painted gypsum board.	trash
Concrete and brick	Concrete and brick. Concrete means a hard material made from sand, aggregate, gravel, cement mix, and water. Examples include pieces of building foundations, concrete paving, and concrete/cinder blocks. This category includes concrete with a steel internal structure composed of reinforcing bars (re-bar) or metal mesh.	trash
Carpet & padding	Carpet means flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material. This category includes carpet padding.	trash
Other C&D	Inerts and other material that cannot be put in any other type. This type may include items from different types combined, which would be very hard to separate. Examples include ceramics, tiles, toilets, sinks, dried paint not attached to other materials, and fiberglass insulation. This type may also include demolition debris that is a mixture of items such as plate glass, tiles, synthetic counter tops, fiber or composite acoustic ceiling tiles.	trash
TEXTILES		
Clothing	Clothing items made of natural or manmade woven thread, yarn, fabric, or cloth.	textiles
Shoes	Shoes and boots made of any material, including leather.	textiles
Leather	Items made of leather other than shoes.	textiles
All other textiles	All other items made of natural or manmade woven thread, yarn, fabric, or cloth. This subcategory includes fabric trimmings, draperies, towels, and all natural and synthetic cloth fibers.	textiles
BULKY WASTE		
Small household appliances	Electrically-powered household products with very little or no circuit boards fabricated from metals and plastics not easily separable into individual materials. Examples include hair dryers, toasters, coffee makers, etc.	bulky waste
Furniture	Furniture	bulky waste
Mattresses/box springs	Mattresses/box springs	bulky waste
Tires / rubber	Tires and rubber means vehicle tires, tubes, and other material mainly made of rubber. Examples include tires from trucks, automobiles, motorcycles, heavy equipment, bicycles, some shoes, and floor mats.	trash
Diapers & feminine hygiene products	Diapers & feminine hygiene products	trash
Pet waste	Pet waste, including the bag.	trash
Fines	Material that is 2" minus.	trash
Other not elsewhere classified	Other not elsewhere classified	trash
Usable household goods	Items that appear to be in usable condition and not otherwise listed - dishes, lamps, art, cookware, sports equipment, toys	bulky waste
Bulky materials	Bulky items not elsewhere classified (i.e. non-furniture)	bulky waste

APPENDIX C

DATA COLLECTION FORMS

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HENNEPIN COUNTY – BROOKLYN PARK TRANSFER STATION
MULTI-FAMILY WASTE CHARACTERIZATION STUDY
DATA COLLECTION SHEET FOR MSW
APRIL 10-14, 2017

Date: _____/_____/_____ Day: _____ Sample # _____

Time Sampled: _____ Time Sorted: _____

Hauler: _____ Truck #_____

Comments (i.e., condition of waste (unusually wet), weather, large quantities of bulky waste, etc.)

_____

_____

WASTE COMPONENT	WEIGHTS (circle if net weight)
1. Trash	
2. Recyclables	
3. Organics	
4. HHW & Electronics*	
5. Bulky Waste	
6. Textiles	

* HHW, computer monitors, laptop computers, and TVs should be set aside after weighing; transfer station staff will be notified for proper disposal.

RECYC

HENNEPIN COUNTY – BROOKLYN PARK TRANSFER STATION
MULTI-FAMILY WASTE CHARACTERIZATION STUDY
DATA COLLECTION SHEET FOR RECYCLABLES
APRIL 17-21, 2017

Date: _____/_____/_____ Day: _____ Sample # _____

Time Sampled: _____ Time Sorted: _____

Hauler: _____ Truck #_____

Comments (i.e., condition of waste (unusually wet), weather, large quantities of bulky waste, etc.)

_____

_____

WASTE COMPONENT	WEIGHTS (circle if net weight)
1. Trash	
2. Recyclables	
3. Organics	
4. HHW & Electronics*	
5. Bulky Waste	
6. Textiles	
7. Film	

* HHW, computer monitors, laptop computers, and TVs should be set aside after weighing; transfer station staff will be notified for proper disposal.

APPENDIX D

WASTE SORT PHOTOS

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Appendix D
WASTE SORT PHOTOS

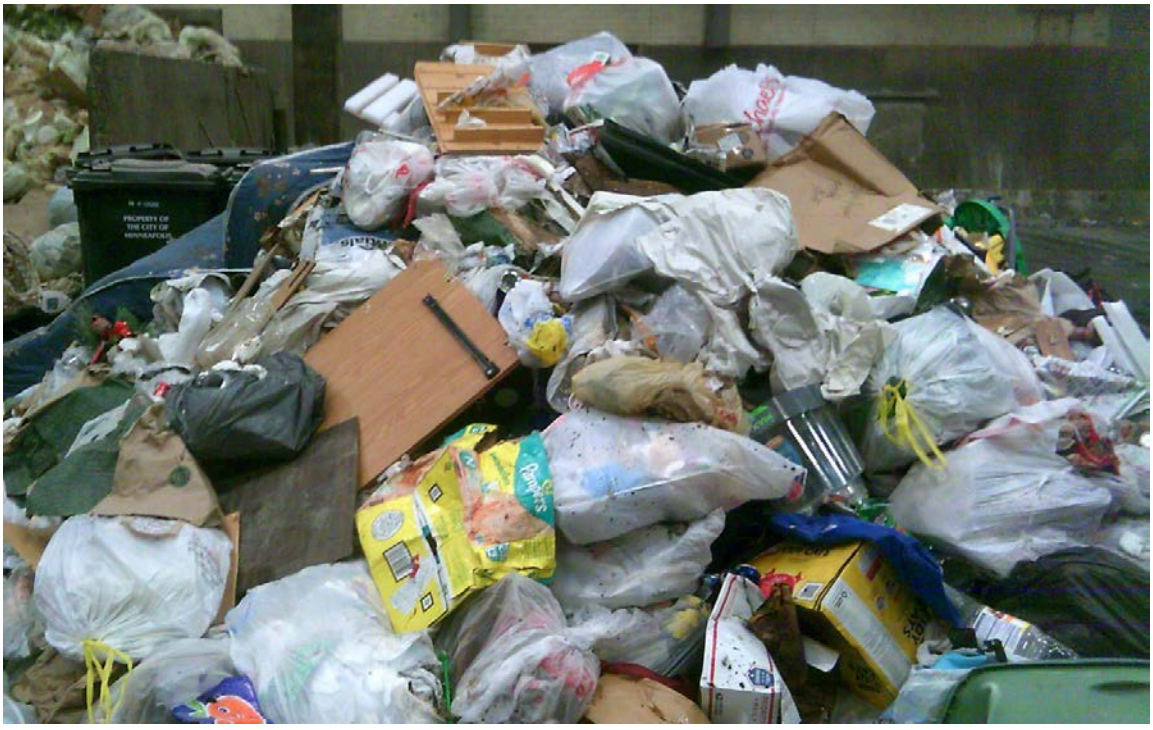

Figure D-1. MSW Load, Pre-Sort

Figure D-2. Recycling Load, Pre-Sort

Figure D-3. Recycling Load, Pre-Sort

Figure D-4. Recycling Sample, Pre-Sort

Figure D-5. Contamination in Recycling Sample

Figure D-6. Contamination in Recycling Sample

Figure D-7. Textiles from MSW Sample, Post-Sort

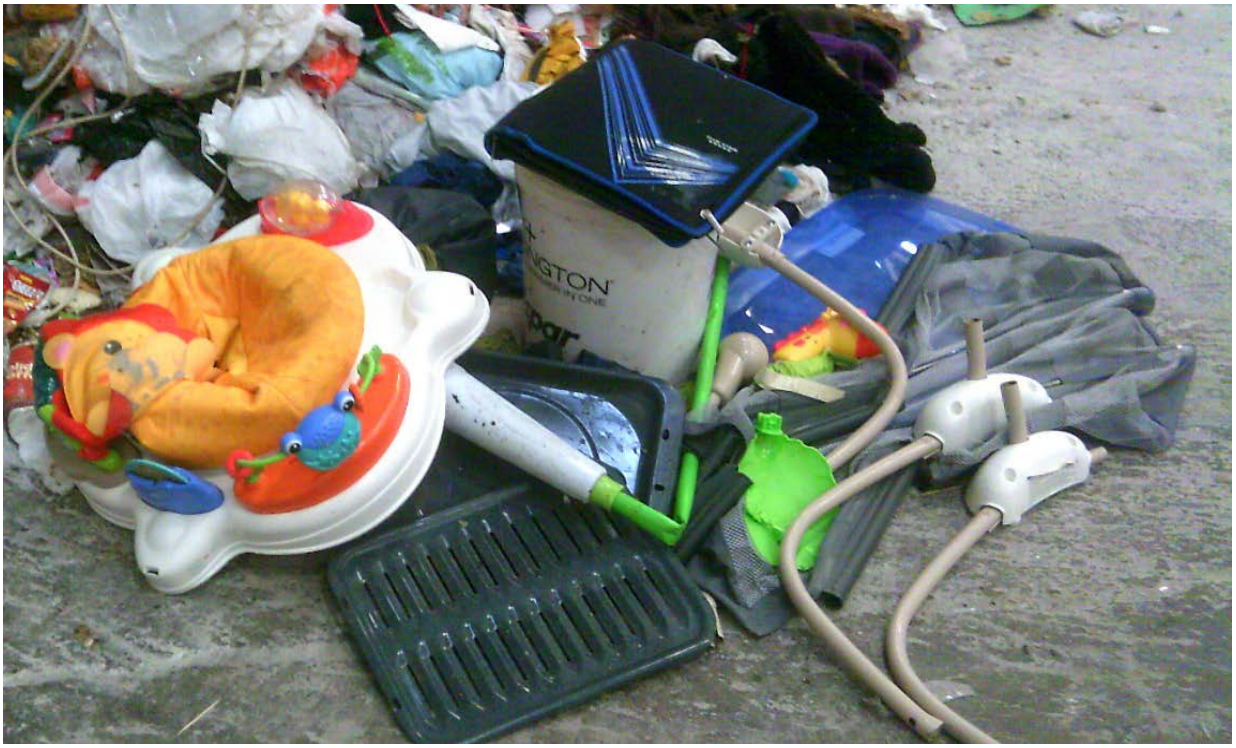

Figure D-8. Bulky Waste from MSW Sample, Post-Sort

(Broiler pan, 5-gallon bucket, and notebook/organizer categorized as “Usable Household Goods” under Bulky Waste category.)

Figure D-9. Bulky Waste from Recycling Sample, Post-Sort

(All items categorized as “Usable Household Goods” under Bulky Waste category.)

Figure D-10. Recoverable Film/Bags in Recycling Sample

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APPENDIX E

MULTIFAMILY SERVICE LEVEL SURVEY

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Hennepin County Multifamily Waste Study
Service Level Survey

All responses are confidential. No company or address-specific information will be published. The answers provided will be aggregated to determine the average per household service level by volume and the average cost for waste and recycling service in Hennepin County. A cost range will be reported, but will not be linked to location.

Property Name/Address: _____

Number of units: _____

Trash Collection

1. What type of containers are in place at this property for trash collection?

   ☐ Wheeled Cart ☐ Roll-off Box

   ☐ Dumpster ☐ Compactor

2. What size and how many trash container(s) are at the property?

   Carts: ☐ Not Applicable ☐ 60-gallon ☐ 90-gallon How many? _____

   Dumpster: ☐ Not Applicable ☐ 2-yard ☐ 4-yard ☐ 6-yard ☐ 8-yard

   How many? _____

   Roll-off Box or Compactor: ☐ Not Applicable ☐ 20-yard ☐ 30-yard

   How many? _____

3. How often is the property serviced for trash collection?

   ☐ 1x/week ☐ 2x/week ☐ 3x/week ☐ 4x/week ☐ 5x/week ☐ Every-other-week

4. Cost for trash collection: $_____ per ☐ week or ☐ month (check one).
5. Does the trash hauler also collect large or bulky waste? ☐ Yes or ☐ No

   If yes, please list the type of item and cost for removal (examples: mattress/box spring, furniture, tires, appliances, fluorescent bulbs, carpet, and construction & demolition debris, electronic waste):

   _____
   _____
   _____

   If no, does a different hauler/company collect bulky waste? ☐ Yes or ☐ No

Recycling Collection

6. Does the property have recycling collection service? ☐ Yes or ☐ No

   If yes, please continue to question 7. If no, please proceed to the next section.

7. What type of containers are in place at this property for recycling collection?

   ☐ Wheeled Cart ☐ Roll-off Box

   ☐ Dumpster ☐ Compactor

8. What size and how many recycling container(s) are at the property?

   Carts: ☐ Not Applicable ☐ 60-gallon ☐ 90-gallon How many? _____

   Dumpster: ☐ Not Applicable ☐ 2-yard ☐ 4-yard ☐ 6-yard ☐ 8-yard

   How many? _____

   Roll-off Box or Compactor: ☐ Not Applicable ☐ 20-yard ☐ 30-yard How many? _____

9. How often is the property serviced for recycling collection?

   ☐ 1x/week ☐ 2x/week ☐ 3x/week ☐ 4x/week ☐ 5x/week ☐ Every-other-week

10. Cost for recycling collection: $_____ per ☐ week or ☐ month (check one).

    If recycling is included in the trash cost, please check here. ☐

Organics Collection

11. Does the property have organics collection service? ☐ Yes or ☐ No

    If yes, please continue to question 12. If no, your survey is complete! Please submit. Thank you.

12. What type of containers are in place at this property for organics collection?

    ☐ Wheeled Cart ☐ Roll-off Box

    ☐ Dumpster ☐ Compactor

13. What size and how many organics container(s) are at the property?

    Carts: ☐ Not Applicable ☐ 60-gallon ☐ 90-gallon How many? _____

    Dumpster: ☐ Not Applicable ☐ 2-yard ☐ 4-yard ☐ 6-yard ☐ 8-yard

    How many? _____

    Roll-off Box or Compactor: ☐ Not Applicable ☐ 20-yard ☐ 30-yard How many? _____

14. How often is the property serviced for organics collection?

    ☐ 1x/week ☐ 2x/week ☐ 3x/week ☐ 4x/week ☐ 5x/week ☐ Every-other-week

15. Cost for organics collection: $_____ per ☐ week or ☐ month (check one).

16. Is organics collection included in the trash or recycling cost? ☐ Yes, with Trash ☐ Yes, with Recycling

    If no, please explain cost structure: _____

    _____

Thank you for participating in this survey!

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APPENDIX F

MULTIFAMILY SERVICE LEVEL SURVEY RESULTS

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Multifamily Service Level Survey Results
Hennepin County, MN

Number of Units	Trash Container Size[1]	Number of Trash Containers	Trash Collection Frequency	Recycling Container Size[1]	Number of Recycling Containers	Recycling Collection Frequency	Trash Cost per Month	Recycling Cost per Month	Total Cost per Month	Total Cost per Unit
36	6-yd	1	2/wk	4-yd	1	1/wk	$ 403	$ 85	$ 488	$ 13.56
39	2-yd	4	3/wk	90-gal carts	7	1/wk	$ 983	$ 199	$ 1,183	$ 30.32
47	4-yd	1	2/wk	2-yd	1	1/wk	$ 1,295	Included	$ 1,295	$ 27.55
58	6-yd	1	3/wk	6-yd	1	3/wk	$ 442	Included	$ 442	$ 7.62
60	2-yd	1	2/wk	90-gal carts	9	1/wk	$ 600	Included	$ 600	$ 10.00
77	2-yd	2	1/wk	2-yd	4	1/wk	$ 592	$ 462	$ 1,054	$ 13.69
90	4-yd	3	3/wk	2-yd	1	3/wk	$ 945	$ 180	$ 1,125	$ 12.50
93	8-yd	1	1/wk	2-yd	unknown	1/wk	$ 580	Included	$ 580	$ 6.24
108	2-yd	3	1/wk	2-yd	3	3/wk	$ 746	$ 155	$ 901	$ 8.34
108	2-yd	3	3/wk	2-yd	2	3/wk	$ 555	$ 171	$ 726	$ 6.72
119	2-yd	2	2/wk	2-yd	2	2/wk	$ 955	Included	$ 955	$ 8.03
122	2-yd	6	2/wk	90-gal carts	27	EOW	$ 464	$ 395	$ 859	$ 7.04
129	4-yd	2	2/wk	4-yd	1	2/wk	$ 800	Included	$ 800	$ 6.20
132	6-yd	2	3/wk	6-yd	2	3/wk	$ 1,578	Included	$ 1,578	$ 11.95
138	4-yd	4	2/wk	4-yd	4	2/wk	$ 1,106	Included	$ 1,106	$ 8.01
200	4-yd	4	1/wk	4-yd	2	1/wk	$ 845	$ 206	$ 1,051	$ 5.26
200	4-yd	5	4/wk	2-yd	10	1/wk	$ 2,363	$ 250	$ 2,613	$ 13.07
238	4-yd	9	3/wk	4-yd	6	1/wk	$ 2,000	Included	$ 2,000	$ 8.40
324	6-yd	1	4/wk	90-gal carts	20	1/wk	$ 4,000	Included	$ 4,000	$ 12.35
Combination of Containers										
51	2-yd + 2-yd Compactor	1 2	1/wk 1/wk	2-yd	3	1/wk	$ 431	$ 213	$ 644	$ 12.63
56	2-yd +	1 1	2/wk 2/wk	2-yd	1	2/wk	$ 304	Included	$ 304	$ 5.43

Multifamily Service Level Survey Results
Hennepin County, MN

Number of Units	Trash Container Size[1]	Number of Trash Containers	Trash Collection Frequency	Recycling Container Size[1]	Number of Recycling Containers	Recycling Collection Frequency	Trash Cost per Month	Recycling Cost per Month	Total Cost per Month	Total Cost per Unit
	20-yd Roll-off									
135	2-yd + 4-yd	1 1	3/wk 3/wk	4-yd	3	3/wk	$ 627	$ 150	$ 777	$ 5.76
156	2-yd + 2-yd Compactor	11 1	2/wk On-call	4-yd	2	1/wk	$ 1,190	Included	$ 1,190	$ 7.63
192	3-yd	4	3/wk	2-yd + 90-gal carts	2 4	6/wk 4/wk	$ 636	$ 309	$ 945	$ 4.92
259	6-yd + 20-yd Roll-off	6 2	2/wk 2/wk	6-yd	6	1/wk	$ 1,300	Included	$ 1,300	$ 5.02

[1] Containers are dumpsters unless otherwise noted.

APPENDIX G

COMPARISON OF MULTIFAMILY WASTE CHARACTERIZATION STUDY RESULTS

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Hennepin County Multifamily Waste Study

Comparison of Multifamily Waste Characterization Study Results

	Hennepin County, MN (2017)	Ramsey/ Washington Counties, MN (2014)	Montgomery County, MD (2012-2013)	City of San Diego, CA (2012)	City of Chicago, IL (2010)	Orange County, NC (2010)	Wisconsin Statewide (2009)	City & County of San Francisco, CA (2006)	Average of 7 Studies
Trash	29.7%	35.5%	42.7%	26.6%	22.3%	38.1%	43.2%	24.3%	33.2%
Recyclables	23.0%	16.9%	28.9%	25.5%	50.8%	25.9%	14.6%	29.8%	27.5%
Organics	30.2%	35.0%	20.4%	39.8%	21.3%	26.4%	18.4%	37.7%	28.4%
HHW & Electronics	2.0%	2.5%	2.6%	1.3%	1.2%	2.6%	3.9%	2.5%	2.4%
Bulky Waste	8.0%	5.5%	0.0%	2.7%	0.0%	0.0%	18.8%	0.0%	3.9%
Textiles	7.0%	4.6%	5.4%	4.1%	4.4%	7.6%	1.6%	5.8%	4.8%
Grand Total	100%	100%	100%	100%	100%	101%	101%	100%	100.2%

Note: This table provides a comparison of means and not confidence intervals. The ranges of the lower and upper confidence intervals would indicate where there are statistically significant differences among the categories.

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APPENDIX H

CASE STUDY: UTILIZING OUTREACH TO PROMOTE PARTICIPATION IN ORGANICS RECYCLING IN MULTIFAMILY DWELLINGS

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Appendix H
Case Study:
Utilizing Outreach to Promote Participation in Organics Recycling in Multifamily Dwellings

Project Summary

The results of the Hennepin County Multifamily Waste Study indicate that 30.2 percent of the total multifamily MSW stream is composed of organic material. Though the portion that consists of food scraps was not calculated, it is likely that food waste is the largest percentage because of limited green space at some multifamily properties and landscape waste often being backhauled by the service provider (as well as the State of Minnesota's ban of yard waste being disposed with MSW).

As stated in the report, there is potential to divert organics from multifamily properties as SSO programs expand from single-family homes to multifamily buildings. As with any new program, education and outreach are the keys to success. This case study presents an example of an organics collection program developed for multifamily properties that greatly increased the amount of organic material diverted away from landfill and to composting facilities.

Because introducing an organics collection program with co-collected yard and food waste could be viewed by some residents as having some perceived or actual downsides (odor, flies, hassle, etc.), it is instructive to examine how other communities introduced and/or increased participation in organics programs at multifamily properties. Global Green USA, a national environmental non-profit organization, received a grant from the Alameda County (California) Source Reduction and Recycling Board (also known as StopWaste) in July 2015 to utilize outreach to increase food scrap recovery at multifamily buildings. The project was titled the Alameda County Food Waste Prevention and Diversion Outreach Study and its purpose was to determine the impact on food scrap recycling achieved through enhanced resident outreach and engagement strategies, specifically door-to-door (D2D) outreach.

The project included D2D outreach and technical assistance to 15 multifamily buildings that were starting or improving organics (co-collected yard and food waste) diversion programs and 3 control sites. Waste audits were conducted to determine what change in diversion rates resulted from D2D outreach to residents. In-person surveys were integrated with D2D outreach scripts to help identify changes in attitude and behaviors. The project took place primarily in the Spring and Summer of 2016 with the final waste audits occurring in August. There were 3 participating sites with

new organics collection service and 12 sites with existing, yet underutilized organics collection service. All 3 of the control sites had existing service. Sites were recruited in cooperation with the waste hauler and the Recycling Coordinator for the participating cities (Emeryville, Alameda, and Albany, CA).

Project Design

Waste Audits

Waste audits were conducted at each of the 15 multifamily buildings before and after the increased education, with approximately four weeks between the time of the pre- and the post-audits. For each audit, a sample of the trash was sorted including up to ten 30-gallon bags. All of the material in the organics bins was audited, primarily for logistical purposes since the audits occurred on site and the trash was typically in dumpsters whereas the organic material was in wheeled carts and easier to access. (This was also the practice previously established by StopWaste for apartment waste audits.) Materials were sorted on a table over a tarp and separated into the following categories: trash, recycling, plant debris, food-soiled paper/compostable paper, avoidable food scraps, avoidable produce, unavoidable food scraps, and an "other" category for materials such as HHW, batteries, e-waste, and textiles which didn't belong in the trash, recycling, or organics bin. The materials pulled from the organics cart were separated into the same categories. The reason the food waste was broken down into avoidable versus unavoidable categories was to see how much of the food waste would have otherwise been edible, which was another aspect of this project. Since this is not a focus of this case study, the food waste prevention aspect of the project is not specifically discussed in this paper.

The data from the waste audits was analyzed to look for trends across all sites, among similarly sized sites, and by income level of the residents. Waste audits were not announced to residents and were conducted during the day to avoid the residents being aware they were occurring and potentially changing their behavior due to being audited.

Surveys

The project utilized a D2D outreach script and survey that focused on the site's new or existing organics collection program. The survey gave residents a chance to share their previous exposure to compost programs, their feelings about the importance of separating out food waste, perceived barriers and benefits to separating food waste from trash, and how likely they would be to separate out their food waste moving forward. It was estimated that resident engagement would require approximately 5 minutes per interaction, however in actuality the survey took 7 minutes at the door. A post-outreach survey was administered about 4 weeks after the initial outreach and sought to identify attitude and behavior changes, confirm continued participation in the organics collection program, and inquire about the resident's perceptions on the usefulness of the outreach. The post-outreach survey was immediately preceded by the post-audit. Residents were informed of the visits for the pre- and post-surveys by flyers posted by property management. Participation in the surveys was incentivized

by respondents being entered into a raffle for a $75 Visa gift card for completing the survey.

In addition to surveys, educational materials in the form of informational brochures, flyers, signage, and in-unit kitchen pails were distributed during D2D outreach. In many cases the pails were made available in the property management office afterward for those not home during outreach or in a few cases, the pails were distributed to every door even if the resident wasn't home. This variation was dependent on the request of property management. In addition, posters were hung in the trash enclosures or at other locations around the site depending on property management request and site layout. Educational materials and pails were provided by Recycling Coordinators of the participating cities and/or the waste haulers. Lastly, StopWaste provided a flyer that was distributed at all sites, that discussed techniques for collecting food scraps, which included utilizing the kitchen pail as well as other alternatives (bowls, Tupperware® in the refrigerator, etc.).

Project Results

Waste Audits

The most prevalent and consistent finding across all sites was a significant increase in organics recycling as measured by the weight of organic material found in the organics collection carts. The project found an average increase of 44.9 pounds in the organics bin which represented a 91% increase in the amount of organic material in the organics cart from the time of the pre-audit. The data from both the pre- and post-audit was also analyzed to determine the Organics Contamination Rate, the Organics Capture Weight, and the "Good in Garbage" rate, as defined below.

- **The Organics Contamination Rate** measures how much of the material sent to a sorting or compost facility is appropriate to that facility and is calculated as:

$$\frac{\textit{Amount of Trash + Recycling + Other Non-Organic in Org Cart}}{\textit{Total Amount in Org Cart}}$$

- **The Organics Capture Rate** measures how much of the total organic materials sent to the sorting or compost facility rather than to the landfill and is calculated as:

$$\frac{\textit{Amount of Organic Material in Org Cart}}{\textit{Total Organic Material Amount in Org Cart + Garbage Cart}}$$

- **The "Good in Garbage" Rate** measures how much of what was found in the garbage could have been recycled and/or composted and is calculated as:

$$\frac{\textit{Amount of Organics + Recycling in Garbage Cart}}{\textit{Total Amount in Garbage Cart}}$$

The Organics Contamination Rate dropped from 8% to 4% and the Organics Capture Rate significantly increased from 61% to 79%, as shown in Table H-1. This finding was consistent among all groups, sizes, and income levels. These results seem to indicate D2D outreach to residents is a highly effective approach to improve participation in organics programs in multifamily buildings.

Table H-1
Overall Results – Waste Audits

Category	Pre-Audit	Post-Audit	Change
Garbage Sample (Lbs)	740.7	701.8	-5%
Organics Sample (Lbs)	733.5	1,402.3	91%
Organics Contamination Rate (%)	8%	4%	-4%
Organics Capture Rate (%)	61%	79%	18%
Total Good in Garbage (%)	77%	73%	-4%

When broken down by site size, the project found an average increase of organic waste in the organics cart of 69 pounds for large sites (defined as 100 units or more, 2 sites included in project), 44.2 pounds for medium sites (defined as 30-60 units, 9 included in project), and 20.2 pounds for small sites (defined as 30 units or less, 4 sites included in project). When controlled for income status, the project found an average increase in the organics cart of 65.1 pounds for low-income housing sites and 32.4 pounds among mid-high income sites. For this comparison, all project sites were medium-sized to control for disparities based on size. This outcome seems to indicate that at the very least, there is no difference among low-income or subsidized housing and their level of participation and in fact, in this project, they were more likely to participate than in other mid- to high-income multifamily sites.

Small sites saw an increase of approximately 1.2 pounds per unit of organics material in the organics collection cart and an average of 53 pounds per site per week in organics participation. When extrapolated, this represents 2,746 pounds annually diverted away from landfills. Medium-sized sites increased their participation by 0.9 pounds per unit, and 87 pounds per site per week of organics captured. When extrapolated, this represents 4,524 pounds annually. Large sites had the least increase of materials per unit, with only a 0.5 pounds per unit increase. However, at 175 pounds of organics per site per week, this equates to 9,121 pounds annually. Focusing on larger sites is still worthwhile when looking to increase overall organics collection. The results are depicted in Figures H-1 and H-2 below.

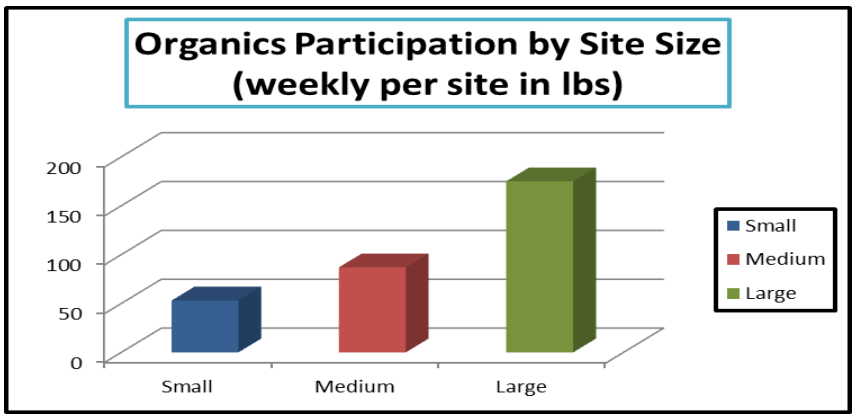

Figure H-1. Organics Participation by Site Size (weekly per site in pounds)

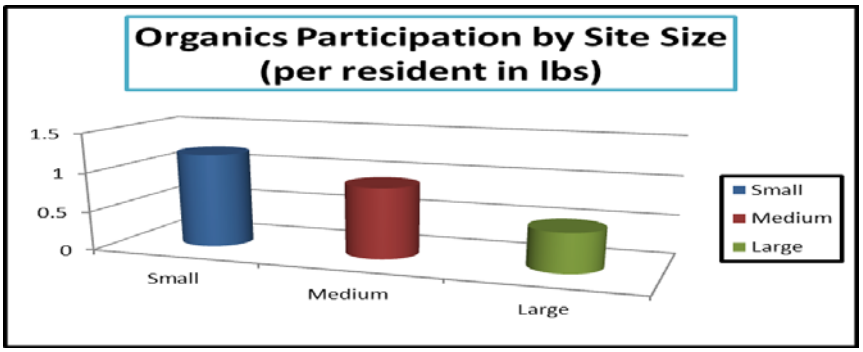

Figure H-2. Organics Participation by Site Size (per resident in pounds)

These findings seem to indicate that while larger sites are good targets because of the volume of organic material they generate, the residents that live in them may be less likely influenced by D2D outreach than those that live in smaller multifamily buildings. However it is worthy of note that the sample size for the large sites is likely too small to draw definitive assumptions from it.

The last measurement of success was the "Good in Garbage" or the amount of otherwise divertible material still found in the trash bin. Though there was an 8% decrease in the amount of organic material found in the trash, the Good in Garbage rate only decreased by 4% overall, from 77% to 73%, meaning the percentage of recyclable material in the trash actually increased from pre- to post-audit, as shown in Figures H-3 and H-4 below.

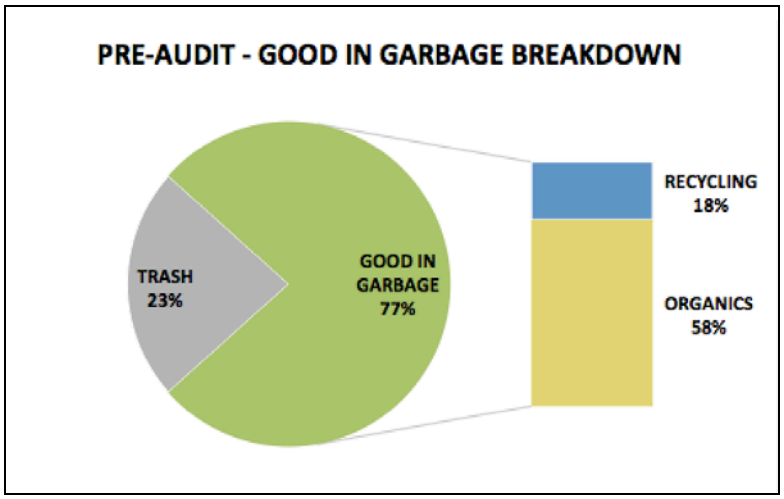

Figure H-3. Pre-Audit – Good in Garbage Breakdown

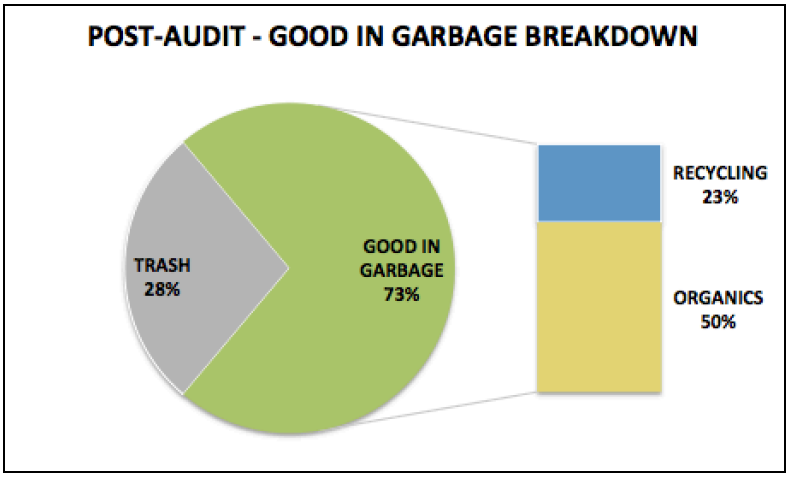

Figure H-4. Post-Audit – Good in Garbage Breakdown

One likely explanation for this is that the bagged materials in the trash are highly skewed toward "wasters." Because the audit protocol was to look for up to ten 30-gallon bags for the trash audit, the residents filling up those bags tended to be those who were not recycling or composting. Residents who were doing both may not need to throw out there trash weekly and if they did, their bags may be smaller than 30-gallon bags and would not likely weigh very much. The project recognized the sampling bias in the middle of the project and tried to address this by seeking to include smaller bags in the audits as well as the larger bags.

Surveys

Highlights from the survey data include:

- Total number of units involved in the project: 792
- Percentage of units surveyed during the pre-survey: 47%
- Total number of pre-surveys conducted: 385

- Number of kitchen pails handed out: 297
- Percentage of residents whose building already had an organics program that reported participating before outreach: 50%
- Number of post-surveys conducted: 167 (Post-surveys only administered to residents who had participated in the pre-survey.)
- Percentage of units reached for the post-survey: 43%
- Percentage who reported continued participation in organics program during post-survey: 87%
- Percentage using kitchen pails provided (when asked in the post- survey): 66%
- Percentage of respondents who reported door-to-door (D2D) outreach was effective: 79%
- Average number of residents per unit: 2.4
- Total approximate time to conduct all door-to-door outreach (both pre- and post-surveys for all 15 participating sites): 76.6 hours or 5.1 hours per site
- Approximate cost to conduct outreach to 15 sites: $9,350 or $623 per site (Did not include time to conduct waste audits or develop materials.)

Residents were asked on a scale of 0 to 10 (0 representing not important at all and 10 representing extremely important) to rate how important participating in the organics program was to them. The project found that residents ranked importance at 8.3 in the pre-survey and 8.5 in the post-survey. Residents were also asked to rank the difficulty of participating in the organics program, on a scale of 0-10 (0 being not difficult at all and 10 being very difficult). Residents reported, on average, a difficulty of 2.4 in the pre-survey and 2.3 in the post survey. When residents were asked to commit to the organics collection program in the pre-survey, 98% responded yes.

During the pre-survey, many residents when asked open-ended questions felt participating in the program would be too hard, too much work, or too challenging. Sentiments like these, however, were less common in the post-survey. Additionally, in the post-survey, there were comments suggesting continued education, email communication, and development of on-site workshops would be desired. These comments were conveyed to the property manager for follow-up. Respondents during the post-survey commonly felt that D2D outreach provided motivation for participation. Tables H-2 and H-3 below provide the comments received and their prevalence.

Table H-2
Pre- and Post-Survey Comments Regarding Concerns

Prevalence		
Pre-Survey	Post-Survey	Concerns
3	7	Carts are gross, dirty, smelly, flies, maggots, etc.
7	2	Kids/husband/partner/family challenge to participate
5	3	Too lazy/too busy/don't remember
6	1	Too hard/too much work/challenging
0	6	Unhappy with size or design of pail
1	3	Hard to form new habits
3	0	Not enough space in apartment
1	1	Contamination by others in building
1	1	Disability makes it harder
0	1	Organic carts overflowing
0	1	Cart is too far away

Table H-3
Pre- and Post-Survey Comments Regarding Motivation

Prevalence		
Pre-Survey	Post-Survey	Motivations
0	9	Happy with pail
0	8	Continue to monitor/email
0	6	More posters/signage
0	5	On-site community workshop/class
1	4	Education is motivation
2	2	It's second nature
0	3	Environment/future is important
0	2	Outreach reminded resident to not be lazy
0	1	Illegal to not compost*

*Note this comment is not actually true.

Lessons Learned

One important lesson learned during the project was the sample bias inherent in the waste audit design to sample only 30-gallon bags which represented more "wasters," or those residents generating the most volume. Though efforts were made to not include more than one bag from the same resident (grabbing bags of different styles or colors, paper versus plastic, etc.), there were likely instances where this occurred because some residents were generating more than one 30-gallon bag of trash weekly. An ideal, but difficult to orchestrate, way to address this challenge in a future project would be to conduct a complete audit of the entire trash bin. This would provide a

better sense of the overall decrease in garbage after the D2D outreach. The difficulty would be finding a waste hauler willing to collect the material as this would be outside of their normal operations and it would be difficult to collect all the sites on the same day due to collection schedules. In addition, a location to sort the waste would need to be arranged and this could be a burden to the waste hauler to provide space at a transfer station or landfill.

Utilizing surveys greatly increased the amount of time at the door and the level of resident engagement. The survey created a dialogue between the resident and the outreach staff and gave the latter the opportunity to address concerns or barriers in real time. Additionally, the outreach staff had the time to provide rationale for why the program was important and this might have served to assuage the perceived challenges the resident had to participation. While conducting post-surveys may not be economically feasible in all cases, a response rate of 43% is unlikely if post-surveys are conducted via email.

Along these same lines, it was important to inform residents of the upcoming D2D outreach, either by a letter posted in the common areas, leaving one at each door, or via an email (if available). This was not originally part of the project design but it was discovered that residents were more likely to assume the outreach staff were solicitors and less likely to talk with them if they hadn't been informed in advance.

Lastly there is a significant need to target recycling participation as well as rolling out organics programs. During the project, it was observed that a significant amount of recycling is still being placed in the trash and though the outreach materials often included some information about recycling, the focus of the project was solely on organics participation. Including more emphasis on recycling seems imperative to address the large amounts of recyclable materials that are still going to the landfill.

Recommendations

The results of the project indicate organics diversion increases significantly as a result of enhanced resident engagement including door-to-door outreach. It is recommended that this be utilized as a tool when rolling out organics programs in multifamily buildings. In addition, the following recommendations are made based on this project's findings:

1. **Project costs were relatively high but could be minimized through use of property management support and/or resident "ambassador(s)."** At an average cost of $623 per site to conduct D2D outreach, this cost is likely too high for widespread adoption in most communities. However there are recommendations for how to implement similar programs with lower costs. One recommendation is to identify and utilize resident "ambassadors" of the program, or those that would be willing to assist in D2D outreach and monitor the program once implemented. This could be an on-site property manager and/or highly motivated individuals who self-identify or are recruited by the

property manager. Global Green did not employ resident ambassadors in this project, but is currently utilizing this approach in a project with a final report due in Spring 2018. An additional way to cut costs per site would be to visit the site only once for outreach (most sites in this project were visited on two occasions) and conduct the post-survey via email. Community meetings (for sites that have a community room) are another cost-saving option but the percentage of residents reached would likely be much lower. Community meetings can be a useful recruitment tool to identify resident ambassadors however.

2. **Utilizing pails, brochures, and surveys greatly improves project effectiveness.** Though the survey responses showed that residents either liked or hated the pails, they are effective as a tool because receiving a pail gets the resident thinking about how they would collect food scraps and transport them to the organics cart. Without this, it is likely many residents would think participation was a good idea in theory but wouldn't be motivated to purchase another collection container or create a system for collecting organic materials. Providing printed information is helpful so that residents have something to reflect on if they were not able to remember all of the information provided orally. Surveys, as mentioned previously, greatly increase the level of engagement at the door. Lastly, incentivizing participation with a small gift, such as a raffle for a gift card that occurred four times during this outreach effort, will greatly increase the likelihood residents will open their doors to the outreach staff.

3. **Develop materials specific to the multifamily sector.** It is recommended that outreach materials utilized in D2D outreach for the multifamily sector are created with the audience in mind. Some of the materials provided by Recycling Coordinators and/or the waste haulers were more directly suited for the multifamily audience than others. It is important that pictures of organics, recyclables, and trash in the brochure or pamphlet are consistent with those likely to be encountered in a residential setting so they can be useful when referred to after the outreach staff depart.

4. **Whenever possible, conduct outreach in the languages prevalently used in the community.** In this project, surveys were conducted in English, Spanish, Russian, and Cantonese. This was valuable in order to convey the message to residents who may not understand otherwise and are may not often be directly communicated to by property management about issues pertaining to the complex. It is also important that brochures have at least the headings translated into Spanish and Chinese (or the most predominant language spoken) whenever possible. Finding outreach staff who speak the languages prevalent in the area is important to program comprehension and therefore success.

5. **Revisit sites in six months or one year to determine behavior change longevity.** Ideally, sites would be revisited after six months or up to a year

later to determine whether the increased levels of participation continued. Most likely by the one year mark, there will have been some resident turnover which may affect participation rates. Utilization of a resident ambassador(s) would make a revisit more feasible so that a phone call from the Recycling Coordinator to the ambassador might be all that is needed to check-in on the site.