Waste Composition and Characterization Analysis Report

Prepared for:

City of X

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1. EXECUTIVE SUMMARY

Sloan Vazquez McAfee (SVM) was commissioned to identify the waste compositions and characteristics at the LOCATION (LOCATION). LOCATION is a municipal solid waste disposal facility, located in the central LOCATION, within eastern LOCATION in LOCATION County.

The purpose of the waste composition and characteristics analysis is to identify and characterize municipal solid waste (MSW) material types received for disposal including residential and commercial solid waste. SVM will analyze waste types and quantities delivered to LOCATION characterized by waste type and generator type and determine weight and percentage of each type of material in comparison to total waste, then prepare draft and final reports for use by the City.

2. METHODOLOGY

The intent of the solid waste composition and characteristics analysis was to identify, quantify and characterize MSW material types received for disposal at LOCATION through field sampling conducted at the landfill during the week of DATE, 2016.

SVM collected waste samples at the LOCATION. Residential and Commercial MSW samples were hand sorted.

The waste generation categories specifically identified and sampled as part of this composition and characterization study include residential and commercial loads exclusively generated in the City of LOCATION and disposed of at LOCATION. The material does not include waste materials collected in the City but not disposed at LOCATION, nor does it include materials disposed at LOCATION but not generated in the City.

A. Sampling Approach

All residential and commercial waste samples were hand-sorted. Twenty-five samples of both residential and commercial waste were characterized.

Sample Cell Selection

To randomly select samples, each load was divided into a sixteen (16) cell grid as depicted below. A randomizer tool was used to assign a primary and alternative cell for sampling. The sample was taken from the randomly assigned cell for each selected load.

When the load arrived, the vehicle was directed to a designated location. Once the load was dumped, the randomly selected cell was extracted from the load and separated for sorting. The randomizer is an MS-Excel worksheet that uses a set of formulas to randomly select material for sorting. Each cell in the sixteen cell table was assigned a random number. The first two cells were assigned an integer value based on their rank with the other cells. The number assigned to the first cell was the cell to be sampled. If the first cell was inaccessible, the second cell was sampled.

By using the randomizer to select the samples from the loads delivered by the transfer trailers, the samples are representative of the residential and commercial waste collected throughout the City.

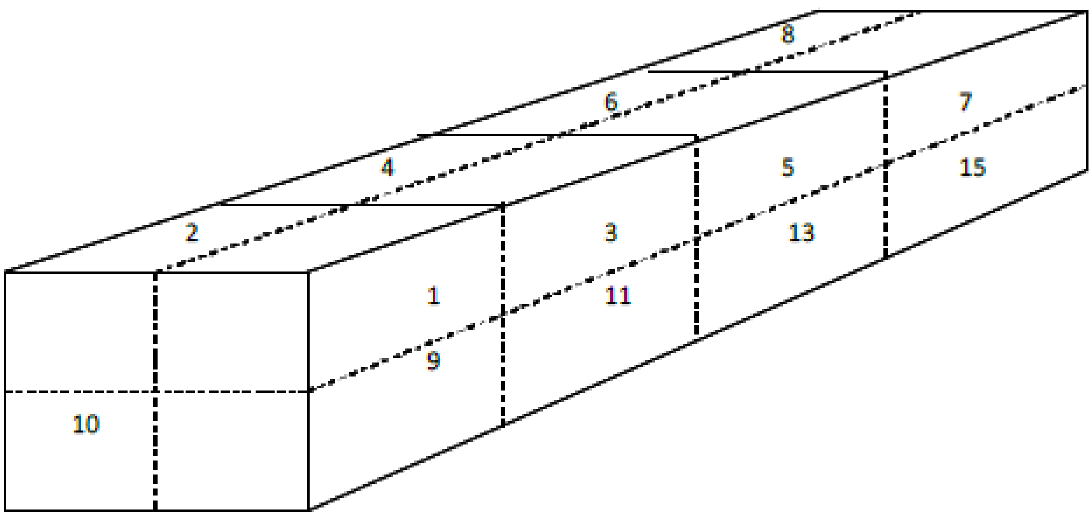

Figure 1: Sixteen (16) Cell Grid *Cells 12, 14, and 16 are below cells 4, 6 and 8, respectively.*

B. Material Categories

The materials identified, extracted, sorted and weighed were divided into designated categories for each sample in order to establish the composition, or the various types of material, as well as the characterization, which is the shape and size of those materials. The types of items included in each material category are described below.

Dry Recoverable Fiber	**All clean dry fiber, including cardboard (OCC), chip board (cereal/shoe box), office paper, junk mail, and shredded paper that is readily recoverable using current waste/recycling processing technology.**
PET UBC's	**PET plastic (#1) used beverage containers (UBCs)**

HDPE	**All readily identifiable HDPE, including UBCs, 5-gallon pails, laundry baskets, trash cans, toys, et al**
Film Plastic	**All film plastic from t-shirt bags to large garbage bags and painters' tarps**
Mixed Plastics	**All readily identifiable plastics except PET, HDPE, and Film**
Glass	**California Redemption Value (CRV) and plate (window) glass**
Aluminum UBC's	**All aluminum beverage containers, primarily CRV**
Mixed Ferrous	**Tin cans, steel (pots, pans, construction material, shelving, etc.)**
Mixed Non-Ferrous	**Aluminum windows and doors, folding lawn chairs, stainless steel fixtures, brass hardware, copper pipe, et al**
Inerts	**Dirt, rock, sand, brick, tile, ceramic, concrete, et al**
Hazardous Waste	**Pesticide, insecticide, paint, solvents, oil, cleaning solutions, et al**
E-waste	**All items that operate via AC current or battery**
Textiles	**Clothing, bedding, carpet, towels, rags, et al**
Organics	**Unprocessed yard/garden waste, food waste, clean wood, painted/treated wood, wet contaminated fiber, rubber**
Wet Contaminated Fiber	**Fiber that has been soiled and is not marketable as a post-consumer fiber grade, and fiber that would disintegrate during the mechanical sorting process (screens and/or air classification) making it non-recoverable with fiber products.**
Fines	**Materials that fall through the 2" lattice on the sort table. Depending upon the source of the sample, the fines may be heavy in organic and inert materials, or in glass shards and small fiber (shred). The organic/inert fines are produced from unprocessed MSW or from "dirty" MRF**

	operations. The glass/fiber fines are produced from "clean", or single-stream recycling processing plants.
Other	**These materials generally include items that are comprised of more than one material and cannot be readily, economically separated and recovered. Many of these materials are not as readily recoverable as any of the other commodity/products because they would require disassembly or other special handling that is not typically built-in to a waste processing system.**

C. Detailed Hand-Sort Protocol

At LOCATION, a total of 20 samples of curbside residential MSW, a total of 10 samples of multi-family residential MSW, and a total of 20 samples of commercial MSW were hand-sorted. The step-by-step protocol for the hand-sort is described below.

1. **Conducted daily safety briefings, then reviewed methodology and sorting categories with the crew to ensure that all crewmembers understood the detailed material definitions before sampling began. The members of the crew were the same throughout the sampling process, and same crew members conducted the same activities during each day of the sampling. This consistency of team membership and assignment ensured reliability and uniformity of results throughout the process.**

2. **Obtained waste samples from the randomly selected cell, as identified by the Field Crew Manager. The samples consisted of approximately 150-200 pounds of waste that were removed and placed onto a 9' X 12' tarp. The larger items were recovered directly from the tarp and deposited into 30-gallon tubs. Once the larger materials were removed from the sample, the sorting table was moved into place and used for the recovery of smaller items and the allocation of fines.**

3. **Hand-sorted materials were placed into the prescribed categories. Sorting crew members specialized in specific material categories and placed the sorted materials into a designated plastic container while the Field Crew Manager monitored the sorting process to ensure proper classification. Additionally, the Field Crew Manager verified the purity of each material classification as it was weighed, prior to recording data on the data sheet.**

4. **The composition weights were then recorded by the Field Crew Manager on the data sheet, depicted below as Figure 2. At the end of each day, the Field Crew Manager conducted a quality control review of the data recorded.**

		WEIGHT #1	WEIGHT #2	WEIGHT #3	WEIGHT #4	WEIGHT #5
DRY, RECOVERABLE FIBER						
PET						
HDPE						
FILM PLASTICS						
MIXED PLASTICS						
GLASS						
ALUMINUM UBC's						
MIXED FERROUS						
MIXED NON-FERROUS						
INERTS						
HAZARDOUS WASTE						
E-WASTE						
TEXTILES						
Organics	YARD WASTE					
	FOOD WASTE					
	CLEAN WOOD					
	TREATED/PAINTED WOOD					
	WET/CONTAMINATED FIBER					
	RUBBER PRODUCTS					
	ALLOCATED ORGANICS					
FINES						
OTHER						

Figure 2: Data Form

Examples of materials identified as "Fines" as part of the field work conducted at LOCATION included the following:

- **organic materials, which were primarily yard and food waste**
- **inert materials, which were primarily rock, gravel, sand and dirt**
- **small shards of glass, and**
- **<2" fiber, which was primarily 3x5 card or Post-it® note sized and shredded paper.**

The four types of material described above made up >95% of the identified fines. The remaining material identified as fines made up <5% including items such as ammunition, pens and pencils, medication bottles, batteries and bottle caps.

Material identified as "Other" during the LOCATION field work included the following items:

- **Diapers & Beds Pads**
- **Garbage Disposal Unit**
- **Child's Car Seat**
- **Plastic Coated Pipe**
- **Numerous Bags of Feces**
- **Vinyl/Fabric Smocks**
- **Bean Bag Chair**
- **Shoes**
- **Belts**
- **Basketball goal**
- **Folding Table**
- **Folding Chair**
- **Foam Mattress**
- **Box Springs**
- **Suitcases**
- **Large Christmas Wreaths**
- **Christmas Ornaments (Store Inventory)**
- **Backpacks**

D. Data Analysis

Following the separation of each sample, all material was weighed and the weight was recorded on field forms and then entered into the database and reviewed for accuracy. Data input was checked twice by a two-person team for quality control to confirm that there were not any typos such as transposed numbers or misplaced decimal points. The equations used in these calculations are provided below.

Waste Sort Analytical Procedures

The waste characterization and quantity profiles for this study were developed through the following steps:

Converting Volumes to Weights

The composition calculations relied on the availability of individual material weights for each sample. For industrial and self-haul samples, volume estimates were converted to weights using accepted waste density conversion factors. Using the volume-to-weight conversion factors and the volume estimates obtained during the characterization of visual samples, individual material weights were calculated using the following formula:

$$c = m \times s \times v \times d$$

where:

m **= percentage estimate of the material, as a portion of the material class (e.g., the extent to which newspaper constitutes all of the paper in the sample)**

s **= percentage estimate of the material class, as a portion of all the material in the sample (e.g., the extent to which paper constitutes all of the material in the sample)**

v **= total volume of the sample (in cubic yards)**

d **= density conversion of the material (in pounds/cubic yard)**

c **= the total weight of the specific material in the sample**

Each material weight was scaled so that the sum of all material weights equals the actual total sample weight (or net weight of the load).

Composition Calculations

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

$$r_j = \frac{\sum_i c_i}{\sum_i w_i}$$

where:

c **= weight of a particular material**

w **= sum of all material weights**

for *i* = 1 to *n*

where *n* = number of selected samples

for *j* = 1 to *m*

where *m* = number of material categories

Confidence Interval

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

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

where:

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

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

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

where:

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

Weighted Averages

The overall County waste composition estimates was calculated by performing a weighted average across the five waste types. The weighted average for an overall composition estimate was performed as follows:

$$O_j = (p_1 * r_{j1}) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + \cdots$$

where:

***p* = the proportion of tonnage contributed by the noted sample group**

***r* = ratio of material weight to total waste weight in the noted sample group for *j* = 1 to m**

where: *m* = number of material categories

The variance of the weighted average is calculated

$$\boldsymbol{VarO_j} = \left(\boldsymbol{p_1^2} * \widehat{\boldsymbol{V_{r_{J1}}}}\right) + \left(\boldsymbol{p_2^2} * \widehat{\boldsymbol{V_{r_{J2}}}}\right) + \left(\boldsymbol{p_3^2} * \widehat{\boldsymbol{V_{r_{J3}}}}\right) + \cdots$$

E. Implementation Personnel

The SVM project team included a crew of four sorters, a loader operator, a field crew manager and a principal. The team was equipped with a sorting table, a work table, tarps, tubs, hand tools, a skid steer, a digital scale with a 2/10ths of one-pound increment, and personal protective equipment including high visibility vests, hard hats, dust masks, steel-toed boots, puncture resistant gloves and safety glasses. A storage box was secured at the site for placement of the equipment at end of each workday.

The sampling process was effectively facilitated by the cooperation and active support of the LOCATION management and field personnel at the site. The contribution of the LOCATION management and field staff was critical to the timely, successful completion of the field sorting process.

3. FIELD WORK PROCESS PICTORIAL

The following photos depict the implementation of the waste composition and characterization process and provide an illustration of the types of materials delivered to LOCATION.

The following photograph shows the SVM waste composition/sampling set-up at LOCATION.

Figure 3: SVM Set-Up

- **9' X 12' canvas tarps were arranged in order to host up to six separate 200 (+-) samples simultaneously**
- **Digital scale with .2-pound increment used to weigh and record the specified material types.**
- **Skid-steer track-loader equipped with a grapple bucket to extract the randomly selected cell from each randomly selected route.**

4. WASTE COMPOSITION AND CHARACTERIZATION RESULTS

Using the prescribed methodology and protocols, the waste composition and characterization studies were completed at LOCATION. The data are provided for each material category and then presented in aggregate form. The data are presented in tables and in pie charts, with a separate pie chart including more detail for Organics.

A. Residential MSW Composition and Characterization

Table 1: Residential MSW Composition and Characterization

Residential MSW (25 Samples, Hand Sort)	Mean Composition	Standard Deviation	Lower	Upper
1. Dry Recoverable Fiber	12.6%	6.9%	10.4%	14.9%
2. PET UBC's	0.5%	0.3%	0.4%	0.6%
3. HDPE	0.6%	0.5%	0.4%	0.8%
4. Film Plastic	3.0%	1.7%	2.4%	3.5%
5. Mixed Plastics	2.8%	2.6%	2.0%	3.7%
6. Glass	2.0%	2.5%	1.2%	2.8%
7. Aluminum UBC's	0.1%	0.3%	0.1%	0.2%
8. Mixed Ferrous (Tin & Salvage)	3.5%	6.3%	1.4%	5.6%
9. Mixed Non-Ferrous (Salvage)	0.1%	0.2%	0.0%	0.1%
10. Inerts	5.0%	10.2%	1.6%	8.4%
11. Hazardous Waste	0.1%	0.4%	0.0%	0.2%
12. E-Waste	0.9%	2.4%	0.1%	1.7%
13. Textiles	4.2%	5.1%	2.6%	5.9%
14. Organics	*45.9%*	19.1%	39.6%	52.1%
a. Yard Waste	7.5%	14.8%	2.7%	12.4%
b. Food Waste	26.6%	15.7%	21.5%	31.8%
c. Clean Wood	3.1%	6.8%	0.9%	5.3%
d. Treated/Painted Wood	2.3%	6.6%	0.2%	4.5%
e. Wet/Contaminated Fiber	5.8%	4.4%	4.4%	7.3%
f. Rubber	0.4%	1.9%	0.0%	1.1%
15. Fines (<2" Items)	8.6%	6.9%	6.3%	10.9%
16. Other	10.1%	7.8%	7.5%	12.7%

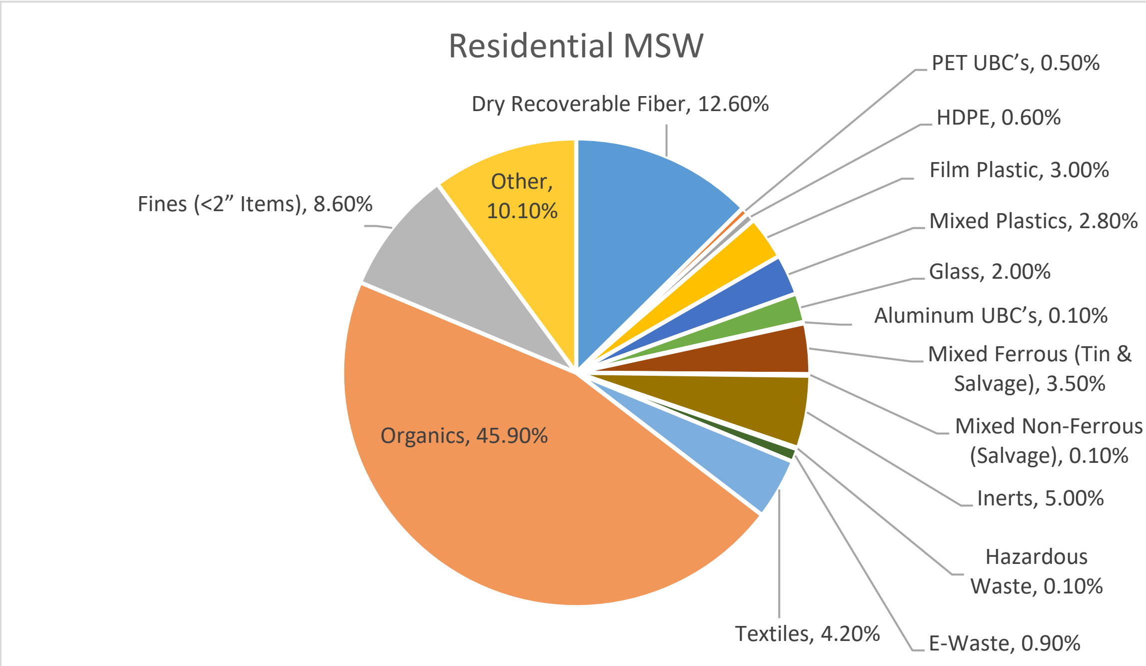

Figure 4: Residential MSW

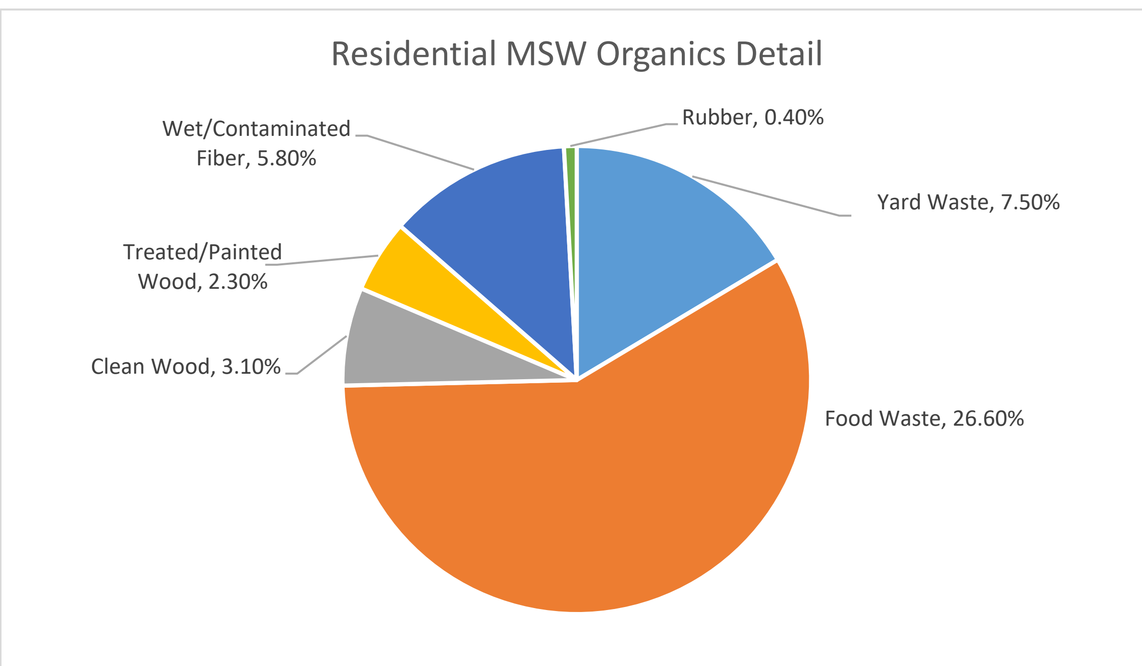

Figure 5: Residential MSW Organics Detail

B. Commercial MSW Composition and Characterization

Table 2: Commercial MSW Composition and Characterization

Commercial MSW – (25 Samples, Hand Sort)	Mean Composition	Standard Deviation	Lower	Upper
1. Dry Recoverable Fiber	16.4%	11.2%	12.7%	20.1%
2. PET UBC's	0.5%	0.4%	0.4%	0.6%
3. HDPE	0.5%	0.4%	0.4%	0.6%
4. Film Plastic	3.5%	1.6%	3.0%	4.0%
5. Mixed Plastics	3.1%	2.6%	2.3%	3.9%
6. Glass	2.9%	2.4%	2.1%	3.7%
7. Aluminum UBC's	0.1%	0.2%	0.0%	0.2%
8. Mixed Ferrous (Tin & Salvage)	1.7%	2.7%	0.8%	2.5%
9. Mixed Non-Ferrous (Salvage)	0.8%	2.6%	0.0%	1.7%
10. Inerts	2.2%	5.8%	0.3%	4.1%
11. Hazardous Waste	0.1%	0.3%	0.0%	0.2%
12. E-Waste	2.2%	5.1%	0.5%	3.9%
13. Textiles	2.7%	3.7%	1.5%	3.9%
14. Organics	42.2%	15.2%	37.2%	47.2%
a. Yard Waste	1.7%	3.8%	0.5%	3.0%
b. Food Waste	30.9%	15.2%	25.9%	35.9%
c. Clean Wood	0.2%	0.6%	0.0%	0.4%
d. Treated/Painted Wood	4.4%	9.1%	1.4%	7.4%
e. Wet/Contaminated Fiber	5.0%	3.4%	3.9%	6.1%
f. Rubber	0.0%	0.1%	0.0%	0.1%
15. Fines (<2" Items)	10.2%	6.1%	8.2%	12.2%
16. Other	11.0%	7.6%	8.5%	13.5%

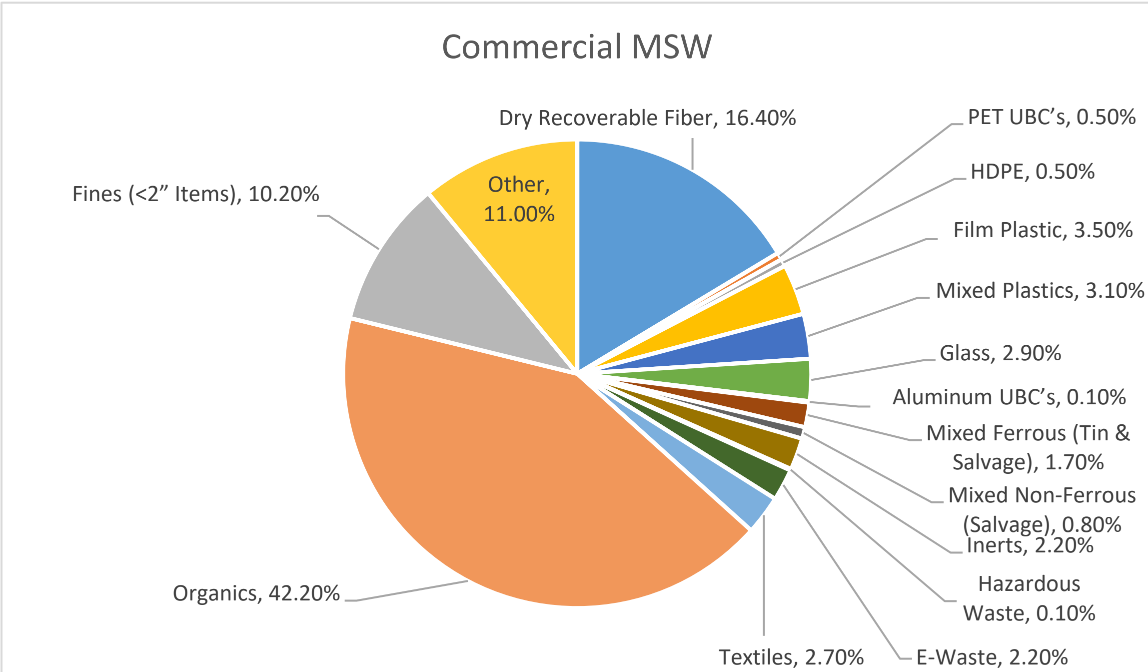

Figure 6: Commercial MSW

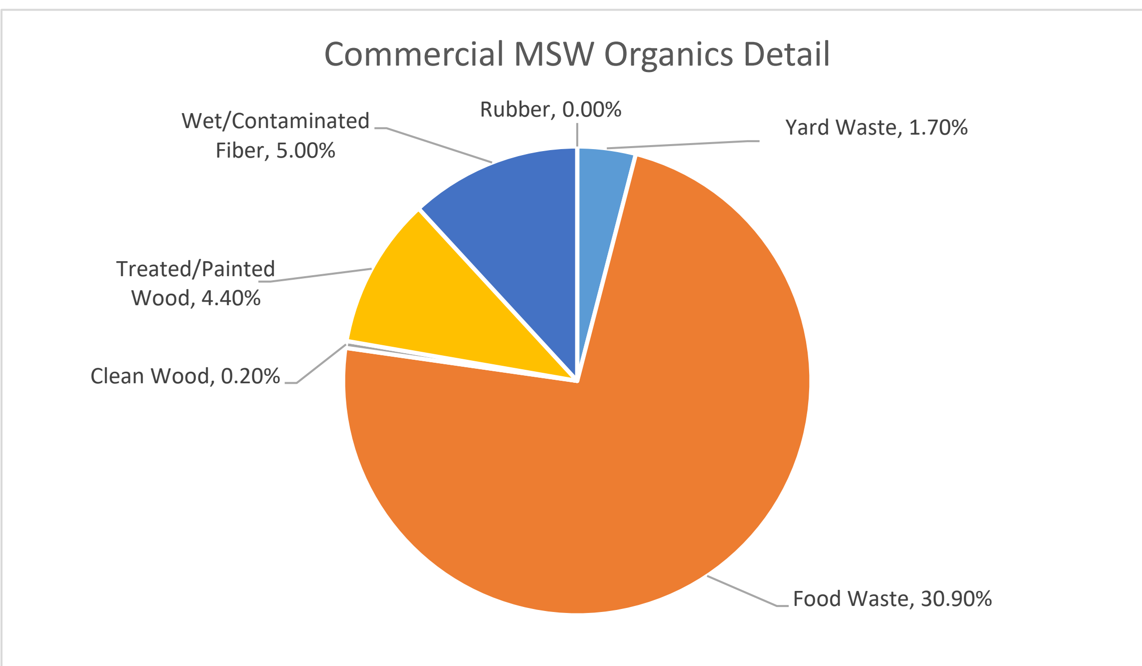

Figure 7: Commercial MSW Organics Detail