Memorandum

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December 18, 2017

TO: Zack Hansen and Judy Hunter
             Ramsey/Washington Recycling & Energy Board Joint Leadership Team

CC: Jennefer Klennert and Nathan Klett,
             Foth Infrastructure & Environment, LLC (Foth)

FROM: Jill Morris, Foth

RE: Summary of 2016-2017 Seasonal Waste Characterizations

Introduction

The purpose of this Memorandum is to summarize the Waste Characterization events completed in 2016 and 2017 for the Ramsey/Washington Recycle & Energy Board (R&E Board). Four (4) characterization events were completed from October 2016 to August 2017 to evaluate potential seasonal waste trends at the Recycle & Energy Center (R&E Center). During each waste characterization event, samples from random residential waste haulers, serving the Ramsey and Washington Counties, were collected twice a day. Neighborhoods sampled can be found in Attachment 1. Approximately 2,000 lbs. of residential waste was sampled during each event. Specific waste characterization summaries have been previously submitted for the October 2016, March 2017, May 2017, and August 2017 waste characterization events. This memo is intended to highlight major trends and supplement the individual summaries. A Waste Characterization Comparison for each event can be found in Attachment 2.

Characteristics of Waste Sampled

The waste characterization events were intended to identify traditional recyclables that could be recovered from the waste stream as well as materials that could be composted or digested in an anaerobic digester. Traditional recyclables were classified as plastic bottles and containers, old corrugated containers (OCC), ferrous and non-ferrous metals. There were limited amounts of traditional recyclables in the waste stream. Non-recyclable material comprised 89% to 95% of the total material sampled.

Material was sorted into bagged and loose materials. Bagged waste represented 58 to 69 percent of the waste stream. Materials that were bagged were liberated prior to sorting using a prescribed method. Once all the materials were liberated and sorted by size, the

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greatest amount of material was in the 2 inch to 6 inch size fraction, followed by the 6 inch to 12 inch size fraction.

Bagged Waste Characteristics

As discussed above, more waste was bagged than loose. During the sorting events, it became apparent that new technology is creating stronger, more durable bags. Some wastes were also double bagged increasing the difficulty of ripping open and processing the waste. Knives were necessary to open the bags as they were difficult to rip open. If materials are to be sorted at the R&E Center, it will be necessary to add equipment to open bags.

Food Waste

Separation of recoverable food waste (greater than 2 inches in diameter) began during the March 2017 characterization. Overall there was more food waste recovered within the bagged waste. During the May 2017 and August 2017 characterization events, approximately 10-12% of the waste stream was made up of food waste in the 2 inch to 6 inch size fraction. Approximately 5% of the waste separated derived from the 2 inch to 6 inch size fraction. Due to seasonality of foods, corn cobs were found in every sample in the August 2017 characterization. During the May 2017 characterization, the Saint Paul Neighborhoods of Shelby/Paine had the greatest fraction of food waste. Food waste is a contributor of moisture and organic content to the Refuse Derived Fuel (RDF) material, decreasing the combustion and gasification properties of the RDF product. Organic programs such as durable compostable bags for source separation or additional organic drop off centers could be reviewed and implemented to source separate food waste prior to arriving at the R&E Center.

Old Corrugated Cardboard (OCC) Waste

The May 2017 and August 2017 waste characterization events had the greatest fraction of OCC in the greater than 12 inch size fraction. The March 2017 and October 2016 waste characterization events had the greatest amount of OCC in the 6 inch to 12 inch size fraction with most characterized as Pizza Discs. OCC material represented approximately 0.4% to 2.02% of the waste stream. At this time, OCC from the residential waste characterization was not a major portion of the waste stream. OCC should be continuously monitored for cultural and lifestyle changes resulting in additional OCC in the mixed municipal solid waste (MSW) within the communities served.

Recoverable Recyclables

Plastics made up 3.4% to 4.9% of the waste stream. The March 2017 waste characterization event had the highest amount of plastics in the waste stream and the October 2016 event, the lowest. Plastics No. 1, PET, was the majority of plastics found during all seasonal characterization events, followed by Plastics No. 5 (PP) and Plastics No. 2 (HDPE). Plastics recovered in the characterization events appeared appropriate for separation with optical sorting technology.

RDF Samples

As the R&E Board looks toward alternative technologies such as gasification, it is important to note that the RDF does not meet the requirements for gasification under the Enerkem Specifications. Technology to improve the sort process to remove fines and inorganics as well as lower moisture content within the facility should continue to be investigated.

Yard Waste in Samples

Yard Waste was found in the waste sampled throughout the characterization events despite being banned from disposal with MSW statewide since 1992. Outreach and education should continue to focus on proper yard waste disposal.

Analysis of Samples at North Carolina State University

During the four (4) events, RDF, 2 inch minus material from the waste characterization event and residue from the RDF production process were sampled and sent to Dr. Morton Barlaz at North Carolina State University for analysis. RDF samples were tested for moisture content, percent fines, carbon content, hydrogen, nitrogen, inorganics and calorific value. 2 inch minus material and residue from the RDF production process were sampled for moisture content, percent fines, inorganics and biomethane potential. Attachment 3 contains table comparisons of the results.

Recommended Next Steps

Based on the waste characterization events, there are several next steps the R&E Board could investigate to improve the RDF quality and overall separation process:

- ♦ Food Waste represents approximately 10%-12% of the waste stream. Continued source separated diversion programs for food waste including drop off organics and potentially curbside collection should be investigated and potentially implemented.

- ♦ Optical sorters, artificial intelligence and other mechanical sorting systems should continue to be investigated for potential additional recovery of recyclables.

- ♦ Increase outreach and education on proper yard waste disposal to decrease the amount of yard waste found in the MSW.

- ♦ Further investigate the composition of RDF to determine alternative technology uses other than gasification and/or further investigate technologies to "polish" RDF to meet published specifications for gasification.

Attachment 1
Cities and Neighborhoods Sampled

Neighborhoods Sampled

- Afton
- Cottage Grove
  - Old Cottage Grove (2)
  - New Cottage Grove
- Hastings, West
- Maplewood (7)
- Newport
- North Oaks (2)
- Oakdale (2)
- Oak Park Heights (2)
- Roseville
- Saint Paul:
  - General (6)
  - East Side
  - Upper East Side
  - Highland Park
  - Thomas-Dale Neighborhood
  - Shelby/Paine
  - Highland Neighborhood
- White Bear Lake
- Woodbury:
  - General (6)
  - Bailey to Lake
  - Glen Road to Newbury

Attachment 2
Waste Characterization Comparison

Attachment 2
Seasonal Comparison of Characterization

	Oct-16	Mar-17	May-17	Aug-17
Pounds of Sample (lbs)	2257.9	2209.42	2118.3	2201.3
Percent of Bagged	56%	65%	69%	65%
Percent of Loose Material	39%	35%	31%	35%
Percent of Plastics	3.4%	4.9%	3.7%	4.1%
Percent of Polyethylene Terephthalate (PET)	1.2%	2.0%	1.7%	1.6%
Percent of HDPE	0.4%	1.2%	0.5%	0.8%
Percent of PVC	0.0%	0.0%	0.0%	0.0%
Percent of LDPE	0.0%	0.0%	0.0%	0.0%
Percent of PP	0.8%	0.9%	0.9%	0.8%
Percent of PS	0.3%	0.7%	0.5%	0.6%
Percent of Plastics #7 Other	0.2%	0.1%	0.1%	0.3%
Percent of Old Corrugated Containers (OCC)	0.46%	0.75%	1.88%	2.02%
Percent of Metals (non-Ferrous and Ferrous)	2.0%	2.4%	2.9%	2.0%
Percent of Ferrous	1.0%	1.4%	1.8%	1.0%
Percent of non-Ferrous	0.9%	1.0%	1.2%	1.0%
Percent of Glass	-	3.3%	2.2%	1.7%
Percent Waste	95%	89%	90%	90%
Percent in +12"	15.3%	14.5%	14.1%	13.7%
Percent in 6" to 12" fraction	29.6%	16.9%	14.1%	21.0%
Percent in 2" to 6" fraction	36.4%	34.2%	27.7%	26.7%
Percent of food waste in 2" to 6" fraction	-	5.3%	10.4%	12.3%
Percent in -2"	13.5%	18.0%	23.8%	16.6%

Attachment 3
North Carolina State University (NCSU) Testing Data

	October 2016	March 2017	May 2017	August 2017	Enerkem Gasification Specification
Moisture Content (%)	33.18	30.19	30.50	34.70	<20
Percent Fines (<6mm, %)	12.68	17.25	6.19	8.99	<15
Carbon Content (%)	43.21	46.31	42.12	46.34	>45
H (%)	12.50	22.34	17.90	6.60	
N (%)	0.35	0.48	0.43	0.82	
Inorganics (%)	19.40	23.94	18.56	16.07	
Calorific value (BTU/lb dry material)	9322	8226	7479	7917	>6,450
BMP (mL CH4/g)	NT	NT	NT	NT	NA

NCSU Data Sort - Summary of Results
Waste Characterization Less than 2 Inch

	October 2016	March 2017	May 2017	August 2017
Moisture Content (%)	46.97	33.28	37.2	60
Percent Fines (<6mm, %)	30.21	no data	19.76	11.36
Carbon Content (%)	NT	NT	NT	NT
H (%)	NT	NT	NT	NT
N (%)	NT	NT	NT	NT
Inorganics (%)	NT	47.71	30.21	14.59
Calorific value (BTU/lb dry material)	NT	NT	NT	NT
BMP (mL CH4/g)	196.9	NA	149.6	339

NCSU Data Sort - Summary of Results
Residue

	October 2016	March 2017	May 2017	August 2017
Moisture Content (%)	26.61	33.88	38	37.1
Percent Fines (<6mm, %)	28.31	6.79	11.39	9.76
Carbon Content (%)	NT	NT	NT	NT
H (%)	NT	NT	NT	NT
N (%)	NT	NT	NT	NT
Inorganics (%)	NT	16.92	41.19	41.19
Calorific value (BTU/lb dry material)	NT	NT	NT	NT
BMP (mL CH4/g)	110.1	NA	109.72	NA