Memorandum

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TO: Zack Hansen and Nikki Stewart
Ramsey/Washington Recycling & Energy Joint Leadership Team

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

FROM: Kate Bartelt, Foth

RE: Processing Alternatives: Durable Compostable Bag (DCB) Technology

Executive Summary

Between 25 percent and 40 percent of municipal solid waste (MSW) being disposed of in Ramsey and Washington Counties is organic waste including food waste. This represents a loss of not only the needed food for nutrition but also the resources it took to grow, produce, manufacture, distribute, and prepare the food. There is a need to reduce wasted food across all sectors of the food system – from producer to consumer – through policy, education, and collaboration. This is a national priority receiving attention from all levels of government, as well as major non-profit institutions.

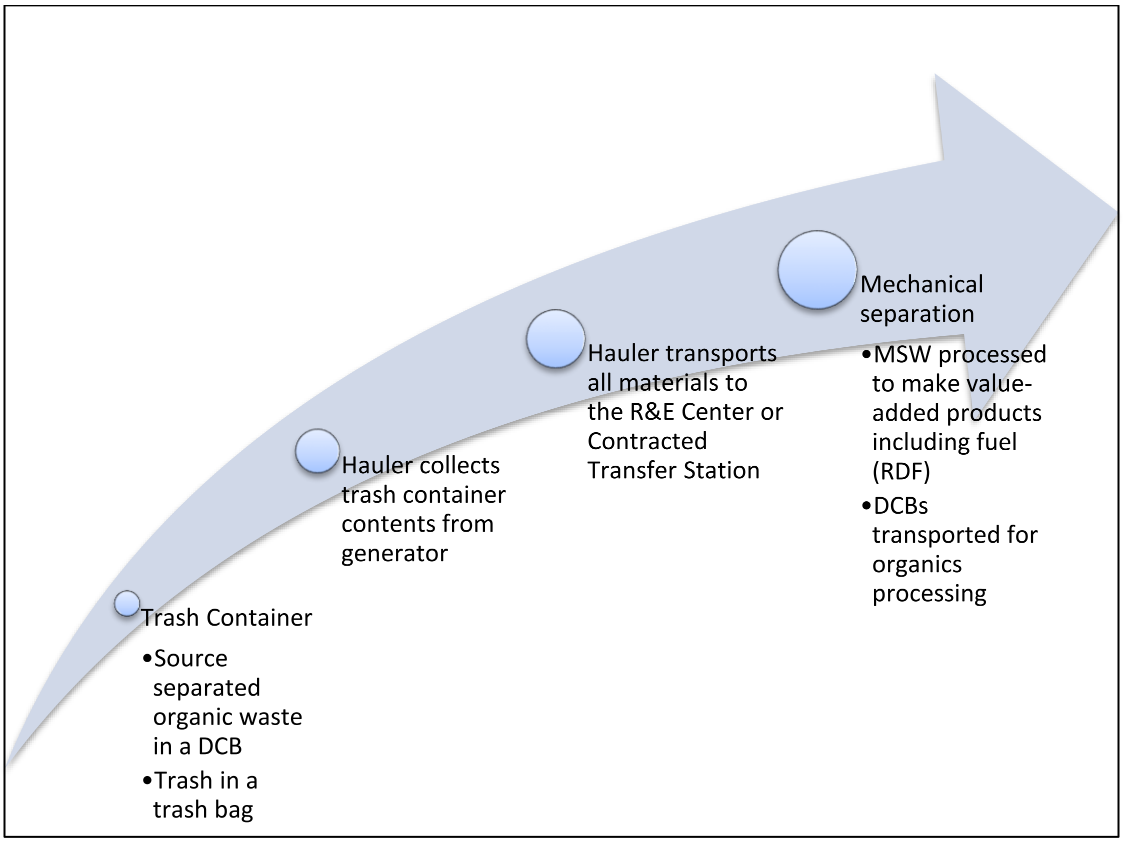
Both Ramsey and Washington Counties included the evaluation of methods of organics collection, including the use of durable compostable bags (DCBs) co-collected with MSW as a means to collect source separated organics, in their respective Solid Waste Master Plan strategies. [Ramsey County Residential Organics Strategy #4, Washington County Recycling, Organics, & Yard Waste Strategy #3]

Ramsey and Washington Counties are interested in evaluating co-collecting DCBs with MSW as it has the potential to create a convenient, cost-effective, efficient, and flexible organics collection system. The counties desire a system that can expand and evolve as participation in organics recovery programs grows. The counties are also focused on ensuring that all new organics diversion programs are designed to provide a high-quality end product for composting or anaerobic digestion (AD) while maintaining worker safety.

Durable Compostable Bag (DCB) Program to Source-Separate Organics from Residential and Non-residential Generators

A DCB collection system starts with the waste generator (i.e. resident or business). The waste generator would separate and place organic materials in a designated DCB and place MSW into a separate bag or container. Organic materials or organic waste as used in this document includes food waste, food-soiled paper, etc. but does not include yard waste. As with all source-separated programs, the system is reliant on the waste generator correctly separating materials and using the correct bag or container for each material type. [1]

Figure 1
A Summary of a DCB Co-Collection System



The generator would then place filled DCBs and loose or separately bagged MSW in the generators MSW trash cart or dumpster, collectively known as the container. The generator's trash hauler would collect the container on its regular trash pick-up day. There would be no change in how the co-collected materials (MSW and DCBs) are collected or by whom the materials are collected. A DCB system can work with any licensed MSW hauler.

[1] Note: The source separation of traditional recyclables would still be done by the generator. A co-collection program for organics using DCBs and MSW has no impact on recycling programming.

In this system, a separate container for the source-separated organic material is not used. Instead, the source-separated organic materials within the DCB are collected in the same container with MSW. This eliminates the costs associated with an additional container and separate collection. The additional cost is the purchase of the DCB itself. In most cases, the organic material is currently being disposed of in the MSW trash container so container capacity should not be an issue.

The MSW hauler would then bring the co-collected material to the Recycling & Energy Center (R&E Center) or to a transfer station under contract with the Recycling & Energy Board (R&E Board) that has DCB sorting capability. At both locations, loads containing DCBs would be processed to separate DCBs. This would require manual labor or the purchase and installation of equipment designed to mechanically separate the DCBs. The DCBs would be transported to an organics compost or AD facility for management (e.g., for composting or AD). From the transfer stations, the remaining MSW would be transported to and processed into value-added products at the R&E Center.

Paying for Organics Management

There will be additional costs to manage and process organic waste collected via DCBs. The collection operations model and equipment to collect DCBs with MSW is the same as the collection operations model and equipment to collect MSW alone. Collection costs are assumed to be the same with DCBs as with MSW alone. There are new costs associated with the management and processing costs to separate the DCBs from MSW.

There are currently two user payment models being used in the Twin Cities Metropolitan region for organics programming: opt-in and subscription.

A. In an opt-in program (where everyone pays), every household or business pays for the organics collection programming even if they do not use the program. For example, the City of Minneapolis uses the opt-in model for its source-separated organics collection program from residential households. In 2016, 100 percent of households paid for organics collection programming but only 38 percent of households opted-in to use the program and received a dedicated organics diversion cart[2]. In this model, every household pays for the service and the costs are often embedded in municipal trash bills.

B. In a subscription program (where only subscribers pay), every household or business that is interested in participating in an organics diversion program must contact a participating provider to sign-up for and commit to paying for the service. Set out rates and participation rates are found to be higher in cities with contracts.

[2] 2016 Minneapolis Residential Solid Waste Composition Analysis and Recycling Program Evaluation. Prepared for Hennepin County and City of Minneapolis, MN. Foth, September 2016.

Residential Programs

Participation Projections for Residential Programs

Participation projections are difficult to predict as residential curbside source separated organics is a new concept and a new program option for all municipalities within Ramsey and Washington Counties. Organix Solutions provided participation rates for a new program as contrasted to a mature program. Typical Blue Bag Organics® programs have a 10 to 15 percent participation rate at the end of the first to beginning of the second program year and mature to 40 percent participation at the end of year four into the beginning of year five.

Applying the participation rates provided by Organix Solutions for similar Blue Bag Organics® programs to the households in Ramsey and Washington Counties, results in an estimated 31,900 to 127,500 households participating in a potential curbside co-collection program, see Table 1.

Table 1
Potential Participation Projections for a Residential Curbside Co-Collection Program

	Total number of households in Ramsey/ Washington County [3]	Year 1 - 10 Percent Participation		Year 4 - 40 Percent Participation	
		End of Year 1 into Year 2	Number of Households	End of Year 4 into Year 5	Number of Households
No. of households participating	318,699[4]	10%	31,870	40%	127,480

Residential Diversion Potential

Organix Solutions has reported that the average weight of organics collected per 13-gallon DCB is 8 pounds. Participating households on average use all 60 bags provided per year. Diversion potential will be directly related to the number of participants in the program. The average quantity of DCBs set out annually will range from 1.9 million at the end of year 1 into year 2 of the program to 7.6 million at the end of year 4 into year 5 of the program.

Utilizing the calculations of participating households, pounds per bag per participating household would result in diverting approximately 7,600 to 30,600 tons per year of organics, see Table 2.

[3] Population data provided by United States Census Bureau Quick Facts, https://www.census.gov/quickfacts/fact/table/washingtoncountyminnesota,ramseycountyminnesota/PST045217, July, 2017.

[4] 220,443 Ramsey County & 98,256 Washington County

Table 2
Potential Diversion Projections from a Residential Curbside Co-Collection Program

	Number of households participating	Pounds per participating household per DCB	Total tons per year	The quantity of bags set out per year
Initial Program Roll-Out	31,870	8	7,649	1,912,200
Program Maturity	127,480	8	30,595	7,648,800

Residential DCB Program Education, Distribution and Manufacturer

Two separate programs have been identified for DCB program education, distribution, and manufacture. Organix Solutions offers an education, distribution and bag manufacture program called Blue Bag Organix®[5]. During meetings with Organix Solutions, a price inclusive of education, distribution and bag manufacturer was reported as $69.95 per participating household per year.

Additional outreach was conducted to WasteZero®, a municipal waste reduction and pay-as-you-throw program company. WasteZero® indicated a willingness to offer outreach assistance, bag manufacture and distribution of DCBs through Retail Store Distribution although specific pricing information was not offered.

Research into other bag manufacturers is ongoing, and data will be provided in a separate Memorandum.

Residential DCB Program Collection, Sorting and Processing Costs

Curbside source separated organics co-collected with MSW will have ongoing, net operational costs for the separation of the DCBs from MSW, processing at a composting facility or AD facility, and management of the end product. All new co-collection costs for DCB organics would be in addition to existing MSW processing costs, but there should be some savings for the generator due to avoided disposal fees and taxes.

According to the MPCA, the average price of residential MSW collection is $17 to $18 per month per household[6]. This should remain consistent with the addition of DCBs as the change in cost is related only to processing the MSW to remove the DCB's.

For residential curbside co-collection of organics, generators would need to use a specific DCB. The cost per bag for DCBs currently ranges from $0.30 to $1.00[7] depending on the provider, quality of the DCB, and quantity purchased. Annual DCB delivery costs are not included in the current bag pricing. Organix Solutions program which includes 60 Blue Bags, distribution, education and outreach is $69.95 per year per household. Each

[5] Program specifics are located at https://www.organixsolutions.com/blue-bag-organics/blue-bag-organics-program
[6] Minnesota Pollution Control Agency Report: Analysis of Waste Collection Service Arrangements, Foth, June 2009. https://www.pca.state.mn.us/sites/default/files/w-sw1-06.pdf.
[7] Pricing from Randy's Sanitation program, MN State Contract current pricing, and Amazon.

household is projected to need 52 to 60 bags per year.[8] Bag pricing may be reduced with increased volume purchased. Multiple vendors have been identified that can produce DCBs and a procurement with proper specifications would be necessary to verify bag pricing.

In order to ensure the reliability of the DCBs and that the organics stay intact in the DCB, DCBs should be sorted from MSW at the initial facility at which they are received. Various methods of sorting DCBs will likely be used by the contracted transfer stations and the R&E Center. This memo provides a compilation of methods that could be utilized at the R&E Center for sorting of DCBs without specific costs assigned. Foth completed preliminary research on costs of a manual sorting line, one of the less complex, proven methods for removing DCBs from MSW. Preliminary cost estimates are approximately $3.00 per ton of inbound MSW. However, processing costs should be further evaluated.

Model for Residential Co-Collection System Cost Projections

A model for a residential co-collection system was designed to better understand system costs using estimated diversion potential and participation rates. The Twin Cities Metropolitan municipalities and haulers that have introduced co-collection programs have found that it takes time for generators to adopt the new program and fully understand the co-collection system. Other methods of organics collection including collection with a separate cart and separate truck are explored in a separate memo.

The model results displayed in Table 3 and Table 4 show the effect of changes in the participation rate (i.e. sign-up rate varies from ten percent in year one to 40 percent in year four) and diversion in terms of tons per year of organics collected. Increases in participation rate and diversion are anticipated as a co-collection system matures and the generators become more familiar with the program. A single start date for all households is impractical from an education and roll out stand-point. Table 3 models a 2 year ramp-up schedule and Table 4 models a 3 year ramp-up schedule.

The model aims to provide an understanding of the system costs but does not specifically assign those costs. Those costs could be borne by the waste generator, the waste hauler, or Ramsey/Washington counties solely or collectively. Low-end cost per bag and the number of bags per household per year was used in the model.

Model for Residential Co-Collection System – 2 Year Ramp-Up

Table 3 presents model results from residential DCBs only and assumes a two-year ramp up with one-half of households receiving access to the program in year 1 with full implementation by the end of year two (2021) and system maturity achieved by year five (2024). Note the cost for processing and cost per bag are held constant throughout the model.

[8] Assumption provided by Randy's Sanitation during the development of the Ramsey County Master Plan.

***Model assumptions*:**

- Number of total households: 318,699 (US Census Bureau estimate, July, 2017 number of households in Ramsey and Washington Counties)
- The two-year ramp-up of the system with one-half, 159,350 households, added in year 1 and year 2.
- Cost per bag: $0.30 (low end estimate)
- Number of bags needed per household per year: 60
- Processing Cost – derived from a manual picking system: $3.00 per ton of MSW.
- No education or outreach costs are included. Summary is for the technical elements only.
- No costs associated with organics transfer or management (compost or AD) are included.

Table 3
Summary of Residential Co-Collection System Costs
2 Year Ramp-Up Schedule

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number Households Participating**	**Tons Per Year of MSW Processed**	**Pounds per household per bag collected**	**Diverted Tons[9] of Organics per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	5%	15,935	112,500	8	3,824	$286,829	$337,500	$624,329	$163
2	2021	15%	47,805	225,000	8	11,473	$860,487	$675,000	$1,535,487	$134
3	2022	25%	79,675	225,000	8	19,122	$1,434,146	$675,000	$2,109,146	$110
4	2023	35%	111,545	225,000	8	26,771	$2,007,804	$675,000	$2,682,804	$100
5	2024	40%	127,480	225,000	8	30,595	$2,294,633	$675,000	$2,969,633	$97

[9] Calculation based on Number of Households Participating * 60 bags * 8 pounds per bag / 2,000 pounds per ton.

Results in Table 3 show approximately 3,824 tons of organics are anticipated to be diverted during the first year of implementation at an estimated cost of $163 per diverted ton of organics (total annual cost/diverted tons of organics per year). The total annual processing cost is a fixed cost based on the tons per year MSW processed so the cost per diverted ton of organics decreases with increased participation.

<u>Model for Residential Co-Collection System – 3 Year Ramp-Up</u>

A single start date for all households is impractical from an education and roll out stand-point. Table 4 presents model results for residential DCBs only and assumes a three-year ramp up with one-third of households receiving access to the program each of three consecutive years with full implementation by the end of year three (2022) and system maturity achieved by the end of year six (2025). As only one-third of households are offered DCBs each year, the ramp up progresses more slowly over time. Note the cost for processing and cost per bag are held constant throughout the model.

***Model assumptions*:**

- ♦ Number of total households: 318,699 (US Census Bureau estimate, July, 2017 number of households in Ramsey and Washington Counties)
- ♦ The three-year ramp-up of the system with one-third, 106,233 households, added each year
- ♦ Cost per bag: $0.30 (low end estimate)
- ♦ Number of bags needed per household per year: 60
- ♦ Processing Cost – derived from a manual picking system: $3.00 per ton of MSW.
- ♦ No education or outreach costs are included. Summary is for the technical elements only.
- ♦ No costs associated with organics transfer or management (compost or AD) are included.

Table 4
Summary of Residential Co-Collection System Costs

3 Year Ramp-Up Schedule

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number Households Participating**	**Tons Per Year of MSW Processed**	**Pounds per household per bag collected**	**Diverted Tons[10] of Organics per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	3%	10,623	75,000	8	2,550	$191,219	$225,000	$416,219	$163
2	2021	10%	31,870	150,000	8	7,649	$573,658	$450,000	$1,023,658	$134
3	2022	20%	63,740	225,000	8	15,298	$1,147,316	$675,000	$1,822,316	$119
4	2023	30%	95,610	225,000	8	22,946	$1,720,975	$675,000	$2,395,975	$104
5	2024	37%	116,856	225,000	8	28,046	$2,103,413	$675,000	$2,778,413	$99
6	2025	40%	127,480	225,000	8	30,595	$2,294,633	$675,000	$2,969,633	$97

[10] Calculation based on Number of Households Participating * 60 bags * 8 pounds per bag / 2,000 pounds per ton.

Results in Table 4 show approximately 2,550 tons of organics are anticipated to be diverted during the first year of implementation at an estimated cost of $163 per diverted ton of organics (total annual cost/diverted tons of organics per year). Similar to the 2-year ramp-up scenario, the total annual processing cost is a fixed cost based on the tons per year MSW processed so the cost per diverted ton of organics decreases with increased participation.

Non-Residential Programs

Non-Residential Diversion Potential

Diversion potential from non-residential generators is more difficult to analyze because there is very little publicly available data. For this analysis, Foth assumed that a mature non-residential DCB program could target both food waste and "compostable paper". Compostable paper should be defined as compostable fiber material acceptable to the current composting facilities in the region, but does *NOT* include readily recyclable fiber such as typical cardboard and mixed paper grades. This definition is similar to the sort category for "Compostable Paper" used for the Minnesota Pollution Control Agency's (MPCA) 2013 Waste Characterization Study.[11]

Rescue, collection and recovery of non-residential generator food waste alone (e.g., food to people, food to animals, etc.) is much more developed than the collection of mixed organics with compostable paper. These types of higher value food waste recovery options have been well studied and documented by Ramsey and Washington Counties. One such study estimated that about 47 percent (about 39,000 tons per year) of total organics generated (excluding yard waste) was being recovered at the time of the analysis through food rescue (i.e., food to people), food to hogs, animal feed manufacturing, and a small fraction of mixed organics (with compostable paper) to composting systems. Nearly all of the organics rescue and recovery was from the non-residential sector. About 53 percent of the total amount of organics generated (about 43,000 non-residential tons per year) was estimated to be remaining in the MSW stream for disposal.[12]

This fraction of the organics that are still disposed of as MSW is the proposed target for new initiatives. Ramsey and Washington Counties will likely encourage the continuation of current, sustainable non-residential food rescue and food waste recovery systems and not divert this same material into a new collection system such as a DCB program.

Non-residential diversion potential using DCBs for mixed organics will be directly related to the number of business participants in the program. To get a preliminary estimate of the potential amount of organics that could be diverted, Foth used the same database and food waste generation rates from the Foth Commercial Organic Materials Supply Assessment (June 2010).

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[11] MPCA *2013 Statewide Waste Characterization – Final Report* (December 2013), by Burns & McDonnell. The "Compostable Paper" sort category is defined as: "Paper products including wax-coated paper, napkins, paper towels, frozen food packaging, tissues, paper plates, cups, and pizza boxes (excludes aseptic packaging)."

[12] Foth (June 2010), *Organic Materials from Commercial Establishments: A Supply Assessment.* Prepared for the Ramsey/Washington County Resource Recovery Project Board.

The intent was to develop a feasible range of mixed organics tonnages that could potentially be recovered from business establishments without any form of current food rescue or food waste recovery service.

Appendix A at the end of this memo is a table that contains the generation rate assumptions used for the Foth June 2010 study. The food wastes disposed of are estimated by category of non-residential establishments in terms of tons of food waste per employee per year. The data is based on sorting samples from individual businesses in Southern California.[13] This California food waste generation rates were used as the data was readily available, already analyzed by Foth, and no new data set providing per employee generation rates could be identified.

As part of the methodology for the June 2010 study, Foth developed a list of all the commercial and industrial establishments characterized by one of the previously defined primary SIC codes in Ramsey and Washington Counties. The source utilized for non-residential population and other census type of data in developing this list of commercial and industrial establishments was the Dun and Bradstreet (D&B) database.

The D&B database is a searchable, public resource that contains information about non-residential businesses and government institutions. Foth queried the D&B database for business with the chosen primary SIC codes within Ramsey and Washington Counties. The results of these queries provided information about each facility including company name, address, and employee count for each site/location. Foth produced two D&B database lists of relevant non-residential establishments: one each for Ramsey County and Washington County.

Two scenarios were developed to help illustrate the challenges and opportunities of a non-residential DCB service:

> **Scenario 1 (Moderate):** 15 percent of ***all*** non-residential businesses from the D&B database in Ramsey and Washington County recovering mixed organics at a 50 percent capture rate.
>
> **Scenario 2 (High):** 25 percent of the ***top three*** food waste generator categories (grocery stores, restaurants, and educational institutions) at a 75 percent capture rate. It is understood that the generators in this category are more likely to use source-separated collection (e.g. in a container or compactor) rather than DCBs. As limited data is available for the non-residential sector, Scenario 2 is provided for comparative purposes only.

[13] California Integrated Waste Management Board (February 2000), *Business Group Waste Compositions, Solid Waste Characterization Database.*

The Foth June 2010 study methodology resulted in an estimate of about 5,600 total non-residential establishments in Ramsey and Washington Counties combined. Three business categories, grocery stores, restaurants/bars, and educational institutions, were estimated to generate over 80 percent of the food waste generated from the non-residential sector. The two scenarios have the potential organic recovery results displayed in Table 5.

Table 5
Potential Diversion Projections from a
Non-residential DCB Co-Collection Program

	Number of Non-Residential Establishments Participating	Tons per Year of Food Waste Collected	Tons per Year of Compostable Paper Collected	Total Tons per Year of Mixed Organics Collected	Pounds of Mixed Organics Collected per Non-Residential Establishments
Scenario 1 (Moderate)	840	3,400	1,700	**5,100**	**12,143**
Scenario 2 (High)	1,400	6,700	3,400	**10,100**	**14,429**

Model for Non-Residential Establishments Co-Collection System – 2 Year Ramp-Up

A single start date for all non-residential establishments is impractical from an education and roll out stand-point. Table 6A and 6B present model results for non-residential DCBs only and assumes a two-year ramp up with half of non-residential establishments receiving access to the program in year 1 and half in year 2 with full implementation by the end of year two (2021) and system maturity achieved by the end of year five (2024).

Note the cost for processing and cost per bag are held constant throughout the model. This model assumes the same average of 8 pounds of organics per DCB. This is likely lower than will be achieved by non-residential establishments and does not take into consideration that larger DCBs may be utilized. It is unknown how many actual tons of MSW are from the particular non-residential establishments in the two Scenarios. For comparative purposes, all 225,000 tons of Commercial/Industrial MSW is assumed to be processed for DCBs.

The estimated cost for commercial co-collection by scenario is show in Tables 6A and 6B.

***Model assumptions*:**

- Number of participating establishments is shown in Table 5.
- A two-year ramp-up of the system with one-half of the establishments added in year 1 and one-half added in year 2.
- Cost per bag: $0.30 (low end estimate).
- Number of bags needed: Calculated assuming 8 pounds per bag.

- Scenario 1 assumes 12,143 pounds per non-residential establishment and Scenario 2 assumes 14,429 pounds per non-residential establishment of mixed organics.
- Processing Cost – derived from a manual picking system: $3.00 per ton of MSW.
- No education or outreach costs are included. Summary is for the technical elements only.
- No costs associated with organics transfer or management (compost or AD) are included.

Table 6A
Summary of Non-residential Co-Collection System Costs by Scenario

Scenario 1 (Moderate) – 2 Year Ramp-Up

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number of Establishments Participating**	**Tons Per Year of MSW Processed**	**Number of Bags needed annually**	**Tons per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	5%	42	112,500	63,750	255	$19,125	$337,500	$356,625	$1,399
2	2021	15%	126	225,000	191,250	765	$57,375	$675,000	$732,375	$957
3	2022	25%	210	225,000	318,750	1,275	$95,625	$675,000	$770,625	$604
4	2023	35%	294	225,000	446,250	1,785	$133,875	$675,000	$808,875	$453
5	2024	40%	336	225,000	510,000	2,040	$153,000	$675,000	$828,000	$406

Table 6B
Summary of Non-residential Co-Collection System Costs by Scenario

Scenario 2 (High) – 2 Year Ramp-Up

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number of Establishments Participating**	**Tons Per Year of MSW Processed**	**Number of Bags needed annually**	**Tons per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	5%	70	112,500	126,250	505	$37,875	$337,500	$375,375	$743
2	2021	15%	210	225,000	378,750	1,515	$113,625	$675,000	$788,625	$521
3	2022	25%	350	225,000	631,250	2,525	$189,375	$675,000	$864,375	$342
4	2023	35%	490	225,000	883,750	3,535	$265,125	$675,000	$940,125	$266
5	2024	40%	560	225,000	1,010,000	4,040	$303,000	$675,000	$978,000	$242

Model for Non-Residential Establishments Co-Collection System – 3 Year Ramp-Up

A single start date for all non-residential establishments is impractical from an education and roll out stand-point. Table 7A and 7B models non-residential DCBs only and assumes a three-year ramp up with one-third of non-residential establishments receiving access to the program each of three years with full implementation by the end of year three (2022) and system maturity achieved by the end of year six (2025). As only one-third of non-residential establishments are offered DCBs each year, the ramp up progresses more slowly over time.

Note the cost for processing and cost per bag are held constant throughout the model. This model assumes the same average of 8 pounds of organics per DCB. This is likely lower than will be achieved by non-residential establishments and does not take into consideration that larger DCBs may be utilized. It is unknown how many actual tons of MSW are from the particular non-residential establishments in the two Scenarios. For comparative purposes, all 225,000 tons of Commercial/Industrial MSW is assumed to be processed for DCBs.

The estimated cost for commercial co-collection by scenario is show in Tables 7A and 7B.

***Model assumptions*:**

- Number of participating establishments is shown in Table 5.
- A three-year ramp-up of the system with one-third of the establishments added each year is assumed in the non-residential co-collection system.
- Cost per bag: $0.30 (low end estimate).
- Number of bags needed: Calculated assuming 8 pounds per bag.
- Scenario 1 assumes 12,143 pounds per non-residential establishment and Scenario 2 assumes 14,429 pounds per non-residential establishment in Scenario 2 of mixed organics.
- Processing Cost – derived from a manual picking system: $3.00 per ton of MSW.
- No education or outreach costs are included. Summary is for the technical elements only.
- No costs associated with organics transfer or management (compost or AD) are included.

Table 7A
Summary of Non-residential Co-Collection System Costs by Scenario

Scenario 1 (Moderate) – 3 Year Ramp-Up

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number of Establishments Participating**	**Tons Per Year of MSW Processed**	**Number of Bags needed annually**	**Tons per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	3%	28	75,000	42,500	170	$12,750	$225,000	$237,750	$1,399
2	2021	10%	84	150,000	127,500	510	$38,250	$450,000	$488,250	$957
3	2022	20%	168	225,000	255,000	1,020	$76,500	$675,000	$751,500	$737
4	2023	30%	252	225,000	382,500	1,530	$114,750	$675,000	$789,750	$516
5	2024	37%	308	225,000	467,500	1,870	$140,250	$675,000	$815,250	$436
6	2025	40%	336	225,000	510,000	2,040	$153,000	$675,000	$828,000	$406

Table 7B
Summary of Non-residential Co-Collection System Costs by Scenario

Scenario 2 (High) – 3 Year Ramp-Up

					Organics Recycling		System Costs			
Year	**Year**	**Sign-up Rate**	**Number of Establishments Participating**	**Tons Per Year of MSW Processed**	**Number of Bags needed annually**	**Tons per year**	**Total Annual Bag Cost**	**Total Annual Processing Costs**	**Total Annual Cost**	**Cost Per Diverted Ton of Organics**
1	2020	3%	47	75,000	84,167	337	$25,250	$225,000	$250,250	$743
2	2021	10%	140	150,000	252,500	1,010	$75,750	$450,000	$525,750	$521
3	2022	20%	280	225,000	505,000	2,020	$151,500	$675,000	$826,500	$409
4	2023	30%	420	225,000	757,500	3,030	$227,250	$675,000	$902,250	$298
5	2024	37%	513	225,000	925,833	3,703	$277,750	$675,000	$952,750	$257
6	2025	40%	560	225,000	1,010,000	4,040	$303,000	$675,000	$978,000	$242

Options for Integrating DCB Separation at the R&E Center

The R&E Center receives 450,000 tons of MSW annually. Fifty percent is from a residential source and fifty percent is from a commercial/industrial source. Forty percent of the MSW is direct-hauled to the R&E Center by hauler collection vehicles. The remaining sixty percent is first delivered to one of six transfer stations, then loaded and hauled to the R&E Center for processing.

DCBs are intended to be handled four (4) times.

1. Filled in the home with organic materials.
2. Placed in the cart with MSW.
3. Cart emptied into the truck mixed with MSW.
4. Unloaded and sorted at a processing facility.

In order to ensure the reliability of the DCBs and that the organics stay intact in the DCB, DCBs should be sorted from MSW at the initial facility at which they are received. Transfer stations should be contacted to determine if there is a willingness to sort DCBs at their facility with the transfer of sorted MSW only to the R&E Center.

Specific options for sorting are available to the R&E Center for separation of DCBs from MSW. Options include the location of a sorting line on the tip floor, in a separate building, or alongside the current processing line. Multiple options include a DCB sorting line run separately from the main line with a slower speed or with smaller burden depth to improve recovery rates. Options for sorting are explored later in this memorandum.

System Goals:

- Provide a flexible system that can grow and evolve as participation grows.
- Incorporate system design into current operations at the R&E Center.
- Provide a quality separated end product that can be composted or anaerobically digested (AD).

Several alternatives for DCB separation have been identified. Each alternative has its pros, cons, and associated costs. Transportation costs to a composting or AD facility are not included as they are a constant regardless of the organics management method and depend on the location of the organics management facility. All options are ranked on a low, medium, or high scale pertaining to the success rate of the technology and how it meets R&E criteria (i.e. no manual pickers).

An estimated success rate is offered for each of the DCB separation methods. Success rate is based on degree the technology has been proven for use in sorting, accuracy of picks, system flexibility, and allignment with R&E system goals.

Picker Method

In this alternative, a load of MSW containing DCBs is spread across an area of the tipping floor. The DCBs are located by staff members who then manually pull them from the pile. This is the method Great River Energy (GRE) – Elk River Resource Recovery and Processing Facility attempted to use but has discontinued due to safety concerns. GRE estimates that the garbage is handled a minimum of five times using this method.

Need:

- Tipping floor space.
- One to two staff members (pickers) per shift to pick DCBs.
- Space to store separated DCBs.
- Loading area and transfer trailer or roll-off container to transport DCBs to the organics processor.
- SOPs and safety protocols for pickers.

Annual Operating Costs:

- Two pickers working the following schedule, 18 hours/day 4 days/week, 10 hours/day 2 days/week, and 8 hours/day the remaining day/week for a total time of operation of 4,836 hours/year. Total cost = $420,000 per year.

One-time Capital Costs:

- None anticipated

Pros:

- A simple method that requires no anticipated capital costs.
- A potential way to start or pilot a separation program while potential DCB sorting equipment is purchased or until a certain volume of DCBs are collected each day.

Cons:

- Potential safety risks for pickers.
- Need to manage and train pickers.
- Costs

Estimated Success Rate:

- Low. The method is proven to be successful in separating DCBs from MSW. However, this method does not allign with safety and worker goals for the R&E as pickers are directly exposed to MSW on the tipping floor.

Grapple Crane Pick Method

The grapple crane pick method is a process where the existing grapple cranes on the tipping floor are used to extract DCBs from loads of MSW as they are loaded onto the processing line. Grapple cranes are currently used to extract materials that can damage the refuse-derived fuel (RDF) processing system (e.g., concrete chunks, propane tanks, and mattresses). Options include having an individual looking specifically for DCBs for the grapple crane operator to pick or having the grapple crane operator looking for DCBs in addition to the other materials.

Need:

- ♦ Space to store separated DCBs.
- ♦ Loading area and transfer trailer or roll-off container – to transport DCBs to the organics processor.
- ♦ SOPs and safety protocols for grapple crane operators.

Annual Operating Costs:

- ♦ No additional costs as grapple crane operators and equipment maintenance are already accounted for in R&E Center budgets. If a spotter is used, there would be two spotters working the following schedule, 18 hours/day 4 days/week, 10 hours/day 2 days/week, and 8 hours/day the remaining day/week for a total time of operation of 4,836 hours/year. per morning and afternoon shift. Assume 16 hours of labor per day, six days a week. Total cost = $420,000 per year.

One-time Capital Costs:

- ♦ No additional costs as equipment capital costs for replacements are already accounted for in R&E Center budgets.

Pros:

- ♦ A simple method that requires no capital costs.
- ♦ A potential way to start or pilot a separation program while potential DCB sorting equipment is purchased or until a certain volume of DCBs are collected each day.

Cons:

- ♦ Grapple crane operators are already looking for harmful and explosive materials in the waste stream. Looking for additional items may be difficult and reduce the number of DCBs recovered.
- ♦ Grapple cranes may rip, tear or simply miss DCBs during extraction.
- ♦ Safety risk due to the placement of DCB spotters to view DCBs as they enter the two infeed lines.

Estimated Success Rate:

- Low. There is an elevated safety risk due to the location spotters would need to be at to see DCBs. In addition, the burden depth at the infeed conveyors would require grapple crane operators to take more time to move waste around to expose DCBs.

<u>Simple Sort Line</u>

The Simple Sort Line alternative uses a simple sorting line with an infeed conveyor and elevated picking stations located on either side of an elevated conveyor. An elevated sort line has two (or more) manual picking stations located strategically along the line for two (or more) sorters to manually extract DCBs from the MSW. The throughput of an elevated sort line is dependent on the number of sorters and the volume of DCBs in the MSW.

A sorting line differs from the hand pick method in that workers are elevated off the tipping floor, standing at their sort stations, and are not walking through the MSW. One example of this equipment is designed by Marathon Equipment, which has been demonstrated at Randy’s Sanitation.

Need:

- Tipping floor space.
- New equipment and additional staff.
- Space to store separated DCBs.
- Loading area and transfer trailer or roll-off container to transport DCBs to the organics processor.
- SOPs and safety protocols for pickers.
- New equipment maintenance training and SOPs.

Annual Operating Costs:

- Three pickers working the following schedule, 18 hours/day 4 days/week, 10 hours/day 2 days/week, and 8 hours/day the remaining day/week for a total time of operation of 4,836 hours/year. Total cost = $630,000 per year.
- Conveyor operating and maintenance costs. Total cost = $15,000-$20,000

One-time Capital Costs:

- Loading hopper, conveyor and picking stations total cost = $75,000-$125,000 (depending on system layout)

Pros:

- A simple method for separation.
- A potential way to start or pilot a separation program until volumes become such that pickers cannot manage.
- Low-cost alternative for separating DCBs that reduces risk to pickers.
- Pickers are not on the active tip floor or standing in MSW.

Cons:

- Need to manage and train pickers.
- Safety risks still remain for pickers.
- Conveyor belt may need to operate at a speed that makes picking difficult in order to manage burden depth.

Estimated Success Rate:

- Medium. The method is proven to be successful in separating DCBs from MSW, but a safety risk remains for pickers.

Optibag Sorting Technology

Optibag Technology[14] has created a linear system with optical technology that identifies objects based on color (i.e color of DCBs) in MSW. Once a DCB is detected a hard rubber flap is activated to push the bag off the line onto a separate conveyor or storage bin. The throughput of Optibag Technology is unknown. This system is more efficient when all waste is bagged in color-coded bags for each type of material collected and when burden depths are minimal.

Figure 1
Optibag

Optibag image from the http://optibag.nu/en/optibag/.

[14] Specific information on Optibag is available at http://www.envacgroup.com/products/our_products/optibag-optical-sorting.

Need:

- Tipping floor or other space for equipment installation.
- New equipment.
- Space to store separated DCBs.
- Loading area and transfer trailer or roll-off container to transport DCBs to the organics processor.
- New equipment maintenance training and SOPs.
- Possible changes or modifications to the existing odor control system.

Annual Operating Costs:

- Optibag Technology operating and maintenace costs. Total cost = $25,000-$40,000

One-time Capital Costs:

- Optibag Technology (including construction and conveyors costs) Total cost = $2,000,000-$4,000,000 (depending on if additional building space is necessary)

Pros:

- Separation is completed without pickers.
- No new staff is needed for operations.
- Technology is flexible. Color bags could be used to collect various items beyond organics including but not limited to textiles or batteries.
- Technology is successfully being utilized in Norway and Sweden. There are not currently any North American installations of Optibag.

Cons:

- Separation is dependent on a newer technology that has not been previously used at the R&E Center or by R&E Center staff.
- The technology works best when all items are contained within bags. Currently, waste coming into the R&E Center comes bagged and unbagged. The 2016-2017 Waste Characterization at the R&E Center found that 58 to 69 percent of the total sample sorted were bagged. Samples from different communities ranged from 60 percent to 75 percent bagged waste.[15]
- Significant space required to allow for lower burden depth and costly due to the addition of conveyors and potentially a building.

[15] Foth, *Summary of 2016-2017 Seasonal Waste Characterizations Memo,* December 18, 2017.

- ♦ DCB material likely to be contaminated if burden depth is too high and other materials are "flipped" off the conveyors.

Estimated Success Rate:

- ♦ Low. This method is ranked low due to anticipated burden depth at any of the facilities as well as cost of techology.

<u>Robotic Sorting Technology</u>

Robotic sorting machines use artificial intelligence and/or cameras to identify specific items within the garbage and the robot removes the items from the MSW. This technology is being implemented in MRFs and in MWP lines. Several criteria should be considered when pairing robotic sorting technology with DCBs including:

- ♦ Number of picks per hour,
- ♦ The speed of conveyor belts required,
- ♦ Burden depth required,
- ♦ Maintenance required, and
- ♦ The number of separate products that can be sorted.

<u>Bulk Handling Systems (BHS)</u>

BHS has developed a robotic sorting robot that identifies recyclables using artificial intelligence called Max-AI. Max-AI employs both multi-layered neural networks and a vision system to see and identify objects similar to the way a person does. This system is able to make multiple sorting decisions autonomously. Max-AI has been deployed for Quality Control of plastic bottles and aluminum cans in Athens Services' Material Recovery Facility in Sun Valley, CA. The Athens Services' MRF sorts both single-stream recyclables and MSW.

Figures 2 and 3
Max-AI images

Figures 2 and 3: Max-AI images from the BHS website, www.bulkhandlingsystems.com/bhs-nrt-introduce-max-ai.

Plexus Recycling Technologies

Plexus Recycling Technologies has partnered with Zen Robotics to offer a robotic waste sorting system. Zen Robotics technology, the Heavy Picker is in place at Recon Services, Austin, Texas sorting up to 60-pound items utilizing a metered bunker fed conveyor belt and walking floor. Zen Robotics can pick up to 4,000 individual items per hour and sort up to 8 fractions.

Figure 4
ZenRobotics

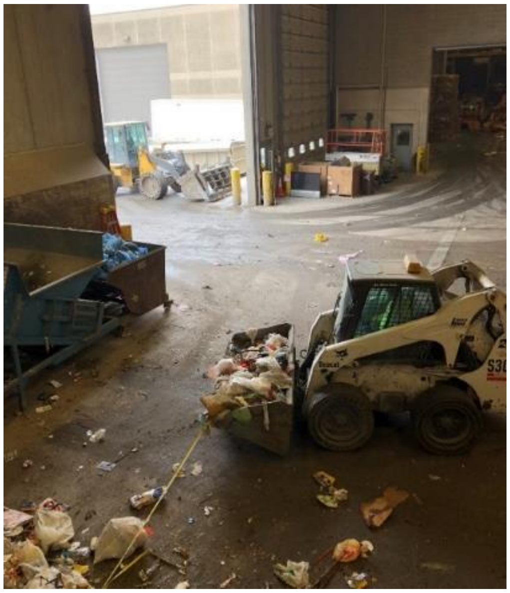
ZenRobotics image from Plexus Recycling Technologies website, www.plexusrecyclingtechnologies.com.

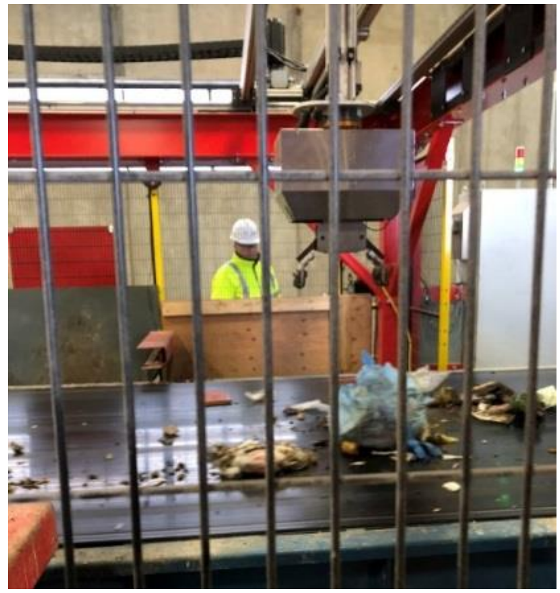
Waste Robotics

Randy's Sanitation in Delano, MN is testing robotic DCB sorting technology manufactured by Waste Robotics, a Canadian technology firm. The Waste Robotics robot picks a DCB where the upstream camera indicates the DCB location. According to Waste Robotics, it is best if there are approximately 50 feet of the conveyor for the MSW to ensure the MSW has stopped rolling prior to scanning and picking of the material. With a short conveyor, the material may move.

To increase the number of picks per minute, multiple robots could be deployed with one scanning system. The robot can pick 25 DCBs per minute on average. The robot in place at Randy's Sanitation is sized to provide picking for a 130,000 ton per year transfer station at a speed of 20 tons per hour.

Figures 5 and 6
Tour of Randy's Sanitation, Delano MN. March 2018





Images taken by Foth Staff on a March 2018 tour of Randy's Sanitation, Delano, MN. The images show waste being loaded onto a conveyor belt and Waste Robotics automatic sorting technology picking "Blue Bags" for separation.

Need:

- Tipping floor space or separate adjoining building for delivery and sorting that eventually feeds into the tip floor or main processing lines.
- New equipment for processing waste, e.g. robotic sorters.
- Collection space for separated DCBs.
- Loading dock time – transfer trailer – to transport DCBs to the organic processor.
- New equipment mainteance training and SOPs.

Annual Operating Costs:

- Automated picking equipment and conveyor operating and maintenance costs. Total cost = $15,000-$25,000

One-time Capital Costs:

- Automated picking equipment (including conveyors and construction costs). Total cost = $800,000-$1,400,000.
- Individual robotic picker units are $400,000 to $800,000 per unit.
- Adjoining building for waste delivery and new sorting equipment. Total cost = $3,500,000- $5,000,000 (depending on size of building).

Pros:

- ♦ Separation is completed without pickers.
- ♦ No new staff is needed for operations.
- ♦ Technology is flexible. Automated picking machines could be used to collect various items beyond organics including but not limited to textiles or batteries.
- ♦ The technology works well with bagged and loose garbage.

Cons:

- ♦ Separation is dependent on a new technology that has not been previously used at the R&E Center or by R&E Center staff.
- ♦ Current space constraints; may require new structure for waste delivery and processing.

Estimated Success Rate*:*

- ♦ High. This method meets the goals of no pickers and safety requirements of the R&E. With this method, initial cost remains the only significant barrier.

<u>Sorting of DCBs at other Facilities</u>

Handling of DCBs in transfer trailers

Currently, 40 percent of incoming waste to the R&E Center is direct hauled and 60 percent is delivered in transfer trailers. The impact of DCBs being loaded into transfer trailers and then hauled to the R&E Center for processing is unknown (e.g. breakage rate of bags).

Instead of sorting all DCBs from trash coming in from transfer stations at the R&E Center, DCBs could be separated at a transfer station or a bag separation vendor. Note no bag separation vendor currently operates in the Twin Cities Metropolitan region. Potential vendors could be requested to provide DCB sorting capabilities on behalf of the R&E Board. Details are in preliminary stages for transfer stations to sort DCBs.

Appendix A
Non-Residential Scenario Details

Scenario 1

15 percent of All Non-residential Businesses from the D&B database

Recovering Mixed Organics at a 50 Percent Capture Rate

		TOTAL R & W (a)		WHAT IF SCENARIOS				GENERATION RATES	
Primary SIC Code	Category	Number of Establish-ments	Number of Employees	15% of All Establish ments	50% FW Capture Rate [Tons/Yr]	50% CP Capture Rate [Tons/Yr]	TOTAL	Tons FW / Employee / Year (b)	Tons CP / Employee / Year (c)
20	Food and Kindred Products	90	2,295	14	71	35	106	0.41	0.21
51	Wholesale Trade - non-durable Goods	578	8,090	87	243	121	364	0.40	0.20
54	Food Stores	549	7,284	82	683	341	1,024	1.25	0.63
58	Eating and Drinking Places	982	20,704	147	1,708	854	2,562	1.10	0.55
70	Hotels, Rooming Houses, Camps, and Other Lodging Places	156	3,734	23	50	25	76	0.18	0.09
79	Amusement and Recreation Services	22	253	3	1	0	1	0.05	0.03
80	Health Services	2,135	40,904	320	123	61	184	0.04	0.02
82	Educational Services	602	30,193	90	294	147	442	0.13	0.07
Public Administration:									0.00
83	Social Services	8	6,495	1	24	12	37	0.05	0.03
87	Engineering, Accounting, Research, Management, and Related Services	7	1,929	1	7	4	11	0.05	0.03
91	Executive, Legislative, and General Government, Except Finance	123	5,545	18	21	10	31	0.05	0.03
92	Justice, Public Order, and Safety	118	5,670	18	21	11	32	0.05	0.03
93	Public Finance, Taxation, and Monetary Policy	15	2,577	2	10	5	14	0.05	0.03
94	Administration of Human Resource Programs	51	5,561	8	21	10	31	0.05	0.03
95	Administration of Environmental Quality and Housing Programs	64	4,211	10	16	8	24	0.05	0.03
96	Administration of Economic Programs	74	9,478	11	36	18	53	0.05	0.03
97	National Security and International Affairs	15	748	2	3	1	4	0.05	0.03
Varies	Other Public Administration	27	5,955	4	22	11	33	0.05	0.03
	TOTALS	5,616	161,626	**842**	**3,353**	**1,677**	**5,030**		

Notes:

(a) Total of Ramsey (R) and Washington (W) Counties' non-residential establishments characterized per the Dun & Bradstreet (D&B) database.

(b) Food waste (FW) generation rates (tons per employee per year) are derived from the California Integrated Waste Management Board (February 2000), *Business Group Waste Compositions, Solid Waste Characterization Database.*

(c) Compostable paper (CP) generation rates (tons per employee per year) are assumed to be one-half of the corresponding FW generation rates.

Yellow highlighted categories represent the top three non-residential food waste generation sectors.

Scenario 2

25 percent of the Top Three Non-residential Business Categories Recovering Mixed Organics at a 75 Percent Capture Rate

		TOTAL R & W [a]		WHAT IF SCENARIOS				GENERATION RATES	
Primary SIC Code	Category	Number of Establish-ments	Number of Employees	25% of Top 3 Categories	75% FW Capture Rate [Tons/Yr]	75% CP Capture Rate [Tons/Yr]	TOTAL	Tons FW / Employee / Year [b]	Tons CP / Employee / Year [c]
20	Food and Kindred Products	90	2,295	0	0	0	0	0.41	0.21
51	Wholesale Trade - non-durable Goods	578	8,090	0	0	0	0	0.40	0.20
54	Food Stores	549	7,284	137	1,707	854	2,561	1.25	0.63
58	Eating and Drinking Places	982	20,704	246	4,270	2,135	6,405	1.10	0.55
70	Hotels, Rooming Houses, Camps, and Other Lodging Places	156	3,734	0	0	0	0	0.18	0.09
79	Amusement and Recreation Services	22	253	0	0	0	0	0.05	0.03
80	Health Services	2,135	40,904	0	0	0	0	0.04	0.02
82	Educational Services	602	30,193	151	736	368	1,104	0.13	0.07
Public Administration:									0.00
83	Social Services	8	6,495	0	0	0	0	0.05	0.03
87	Engineering, Accounting, Research, Management, and Related Services	7	1,929	0	0	0	0	0.05	0.03
91	Executive, Legislative, and General Government, Except Finance	123	5,545	0	0	0	0	0.05	0.03
92	Justice, Public Order, and Safety	118	5,670	0	0	0	0	0.05	0.03
93	Public Finance, Taxation, and Monetary Policy	15	2,577	0	0	0	0	0.05	0.03
94	Administration of Human Resource Programs	51	5,561	0	0	0	0	0.05	0.03
95	Administration of Environmental Quality and Housing Programs	64	4,211	0	0	0	0	0.05	0.03
96	Administration of Economic Programs	74	9,478	0	0	0	0	0.05	0.03
97	National Security and International Affairs	15	748	0	0	0	0	0.05	0.03
Varies	Other Public Administration	27	5,955	0	0	0	0	0.05	0.03
	TOTALS	5,616	161,626	**1,404**	**6,713**	**3,357**	**10,070**		

Notes:

(a) Total of Ramsey (R) and Washington (W) Counties' non-residential establishments characterized per the Dun & Bradstreet (D&B) database.

(b) Food waste (FW) generation rates (tons per employee per year) are derived from the California Integrated Waste Management Board (February 2000), *Business Group Waste Compositions, Solid Waste Characterization Database.*

(c) Compostable paper (CP) generation rates (tons per employee per year) are assumed to be one-half of the corresponding FW generation rates.

Yellow highlighted categories represent the top three non-residential food waste generation sectors.