Peer Review of "Preliminary Design for Processing Enhancements at the Recycling & Energy Center" Prepared by Foth Infrastructure & Environment, LLC, January 2019

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Exhibits

1.0 EXECUTIVE SUMMARY

The Ramsey/Washington Recycling & Energy Board (R&E Board) is considering enhancements to its existing Recycling & Energy Center (R&E Center). The purposes of the enhancements are to 1) process a portion of the municipal solid waste (MSW) delivered to the R&E Center to recover residential food waste through a proposed durable compostable bag (DCB) recovery system, and 2) increase the recovery of #1 PET and #2 HDPE plastics and ferrous and non-ferrous metals (other targeted recyclables) from the mixed MSW before processing the remaining screened MSW through its refuse derived fuel (RDF) process. As part of the evaluation process, the R&E Board retained SCS Engineers (SCS) to provide a peer review of the “Preliminary Design for Processing Enhancements at the Recycling & Energy Center” report (Preliminary Design Report) prepared by Foth Infrastructure & Environment, LLC (Foth). The purpose of this review is to identify potential fatal flaws and risks relative to the preliminary engineering and process designs, business and procurement assumptions, operations, regulatory requirements, and costs. This report presents SCS’s findings regarding the fatal flaw and risk analyses.

The preliminary design prepared by Foth presents the basis of design for a processing system to manage 225,000 tons of MSW for DCB recovery and 194,000 tons of MSW for recyclable commodities recovery at the R&E Center. The processing enhancements to the R&E Center would be located adjacent to the current RDF system at the R&E Center within the existing R&E Board-owned or leased property. The project involves expanding the existing building to the north (North Addition), modifications to the existing building, installation of a process line to recover the DCBs (DCB Processing System), and a process line to recover the other targeted recyclables (Recyclables Recovery System) (See Exhibit 1).

The process enhancements capital costs and projected revenues are summarized below:

Summary of Estimated Costs for Process Enhancements and Projected Revenue[1]

Item	Low	High
DCB Processing	$12,200,000	$17,800,000
Recyclables Recovery	$15,100,000	$20,500,000
Total[(a)]	**$27,300,000**	**$38,300,000**
O&M Costs[(b)]	$4,700,000/year	$5,100,000/year
Potential Revenues (Recyclables)	$1,900,000/year	$2,700,000/year
[(a)]SCS understands that R&E staff and its consultants are preparing life-cycle cost analysis that considers other costs (both increases and decreases) that may occur from the implementation of the DCB Processing and Recycling Recovery programs and systems. [(b)]O&M costs do not include DCB compost bag program, transportation, or composting or anaerobic digestion costs. These other high-level business costs are discussed in Section 2.8 and Exhibit 11.		

[1] Foth Infrastructure & Environment, LLC, Preliminary Design for Processing Enhancements at the Recycling & Energy Center,” Draft Report, January 2019, Table 13-1.

SCS's findings from the peer review of Foth's Preliminary Design Report are summarized below:

1. Fatal Flaw Review. SCS did not identify a fatal flaw in the overall preliminary design or estimated facility and operational cost estimates for the facility. SCS believes the goals for the project are well defined, and the proposed preliminary design concepts developed by Foth and presented in the Preliminary Design Report are consistent with these goals.

2. Technical and Process Risks. The facility design is well developed and fully explained in the Preliminary Design Report. The performance metrics for each piece of equipment are described in detail and are reasonable. Several design comments are provided below for consideration as the design progresses.

    a. The success of diverting household organic waste, and therefore the proposed DCB Processing System, will largely rest on three key components:

        i. Performance and reliability of the robotic arms that will extract the DCBs from the mixed MSW prior to the Recyclables Recovery System line. The proposed equipment has been deployed elsewhere (e.g., Randy's Sanitation), but the technology and equipment is fairly new and relatively unproven. The preliminary design is based on an assumed number of picks per minute. With the DCB recovery occurring at the beginning of the processing train, the DCBs may be obstructed by other materials. The success of the robotics will depend in part on the burden depth. SCS recommends that additional redundancy be provided in the design, including additional robotic arms and/or machines if possible, and sufficient spare parts be maintained to achieve the target extraction rates.

        ii. Minimizing the amount of contamination in the DCBs, which can affect the ability of the post-markets to accept the DCBs. This will require education and monitoring resources, along with willing and conscientious participants. If a compost facility has enough clean material coming in, they may turn away material that has more contamination.

        iii. Capacity of the post-markets to accept the DCBs. SCS recommends that additional research be invested into the potential post-markets for the DCBs. How much remaining capacity do the two existing compost facilities have to accept additional feedstock? What are their standards regarding contamination? Are they willing to accept the organics in the DCBs (i.e., some compost facilities do not want material to be bagged, including those that are Biodegradable Products Institute [BPI]-certified)? Are the bags likely to be acceptable to future anaerobic digestion facilities?

    b. SCS recommends the DCB program be rolled out into neighborhoods in phases for the following reasons:

        i. Foth estimates 10 to 40 percent participation among households, from initial implementation to maturity. This range is reasonable for design of the DCB Processing System. However, if higher participation is realized, the system could be overburdened. By staging the roll-out and monitoring the participation rate, the R&E Board can better manage the tonnages received with the system's capabilities.

        ii. The integrity of the DCBs coming out of the collection trucks can be monitored. While co-collected among other MSW and within compactor trucks, there is a possibility that the bags will not come into the R&E Center intact. If significant issues are identified, alternative options may be explored (e.g., other BPI-certified bags).

c. SCS recommends that Foth consider including sufficient space in the process line to include manual sorting stations in the future if needed to improve the quality of the recyclable materials recovered, or for removal of items that can damage the shredders, screens, conveyors, or other process equipment. SCS understands that available space to construct the Recyclables Recovery System equipment is limited, so providing this future capability may not be feasible.

d. SCS estimates available storage would be approximately 700 to 1,200 tons compared to Foth's estimate of 800 to 1,400 tons. SCS's and Foth's estimates are generally consistent, although SCS's estimate is a little less. The available tip floor storage capacity, including accounting for access needs, should be confirmed for the preliminary design report and refined as the design progresses. Given that the R&E Center can divert to the main RDF tip floor and that the space available for the tip floor is constrained, this probably is not material.

e. Additional consideration should be given during the final design/specification stage to confirm the capacities of the equipment and address peak disposal rates and available storage, given the relatively limited tipping floor area proposed for the processing system enhancements.

f. SCS believes the supporting waste characterization studies are adequate for the design development. SCS performed a conceptual analysis on the impact to the theoretical energy content of the RDF based on the waste characterization studies and the materials that would be removed through the proposed processing systems. SCS estimates the total energy delivered from the RDF facility could be marginally reduced (less than 2 percent) based on extraction of recyclables from the proposed processing system enhancements. This reduction is within the margin of accuracy of the estimates and is not thought to be material.

3. Procurement Risks. SCS concurs with Foth's recommendations that the building addition improvements are well-suited for the traditional Design-Build Approach, and that an Alternative Project Delivery method should be considered for the DCB Processing and Recyclables Recovery Systems. The scope of the work for the building addition and site improvements can be well defined from an engineering perspective for bidding purposes. Local general contractors with commercial/industrial building and sitework experience could readily bid and construct this element of the project based on design plans prepared by the R&E Board's Architectural and Engineering Firm, and oversight of the building additions and site improvements are within the management and technical capabilities of R&E staff and its consultants. However, for the DCB Processing and Recyclables Recovery Systems, the equipment vendors that might respond to a bid request for the DCB Processing and Recyclables Recovery Systems likely would employ potentially alternative, innovative, and unique approaches to achieve the design objectives established for these recovery systems. An Alternative Project Delivery approach would allow the processes to be better integrated and performance guarantees and warranties established and controlled. We recommend that the DCB Processing and Recyclables Recovery System equipment be procured as one project in order to maximize the efficiency of the design and reduce contractual conflicts if problems arise with the processes. However, the DCB Processing and Recycling Recovery Systems do function independently, and if procuring these systems under separate procurements would provide scheduling or other cost benefits, such an approach would be manageable.

4. Environmental Risks. SCS believes the proposed environmental controls are appropriately considered in the Preliminary Design.

5. Regulatory Risks. SCS believes that Foth has identified the permits and approvals required for the processing system enhancements, including from the City of Newport, Minnesota Pollution Control Agency, and Washington County, and the permitting processes should be manageable and not cause unanticipated delays in the project implementation.

6. Construction Risks. The area proposed for the processing system enhancements is adjacent to the existing RDF processing lines. Foth has considered the existing space constraints in the preliminary design using 3-D modeling. This should minimize construction risks; however, retrofitting existing buildings always poses higher risks, which should be accounted for in the contingency budget.

7. Operations Risks. The R&E Center staff are experienced with mixed waste processing equipment and operations. The proposed Processing Enhancement equipment and facilities are similar to the existing R&E Center equipment and operations. As such, the operations risks are manageable.

8. High-Level Business Risks.

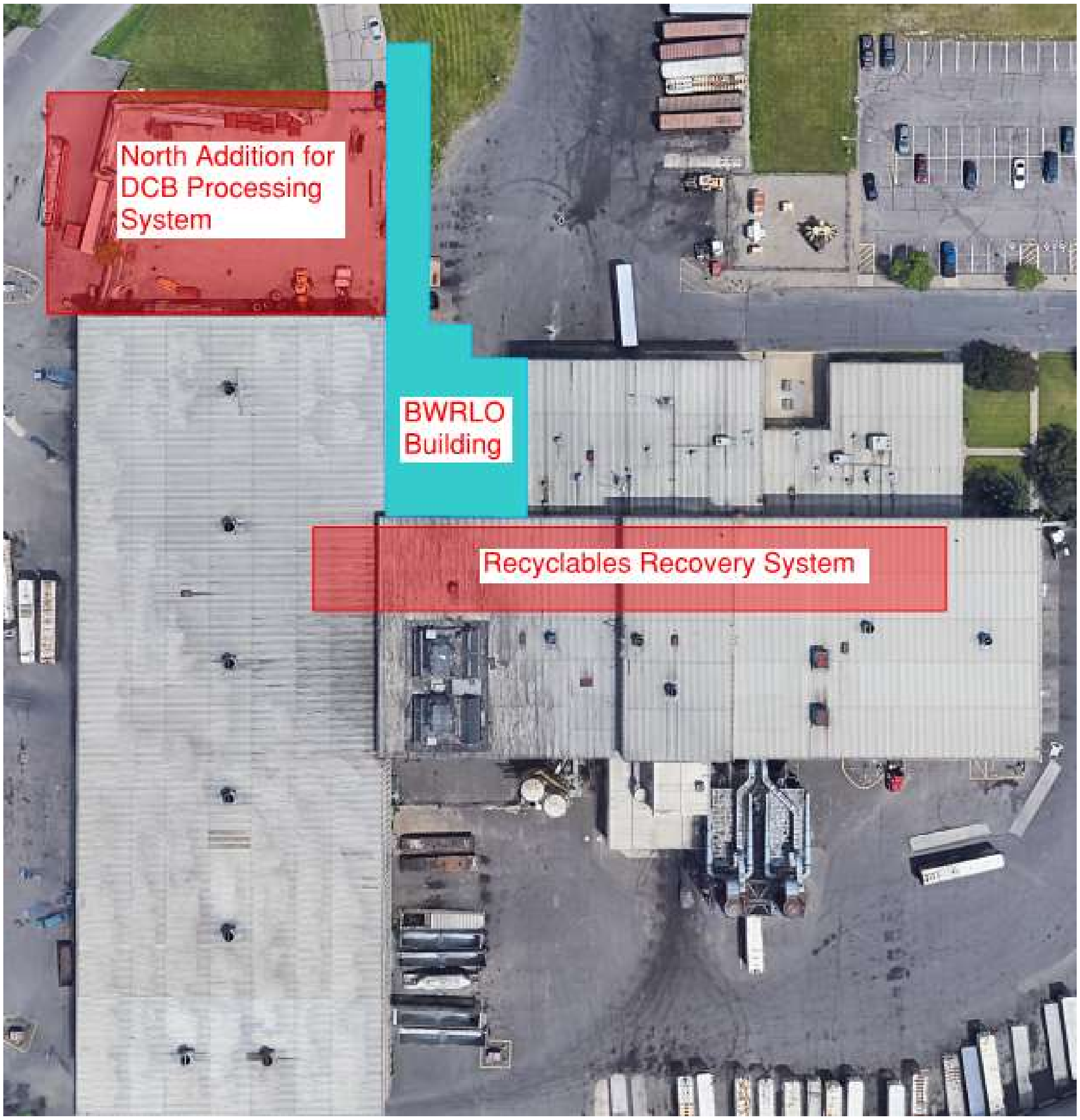
    a. The Processing Enhancement project will remove the DCBs and extract #1 PET, #2 HDPE, ferrous and non-ferrous metals, and old corrugated cardboard (OCC). The balance of the materials will be processed through the existing RDF, and process residuals managed as they currently are. The initial plan is to compost the DCBs at an existing facility in the Ramsey/Washington County metropolitan region, but the long-term goal is to anaerobically digest the organics and recover the biogas, and then compost the digestate for beneficial use.

    b. From a high level perspective, the technology proposed is generally proven, the costs reasonably identified, and the risks manageable.

    c. Offsetting revenues from the sale of recyclable commodities is considered in the Foth analysis. Commodity markets are volatile, and the recycling industry has experienced significant commodity pricing headwinds (i.e., lower prices) for certain commodities as a result of China's stricter contamination limit requirements. However, Foth has considered the current pricing stresses and provided a range of anticipated revenues based on estimated recoveries and discounted pricing. An explanation of the "negative" revenues shown in Exhibit 6 for the DCB Processing System should be explained. The project will result in significant increased costs to the Ramsey/ Washington R&E Board, which will need to be considered in the establishment of future tip fees and/or subsidies from the counties.

    d. The proposed enhancements will increase overall system costs. A preliminary assessment of the additional costs is presented in Exhibit 11; however, SCS understands that the R&E staff and its consultants are evaluating the life-cycle costs associated with the proposed system enhancements and will be reporting on this in the near future.

Exhibit 1. R&E Center Preliminary Design Layout[2]



[2]Foth Infrastructure & Environment, LLC, Preliminary Design for Processing Enhancements at the Recycling & Energy Center," Draft Report, January 2019, p. 8.

2.0 PEER REVIEW ANALYSIS

2.1 GOALS AND OBJECTIVES OF PROPOSED SYSTEM

Minnesota's State goal for Metropolitan Counties is to recycle 75 percent of waste generated by 2030.[3] Minnesota statutes define recycling as "the process of collecting and preparing recyclable materials and reusing the materials in their original form or using them in manufacturing processes that do not cause the destruction of recyclable materials in a manner that precludes further use."[4] For purposes of determining recycling rates, recyclable materials are further defined by statute as "materials that are separated from mixed municipal solid waste for the purpose of recycling or composting, including paper, glass, plastics, metals, automobile oil, batteries, source-separated compostable materials, and sole source food waste streams that are managed through biodegradative processes. Refuse-derived fuel or other material that is destroyed by incineration is not a recyclable material."[5] Resource recovery is defined as "the reclamation for sale, use, or reuse of materials, substances, energy, or other products contained within or derived from waste."[6]

Ramsey and Washington Counties have specific recyclables recovery goals. According to the Minnesota Pollution Control Agency (MPCA) SCORE Report for 2016, Ramsey and Washington Counties have achieved recycling rates of 36.1 percent and 41.5 percent, respectively.[7] Ramsey County believes that the MPCA's analysis understates the County's recycling because MPCA did not allow for commercial recycled tonnage estimates provided by Ramsey County to be considered in the calculation. The County believes it has achieved approximately 52 percent recycling. The proposed DCB Processing System and Recyclables Recovery System are designed to facilitate Ramsey/Washington Counties achieving the 75 percent recycling goal by:

1. Removal and recovery of residentially collected household organics including:
    a. composting and/or
    b. energy generation through Anaerobic Digestion (AD) and utilization of the AD digestate through composting.

2. Recovery of ferrous and non-ferrous metals, readily recoverable #1 PET and #2 HDPE plastics, and OCC in the remaining MSW prior to processing for RDF.

In addition, the preliminary design of the proposed facility includes provisions for future enhancements for the recovery of OCC and Organic Rich Materials. Organic Rich Materials are a subset of the residuals generated through the DCB Processing and Recyclables Recovery Systems that have a high organic content, but are contaminated with other non-organic items.

SCS believes the goals for the project are well defined, and the proposed preliminary design concepts developed by Foth and presented in its Preliminary Design for Processing Enhancements at the Recycling & Energy Center are consistent with these goals.

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[3] Minnesota Statutes, § 115A.551.
[4] Minnesota Statutes, § 115A.03
[5] Minnesota Statutes, § 115A.551
[6] Minnesota Statutes, § 115A.03.
[7] Report on 2016 SCORE Programs, MPCA, January 2018.

2.2 WASTE COMPOSITION ASSUMPTIONS

Several waste characterization studies have been conducted at the R&E Center over the last 6 years.[8] The 2016 to 2017 waste characterization estimated seasonal variations and other waste characteristics of the residential waste stream such as bagged versus loose, percent by size, and moisture content. Based on a review of these studies and SCS's experience on other waste characterization projects, SCS believes the supporting waste characterization studies are adequate for the design development.

SCS performed a conceptual analysis on the impact to the theoretical energy content of the RDF based on the waste characterization studies and the materials that would be removed through the processing system enhancements. SCS estimates the total energy delivered from the RDF facility could be marginally reduced (less than 2 percent) based on extraction of recyclables from the processing system enhancements. This reduction is within the margin of accuracy of the estimates and is not thought to be material.

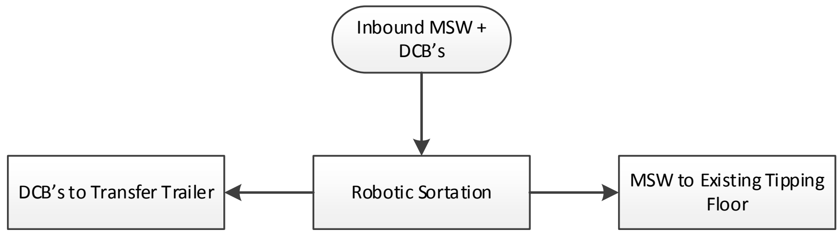
2.3 PROCESS FLOW DIAGRAMS

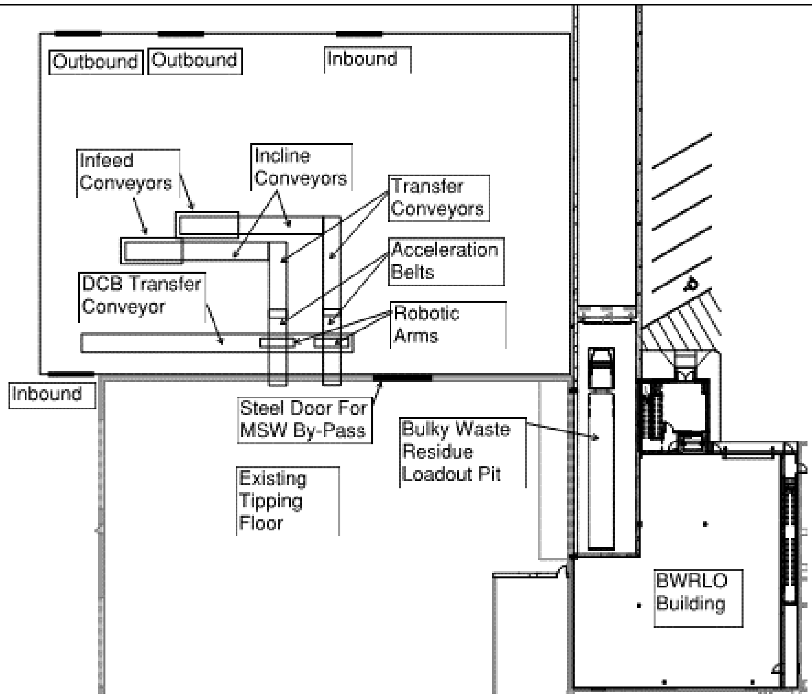
The process flow diagrams for the proposed DCB Processing and Recyclables Recovery Systems are presented in Exhibit 2 and Exhibit 3, respectively. The process system design is governed by the following major design criteria:

1. Maximize automation and minimize the use of labor for sorting recyclables. This is based on the R&E Board's desire to minimize manual sorting of materials.
2. Maximize the recovery of DCBs (residential household organics) prior to processing recyclables.
3. Maximize recovery of #1 PET and #2 HDPE plastics, OCC, and ferrous and non-ferrous metals.
4. Fit within the R&E Center property.

[8] The following waste characterization studies were prepared for the R&E Board using standard sampling and sorting procedures in accordance with ASTM Standard D5231:
Foth. *Waste Composition Study*. September 2014.
Burns & McDonnell. *Solid Waste Composition Analyses – Letter Report*. February 13, 2018.
SAIC. *Solid Waste Composition Study – Newport Resource Recovery Facility*. September 17, 2012.

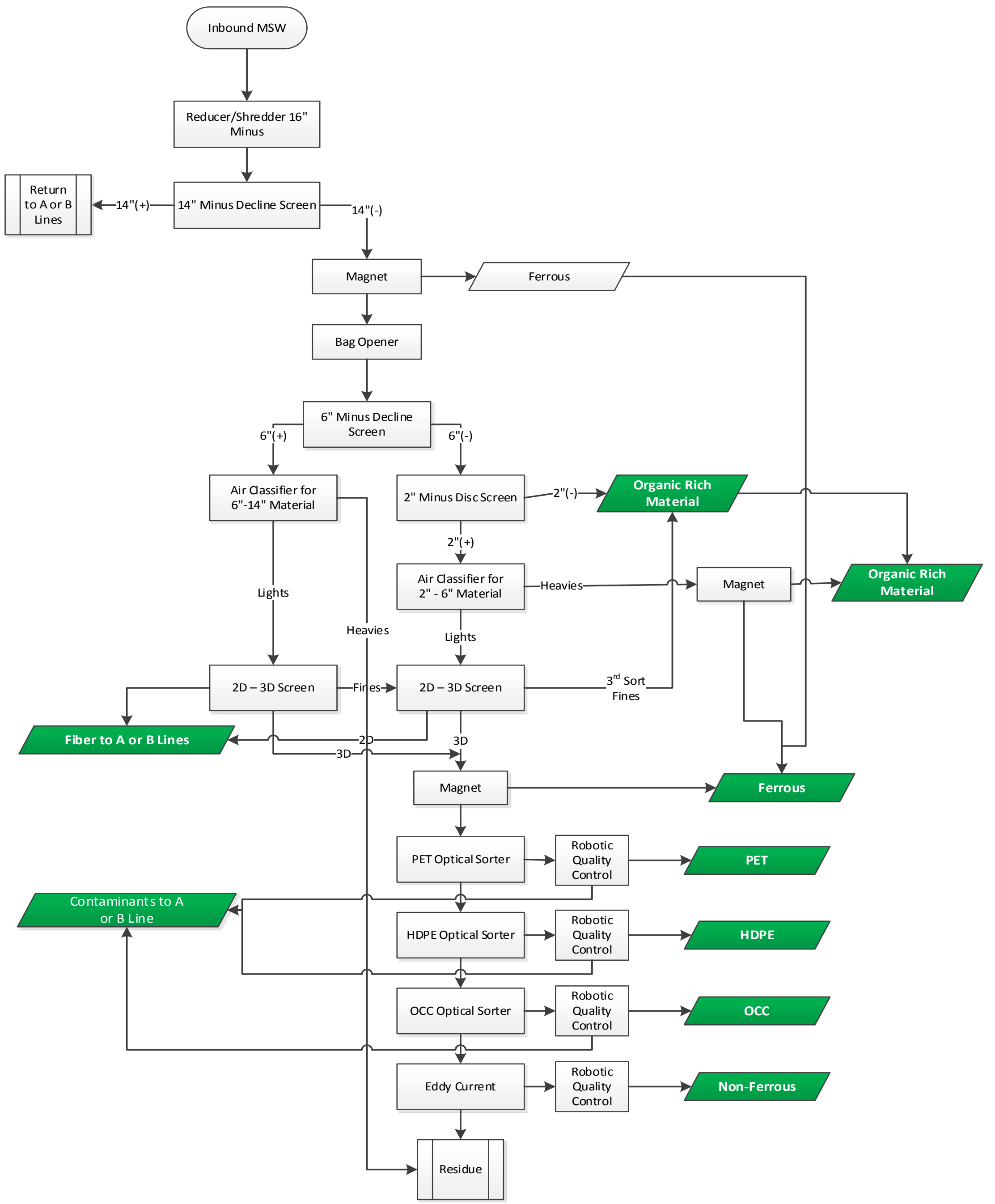
Exhibit 2. Process Flow Diagram for the DCB Processing System





Source: Foth Infrastructure & Environment, LLC, Preliminary Design for Processing Enhancements at the Recycling & Energy Center," Draft Report, January 2019, p. 12-13.

Exhibit 3. Process Flow Diagram for the Recyclables Recovery System



Source: Foth Infrastructure & Environment, LLC, Preliminary Design for Processing Enhancements at the Recycling & Energy Center," Draft Report, January 2019, p. 19.

2.4 MATERIAL RECOVERY PROCESS DESIGN FEATURES AND EQUIPMENT

SCS understands that Foth and members of the R&E Board and staff have conducted site visits and consulted with a number of equipment vendors during the preparation of the preliminary design. [9] SCS further understands that the meetings, discussions, and site visits with these vendors has informed the development of the preliminary design and estimated costs.

2.4.1 Tipping Floor

Foth indicates that the North Addition will provide approximately 8,000 square feet of tipping floor space for MSW, and will provide 4,000 cubic yards of storage, equating to 800 to 1,400 tons of MSW. Based on the proposed tip floor sizing, SCS independently checked the potential available capacity of the tip floor, and compared it against the average daily and potential maximum daily deliveries to the facility. A summary of the review calculations is provided in Exhibit 4.

SCS estimates available storage would be approximately 700 to 1,200 tons compared to Foth's estimate of 800 to 1,400 tons. SCS's and Foth's estimates are generally consistent, although SCS's estimate is a little less. The available tip floor storage capacity, including accounting for access needs, should be confirmed for the preliminary design report and refined as the design progresses. Given the R&E Center can divert to the main RDF tip floor and that the space available for the tip floor is constrained, this probably is not material.

2.4.2 Durable Compost Bags Processing System

The DCBs would be recovered using two robotic arms to pull the bags off the conveyor belt before being processed through the Recyclables Recovery System. The recovered DCBs would be transported either to an existing compost facility or future AD facility. Foth reports that compost facilities exist currently in the region that could support this program; however, regional AD facilities have yet to be developed. The other targeted recyclables would be removed from the waste stream through a series of size reduction, mechanical screening, mechanical separation, air separation, and optical screening equipment (see Exhibit 2). The other targeted recyclables would be sold to existing regional recycling markets.

The proposed DCB Processing System is estimated to achieve the following recovery:

1. DCBs: 1.9 million bags per year at the beginning of the DCB program to 7.6 million bags per year at program maturity.[10]
2. Foth estimates this to equate to 7,600 to 31,000 tons per year of organics diverted from the waste stream.[11]

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[9] Bulk Handling Systems (BHS), CP Group, Machinex, and Van Dyk, AMP Robotics, Eggersman, Green Machine, Mayfran International, Novamont, Optibag, Organix Solutions, Plexus, RRT Design & Construction, SSI Shredders, Stadler, Vecoplan, and Waste Robotics.

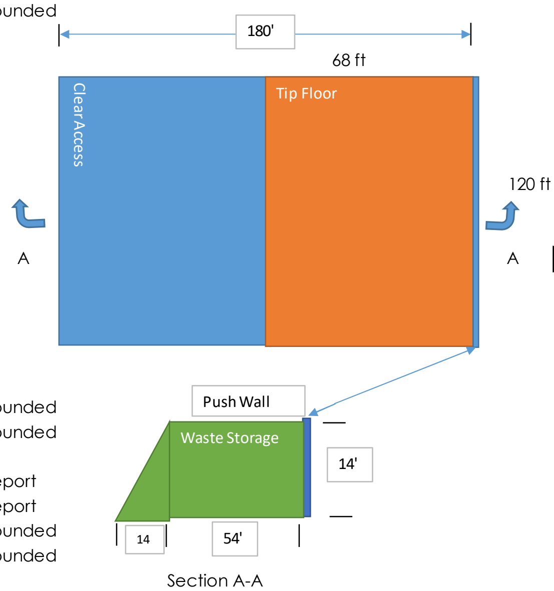
[10] Foth Infrastructure & Environment, LLC, Preliminary Design for Processing Enhancements at the Recycling & Energy Center", Draft Report, January 2019, p. 12.

[11] Foth Infrastructure & Environment, LLC, Processing Alternatives: Durable Compostable Bag (DCB) Technology, November 20, 2018, p. 5.

Exhibit 4. SCS Independent Conceptual Review of Tip Floor Sizing and Storage Capacity

Tip Floor Calculations

Item	Description	Value	
1	Total Yearly Tonnage	450,000 tpy	
2	Yearly Tonnage to R&E Expansion	225,000 tpy	
3	Operating Days Receiving Waste/week	6	http://morevaluelesstrash.com/recycling-energy-center/
4	**Daily Averages**		
4.1	Total Facility	1,440 tpd	rounded
4.2	New Processing Area	720 tpd	rounded
5	**Daily Max**		
5.1	Assumed Peak Daily Factor	1.50	
5.2	Peak Daily	2,160 tpd	
5.3	Peak Daily, New Processing Area, say 1.5 factor	1,080 tpd	
6	Tip Floor Area (Per Foth)	8,000 sf	
7	Check on available tip floor area	8,160 sf	
8	**Volume/Storage Capacity Calculations**		
8.1	Wall	14 ft	
8.2	Waste Slope (x:1)	1	
8.3	Volume Estimate	3,600 cy	
8.4	Density, pounds (lb)/cy (Low)	400 pcy	
	Density, lb/cy (High)	675 pcy	
8.5	Density, tons/cy (Low)	0.20 tcy	
	Density, tons/cy (High)	0.34 tcy	
9	**Confirm Storage Capacity**		
9.1	Tons Storage Capacity (Low)	700 tons	rounded
9.2	Tons Storage Capacity (High)	1,200 tons	rounded
10	**Report Capacity**		
10.1	Low	800 tons	report
10.2	High	1,400 tons	report
10.3	Assumed Basis: (8,000 x 14)/27*400 lbs/cy= (Low)	800 tons	rounded
10.4	Assumed Basis: (8,000 x 14)/27 * 675 lb/cy = (High)	1,400 tons	rounded
11	**Conclusion:** SCS estimates available storage would be approximately 700 to 1,200 tons compared to Foth's estimate of 800 to 1,400 tons. SCS's and Foth's estimates are generally consistent, although SCS's estimate is a little less. The available tip floor storage capacity should be confirmed for the preliminary design report and refined as the design progresses; however, given the waste can diverted to the main RDF tip floor and that the space available for the new processing system tip floor is constrained, this probably is not material.		



Note: The analysis presented above is conceptual. The design has not been finalized. The point of the analysis is to provide a point of reference with respect to the adequacy of the tipping floor area.

The use of robotic arms for automatic removal of targeted materials is a rapidly developing technology now being deployed at material recovery facilities. Foth evaluated both mechanical claw type and vacuum type configurations for the automated removal of the DCBs; and recommended the use of the mechanical claw type configuration due to concerns regarding the weight of the bags and the ability of the vacuum devices to pick up the heavier bags. Foth believes they have sufficient space to install one robotic arm on each line. The basis of the design established by Foth for the robotic arms is as follows:

Annual operating hours: 4,836 (18 hours per day, 4 days per week; 10 hours per day, 2 days per week; and 8 hours per day, 1 day per week, with 1 hour per day for startup and shutdown).

1. Type of Robot: Mechanical Claw
2. Number of Robotic arms: two
3. Number of Picks Required: 1.9 million to 7.6 million bags

4. Picks per minute: 7 to 27
    a. Min.: 1,900,000/4,836/60 = 7 picks per minute (confirmed)
    b. Max: 7,600,000/4,836/60 = 26 picks per minute (confirmed)

5. Reported performance range from mechanical clay type robotic arm: 30 picks per minute

Foth proposes two arms because the process line needs to run at 45 tons per hour, which they have concluded would be too fast for one arm. The incoming MSW would drop onto an in-line, 72-inch wide acceleration belt, which would minimize the burden depth and allow the robotic vision system and robotic arm to more efficiently detect and recover the DCBs. Foth does not believe that additional robotic arms will be necessary since two arms (one for each line) are reported to be capable of removing 50 bags per minute, and the maximum production rate at full maturity of the DCB program is 27 bags per minute.

SCS understands that Randy's Sanitation, located in Delano, Minnesota, operates a material recovery facility and recently installed a mechanical claw type robotic arm provided by Waste Robotics, based in Quebec City, Quebec, Canada to extract DCBs from the incoming waste stream. SCS understands the R&E Center team has visited this facility and reviewed their operations. The robotic equipment integrates artificial intelligence to learn what material to extract, and even includes the ability to select questionable bags for additional screening. The robots can also be programmed to extract other materials such as metal, OCC, plastics, rocks, etc.[12]

SCS confirmed the basic process flow calculations developed by Foth. However, the calculation assumes 100 percent uptime of the robotic arms; therefore, some percentage downtime should be considered in the performance specification and design of the system. The robotic arm is one of the more critical components of the proposed system in terms of production performance. As such, some redundancy, either in spare parts or additional arms, should be considered. SCS understands that the robotic arms can be configured with two mechanical claws each, which, if possible, would provide additional redundancy for this critical equipment. If this is the case, SCS recommends that Foth consider specifying additional mechanical claws or have sufficient spare parts in inventory to minimize downtime of the equipment.

In addition, SCS recommends that Randy's Sanitation be contacted again to confirm the performance of their relatively new robotic arms and document their operational experience. Information such as reliability, picks per minute, the number of bags delivered, etc. would be helpful in finalizing the specifications for the R&E Center's proposed facility. SCS understands that the DCB program feeding into Randy's Sanitation facility is relatively new, and that the number of bags delivered and the picks per minute may not be representative of what the R&E will experience. However, the additional information on this critical piece of information would be helpful nonetheless. SCS further recommends getting feedback from Randy's Sanitation and other DCB processing system owners on the amount of contamination observed in the DCBs and the resulting impact on being able to establish post-markets for these commodities. Lastly, SCS recommends that the existing compost facilities in the area be contacted to determine their ability to potentially accept the additional material and to obtain contamination standards, if available.

In addition, it may be worth exploring if some test runs could be conducted at the Randy's Sanitation facility during their off-hours to confirm the needed burden depth and see how the claw performs. We do not know if Randy's Sanitation would be open to this. This would require negotiating a short-term contract with them to do a test run, but given that the robotic arms are relatively

[12] https://www.waste360.com/fleets-technology/how-minnesota-operation-using-robotics-solution-sort-organics

expensive and are critical to the DCB Processing System performance objectives, such tests may be justifiable.

The success of the DCB system from the bigger picture also depends on making sure the proper materials are disposed in the DCBs. High levels of contamination could impact the success of diverting these materials altogether.

The grapple crane operators will be responsible for identifying and removing bulky waste and other unacceptable material from the incoming waste stream prior to the Recyclables Recovery System. There is not a similar defined means to remove these bulky and other unacceptable wastes prior to the DCB Processing System. As such, careful attention must be given to monitoring excessive wear and tear of the DCB Processing System equipment that might result from bulky materials inadvertently being loaded onto the infeed conveyors.

SCS recommends the DCB program be rolled out into neighborhoods in phases for the following reasons:

- Foth estimates 10 to 40 percent participation among households, from initial implementation to maturity. This range is reasonable for design of the DCB Processing System. However, if higher participation is realized, the system could be overburdened. By staging the roll-out and monitoring the participation rate, the R&E Board can better manage the tonnages received with the system's capabilities.

- The integrity of the DCBs coming out of the collection trucks can be monitored. While co-collected among other MSW and within compactor trucks, there is a possibility that the bags will not come into the R&E Center in-tact. If significant issues are identified, alternative options may be explored (e.g., other BPI-certified bags).

2.4.3 Recyclables Recovery System

The new Recyclables Recovery System equipment will be located adjacent to the existing RDF Facility A and B RDF Processing Lines. The new equipment will include shredders, bag openers, various disc screens, magnets, air classification, optical sorting, eddy current separation, and robotics for quality control of separated recyclable materials (see Exhibit 3). Foth's estimate of the low and high recovery of Other Targeted Recyclables is presented in Exhibit 5.

Foth indicates the equipment shown in the preliminary design was selected to minimize manual sorting. The grapple crane operator will be the primary screener for the incoming waste stream to remove unacceptable materials such as bulky items, combustible items (e.g., propane tanks), or other hazardous materials. Given the overall objectives of this mixed waste system, this approach seems reasonable. Contamination will be higher regardless of whether there were manual sorting stages. However, SCS recommends that Foth consider including sufficient space in the process line to include manual sorting stations in the future if needed to improve the quality of the recyclable materials recovered, or for removal of items that can damage the shredders, screens, conveyors, or other processing equipment. SCS understands that available space to construct the Recyclables Recovery System equipment is limited, so providing this future capability may not be feasible.

Foth estimates that PET, HDPE, ferrous and non-ferrous metals, and OCC recovery will be between 6,400 to 9,200 tons per year of recyclables, which will increase the recycling rate from 1.4 to 2.0 percent, assuming a total disposal rate of 450,000 tons per year delivered to the R&E Center. The values presented in Exhibit 5 are conservative from a tonnage perspective, which is appropriate for equipment sizing.

Exhibit 5. Estimated Tons Recovered with Recyclables Recovery System at the R&E Center[13]

Material[4]	Waste Composition (%)	Total Tons [1, 2]	Low Estimated Percent Recovery (%)	Low Estimated Tons Recovered	High Estimated Percent Recovery (%)	High Estimated Tons Recovered
PET	1.63%	3,153	60%	1,892	85%	2,680
HDPE	0.73%	1,407	60%	844	85%	1,196
Cardboard/ Boxboard	1.28%	2,478	30%	744	50%	1,239
Ferrous (tin/steel containers)	1.30%	2,522	65%	1,639	90%	2,270
Non-ferrous (Aluminum)	1.03%	1,989	65%	1,293	90%	1,790
Organic Rich Materials (food and yard waste)[3]	25%	48,452	30%	14,535	50%	24,226
Totals	**NA**	**59,999**	**NA**	**20,946**		**33,400**

[1] Material in Waste Stream Based on Waste Characterization.
[2] Assumes 194,000 tons of MSW will be processed with two processing lines at the R&E Center annually.
[3] Assumes recovery of Organic Rich Materials from the processing enhancements equipment targeting recyclables only (not DCB organics recovery). Volumes may change significantly at DCB system maturity.
[4]Shaded rows indicate initial materials targeted for recovery.

The fundamental basis of design for the proposed system is to size the incoming materials through the shredders, initial screens, magnets, and eddy current separators to separate and recover specific targeted items. The initial shredder will size the materials to 16-inch minus for the purpose of minimizing damage to the recyclable materials, as well as break open some of the bags. The 14- and 16-inch materials would be conveyed back to the tipping floor to be processed through the existing A or B RDF Processing Lines. The 14-inch minus material would pass over an electro-magnet to remove ferrous materials before continuing to a bag opener to break open the remaining unopened bags. This magnet may not be very effective at the front of the processing line, but may help remove some larger ferrous materials before it goes through the remaining processing line.

The material would then be segregated using a decline screen into 6- to 14-inch fraction and 6-inch minus fraction materials. The 6- to 14-inch materials would be conveyed to an air classifier to further segregate light and heavy fractions. The heavy fractions would be conveyed to the residue lines serving the A and B RDF Processing Lines. The lighter fraction materials would be further screened using 2D/3D screens to separate two-dimensional (fiber) and three-dimensional materials (bottles, cans, etc.). Materials that fall through the 2D/3D screens are anticipated to be Organic Rich Material. The two-dimensional materials would be conveyed to the existing A and B RDF Processing Lines.

The 6-inch minus fraction would be conveyed to a disc screen to remove organics (2-inch minus materials). The 2- to 6-inch fraction would pass through an air classifier to separate lighter and

[13] Ibid., Table ES-1, p. xi.

heavier factions, and then be passed over another belt-magnet to remove any remaining ferrous materials. The heavier fraction would be combined with the other organic rich fractions separated earlier in the process. The organic rich materials would be handled separately from the DCB materials. Initially the organic rich materials will be landfilled, but future processing may be considered to either anaerobically digest or compost these materials.

The light fraction would be conveyed to additional 2D/3D screens to separate fiber and three-dimensional containers and remaining fines. Two-dimensional fiber would be conveyed to the existing A or B RDF Processing lines, and the three-dimensional materials would be combined with the other 6- to 14-inch fraction three-dimensional materials and conveyed over another belt magnet to remove any remaining ferrous materials.

Optical sorters would remove #1 PET, #2 HDPE, and OCC from the three-dimensional material. The remaining materials would be conveyed over an eddy current separator to recover non-ferrous metals. Any remaining material would be considered residue and be processed along with the residue from the A and B RDF Processing Lines for disposal. Additional robotic quality control stations are planned to remove contaminants that remain prior to storage of the plastics and metals. The contaminants would be conveyed to the existing A and B RDF Processing Lines to be processed into RDF. A baler is included for baling the various plastics and metals. Bales would be stored where space is available. Removal of bales on a regular basis is expected to be necessary due to the limited bale storage space.

Foth indicates that the incoming feed through the DCB Processing System removal is designed to process between 45 and 50 tons per hour, based on 4,836 annual processing hours and 225,000 tons per year. SCS double-checked the math on the preliminary process rate and came up with an average 47 tons per hour as a minimum process capacity needed, which is within this range. Foth compares this design rate against the existing A and B RDF Processing Lines, which handle between 217,000 and 242,000 tons per year. However, additional consideration should be given during the final design/specification stage to confirm this capacity and address peak flows and available storage, given the relatively limited tipping floor area proposed for the process system enhancement areas.

2.4.4 Other Environmental Controls

The North Addition will include several high-speed access doors, a dry fire suppression system, dust and odor control, security, and lighting. The air handling system for the facility will be designed to create negative air pressure to control unsafe dust, odors, and carbon monoxide levels. An additional OMI – Ecosorb Vaporization Delivery Systems (VDS) will be installed for the building to assist with odor neutralization when the fan is in use. This system is consistent with the system used in the RDF Facility and has proven effective at controlling odors.

Current odor monitoring at the R&E Center includes random testing with the Nasal Ranger® Field Olfactometer periodically, as well as bare nose monitoring by R&E Center staff at each shift change. Foth recommends that monitoring should continue with an increased schedule as the DCB Processing System and Recyclables Recovery System begin operation in order to quickly detect odor issues and resolve them.

SCS believes the proposed environmental controls are appropriately considered in the Preliminary Design.

2.5 PERMIT AND REGULATORY ISSUES

The following permits have been identified:

1. Building permit (City of Newport). Foth reports that the building permit process can take 4 to 6 weeks to complete before construction can begin. **SCS believes the building permit process is straightforward and will not result in any unanticipated delays in the project implementation.**

2. Solid Waste Permit Modification (Minnesota Pollution Control Agency). Foth believes, based on conversations with the MPCA, that only a minor permit modification will be needed because the proposed enhancements do not increase the facility capacity, nor do they increase risk to human health and the environment. A minor permit modification will require submission of an Operations Manual and updated Stormwater Prevention Plan, along with a signed Solid Waste Permit Application for Construction and Operation. These documents would include updated documents, flow diagrams, and drawings showing the proposed changes. Public notice is not required for a minor modification, and MPCA must issue or deny the permit within 150 days of receipt of a complete application. **SCS concurs that permitting through the MPCA is a manageable process and is not expected to be an issue or cause unanticipated delays in the project implementation. A National Pollution Discharge Elimination System (NPDES)/State Disposal System (SDS) Construction Stormwater General Permit will also be required through MPCA. SCS does not expect this to be an issue, but it is another permit that will be required.**

3. Solid Waste Permit (Washington County). The County indicated that they would only need to be informed of the proposed process changes and schedule, and be provided the opportunity to review the construction plans for compliance with the Washington County Solid Waste Management Ordinance No. 202. Some changes to the existing permit may be required to address the organics removal components of the project. **SCS concurs that permitting through the County is a manageable process and should not cause unanticipated delays in the project implementation.**

2.6 CONTRACT AGREEMENTS AND PROCUREMENT

Foth identified the following construction and procurement approaches for the proposed recycling project:

1. Design-Bid-Build
2. Construction Manager-Agent
3. Construction Manager-Contractor (Construction Manager at Risk)
4. Design-Build
5. Integrated Project Delivery

Foth concluded that the R&E Board likely has significant leeway in contracting for the procurement of the North Addition and DCB Processing and Recyclables Recovery Systems. Foth's opinion is that the North Addition and other building improvements would be well-suited to a traditional Design-Bid-Build procurement approach. Foth believes that the DCB Processing and Recyclables Recovery System components may be better suited for one of the alternative procurement approaches because these systems are not as straight-forward.

SCS concurs with Foth's recommendations that the building addition improvements are well-suited for the traditional Design-Build Approach and that an Alternative Project Delivery method should be considered for the DCB Processing and Recyclables Recovery Systems. The scope of the work for the building addition and site improvements can be well defined from an engineering perspective for bidding purposes. Local general contractors with commercial/industrial building and sitework

experience could readily bid and construct this element of the project based on design plans prepared by the R&E Board's Architectural and Engineering Firm, and oversight of the building additions and site improvements are within the management and technical capabilities of R&E Center staff and its consultants. However, for the DCB Processing and Recyclables Recovery Systems, the equipment vendors that might respond to a bid request for the DCB Processing and Recyclables Recovery Systems likely would employ potentially alternative, innovative, and unique approaches to achieve the design objectives established for these recovery systems. An Alternative Project Delivery approach would allow the processes to be better integrated, and performance guarantees and warranties established and controlled. We recommend that the DCB Processing and Recyclables Recovery System equipment be procured as one project in order to maximize the efficiency of the design and reduce contractual conflicts if problems arise with the processes, assuming both processing enhancement systems were pursued at the same time. However, the DCB Processing and Recycling Recovery Systems do function independently, and if procuring these systems under separate procurements would provide scheduling or other cost benefits, such an approach would be manageable.

2.7 OPERATION AND MAINTENANCE PROCESSES

The Preliminary Design report provides an overview of the operation and maintenance requirements for the proposed facility and process enhancements, including safety processes and procedures relative to electrical systems, traffic, signage, and alarms; operation and maintenance training; and standard operating procedures. The items covered for operation and maintenance are appropriately and adequately covered. Foth should consider adding security systems and IT infrastructure to the list of items covered under this section.

2.8 ECONOMIC EVALUATION

2.8.1 Facility Cost Estimates

The Preliminary Design Report summary costs, revenue estimates, and supporting estimates for the building and equipment capital expenditures and O&M costs are presented in Exhibit 6, 7, 8, 9, and Exhibit 10 for the processing enhancements. Foth estimates the capital costs for enhancements will range between $27.3 and $38.3 million, which includes 20 percent contingency for construction costs and 30 percent for the equipment costs. O&M costs are estimated to range between $4.7 to $5 million per year. An explanation of the "negative" revenues shown in Exhibit 6 for the DCB Processing System should be provided.

SCS believes that Foth's estimates are thorough, rational, and appropriate for the preliminary design stage. They are based on a relatively detailed process design development, information provided by vendors, standard construction pricing, and their professional judgment. The estimates do not include financing costs. SCS suggests that the mechanical and electrical estimates be carefully reviewed, because these costs tend to be underestimated for projects of this nature. A higher contingency factor might be appropriate at this stage of the project for the construction elements, but this is a matter of judgment.

Exhibit 11 presents a summary of the projected annual system costs assuming the project is financed at 6 percent over a 25-year term. The Process Enhancements costs are presented on a unit-process basis (i.e., $/processed ton costs) and the system cost basis (i.e., $/total tonnage processed at the R&E Center, assumed at 450,000 tons per year). SCS also included estimates for transporting the DCBs to a compost facility ($15 per ton), the compost process costs based on the range of estimates provided by Foth ($40 to $60 per ton), the yearly DCB program bag cost estimate of $2.6 million per year, and savings resulting from diversion of materials from either Xcel (recyclables) or the landfill (DCBs).

SCS estimates that annual additional costs resulting from the Process Enhancements would be approximately $11.1 million to $11.7 million per year. This equates to a unit process cost of $50 to $52 per ton and a system cost increase of $25 to $26 per total ton processed at the R&E Center (see calculations and notes with Exhibit 11).

Exhibit 6. Summary of Costs Associated with Processing Enhancements and Potential Revenue[14]

System	Site Capital Costs	Equipment Capital Costs	Total Estimated Capital Costs	Annual O&M Costs	Potential Annual Revenue
DCB Processing	$7,000,000 - $10,800,000	$5,240,000 - $7,000,000	$12,240,000 - $17,800,000	$2,333,000 - $2,468,000	($3,798,000) – ($3,948,000)
Recyclables Recovery	NA	$15,100,000 – $20,500,000	$15,100,000 – $20,500,000	$2,382,000 - $2,621,000	$1,986,000 - $2,785,000
DCB Processing + Recyclables Recovery	$7,000,000 - $10,800,000	$20,340,000 - $27,500,000	$27,340,000 - $38,300,000	$4,715,000 - $5,089,000	($1,163,000) - ($1,812,000)
NA = No site capital costs are associated with the Recyclables Recovery System as it is designed to be installed within the existing R&E Center building.					

[14] Foth, Table ES-2, Page xi

Exhibit 7. North Addition Construction Cost Range[15]

Description	Low Range Cost	High Range Cost
General Conditions	$533,600	$816,400
Site Development	$637,300	$975,000
Concrete	$1,353,500	$2,070,900
Metals	$1,190,100	$1,820,900
Woods & Plastics	$52,500	$80,400
Thermal & Moisture Protection	$149,600	$228,900
Doors & Windows	$555,000	$849,200
Finishes	$70,000	$107,100
Mechanical	$314,200	$480,800
Electrical	$397,400	$607,900
SUBTOTAL	$5,253,200	$8,037,500
Contingency (20%)	$1,050,700	$1,607,500
TOTAL CONSTRUCTION COST	**$6,303,900**	**$9,645,000**
ADMIN/OTHER PROJECT COSTS (SEE NOTE 3)	**$725,000**	**$1,109,200**
TOTAL	**$7,028,900**	**$10,754,200**

NOTES:
1. Costs shown above do not include:
   a. Equipment
   b. Relocation expenses.
2. Costs were developed using 2019 dollars.
3. Includes engineering fees and an allowance for miscellaneous administrative costs.

[15] Ibid, Table 6-1.

Exhibit 8. Summary of Major Component Cost for the DCB Processing System[16]

Equipment Description	Quantity	Low Range Cost	High Range Cost
Robotics	2	$1,600,000	$2,000,000
Additional Loader	1	$500,000	$700,000
Conveyor Allowance	1	$1,125,000	$1,575,000
Subtotal		$3,225,000	$4,275,000
Installation	25%	$806,250	$1,068,750
Contingency	30%	$1,209,375	$1,603,125
Total Capital Costs		**$5,240,625**	**$6,946,875**

[16] Ibid, Table 6-2.

Exhibit 9. Summary of Major Component Cost for the Recyclable Recovery System[17]

Equipment Description	Quantity	Low Range Cost	High Range Cost
Shredder	1	$750,000	$1,000,000
Decline Screen	2	$700,000	$900,000
Electro-Magnets	3	$105,000	$180,000
Bag Opener	1	$150,000	$200,000
2-Inch Minus Screen	1	$275,000	$400,000
2D/3D Screen	2	$700,000	$850,000
Air Classifier	2	$900,000	$1,150,000
Optical Sorters	3	$1,800,000	$2,250,000
Eddy Current Separator	1	$300,000	$450,000
Robotic Quality Control	4	$1,100,000	$1,700,000
Conveyor Allowance	1	$2,000,000	$2,750,000
Grapple Crane	1	$225,000	$275,000
Silo Allowance	1	$300,000	$500,000
Subtotal		$9,305,000	$12,605,000
Installation	25%	$2,326,250	$3,151,250
Contingency	30%	$3,489,375	$4,726,875
Total Capital Costs		**$15,120,625**	**$20,483,125**

[17] Ibid, Table 6-3.

Exhibit 10. Overall O&M Cost Estimates For Both Processing Enhancement Systems[18]

Item	Annual Cost Estimates								
	DCB Processing System			Recyclables Recovery System			TOTAL		
Labor[1]			$1,715,000			$1,464,000			$3,179,000
Parts and Supplies	$250,000	to	$333,000	$500,000	to	$667,000	$750,000	to	$1,000,000
Electricity	$108,000	to	$133,000	$217,000	to	$267,000	$325,000	to	$400,000
Fuel	$55,000	to	$70,000	$0	to	$0	$55,000	to	$70,000
Contingency	$205,000	to	$217,000	$201,000	to	$223,000	$406,000	to	$440,000
TOTAL O&M COST ESTIMATE	**$2,333,000**	**to**	**$2,468,000**	**$2,382,000**	**to**	**$2,621,000**	**$4,715,000**	**to**	**$5,089,000**

[18] Ibid, Table 7-3.

Exhibit 11. Estimated Total System Costs for Process Enhancements[(a)]

Item	Description	Assumption		Comments
1.	Interest	6%		Assumed
2.	Term	25		Assumed
3.	Development and Financing	20%		Assumed
4.	Assumed DCB and RDF Transfer Costs	$15.00/ton		Estimated
5.	Assumed Xcel Tip Fee	$22.00/ton		Telcon with Foth, 2/28/19
6.	Assumed LF Tip Fee	$37.05/ton		3/1/19 Email from Leigh Behrens
7.	Full Disposal Tonnage	450,000 tons/yr		R&E estimate
8.	Tons Processed by Process Enhancements	225,000 tons/yr		Foth estimate
9.	Diverted Recyclables			
10.	High	9,200 tons/yr		Foth estimate (Table 8-2, less org rich mat'l)
11.	Low	6,400 tons/yr		Foth estimate (Table 8-2, less org rich mat'l)
12.	Total DCBs Organics Removed	31,000 tons/yr		Foth estimate for mature DCB program
13.	Weight reduction via RDF	70%		SCS assumption
14.	Capital Costs	($38,300,000)		Foth estimate, High
15.	Development and Financing	($7,660,000)		Item 14 x Item 3
16.	Total Costs	($45,960,000)	($3,595,000)/yr	Item 14 + Item 15; Amortized Costs
17.	O&M		($5,089,000)/yr	Foth estimate, High
18.	Subtotal Annual Process Enhancement Costs		($8,684,000)/yr	Item 16 + Item 17
19.	Processing Costs, $/ton		**($38.60)/ton**	Item 18/Item 8
20.	Average Revenue from Recyclables		$2,386,000/yr	Foth estimate (Table 13-1 average)
21.	Net System Costs		($6,298,000)/yr	Item 18 + Item 20
22.	Net Processing Costs		**($27.99)/ton**	Item 21/Item 8
23.	Cost to Compost/AD	High	**($60.00)/ton**	Foth estimate
24.		Low	**($40.00)/ton**	Foth estimate
	Summary of Costs(-)/Savings(+)			
25.	Processing Costs		($8,684,000)/yr	Item 18
26.	DCB Transfer		($465,000)/yr	Item 4 x Item 12
27.	DCB Composting	High	($1,860,000)/yr	Item 12 x Item 24
28.		Low	($1,240,000)/yr	Item 12 x Item 25
29.	DCB Bag Program		($2,600,000)/yr	Foth estimate, DCB Memorandum
30.	Reduced Xcel Disposal Costs (Recyclables)	High	$340,000/yr	Item 10 x (Item 4 + Item 5)
31.		Low	$237,000/yr	Item 11 x (Item 4 + Item 5)
32.	Reduced LF Disposal Costs (DCB materials)		$1,613,550/yr	Item 12 x (Item 6 + Item 4)
33.	Total Costs	High	**($11,655,450)**	Items 25+26+27+29+30+32
34.		Low	**($11,138,450)**	Items 25+26+28+29+31+32
35.	Processing Costs, $/ton	@ 225000 tpy		
36.		High	($52.00)	Item 33/Item 8
37.		Low	($50.00)	Item 34/Item 8
38.	Additional System Costs, $/ton	@ 450000 tpy		
39.		High	($26.00)	Item 33/Item 7
40.		Low	($25.00)	Item 34/Item 7

[(a)]Analysis includes preliminary analysis of disposal savings from diverted waste (disposal and transportation). Other potential savings and/costs may also result from the implementation of the proposed recycling enhancements. SCS understands that R&E staff and its consultants are preparing life-cycle cost analysis that considers other costs (both increases and decreases) that may occur from the implementation of the DCB Processing and Recycling Recovery programs and systems.

2.8.2 Commodity Price Estimates

Foth estimates potential revenues from the sale of recyclable commodities could range from $1.9 million to $2.8 million annually (See Exhibit 12). The estimates consider market pricing and discounts due to contamination. The current contracts for ferrous and non-ferrous recovery from the R&E Center provided Foth the background data for these discounts. Similar pricing for #1 PET, #2 HDPE, and OCC is not readily available; therefore, Foth recommended that these discount estimates be further verified. **SCS reviewed the commodity pricing from the Recyclingmarkets.net database for the past approximately 10 years and for the past approximately 12 months. Exhibit 13 shows the variation in cost under these two timeframes, along with the Assumed Market Price/Ton from the Preliminary Design Report (see Exhibit 12). Foth's estimated revenue projections from the sale of recyclables are reasonable. Foth recognizes current market conditions are highly uncertain due to the imposition of stricter allowable contamination levels imposed by China. SCS agrees that discount estimates for #1 PET, #2 HDPE, and OCC should be further verified.**

Exhibit 12. Estimated Potential Revenue from Materials Recovered Using a Processing Enhancement System[19]

Material	Current Market Price/Ton[1]	Downgraded percentage	Assumed Market Price/Ton[2]	Low Estimated Annual Revenue	High Estimated Annual Revenue
PET	$305	80%	$244	$461,526	$653,829
HDPE	$380	80%	$304	$256,546	$363,440
Cardboard/Boxboard	$93	60%	$56	$41,488	$69,146
Ferrous (Tin/Steel containers)	$225	55%	$124	$202,863	$280,888
Non-ferrous (Aluminum)	$1,440	55%	$792	$1,023,680	$1,417,403
			Estimated Total Annual Revenue	**$1,986,102**	**$2,784,705**

[1] Current market prices from RecyclingMarkets.net accessed on May 7, 2018 as presented in Foth Memo, *Analysis for Recovery of Recyclable Commodities using Pre-Processing*, June 12, 2018.
[2] The assumed market price is reduced from the current market price to be conservative given market variability and product cleanliness.

[19] Ibid, Table 8-3.

Exhibit 13. Commodity Price Summary