Memorandum

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TO: Zack Hansen, Judy Hunter, and Kate Bartelt
Ramsey/Washington Counties Resource Recovery Board (Project Board)
Joint Staff Committee

CC: Jennefer Klennert, Foth Infrastructure & Environment, LLC (Foth)
Curt Hartog, P.E. Foth

FR: Nathan Klett, Foth
Warren Shuros, Foth

RE: Anaerobic Digestion (AD) – Update on Technology Status

This memorandum is intended to provide an update on the current planned scope of anaerobic digestion (AD); status of select vendors and existing projects providing AD systems; and economic and marketability of AD products (i.e. biogas and compost).

The focus of this memorandum is on what additional information is needed to continue forward to include AD as a component in Scope of Resource Management and potential next steps for Ramsey/Washington Counties.

AD was the identified technology in the Scope for Resource Management to provide an outlet for the organics recovered using Mixed Waste Processing (MWP) equipment. These technologies used together will increase recovery and provide a perceived better use for food waste and other organic materials.

The use of AD also provides another outlet for source separated organics (SSO) as that increases in the East Metro area. The organics could be sent directly to a properly permitted composting facility, but AD processing has the advantage of first recovering the energy and is, therefore, considered a higher and better use.

In response to the question, "Does it work?," yes, AD technology works. AD has been used in the United States since the 1930's and the US EPA estimated there were 157 commercial scale livestock digester project operational in 2010 in the US. Most of the facilities are using agricultural feedstock not MSW but the technology works.

1 Anaerobic Digestion (AD) Included in the Scope for Resource Management

Currently the organics in the MSW delivered to the Newport Facility are either sent to the Xcel facilities as a portion of the RDF or landfilled as a part of the residue from RDF processing. The concept for using the proven AD technology is to provide a beneficial/higher use for the organics that would be removed from the waste stream.

Previous characterization of the MSW entering the Newport Facility indicates approximately 25% is considered targetable organics (food waste and yard waste) material potentially suitable for AD. In the *Analysis of Mixed Waste Processing (MWP) Report,* September 2014 prepared by Foth, the MWP equipment is projected to recover 50% of the available organics from the MSW processed by the MWP equipment, which results in an estimated 42,500 ton per year of organics available for an AD process. Currently there are no operational AD facilities located in the vicinity of the Newport Facility using MSW as a feedstock. There are operational AD facilities using agricultural feedstock.

1.1 Necessary Permits and Regulatory Agencies

The necessary permits for an AD facility will depend on the capacity of the facility (i.e. if the facility were to have the capacity to utilize 250,000 dry tons or more per year of input - for fuel conversion - an Environmental Impact Statement (EIS) would be mandatory per Minn. Statue 4410.4400). The permitting requirements will apply to the AD system owner/operator, not the Project Board.

The anticipated permits necessary and associated regulatory agencies involved include:

- Environmental Assessment Worksheet (MPCA)
- Water Permits (MPCA)
  - Wastewater Discharge/NPDES/SDS Permit
  - Industrial Stormwater Permit (included in NPDES/SDS Permit)
  - Water appropriations permit
- Air Permit (MPCA or Federal depending on combustion device)
- Storage tank permits – If applicable (MPCA)
- Waste Permit (MPCA solid waste rules)
- Construction permits (Local and MPCA)
  - Building permit
  - Construction Stormwater
- Local/County Permits
  - County solid waste processing permit
  - Conditional use permit
  - Grading and utility permits.

Depending upon the volume of biogas generated and the end use selected, a permit may also be required from the Public Utilities Commission (PUC).

As there are no facilities currently permitted specifically using MSW as the feedstock for AD, the timeline for permitting and exact permit needed are unclear.

1.2 Material Flow

The flow of material at the Newport Facility includes recovery of approximately 42,500 tpy of organics that will be sent to a private AD contractor. The remaining material flows are summarized in Table 1.

Table 1
Material Flow Summary

Material	Tons			
Total MSW Delivered	400,000			
Bulky Waste to Landfill		26,800		
MWP System Input		340,000		
Bypassed Material Input to RDF process		33,200		
Nonferrous Recycled			2,515	
Ferrous Recycled			14,060	
Organics to Private AD Contractor			42,500	
HDPE Recycled			1,530	
PET Recycled			2,805	
Cardboard Recycled			5,985	
Process Residue to Landfill			14,001	
RDF to Xcel Combustion Plants			289,804	
Ash from Combustion to Landfill				83,029

The anticipated 42,500 tons per year of organics would be delivered to a privately owned and operated AD facility. After the AD process, it is anticipated that approximately 38% material by weight (i.e. 16,150 tons) will be remaining.

The ultimate goal for the material remaining after the AD process is to have a class I or class II compost with minimal landfilled material. However, this may be dependent on the AD system vendor and the amount of contamination (glass, plastic, etc.) contained in the organics provided to the AD vendor. Further processing of this remaining material may be necessary to remove contaminants, which may add to the cost of delivering organics to an AD vendor.

2 AD Technology

The use of AD for decomposing organic materials in a controlled oxygen-deficient (anaerobic) environment is a proven technology that has been used for low solids waste stream such as manure, waste water solids, etc. for centuries. The use of AD for decomposing high solids organic waste (e.g. organics from MSW) has been used to a lesser extent, but is gaining popularity with increased waste diversion goals in many communities and an increased emphasis on renewable/biofuels.

There are two primary AD technologies in use today: Wet and Dry.

2.1 Low Solids (Wet) AD

In a low solids or wet AD system, the organic materials typically enter the AD process at less than approximately 10% solids content (as low as 5% or less). This solids content is typical of waste water sludge, manure, rendering waste, etc. Note: This is the technology proposed by SaniGreen in South Saint Paul.

2.1.1 Advantages

The main advantage of a wet AD system that may be applicable to the organics recovered using MWP is the ability to remove plastics from the incoming material prior to undergoing AD. A low solids AD system may also provide some added flexibility when considering feedstock (i.e. the ability to mix organics from MSW with other organic rich liquids).

2.1.2 Disadvantages

Some of the disadvantages of a wet AD system include the need for additional energy to heat and pump water and to dewater digester contents. There is a potential for more loss of volatile solids and potentially lower gas quality. With respect to the organic fraction removed from the MSW, a low solids AD system would require additional low solids feedstock to be mixed with the high solids organics from MSW. This could result in an increase in capital and operating costs of the system.

2.2 High Solids (Dry) AD

In a high solids or dry AD system, the organic materials typically enter the AD process at between 15 and 40% solids content. The higher solids content is generally more representative of the organics separated from MSW using MWP technology. Note: Project Board Commissioners and Staff saw Dry AD at the 2014 Renewable Energy from Waste Conference in San Jose, CA.

2.2.1 Advantages

The high solids systems require less energy input into the process and typically have more energy available for export. Additionally, the organics separated from MSW may be able to be used directly in a high solids AD process with minimal liquids addition.

2.2.2 Disadvantages

Some disadvantages to high solids AD systems may include addition of bulking agents for system efficiency and a high solids system cannot handle liquids as well as wet AD systems which may limit the available feedstock options.

3 Technology Updates

In the *Preliminary Resource Recovery Feasibility Report*, January 2014, Foth presented information pertaining to AD technology and several large-scale developing or developed AD facilities. This section is an update on the status of development and technology previously presented as well as additional updates in the AD market.

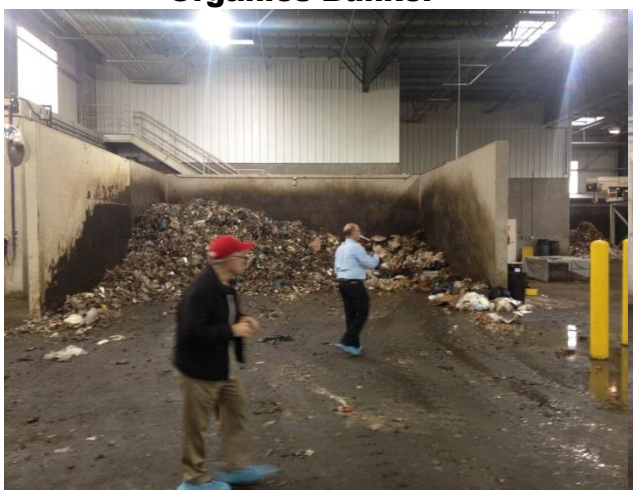
3.1 AD Facilities – Current Status

3.1.1 ZeroWaste Energy, LLC – San Jose, CA

Commercial operation of the first phase of the ZeroWaste Energy Development Company (ZWEDC) facility began December 2013. The first phase includes a 90,000 tpy (250 tpd based on 365 days) thermophilic dry AD facility utilizing Kompoferm technology. A news release from November 25, 2014, from the EPA, indicated "During its first ten months of operation in 2014, the ZWED facility has recycled more than 30,000 tons of food scraps…"

This facility was visited by some of the Project Board representatives in November 2014 as part of the Renewable Energy from Waste Conference. No specific details were provided pertaining to the amount of organics entering the facility from processed MSW.

Photograph 1
Organics Bunker



Photograph 1 is a bunker containing organics for the AD system in San Jose. These organics were recovered using MWP equipment.

Photograph 2
Loaded Vessels

Photograph 2 shows the vessels that are loaded with organics for AD.

3.1.2 Big Ox Energy (aka partner with Sanimax to form SaniGreen) – Denmark, WI

The proposed SaniGreen facility in South St. Paul, MN is a partnership between Big Ox Energy and Sanimax. Big Ox Energy currently has an operational wet AD facility in Denmark, WI with a capacity of 60,000 to 78,000 tons per year based on a daily receiving rate of 250 to 300 TPD (on a 260 days per year operating schedule, normally six days per week, 12 hours per day).

The process components include a tipping floor and receiving tank for the slurry delivered in large tanker trucks. The tipping floor also has a pre-processor mixer and conveyor where food waste or other solid feedstock is size reduced and fed into slurry. The system has been operational for approximately 5 years.

Photograph 3
Receiving Area

Photograph 3 shows the receiving area for low solid and organic materials delivered to the Big Ox facility.

3.1.3 SaniGreen BioEnergy (aka Big Ox Energy and Samimax) – South St. Paul, MN

SaniGreen BioEnergy has received a planned unit development (PUD) amendment for land use as a part of the overall permitting process for an AD facility for processing of organic materials. The AD facility is anticipated to process organics from Sanimax's adjacent rendering operation in South St. Paul, MN and is continuing to search for organic materials from other off-site sources.

The system is designed as a wet (8%-12% solids) AD plug flow reactor using the GEP group/Big Ox Energy design and will have an operating capacity of 150,000 tpy (410 tpd based on 365 days). The facility will be able to handle both solid and liquid wastes and is designed to allow flexibility to address input variabilities. The adjacent rendering facility alone generates approximately 300,000 gallons of effluent per day. Biogas from AD is anticipated to be cleaned/scrubbed to pipeline quality and injected in the area natural gas distribution system. Electricity produced will be either sold or used at the Sanimax rendering facility. Liquid wastes from the digesters will be disposed in the sanitary sewer. Solid wastes from the digesters, estimated by Sanimax at 50-60 tpd, will be dewatered, dried, and pelletized for RDF or will be sent to one of SaniGreen's strategic partners for composting. It is unclear when SaniGreen anticipates breaking ground for the facility.

Discussions with Dan Ostrenga (Sanimax) on March 31, 2015 indicated that during the initial permitting discussions, for the proposed SaniGreen AD facility in South St. Paul, with MPCA, there were representatives from Air, Water and Solid Waste divisions and that the Air division appeared to be taking the lead relative to the SaniGreen AD facility permit with support from Water and Solid Waste divisions. Dan also indicated that SaniGreen is considering voluntarily preparing an Environmental Impact Statement to avoid potential future limitations related to throughput capacity (i.e. in order to utilize 250,000 dry tons or more per year of input for fuel conversion an Environmental Impact Statement (EIS) is mandatory per Minn. Statue 4410.4400).

One final "permitting" note provided during communication with Dan is that the MPCA would be the responsible government unit (RGU) for construction or expansion of a mixed municipal solid waste compost facility or refuse derived fuel production facility with a capacity of 500 or more tons per day, which is considered applicable to the proposed SaniGreen facility if this capacity is reached.

Dan also indicated that Sanimax is planning to complete an application for grant money from the Metropolitan Council's Industrial Pretreatment Partnership and Incentive Program (IPPIP), which is due June 30, 2015. The Sanimax application needs to specify if they will be simply installing additional wastewater pretreatment at the current rendering plant or if they will be constructing an AD plant to create an energy by product as well as the enhanced wastewater pretreatment. It is believe that either scenario would be a candidate for the IPPIP grant opportunity. However, Sanimax may not want to invest the additional money necessary to construct the AD facility without having feedstock commitments for the facility.

Currently the proposed facility does not have feedstock commitments required to proceed with the AD project. In previous discussions it was indicated that commitments for minimally 100,000 tpy of organics would be required. Currently, SaniGreen has commitments for approximately 50% of the necessary organics. Related to the necessary feedstock commitments, Dan indicated that having a commitment for the estimated organics from MWP at the Newport Facility would be a "game changer". That is to say it would result in SaniGreen having adequate committed feedstock to keep moving forward with the AD project.

3.1.4 Avant Energy – Minnesota Municipal Power Agency (MMPA) – Le Sueur, MN

The "Hometown Bioenergy Project," in Le Sueur, MN is currently processing a combination of corn silage and manure through wet AD to ultimately produce electricity. The facility is owned by MMPA, which is a partnership of twelve municipal utilities around the State of Minnesota, and was developed by Avant Energy of Minneapolis, which manages the MMPA.

Two anaerobic digesters produce methane from trucked-in corn silage, manure, and potentially other organic waste. Biogas from the digesters is stored in three fabric domes until it is needed for electrical production, which is produced in four internal combustion engine/generator sets. The plant design includes a total plant output of 8 megawatts generated 12-15 hours per day during peak demand. The plant will process about 45,000 tpy (125 tpd based on 365 days) of agricultural residuals, including corn silage, potato waste and chicken manure. The current plan is to generate additional revenue from the sale of post-digestion liquids as fertilizer and dried solids (digestate) as boiler fuel or animal bedding.

3.1.5 Organix Solution (aka Randy's Sanitation) – Delano, MN

Information presented at the 2014 RAM/SWANA by representatives for the Organix Solutions Project generally indicated that the material recovery facility at Randy's Sanitation is designed to separate recyclables and recover 2 to 3 inch minus material which is comprised mostly of organics. Pre-sorted MSW will also pass through the BurCell ™ process to recover organics and non-recycled paper to produce a processed engineered feedstock (PEF). The PEF will be screened then enter a SmartFerm (Zerowaste) AD process. The digestate will be composted and is assumed to meet Minnesota Pollution Control Agency's "Class 1" compost standards, but

remaining small glass fraction will likely prohibit retail sale. The current proposed completion date is 2015. The AD portion of the process is currently permitted for 80,000 tpy.

Jim Wollschlager from Randy's Sanitation indicated that a demonstration facility for the process proposed at Randy's is anticipated to be operational in early June 2015. The demonstration facility is anticipated to be capable of processing 1 ton batches.

4 Economics

The economics associated with adding AD as a component to the Scope of Resource Management will be dependent on the quality of the organics resulting from the use of MWP equipment at the Newport Facility for sorting MSW. Foth believes that an initial step towards the use of AD for management of the organics from Newport would be to issue a Request for Expressions of Interest (RFEI) to vendors for organics management (compost and/or AD). The RFEI could be structured to encourage AD as the organics management option.

Based on the available information from established markets and preliminary information for organics from MWP supplied by current AD vendors, Foth has estimated net costs for adding AD to the Scope for Resource Management to be an increase to the cost of the existing system. Currently this additional cost is estimated to be $40-$60/tons of organics, but will ultimately be dependent on the quality of the organics resulting from MWP of MSW delivered to the Newport Facility and the distance from Newport to the AD facility.

The current plan is to contract with a private contractor that would own and operate an AD facility. Thus, financing and the capital costs associated with operating, and marketing of the outputs will be under the control of the private contractor. To obtain specific data for the Project Board will require a formal, competitive procurement process. The contractual economic terms could be structured around a per ton of delivered organics arrangement. This structure will need to be determined as one of the next steps for including AD processing as a part of the Scope of Resource Management.

4.1 Potential Jobs Created

Inclusion of AD as a component to the Scope of Resource Management is expected to create new jobs regionally. However, there is not a specific location determined for an AD facility accepting organics from the Newport Facility. The projected number of jobs created for the proposed SaniGreen facility in South St. Paul included 20 new full time positions, 150 temporary construction jobs over a 2 year time period, and 475 indirect jobs based on projections from SaniGreen. Data pertaining to jobs creation was presented by Organix Solutions at the 2014 RAM/SWANA conference and indicated that the AD project will generate 60-80 short term jobs (assumed construction) and 12-15 long-term employment opportunities.

5 Additional Data Needs

5.1 Material Markets and Quality

The main options for the organics are to send them to an AD facility or a composting facility. As indicated previously additional information pertaining to the quality of the organic fraction from

processing MSW using MWP equipment is necessary. This information is necessary for both determine the cost associated with managing organics as well as determining the quality of the final product (e.g. compost). It is also important to determine if additional steps will be necessary to further process the organic material into a Class I or Class II compost. Minnesota Administrative Rule 7035.2836 indicates that Class I compost must not contain greater than three percent inert materials and Class II compost must not contain greater than four percent inert materials. The Organix Solutions (Randy's Sanitation) AD system is anticipated to result in a compost that meets Class I standards, but is believed to contain glass fragments that will inhabit retail sale (Organix Solutions RAM/SWANA presentation 2014).

Currently there is no established AD facility in the vicinity of the Newport Facility using MSW as feedstock. Both SaniGreen and Organix Solutions (Randy's Sanitation) have most or all of the permitting process complete and are solidifying finances or planning for construction. Additional discussions with potential AD vendors for establishment of a facility are necessary.

An interim option for the organics resulting from processing MSW with MWP equipment is to explore options for composting until an AD facility is established. This allows time to determine the quality of the organic from processing with MWP and will provide the Project Board with a better understanding of the cost associated with managing the organic fraction.

5.2 Documented Recovery Rates

The recovery rate of the material is important to understand since the Project Board and AD vendor receiving the material will need to have an understanding of the annual volume to expect. Based on how the MWP equipment will target organics (small heavy fraction of MSW), it is anticipated that the "cleaner" the organics are required to be, the lower the expected rate of recovery. However, the cleanliness required will ultimately be driven by the AD or compost vendor contracted to manage the organics.

6 Potential Specific Steps (Next Steps)

In order for staff to be confident in a recommendation to the Project Board, Foth suggested the following next steps.

AD Pre-procurement Planning	January 2016 to December 2016
♦ Focused waste composition studies in spring, fall and winter for targeted materials.	
♦ Physically processing residential and commercial loads from Ramsey/Washington Counties at Randy's Sanitation to help determine organics quality and potential recovery percentages.	
♦ Explore composting options for organics management until a local AD market is established and as a transition and/or back up technology.	
♦ Gather additional information on the effectiveness of different MWP equipment related to organics recovery and quality.	

♦ Continue to monitor status of potential/proposed AD facilities.	
♦ Meet with regulators (MPCA, Washington County, City of Newport, etc.).	
♦ Comparison of data from reference facility (ies) with particular focus on organics.	
♦ Tours/Presentations:	
▶ Potential presentations from active AD vendors to include status updates from local proposed or "in the works" AD projects.	
▶ Site visit to the Montgomery County Facility with Project Board members and staff to see the facility and to engage in policy and technical discussions.	
▶ Tour to the Hometown Bioenergy Project in Le Sueur, MN to observe similarities and differences in feedstock and operations.	
▶ Discuss the status of the proposed AD facility with Randy's Sanitation.	
♦ Preparation of an RFEI for interested vendors for organics management with emphasis on AD technology.	
♦ Potentially consider a transition period with a compost contractor.	
Procure Private Contractor for Organics Management	January 2018 to June 2018
♦ Examine/test organics produced from MWP (quality and quantity)	
♦ Develop procurement document(s)	
♦ "Market" project to potential contractors	
♦ Gain approvals to issue	
♦ Determine Proposal Evaluation Team	
♦ Go through procurement process of pre- proposal conference, questions, addenda	
♦ Evaluate proposals, potential partnerships formed, etc.	
♦ Select/contract with vendor best fitting needs	
♦ Finalize contract	
♦ Board authorization	