# REQUEST FOR PROPOSAL

## RFP# 949

# BIODIGESTER FEASIBILITY STUDY

City of Ann Arbor
Systems Planning Unit

**Due Date: Thursday, October 22, 2015, by 2:00 p.m.**

Issued By:

City of Ann Arbor
Procurement Unit
301 E. Huron Street
Ann Arbor, MI 48104

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# SECTION I- GENERAL INFORMATION

## A. OBJECTIVE

The city of Ann Arbor is seeking a detailed feasibility study for development of a biodigester to manage biosolids from the wastewater treatment plant, with the potential to add university and commercial organics collection, and fats, oils and greases (FOG). We are looking for an analysis that develops a series of plausible organic inputs for the biodigester from within the City of Ann Arbor and possibly from surrounding areas. $60k is the expected budget for this study. We expect the consultant to propose the timeline.

The internal project team will likely include staff from the environment, energy, solid waste/compost recycling, WWTP, and Project management. County staff may participate. This is a city-funded project.

An earlier study developed a significant amount of data and explored several of these issues and is included herein as Appendix B.

The successful bidder will have:

- Designed or built a biodigester that has been operating for a period of two years or more;
- Experience sourcing material for biodigesters;
- Experience with digestate management and managing all process flows from biodigesters;
- Direct experience designing, building, and operating biodigesters that take municipal biosolids as a significant portion of the organics input
- Direct experience designing, building, and operating biodigesters that take organics input both liquid and solid ( FOG, commercial organics and other organic wastes) in addition to biosolids
- Direct experience designing, building, and operating biodigesters that generate electricity from biogas
- Direct experience designing, building, and operating biodigesters that generate transportation fuel from the biogas
- Direct experience developing economic feasibility studies for municipalities for biodigesters that handle municipal biosolids
- Broad understanding of the regulatory requirements of composting end products
- Broad understanding of managing all process flows from the biodigester

(digested solids and any recycle streams)

- Broad understanding of private and public capital financing options

The city of Ann Arbor currently operates a landfill gas to energy facility and compost facility and all opportunities to explore synergies with these and other municipal lines of business should be explored.

## B. QUESTIONS ABOUT AND CLARIFICATIONS OF THE REQUEST FOR PROPOSAL

All questions regarding this Request for Proposal (RFP) shall be submitted via e-mail. Questions will be accepted and answered accordance with the terms and conditions of this RFP.

All questions shall be submitted on or before Thursday, October 15, 2015, at 5:00 p.m., and should be addresses as follows:

> Scope of Work/Proposal Content questions shall be e-mailed to Matthew Naud, Environmental Coordinator
> mnaud@a2gov.org
>
> RFP Process and HR Compliance questions shall be e-mailed to Colin Spencer - cspencer@a2gov.org

Should any prospective consultant be in doubt as to the true meaning of any portion of this RFP, or should the consultant find any ambiguity, inconsistency, or omission therein, the consultant shall make a written request for an official interpretation or correction by the due date above.

All interpretations, corrections, or additions to this RFP will be made only as an official addendum that will be posted to a2gov.org and MITN.info and it shall be the consultant's responsibility to ensure they have received all addenda before submitting a proposal. Any addendum issued by the City shall become part of the RFP, and must be incorporated in the proposal where applicable.

## C. PRE-PROPOSAL MEETING

There will be no pre-proposal meeting.

## D. PROPOSAL FORMAT

To be considered, each firm must submit a response to this RFP using the format provided in Section III. No other distribution of proposals is to be made by the consultant. An official authorized to bind the consultant to its provisions must sign the proposal in ink. Each proposal must remain valid for at least ninety days from the due date of this RFP.

Proposals should be prepared simply and economically providing a straightforward, concise description of the consultant's ability to meet the requirements of the RFP. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed in ink by the person signing the proposal.

## E. SELECTION CRITERIA

Responses to this RFP will be evaluated using a point system as shown in Section III. A selection committee comprised of staff from the City will complete the evaluation.

The fee proposals will not be reviewed at the initial evaluation. After initial evaluation, the City will determine top consultants, and open only those fee proposals. The City will then determine which, if any, firms will be interviewed. During the interviews, the selected firms will be given the opportunity to discuss their proposal, qualifications, past experience, and their fee proposal in more detail. The City further reserves the right to interview the key personnel assigned by the selected consultant to this project. If the City chooses to interview any consultants, the interviews will be held the week of November 2, 2015. Consultant must be available on these dates.

All proposals submitted may be subject to clarifications and further negotiation. All agreements resulting from negotiations that differ from what is represented within the RFP or in the consultant's response shall be documented and included as part of the final contract.

## F. SEALED PROPOSAL SUBMISSION

All proposals are due and must be delivered to the City Procurement Unit on, or before, **Thursday October 22, 2015, at 2:00 p.m.** (local time). Proposals submitted late or via oral, telephonic, telegraphic, electronic mail or facsimile **will not** be considered or accepted.

**Each respondent must submit in a sealed envelope**

- **one (1) original proposal,**
- **one (1) additional proposal copy**
- **one (1) digital copy of the proposal on a flash drive, preferably in PDF format**

**Each respondent must submit in a separate sealed envelope marked Fee Proposal**

- **one (1) original of the fee proposal**

**The fee proposal and all costs must be separate from the rest of the proposal.**

Proposals submitted must be clearly marked: **"**RFP No.949 – Biodigester Feasibility Study" and list the consultant's name and address.

Proposals must be addressed and delivered to:
City of Ann Arbor
c/o Customer Service
301 East Huron Street
P.O. Box 8647
Ann Arbor, MI 48107

All proposals received on or before the due date will be publicly opened and recorded on the due date. No immediate decisions will be rendered.

Hand delivered proposals must be date/time stamped by the Customer Service Department at the address above in order to be considered. Delivery hours are 9:00 a.m. to 3:00 p.m. Monday through Friday, excluding Holidays.

The City will not be liable to any consultant for any unforeseen circumstances, delivery, or postal delays. Postmarking on the due date will not substitute for receipt of the proposal. Consultants are responsible for submission of their proposal. Additional time will not be granted to a single consultant. However, additional time may be granted to all consultants at the discretion of the City.

**A proposal will be disqualified if:**

1. The fee proposal is not contained within a separate sealed envelope.
2. The fee proposal is submitted as part of the digital copy. Provide fee proposal in hard copy only.

## G. DISCLOSURES

Under the Freedom of Information Act (Public Act 442), the City is obligated to permit review of its files, if requested by others. All information in a consultant's proposal is subject to disclosure under this provision. This act also provides for a complete disclosure of contracts and attachments thereto.

## H. TYPE OF CONTRACT

A sample of the General Terms and Conditions is included as Appendix A. Those who wish to submit a proposal to the City are required to review the General Terms and Conditions carefully. **The City will not entertain changes to its General Terms and Conditions.**

The City reserves the right to award the total proposal, to reject any or all proposals in whole or in part, and to waive any informality or technical defects if, in the City's sole judgment, the best interests of the City will be so served.

This RFP and the selected consultant's response thereto, shall constitute the basis of the scope of services in the contract by reference.

## I. HUMAN RIGHTS REQUIREMENTS

All contractors proposing to do business with the City shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the Section 9:158 of the Ann Arbor City Code. Breach of the obligation not to discriminate as outlined in Attachment E shall be a material breach of the contract. Contractors are required to post a copy of Ann Arbor's Non-Discrimination Ordinance attached at all work locations where its employees provide services under a contract with the City.

## J. WAGE REQUIREMENTS

The Attachments provided herein outline the requirements for payment of prevailing wages or of a "living wage" to employees providing service to the City under this contract. The successful consultant must comply with all applicable requirements and provide documentary proof of compliance when requested.

## K. CONFLICT OF INTEREST DISCLOSURE

The City of Ann Arbor Purchasing Policy requires that the consultant complete a Conflict of Interest Disclosure form. A contract may not be awarded to the selected consultant unless and until the Procurement Unit and the City Administrator have reviewed the Disclosure form and determined that no conflict exists under applicable federal, state, or local law or administrative regulation. Not every relationship or situation disclosed on the Disclosure Form may be a disqualifying conflict. Depending on applicable law and regulations, some contracts may awarded on the recommendation of the City Administrator after full disclosure, where such action is allowed by law, if demonstrated competitive pricing exists and/or it is determined the award is in the best interest of the City. A copy of the Conflict of Interest Disclosure Form is attached.

## L. COST LIABILITY

The City of Ann Arbor assumes no responsibility or liability for costs incurred by the consultant prior to the execution of a Professional Services Agreement. The liability of the City is limited to the terms and conditions outlined in the Agreement. By submitting a proposal, consultant agrees to bear all costs

incurred or related to the preparation, submission, and selection process for the proposal.

## M. PROPOSAL PROTEST

All proposal protests must be in writing and filed with the Purchasing Manager within five (5) business days of the award action. The consultant must clearly state the reasons for the protest. If a consultant contacts a City Service Area/Unit and indicates a desire to protest an award, the Service Area/Unit shall refer the consultant to the Purchasing Manager. The Purchasing Manager will provide the consultant with the appropriate instructions for filing the protest. The protest shall be reviewed by the City Administrator or designee, whose decision shall be final.

## N. SCHEDULE

The proposals submitted should define an appropriate schedule in accordance with the requirements of the Proposed Work Plan in Section III.

The following is the schedule for this RFP process.

| **Activity/Event** | **Anticipated Date** |
|---|---|
| Written Question Deadline | October 15, 2015, 5:00 p.m. |
| Proposal Due Date | October 22, 2015, 2:00 p.m. |
| Interviews (if needed) | Week of November 2 |
| Selection | Week of November 2 |
| City Council Contract Authorization | December 7 |
| Agreement Execution | December 8 |

The above schedule is for information purposes only and is subject to change at the City's discretion.

## O. IRS FORM W-9

The selected consultant will be required to provide the City of Ann Arbor an IRS form W-9.

## P. RESERVATION OF RIGHTS

1. The City reserves the right in its sole and absolute discretion to accept or reject any or all proposals, or alternative proposals, in whole or in part, with or without cause.
2. The City reserves the right to waive, or not waive, informalities or irregularities in terms or conditions of any proposal if determined by the City to be in its best interest.

3. The City reserves the right to request additional information from any or all consultants.
4. The City reserves the right to reject any proposal that it determines to be unresponsive and deficient in any of the information requested within RFP.
5. The City reserves the right to determine whether the scope of the project will be entirely as described in the RFP, a portion of the scope, or a revised scope be implemented.
6. The City reserves the right to select one or more consultants to perform services.
7. The City reserves the right to retain all proposals submitted and to use any ideas in a proposal regardless of whether that proposal is selected. Submission of a proposal indicates acceptance by the firm of the conditions contained in this RFP, unless clearly and specifically noted in the proposal submitted.
8. The City reserves the right to disqualify proposals that fail to respond to any requirements outlined in the RFP, or failure to enclose copies of the required documents outlined within RFP.

## SECTION II - SCOPE OF WORK

Task 1 – Information Gathering

Meet with the city team that may include city WWTP staff, Energy staff, sustainability staff, solid waste/composting staff, University of Michigan, and the city contracted compost partner to review proposed scope of services and available data. Successful bidders should assume budgeting funds for time spent reviewing previous data collection by Quantalux if they are not part of the successful proposal.

Task 2 – INPUTS - Expanded analysis of biomass availability

What is the range of organic material available for collection at the local and regional scales?

*By range we mean the different types of organic materials (e.g., food waste, biosolids, FOG). Within that range there may be available organic material that may not be suitable for biodigestion. We are looking for the contractor to define the materials that are available for biodigestion within the three scales provided in the RFP. If the material is available but of insufficient quality and should not be included in the available material, the consultant should not that as part of the analysis. If the material is available but should not be used in a biodigester (e.g., grass clippings, PLA plastic utensils), the contractor should also note that in the analysis.*

Develop a series of biomass estimates (with associated levels of risk or uncertainty) for the following inputs:

- City of Ann Arbor Biosolids
- All of the above AND commercial organics from institutions and commercial establishments within the city of Ann Arbor including fats, oils and greases and compostable packaging materials from restaurants and food service establishments.
- All of the above AND available biosolids from regional facilities outside the city of Ann Arbor (within 50 miles) AND commercial organics (within 50 miles) from institutions and commercial establishments outside the city of Ann Arbor including fats, oils and greases and compostable packaging materials from restaurants and food service establishments.

The analysis will include a discussion of the quantity and quality of each source's biomass suitability for co-digestion with biosolids.

*We are looking to identify an estimate of how much of the material is available (and how certain you are of the estimate) and whether we should include this material as part of the bidigestion stream for this analysis. If it is included in the analysis, we are interested in the amount of energy that will be produced for the material.* In terms of risk, w*e are interested in estimates of weight and volume of material. We expect the*

*contractor to provide any additional input as to "risk" associated with any one stream of organic material.*

Develop a list of potential sites (within 100 miles) that could compete for regional biomass materials and any information on current charges.

Task 3 - DESIGN

Based on the previous analysis, what system would you recommend to manage organics at the previously discussed scales?

This task includes recommending a design including costs for design, equipment of receiving and managing liquid and solid materials, digester tanks, options of heat recovery, options for any post treatment for biogas for transportation fuel and fueling equipment, options for dewatering and possible recovery of nutrients, construction costs, operation and maintenance costs.

All design, build, operation, and maintenance expenses will be clearly defined based on the input scenarios developed previously, the recommended system size, and any pre- or post-treatment needs to generate output material of sufficient quality. Discuss redundancy needs of the city and system design elements and costs to ensure that biosolids can be managed without any interruption due to system malfunction, loss of electric power, or other low probability/high consequence events.

This task should also clearly state which compostable materials could/should not be accepted and any cost implications of allowing certain materials to be accepted.

We expect the contractor to make a recommendation on the quality/marketability of the remaining solid material – and provide a cost benefit as to the cost to generate Class A vs. Class B solids.

Task 4 – OUTPUTS – Expanded analysis of Biogas and other outputs

Based on the previous analysis, what outputs are available for beneficial use including gas for energy, gas for transportation fuel, waste heat, compostable solids and digestate?

Develop an input/output model that is flexible enough to handle the three input scenarios described above (and others as needed) and the associated outputs (e.g., volumes and characteristics) of biogas (used for electricity generation and/or transportation fuel), heat, compostable solids (managed separately or combined with existing compost), and liquid digestate.

Using the outputs generated above, calculate costs and benefits and discuss opportunities to use the generated electricity to offset energy at existing nearby city facilities based on current costs of electricity.

Using the outputs generated above, calculate costs and benefits and discuss opportunities to use the generated biogas to develop transportation fuel for city CNG vehicles. Model system outputs against current and potential future city CNG fuel demand.

Using the outputs generated above, calculate costs and benefits and discuss opportunities to use the generated heat for building conditioning or other uses such as heating the compost pads or heating hoop houses.

Using the outputs generated above, calculate costs and benefits and discuss opportunities to use the solid material generated after digestion for other beneficial uses including compost. Explore options and make recommendations to manage the material separately or combined with existing compost material based on likely sales prices and regulatory issues associated with each method. This task will be closely coordinated with the city contracted compost operator.

Using the outputs generated above, calculate costs and benefits and discuss opportunities to manage the digestate generated by the biodigester under evaluated scenarios. This discussion must include narrative on the quality and quantity of material and any needs for digestate storage during wet weather events in the case of system capacity issues (if any).

Task 5 – FINANCES

Based on these inputs, outputs, and design costs, develop a financial model under the following scenarios given the expected life of the system:

- Municipal financing and ownership of the land and system – City operation
- Municipal financing and ownership of the land and system – Contracted operation of the system and securing input materials and managing digester outputs. Assume an incentive structure for additional materials brought in from outside Ann Arbor and profit sharing with the city.
- Design build and operated by a contractor under a long term contract. Assume an incentive structure for additional materials brought in from outside Ann Arbor and profit sharing with the city.
- Other financing scenarios may be explored depending on the scale of the organics collection area.

Task 6 – Other Environmental Benefits

Based on the assumptions above, discuss other benefits that support the city's sustainability framework goals including but not limited to the amount of material

diverted from landfills, any green house gas emission reductions, other beneficial reuses of material including nutrient recovery, and renewable energy generation.

The sustainability framework can be found here:

http://www.a2gov.org/departments/systems-planning/Sustainability/sustainability/Documents/Ann%20Arbor%20Sustainability%20Framework%20051313.pdf

## SECTION III - MINIMUM INFORMATION REQUIRED

### PROPOSAL FORMAT

Consultants should organize Proposals into the following Sections:

A. Professional Qualifications
B. Proposed Work Plan
C. Fee Proposal (include in a separate sealed envelope clearly marked “Fee Proposal”)
D. Authorized Negotiator
E. Attachments

The following describes the elements that should be included in each of the proposal sections and the weighted point system that will be used for evaluation of the proposals.

A. Professional Qualifications/Quality of Work – 70 points

1. State the full name and address of your organization and, if applicable, the branch office or other subsidiary element that will perform, or assist in performing, the work hereunder. Indicate whether it operates as an individual, partnership, or corporation. If as a corporation, include whether it is licensed to operate in the State of Michigan.

2. Include the name of executive and professional personnel by skill and qualification that will be employed in the work. Show where these personnel will be physically located during the time they are engaged in the work. Indicate which of these individuals you consider key to the successful completion of the project. Identify only individuals who will do the work on this project by name and title. Resumes and qualifications are required for all proposed project personnel, including all subcontractors. Qualifications and capabilities of any subcontractors must also be included.

3. (5 Points) State history of the firm, in terms of length of existence, types of services provided, etc. Identify the technical details that make the firm uniquely qualified for this work.

4. (35 Points) Project team personnel experience in the design, build, operation and maintenance of biodigesters that digest WWTP biosolids as a significant portion of their inputs. Identify and provide background information on the key personnel who take the most active role(s) in the administration and management of the project. Provide resumes and biographical information on key professionals that will be directly involved in the project. Include the number of years at your firm, total years of experience, and professional licenses and designations (if applicable).

5. (20 points) Past project descriptions of the design, build, operation and maintenance of biodigesters that digest WWTP biosolids as a significant portion of their inputs. Include discussions of experience managing solid materials through composting and handling liquid digestate.

6. (10 Points) State experience understanding the current state of Michigan recycling initiatives and understanding of any state issues that may affect this project.

B. Proposed Work Plan – 20 points

A detailed work plan is to be presented which lists all tasks determined to be necessary to accomplish the work detailed in the scope of services. The work plan shall define resources needed for each task. In addition, the work plan shall include a timeline schedule depicting the sequence and duration of tasks showing how the work will be organized and executed. The consultant may propose tasks and deliverable outside of those listed above if they believe they are necessary to support the city's objectives.

In the scoring for this section, consultants shall be evaluated on the clarity, thoroughness, and content of their responses to the above items.

C. Fee Proposal - 10 points

1. Fee quotations shall be submitted in a separate, sealed, envelope as part of the proposal. Fee quotations are to include the names, title, hourly rates, overhead factors, and any other details, including hours of effort for each team member by task, and sub-task, by which the overall and project element costs have been derived. The fee quotation is to relate in detail to each item of the proposed work plan. Consultants shall be capable of justifying the details of the fee proposal relative to personnel costs, overhead, how the overhead rate is derived, material and time.

2. The fee proposed must include the total estimated cost for the project when it is 100% complete. This total may be adjusted after negotiations with the City and prior to signing a formal contract, if justified. A sample of the required agreement form is included as Attachment A in Section IV of this RFP.

D. Authorized Negotiator

Include the name, phone number, and e-mail address of persons(s) in your organization authorized to negotiate the agreement with the City.

E. Attachments

Legal Status of Consultant, Living Wage Compliance Form, and the Contract Compliance Form must be completed and returned with the proposal. These elements should be included as attachments to the proposal submission.

**PROPOSAL EVALUATION**

1. The selection committee will evaluate each proposal by the above-described criteria and point system (A through B, based on 90 points) to select a short-list of firms for further consideration. The City reserves the right to reject any proposal that it determines to be unresponsive and deficient in any of the information requested for evaluation. A proposal with all the requested information does not guarantee the proposing firm to be a candidate for an interview. The committee may contact references to verify material submitted by the consultants.

2. The committee then will schedule the interviews with the selected firms if necessary. The selected firms will be given the opportunity to discuss in more detail their qualifications, past experience, proposed work plan and fee proposal.

3. The interview must include the project team members expected to complete a majority of work on the project, but no more than six members total. The interview shall consist of a presentation of up to thirty minutes by the consultant, including the person who will be the project manager on this contract, followed by approximately thirty minutes of questions and answers. Audiovisual aids may be used during the oral interviews. The committee may record the oral interviews.

4. The firms interviewed will then be re-evaluated by the above criteria (A through C), and adjustments to scoring will be made as appropriate. After evaluation of the proposals, further negotiation with the selected firm may be pursued leading to the award of a contract by City Council, if suitable proposals are received.

The City also reserves the right to waive the interview process and evaluate the consultants based on their proposals and fee schedules alone.

The City will determine whether the final scope of the project to be negotiated will be entirely as described in this RFP, a portion of the scope, or a revised scope.

Work to be done under this contract is generally described through the detailed specifications and must be completed fully in accordance with the contract documents.

Any proposal that does not conform fully to these instructions may be rejected.

## PREPARATION OF PROPOSALS

Proposals should be prepared providing a straightforward, concise description of the consultant's ability to meet the requirements of the RFP. Proposals shall be typewritten. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed and dated in ink by the person signing the proposal.

***Proposals should have no plastic bindings. Staples or binder clips are acceptable. Proposals should be printed double sided on recycled paper. Proposals should be no more than 10 sheets excluding resumes and past project descriptions.***

Each person signing the proposal certifies that he or she is the person in the consultant's firm/organization responsible for the decision as to the fees being offered in the Proposal and has not and will not participate in any action contrary to the terms of this provision.

## ADDENDA

If it becomes necessary to revise any part of the RFP, notice of the addendum will be posted to Michigan Inter-governmental Trade Network (MITN) www.mitn.info and/or the City of Ann Arbor web site www.A2gov.org for all parties to download.

Each consultant must acknowledge in its proposal all addenda it has received. The failure of a consultant to receive or acknowledge receipt of any addenda shall not relieve the consultant of the responsibility for complying with the terms thereof. The City will not be bound by oral responses to inquiries or written responses other than official written addenda.

## SECTION IV - ATTACHMENTS

Attachment A: - Legal Status of Respondent

Attachment B – Non-Discrimination Ordinance Declaration of Compliance Form

Attachment C – Living Wage Declaration of Compliance Form

Attachment D – Vendor Conflict of Interest Disclosure Form

Attachment E – Non-Discrimination Ordinance Poster

Attachment F – Living Wage Ordinance Poster

# ATTACHMENT A
# LEGAL STATUS OF RESPONDENT

(The Respondent shall fill out the provision and strike out the remaining ones.)

The Respondent is:

- A corporation organized and doing business under the laws of the state of _____, for whom _____ bearing the office title of _____, whose signature is affixed to this proposal, is authorized to execute contracts on behalf of respondent.*

  *If not incorporated in Michigan, please attach the corporation's Certificate of Authority

- A limited liability company doing business under the laws of the state of _____, whom _____ bearing the title of _____ whose signature is affixed to this proposal, is authorized to execute contract on behalf of the LLC.

- A partnership organized under the laws of the state of _____ and filed with the county of _____ , whose members are (attach list including street and mailing address for each.)

- An individual, whose signature with address, is affixed to this RFP.

Respondent has examined the basic requirements of this RFP and its scope of services, including all Addendum (if applicable) and hereby agrees to offer the services as specified in the RFP.

_____Date: _____,
Signature

(Print) Name _____ Title _____

Firm: _____

Address: _____

Contact Phone _____ Fax _____

Email _____

# ATTACHMENT B
# CITY OF ANN ARBOR DECLARATION OF COMPLIANCE

## Non-Discrimination Ordinance

The "non discrimination by city contractors" provision of the City of Ann Arbor Non-Discrimination Ordinance (Ann Arbor City Code Chapter 112, Section 9:158) requires all contractors proposing to do business with the City to treat employees in a manner which provides equal employment opportunity and does not discriminate against any of their employees, any City employee working with them, or any applicant for employment on the basis of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight. It also requires that the contractors include a similar provision in all subcontracts that they execute for City work or programs.

In addition the City Non-Discrimination Ordinance requires that all contractors proposing to do business with the City of Ann Arbor must satisfy the contract compliance administrative policy adopted by the City Administrator. A copy of that policy may be obtained from the Purchasing Manager

The Contractor agrees:

(a) To comply with the terms of the City of Ann Arbor's Non-Discrimination Ordinance and contract compliance administrative policy.

(b) To post the City of Ann Arbor's Non-Discrimination Ordinance Notice in every work place or other location in which employees or other persons are contracted to provide services under a contract with the City.

(c) To provide documentation within the specified time frame in connection with any workforce verification, compliance review or complaint investigation.

(d) To permit access to employees and work sites to City representatives for the purposes of monitoring compliance, or investigating complaints of non-compliance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services in accordance with the terms of the Ann Arbor Non-Discrimination Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Non-Discrimination Ordinance, obligates the Contractor to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract.

_____
Company Name

_____
Signature of Authorized Representative Date

_____
Print Name and Title

_____
Address, City, State, Zip

_____
Phone/Email address

**Questions about the Notice or the City Administrative Policy, Please contact:**
Procurement Office of the City of Ann Arbor
(734) 794-6500

Revised 3/31/15 Rev. 0 NDO-2

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# ATTACHMENT C
# CITY OF ANN ARBOR
# LIVING WAGE ORDINANCE DECLARATION OF COMPLIANCE

The Ann Arbor Living Wage Ordinance (Section 1:811-1:821 of Chapter 23 of Title I of the Code) requires that an employer who is (a) a contractor providing services to or for the City for a value greater than $10,000 for any twelve-month contract term, or (b) a recipient of federal, state, or local grant funding administered by the City for a value greater than $10,000, or (c) a recipient of financial assistance awarded by the City for a value greater than $10,000, shall pay its employees a prescribed minimum level of compensation (i.e., Living Wage) for the time those employees perform work on the contract or in connection with the grant or financial assistance. The Living Wage must be paid to these employees for the length of the contract/program.

*Companies employing fewer than 5 persons and non-profits employing fewer than 10 persons are exempt from compliance with the Living Wage Ordinance. If this exemption applies to your company/non-profit agency please check here* [ ] *No. of employees* ___

The Contractor or Grantee agrees:

(a) To pay each of its employees whose wage level is not required to comply with federal, state or local prevailing wage law, for work covered or funded by a contract with or grant from the City, no less than the Living Wage. The current Living Wage is defined as $12.81/hour for those employers that provide employee health care (as defined in the Ordinance at Section 1:815 Sec. 1 (a)), or no less than $14.30/hour for those employers that do not provide health care. The Contractor or Grantor understands that the Living Wage is adjusted and established annually on April 30 in accordance with the Ordinance and covered employers shall be required to pay the adjusted amount thereafter to be in compliance (Section 1:815(3).

*Check the applicable box below which applies to your workforce*

[ ] Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage without health benefits

[ ] Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage with health benefits

(b) To post a notice approved by the City regarding the applicability of the Living Wage Ordinance in every work place or other location in which employees or other persons contracting for employment are working.

(c) To provide to the City payroll records or other documentation within ten (10) business days from the receipt of a request by the City.

(d) To permit access to work sites to City representatives for the purposes of monitoring compliance, and investigating complaints or non-compliance.

***(e)*** To take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee covered by the Living Wage Ordinance or any person contracted for employment and covered by the Living Wage Ordinance in order to pay the living wage required by the Living Wage Ordinance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services or agrees to accept financial assistance in accordance with the terms of the Living Wage Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Living Wage Ordinance, obligates the Employer/Grantee to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract or grant of financial assistance.

_____
Company Name

_____
Signature of Authorized Representative Date

_____
Print Name and Title

_____
Address, City, State, Zip

_____
Phone/Email address

Questions about this form? Contact Procurement Office City of Ann Arbor Phone: 734/794-6500

## ATTACHMENT D

# VENDOR CONFLICT OF INTEREST DISCLOSURE FORM

All vendors interested in conducting business with the City of Ann Arbor must complete and return the Vendor Conflict of Interest Disclosure Form in order to be eligible to be awarded a contract. Please note that all vendors are subject to comply with the City of Ann Arbor's conflict interest policies as stated within the certification section below.

If a vendor has a relationship with a City of Ann Arbor official or employee, an immediate family member of a City of Ann Arbor official or employee, the vendor shall disclose the information required below.

**Certification:** I hereby certify that to my knowledge, there is no conflict of interest involving the vendor named below:

1. No City official or employee or City employee's immediate family member has an ownership interest in vendor's company or is deriving personal financial gain from this contract.
2. No retired or separated City official or employee who has been retired or separated from the City for less than one (1) year has an ownership interest in vendor's Company.
3. No City employee is contemporaneously employed or prospectively to be employed with the vendor.
4. Vendor hereby declares it has not and will not provide gifts or hospitality of any dollar value or any other gratuities to any City employee or elected official to obtain or maintain a contract.
5. Please note any exceptions below:

| Vendor Name | Vendor Phone Number |
|---|---|
| | |
| **Conflict of Interest Disclosure *** | |
| Name of City of Ann Arbor employees, elected officials, or immediate family members with whom there maybe a potential conflict of interest. | ( ) Relationship to employee<br>( ) Interest in vendor's company<br>( ) Other |
| | |

*Disclosing a potential conflict of interest does not disqualify vendors. In the event vendors do not disclose potential conflicts of interest and they are detected by the City, vendor will be exempt from doing business with the City.

I certify that the information provided is true and correct by my signature below:

Signature of Vendor Authorized Representative _____ Date _____ Printed Name of Vendor Authorized Representative _____

**PROCUREMENT USE ONLY**

☐ Yes, named employee was involved in Bid / Proposal process.

☐ No, named employee was not involved in procurement process or decision.

# ATTACHMENT E
# CITY OF ANN ARBOR NON-DISCRIMINATION ORDINANCE

Relevant provisions of Chapter 112, Nondiscrimination, of the Ann Arbor City Code are included below. You can review the entire ordinance at www. a2gov.org/departments/city-clerk

**Intent**: It is the intent of the city that no individual be denied equal protection of the laws; nor shall any individual be denied the enjoyment of his or her civil or political rights or be discriminated against because of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientati… veteran status, victim of domestic violence or stalking, or weight…

**Discriminatory Emplo**… …n the hire, employment, compensation, work… …motion, or termination of employment of … …mbership, conditions of membership o… …hip program.

**Discriminator**… …or requirement which has t… …erceived age, arrest reco… …sponsibilities, gender ex… …arital status, national o… …me, veteran status, vi… …in housing, employme… …ity. Such a necessity … …tion to such a person …

**Nondiscri**… …h the City of Ann Arbor… …by the City Administra… …s shall ensure that applica… …t in a manner which provid… …based upon any classification … …riminate against an employee or… …ns, conditions, or privileges of emp… …oyment, because of any applicable prote… …to post a copy of Ann Arbor's Non-Discrimi… …its employees provide services under a contract…

**Complaint Procedure:** If any indi… …alleging a violation of this chapter, he/she has 180 calendar days from the date of the individual's knowledge of the allegedly discriminatory action or 180 calendar days from the date when the individual should have known of the alleged discriminatory action to file a complaint with the city's Human Rights Commission. If an individual fails to file a complaint alleging a violation of this chapter within the specified time frame, the complaint will not be considered by the Human Rights Commission. The complaint should be made in writing to the Human Rights Commission. The complaint may be filed in person with the City Clerk, by e-mail at aahumanrightscommission@gmail.com, or by mail (Ann Arbor Human Rights Commission, PO Box 8647, Ann Arbor, MI 48107). The complaint must contain information about the alleged discrimination, such as name, address, phone number of the complainant and location, date and description of the alleged violation of this chapter.

**Private Actions For Damages or Injunctive Relief:** To the extent allowed by law, an individual who is the victim of discriminatory action in violation of this chapter may bring a civil action for appropriate injunctive relief or damages or both against the person(s) who acted in violation of this chapter.

## ATTACHMENT F

## CITY OF ANN ARBOR LIVING WAGE ORDINANCE

### RATE EFFECTIVE APRIL 30, 2015 - ENDING APRIL 29, 2016

**$12.81** per hour
If the employer provides health care benefits*****

**$14.30** per hour
If the employer does **NOT** provide health care benefits*****

Employers providing services to or for the City of Ann Arbor or recipients of grants or financial assistance from the City of Ann Arbor for a value of more than $10,000 in a twelve-month period of time must pay those employees performing work on a City of Ann Arbor contract or grant, the above living wage.

# ENFORCEMENT

The City of Ann Arbor may recover back wages either administratively or through court action for the employees that have been underpaid in violation of the law. Persons denied payment of the living wage have the right to bring a civil action for damages in addition to any action taken by the City.

Violation of this Ordinance is punishable by fines of not more than $500/violation plus costs, with each day being considered a separate violation. Additionally, the City of Ann Arbor has the right to modify, terminate, cancel or suspend a contract in the event of a violation of the Ordinance.

***** Health Care benefits include those paid for by the employer or making an employer contribution toward the purchase of health care. The employee contribution must not exceed $.50 an hour for an average work week; and the employer cost or contribution must equal no less than $1/hr for the average work week.

**The Law Requires Employers to Display This Poster Where Employees Can Readily See It.**

**For Additional Information or to File a Complaint Contact**
**Mark Berryman at 734/794-6500 or mberryman@a2gov.org**

# APPENDIX A: SAMPLE PROFESSIONAL SERVICES AGREEMENT

*If a contract is awarded, the selected Firm(s) will be required to adhere to a set of general contract provisions which will become a part of any formal agreement. These provisions are general principles which apply to all contractors/service providers to the City of Ann Arbor. The required provisions are:*

**SAMPLE PROFESSIONAL SERVICES AGREEMENT BETWEEN**

**_____**
**AND THE CITY OF ANN ARBOR**
**FOR** _____

The City of Ann Arbor, a Michigan municipal corporation, having its offices at 301 E. Huron St. Ann Arbor, Michigan 48103 ("City"), and _____
_____
("Contractor") a(n) _____ _____
(State where organized) (Partnership, Sole Proprietorship, or Corporation)
with its address at _____
agree as follows on this _____ day of _____, 20___.

The Contractor agrees to provide services to the City under the following terms and conditions:

## I. DEFINITIONS

Administering Service Area/Unit means _____.

Contract Administrator means _____, acting personally or through any assistants authorized by the Administrator/Manager of the Administering Service Area/Unit.

Deliverables means all Plans, Specifications, Reports, Recommendations, and other materials developed for and delivered to City by Contractor under this Agreement

Project means _____.
Project name

## II. DURATION

This Agreement shall become effective on _____, 20____, and shall remain in effect until satisfactory completion of the Services specified below unless terminated as provided for in Article XI.

## III. SERVICES

A. The Contractor agrees to provide _____
type of service
("Services") in connection with the Project as described in Exhibit A. The City retains the right to make changes to the quantities of service within the general scope of the Agreement at any

time by a written order. If the changes add to or deduct from the extent of the services, the contract sum shall be adjusted accordingly. All such changes shall be executed under the conditions of the original Agreement.

B. Quality of Services under this Agreement shall be of the level of quality performed by persons regularly rendering this type of service. Determination of acceptable quality shall be made solely by the Contract Administrator.

C. The Contractor shall perform its Services for the Project in compliance with all statutory, regulatory and contractual requirements now or hereafter in effect as may be applicable to the rights and obligations set forth in the Agreement.

D. The Contractor may rely upon the accuracy of reports and surveys provided to it by the City (if any) except when defects should have been apparent to a reasonably competent professional or when it has actual notice of any defects in the reports and surveys.

## IV. INDEPENDENT CONTRACTOR

The Parties agree that at all times and for all purposes under the terms of this Agreement each Party's relationship to any other Party shall be that of an independent contractor. Each Party will be solely responsible for the acts of its own employees, agents, and servants. No liability, right, or benefit arising out of any employer/employee relationship, either express or implied, shall arise or accrue to any Party as a result of this Agreement.

## V. COMPENSATION OF CONTRACTOR

A. The Contractor shall be paid in the manner set forth in Exhibit B. Payment shall be made monthly, unless another payment term is specified in Exhibit B, following receipt of invoices submitted by the Contractor, and approved by the Contract Administrator.

B. The Contractor will be compensated for Services performed in addition to the Services described in Section III, only when the scope of and compensation for those additional Services have received prior written approval of the Contract Administrator.

C. The Contractor shall keep complete records of work performed (e.g. tasks performed/hours allocated) so that the City may verify invoices submitted by the Contractor. Such records shall be made available to the City upon request and submitted in summary form with each invoice.

## VI. INSURANCE/INDEMNIFICATION

A. The Contractor shall procure and maintain during the life of this contract such insurance policies, including those set forth in Exhibit C, as will protect itself and the City from all claims for bodily injuries, death or property damage which may

arise under this contract; whether the act(s) or omission(s) giving rise to the claim were made by the Contractor, any subcontractor or anyone employed by them directly or indirectly. In the case of all contracts involving on-site work, the

Contractor shall provide to the City, before the commencement of any work under this contract, documentation satisfactory to the City demonstrating it has obtained the policies and endorsements required by Exhibit C.

B. Any insurance provider of Contractor shall be admitted and authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-admitted insurance companies are not acceptable unless approved in writing by the City.

C. To the fullest extent permitted by law, Contractor shall indemnify, defend and hold the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses, including attorney's fees, resulting or alleged to result, from any acts or omissions by Contractor or its employees and agents occurring in the performance of or breach in this Agreement, except to the extent that any suit, claim, judgment or expense are finally judicially determined to have resulted from the City's negligence or willful misconduct or its failure to comply with any of its material obligations set forth in this Agreement.

## VII. COMPLIANCE REQUIREMENTS

A. Nondiscrimination. The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of MCL 37.2209. The Contractor further agrees to comply with the provisions of Section 9:158 of Chapter 112 of the Ann Arbor City Code and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity.

B. Living Wage. If the Contractor is a "covered employer" as defined in Chapter 23 of the Ann Arbor City Code, the Contractor agrees to comply with the living wage provisions of Chapter 23 of the Ann Arbor City Code. The Contractor agrees to pay those employees providing Services to the City under this Agreement a "living wage," as defined in Section 1:815 of the Ann Arbor City Code, as adjusted in accordance with Section 1:815(3); to post a notice approved by the City of the applicability of Chapter 23 in every location in which regular or contract employees providing services under this Agreement are working; to maintain records of compliance; if requested by the City, to provide documentation to verify compliance; to take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee or person contracted for employment in order to pay the living wage required by Section 1:815; and otherwise to comply with the requirements of Chapter 23.

## VIII. WARRANTIES BY THE CONTRACTOR

A. The Contractor warrants that the quality of its Services under this Agreement shall conform to the level of quality performed by persons regularly rendering this type of service.

B. The Contractor warrants that it has all the skills, experience, and professional licenses necessary to perform the Services specified in this Agreement.

C. The Contractor warrants that it has available, or will engage, at its own expense, sufficient trained employees to provide the Services specified in this Agreement.

D. The Contractor warrants that it is not, and shall not become overdue or in default to the City for any contract, debt, or any other obligation to the City including real and personal property taxes.

E. The Contractor warrants that its proposal for services was made in good faith, it arrived at the costs of its proposal independently, without consultation, communication or agreement, for the purpose of restricting completion as to any matter relating to such fees with any competitor for these Services; and no attempt has been made or shall be made by the Contractor to induce any other perform or firm to submit or not to submit a proposal for the purpose of restricting competition.

## IX. OBLIGATIONS OF THE CITY

A. The City agrees to give the Contractor access to the Project area and other City-owned properties as required to perform the necessary Services under this Agreement.

B. The City shall notify the Contractor of any defects in the Services of which the Contract Administrator has actual notice.

## X. ASSIGNMENT

A. The Contractor shall not subcontract or assign any portion of any right or obligation under this Agreement without prior written consent from the City. Notwithstanding any consent by the City to any assignment, Contractor shall at all times remain bound to all warranties, certifications, indemnifications, promises and performances, however described, as are required of it under the Agreement unless specifically released from the requirement, in writing, by the City.

B. The Contractor shall retain the right to pledge payment(s) due and payable under this Agreement to third parties.

## XI. TERMINATION OF AGREEMENT

A. If either party is in breach of this Agreement for a period of fifteen (15) days following receipt of notice from the non-breaching party with respect to a breach, the non-breaching party may pursue any remedies available to it against the

breaching party under applicable law, including but not limited to, the right to terminate this Agreement without further notice. The waiver of any breach by any party to this Agreement shall not waive any subsequent breach by any party.

B. The City may terminate this Agreement, on at least thirty (30) days advance notice, for any reason, including convenience, without incurring any penalty, expense or liability to Contractor, except the obligation to pay for Services actually performed under the Agreement before the termination date.

C. Contractor acknowledges that, if this Agreement extends for several fiscal years, continuation of this Agreement is subject to appropriation of funds for this Project. If funds to enable the City to effect continued payment under this Agreement are not appropriated or otherwise made available, the City shall have the right to terminate this Agreement without penalty at the end of the last period for which funds have been appropriated or otherwise made available by giving written notice of termination to Contractor. The Contract Administrator shall give Contractor written notice of such non-appropriation within thirty (30) days after it receives notice of such non-appropriation.

D. The provisions of Articles VI and VIII shall survive the expiration or earlier termination of this Agreement for any reason. The expiration or termination of this Agreement, for any reason, shall not release either party from any obligation or liability to the other party, including any payment obligation that has already accrued and Contractor's obligation to deliver all Deliverables due as of the date of termination of the Agreement.

## XII. REMEDIES

A. This Agreement does not, and is not intended to, impair, divest, delegate or contravene any constitutional, statutory and/or other legal right, privilege, power, obligation, duty or immunity of the Parties.

B. All rights and remedies provided in this Agreement are cumulative and not exclusive, and the exercise by either party of any right or remedy does not preclude the exercise of any other rights or remedies that may now or subsequently be available at law, in equity, by statute, in any agreement between the parties or otherwise.

C. Absent a written waiver, no act, failure, or delay by a Party to pursue or enforce any rights or remedies under this Agreement shall constitute a waiver of those rights with regard to any existing or subsequent breach of this Agreement. No waiver of any term, condition, or provision of this Agreement, whether by conduct or otherwise, in one or more instances, shall be deemed or construed as a continuing waiver of any term, condition, or provision of this Agreement. No waiver by either Party shall subsequently effect its right to require strict performance of this Agreement.

## XIII. NOTICE

All notices and submissions required under this Agreement shall be delivered to the respective party in the manner described herein to the address stated in this Agreement or such other address as either party may designate by prior written notice to the other. Notices given under this Agreement shall be in writing and shall be personally delivered, sent by next day express delivery service, certified mail, or first class U.S. mail postage prepaid, and addressed to the person listed below. Notice will be deemed given on the date when one of the following first occur: (1) the date of actual receipt; (2) the next business day when notice is sent next day express delivery service or personal delivery; or (3) three days after mailing first class or certified U.S. mail.

If Notice is sent to the CONTRACTOR, it shall be addressed and sent to:

If Notice is sent to the CITY, it shall be addressed and sent to:

City of Ann Arbor

_____
(insert name of Administering Service Area Administrator)

301 E. Huron St.
Ann Arbor, Michigan 48103

## XIV. CHOICE OF LAW AND FORUM

This Agreement will be governed and controlled in all respects by the laws of the State of Michigan, including interpretation, enforceability, validity and construction, excepting the principles of conflicts of law. The parties submit to the jurisdiction and venue of the Circuit Court for Washtenaw County, State of Michigan, or, if original jurisdiction can be established, the United States District Court for the Eastern District of Michigan, Southern Division, with respect to any action arising, directly or indirectly, out of this Agreement or the performance or breach of this Agreement. The parties stipulate that the venues referenced in this Agreement are convenient and waive any claim of non-convenience.

## XV. OWNERSHIP OF DOCUMENTS

Upon completion or termination of this Agreement, all documents (i.e., Deliverables) prepared by or obtained by the Contractor as provided under the terms of this Agreement shall be delivered to and become the property of the City. Original basic survey notes, sketches, charts, drawings, partially completed drawings, computations, quantities and other data shall remain in

the possession of the Contractor as instruments of service unless specifically incorporated in a deliverable, but shall be made available, upon request, to the City without restriction or limitation on their use. The City acknowledges that the documents are prepared only for the Project. Prior to completion of the contracted Services the City shall have a recognized proprietary interest in the work product of the Contractor.

Unless otherwise stated in this Agreement, any intellectual property owned by Contractor prior to the effective date of this Agreement (i.e., Preexisting Information) shall remain the exclusive property of Contractor even if such Preexisting Information is embedded or otherwise incorporated in materials or products first produced as a result of this Agreement or used to develop Deliverables. The City's right under this provision shall not apply to any Preexisting Information or any component thereof regardless of form or media.

## XV. CONFLICTS OF INTEREST OR REPRESENTATION

Contractor certifies it has no financial interest in the Services to be provided under this Agreement other than the compensation specified herein. Contractor further certifies that it presently has no personal or financial interest, and shall not acquire any such interest, direct or indirect, which would conflict in any manner with its performance of the Services under this Agreement.

Contractor agrees to advise the City if Contractor has been or is retained to handle any matter in which its representation is adverse to the City. The City's prospective consent to the Contractor's representation of a client in matters adverse to the City, as identified above, will not apply in any instance where, as the result of Contractor's representation, the Contractor has obtained sensitive, proprietary or otherwise confidential information of a non-public nature that, if known to another client of the Contractor, could be used in any such other matter by the other client to the material disadvantage of the City. Each matter will be reviewed on a case by case basis.

## XVII. SEVERABILITY OF PROVISIONS

Whenever possible, each provision of this Agreement will be interpreted in a manner as to be effective and valid under applicable law. However, if any provision of this Agreement or the application of any provision to any party or circumstance will be prohibited by or invalid under applicable law, that provision will be ineffective to the extent of the prohibition or invalidity without invalidating the remainder of the provisions of this Agreement or the application of the provision to other parties and circumstances.

## XVIII. EXTENT OF AGREEMENT

This Agreement, together with any affixed exhibits, schedules or other documentation, constitutes the entire understanding between the City and the Contractor with respect to the subject matter of the Agreement and it supersedes, unless otherwise incorporated by reference herein, all prior representations, negotiations, agreements or understandings whether written or

oral. Neither party has relied on any prior representations, of any kind or nature, in entering into this Agreement. No terms or conditions of either party's invoice, purchase order or other administrative document shall modify the terms and conditions of this Agreement, regardless of the other party's failure to object to such form. This Agreement shall be binding on and shall inure to the benefit of the parties to this Agreement and their permitted successors and permitted assigns and nothing in this Agreement, express or implied, is intended to or shall confer on any other person or entity any legal or equitable right, benefit, or remedy of any nature whatsoever under or by reason of this Agreement. This Agreement may only be altered, amended or modified by written amendment signed by the Contractor and the City. This Agreement may be executed in counterparts, each of which shall be deemed an original, but all of which together shall be deemed to be one and the same agreement.

**FOR CONTRACTOR**

By _____
Type Name

Its

**FOR THE CITY OF ANN ARBOR**

By _____
Christopher Taylor, Mayor

By _____
Jacqueline Beaudry, City Clerk

**Approved as to substance**

_____
Steven D. Powers, City Administrator

_____
Type Name
Service Area Administrator

**Approved as to form and content**

_____
Stephen K. Postema, City Attorney

# EXHIBIT A
# SCOPE OF SERVICES

**(Insert/Attach Scope of Work & Deliverables Schedule)**

**EXHIBIT B**
**COMPENSATION**

General

Contractor shall be paid for those Services performed pursuant to this Agreement inclusive of all reimbursable expenses (if applicable), in accordance with the terms and conditions herein. The Compensation Schedule below/attached states nature and amount of compensation the Contractor may charge the City:

(insert/Attach Negotiated Fee Arrangement)

**EXHIBIT C**
**INSURANCE REQUIREMENTS**

Effective the date of this Agreement, and continuing without interruption during the term of this Agreement, Contractor shall provide certificates of insurance to the City on behalf of itself, and when requested any subcontractor(s). The certificates of insurance shall meet the following minimum requirements.

A. The Contractor shall have insurance that meets the following minimum requirements:

1. Professional Liability Insurance or Errors and Omissions Insurance protecting the Contractor and its employees in an amount not less than $1,000,000.

2. Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

   Bodily Injury by Accident - $500,000 each accident
   Bodily Injury by Disease - $500,000 each employee
   Bodily Injury by Disease - $500,000 each policy limit

3. Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 07 98 or current equivalent. The City of Ann Arbor shall be an additional insured. There shall be no added exclusions or limiting endorsements which diminish the City's protections as an additional insured under the policy. Further, the following minimum limits of liability are required:

   | | |
   |---|---|
   | $1,000,000 | Each occurrence as respect Bodily Injury Liability or Property Damage Liability, or both combined |
   | $2,000,000 | Per Job General Aggregate |
   | $1,000,000 | Personal and Advertising Injury |

4. Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 07 97 or current equivalent. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. Further, the limits of liability shall be $1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

5. Umbrella/Excess Liability Insurance shall be provided to apply in excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of $1,000,000.

B. Insurance required under A.3 above shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City.

C. Insurance companies and policy forms are subject to approval of the City Attorney, which approval shall not be unreasonably withheld. Documentation must provide and demonstrate an unconditional 30 day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number; name of insurance company; name and address of the agent or authorized representative; name and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which shall be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified. Contractor shall furnish the City with satisfactory certificates of insurance and endorsements prior to commencement of any work. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) to the City. If any of the above coverages expire by their terms during the term of this contract, the Contractor shall deliver proof of renewal and/or new policies to the Administering Service Area/Unit at least ten days prior to the expiration date.

## APPENDIX B: 2014 STUDY

# Ann Arbor Biodigester

## A Feasibility Study

30 June 2014

Submitted to the City of Ann Arbor
City of Ann Arbor
301 E. Huron
Ann Arbor, Michigan 48107

In fulfillment of the Scope of Work offered in RFP 889
By Quantalux LLC


*Study Team:*

Joseph Tesar, Quantalux, LLC, Ann Arbor, Michigan
jtesar@quantalux.com
John Willard, Quantalux, LLC, Ann Arbor, Michigan
jwillard@quantalux.com
Chad Antle, Swedish Biogas International LLC, Flint Michigan
chad.antle@swedishbiogas.com

Quantalux, LLC
1005 Lincoln Ave
Ann Arbor, Michigan 48104-3559

Swedish Biogas International LLC,
1300 Bluff Street, Suite 100
Flint Michigan 48504-4827

## Acknowledgements

The Team of Quantalux/Swedish Biogas would like to acknowledge the assistance from the following people during the preparation of this Study:

*Mr. Tom McMurtrie* and *Mr. Matt Naud* from the City of Ann Arbor: Both Mr. McMurtrie and Mr. Naud met with Quantalux multiple times during the course of this Study in order to provide technical inputs, and recommend mid-course corrections (where needed). These meetings were very collaborative, and provided valuable opportunities for the Team to focus the tasks in the Feasibility Study to the specific needs of the City of Ann Arbor.

*Mr. Keith Sanders* and *Mr. Earl Kenzie* from the Ann Arbor Wastewater Treatment Plant (WWTP): Mr. Sanders and Mr. Kenzie provided the Team with technical data and detailed specifications on current WWTP plant operation. Mr. Sanders and Mr. Kenzie were very open to discussions on alternative processing techniques, and were quick to respond to the Team's request for detailed technical information.

*Ms. Tracy Artley*, Manager, Waste Reduction & Recycling Office, University of Michigan: Ms. Artley has worked for several years to determine the available food waste at the University of Michigan, and as the Study shows, the pre-consumer food waste from the University can be a valuable addition to the proposed Ann Arbor biodigester. Ms. Artley generously provided details on the University's food sort data, and shared technical information on the challenges facing a large institution with food waste collection.

*Ms. Jean Henry*, Sustainability Coordinator, Zingermans, Ann Arbor: Ms. Henry is responsible for managing the sustainable disposal of large amounts of food waste from Zingermans' restaurants and food production units. She shared data on the food waste generated by Zingermans, and identified the company's current methods for food waste composting. She was also particularly helpful in helping us understand the challenge of separating pre- and post-consumer food waste in the restaurant disposal stream.

Many other managers and owners of restaurants and breweries were interviewed to determine how food waste is disposed of in their establishments, including *Mr. Kevin Gudejko* (Main Street Ventures), *Mr. Dan Peron* (Corner Brewery) and *Mr. Tony Grant* (Northern United Breweries). We are grateful for the opportunity to see their businesses in person, and to discuss the various day-to-day issues they face with food waste disposal.



# Ann Arbor Biodigester
# A Feasibility Study

## Introduction

A Request for Proposal (RFP) 889 was issued in March of 2014 to conduct a Feasibility Study on the use of biodigesters to process food waste from the City. This RFP was motivated by a Call to Action in the 2013 Ann Arbor Solid Waste Resource Plan, which calls for the City to research options to collect and process all food waste produced within the city. While the City already composts small amounts of food waste mixed with yard waste via weekly pickup from City residences, as much as 40% of the current trash load may consist of food waste, which – with good planning – can be diverted to a beneficial use.

Biodigesters are a good option for processing food waste, and are used routinely in Europe where the landfilling of food waste is prohibited. European systems typically find a good revenue stream from generating electricity from the biogas produced by the biodigester, and this is their primary revenue source. However, since electrical production is far less valuable in the US market, the successful adaptation of biodigester technology here requires that a biodigester find diverse revenue streams in order to maintain financial viability. Other revenue sources can include the sale of digested solids (a soil amendment), biogas (for heat or electricity) and the receipt of tipping fees when accepting materials to put into the digester. Another important revenue stream is the avoided cost of disposing of materials such as food waste or biosolids in the local landfill.

This Feasibility Study is an initial look at the resources needed for a successful biodigester near Ann Arbor. Our goals in the Study were to:

- Identify available food waste from commercial and industrial sources in the Ann Arbor region (excluding residential)
- Develop a high-level Biodigester cost description that is scaled to the available feedstocks
- Estimate the financial viability of the Biodigester (both short term and long term) based on revenues and expenses.

Using the results from this Feasibility Study, the City of Ann Arbor can assess options for enhanced solid waste disposal in the future.

# 1. Executive Summary

This Feasibility Study evaluates the potential for a biodigester for the City of Ann Arbor. Biodigestion is a method for processing organic waste materials (termed "feedstocks") such as food waste, grease, oils and sludges/manures. A biodigester earns revenue from the production of renewable electricity, from the sale of soil amendments, tipping fees for accepting feedstocks and via the avoided cost of landfilling the raw waste.

The Study focused on three main goals:

1. Identify available food waste and other organic waste from commercial and industrial sources in the Ann Arbor region.
2. Create an accurate system description for a biodigester that is scaled to the available feedstocks.
3. Develop software based cost-models to calculate financial viability of the Biodigester based on available feedstocks, including a 20 year pro forma model that includes all anticipated revenues and expenses.

The inclusion of sewage sludge in the list of available feedstocks is an important factor to economic success. Processing sewage sludge in a biodigester offers significant cost savings over the disposal of sludge in landfills or by land application (the current disposal method.)

The Study included the digestion of food waste from restaurants and food processors in the Ann Arbor area, and from the University of Michigan cafeterias. Food waste is a highly desirable feedstock, generating high quality biogas. The renewable electricity created from the biodigestion of food waste will earn significant annual revenue for the proposed biodigester.

Financial modeling of a biodigester showed the following results:

| Case # | Type of financing | Fraction of sludge | Cost of Electricity ¢/kWh | Discount Rate, % | Cost of Money % | Term, years | Return on Investment, % | Internal Rate of Return, % | NPV |
|---|---|---|---|---|---|---|---|---|---|
| 3 | Public | 100% | 9 ¢/kWh | 2.1% | 3.5% | 10 | 13.5% | 6.06% | $2,705,235 |
| 4 | | | 5.5 ¢/kWh | | | | 15.6% | 4.58% | $1,658,744 |

Key requirements for financial viability (i.e. profitabiliy) include the use of public financing using tax-exempt bonds, and the diversion of the sludge from the Ann Arbor Wastewaster Treatment Plant. Revenue from electrical generation can be earned via sale to the local utility (at 5.5 ¢/kWh) or by self-consumption for the plant and other City facilities (at 9 ¢/kWh).

Assuming these requirements are met, the models developed in this Feasibility Study show that an investment in the development of a biodigester system can be profitable to the City. The Study's financial modeling was fairly conservative, assuming very low inflation over the 20 year lifetime of the project. Should costs for current solid waste disposal increase significantly, then the biodigester's project profitability will improve further.

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## 2. Background

Organic waste makes up a large component of the total municipal solid waste (MSW) landfilled in the US. It is estimated that over 34 million tons of food waste is generated each year, which is approximately 15% of the total landfill volume.[1] Landfilling of food waste results in increased methane emissions through the natural decomposition of organic matter. While many landfills seek to capture and destroy methane using flaring and/or gas-to-energy systems, significant leakage means that approximately half of the landfill methane is emitted into the atmosphere

Conversely, biodigesters[i] use sealed vessels to process food waste, which captures nearly 100% of the methane produced from decomposing food waste. The methane can be used for a variety of power generation activities including electricity, natural gas replacement, and or vehicle fuel. Using the residual materials from the biodigester (digestate) as a soil amendment such as compost offers the opportunity to recycle valuable nutrients back into the ecosystem.

Biodigestion of food waste is a natural solution for a number of reasons:

- Food waste is high in nutrients, and can readily be broken-down by anaerobic digestion. Furthermore, food waste is inherently diverse, providing the required trace elements and nutrients for optimal digestion.
- Food waste has a very low potential for unwanted chemicals. In many cases, food waste is produced in USDA and FDA-compliant food processing facilities, assuring quality.
- Biodigesters can sustainably process many types of food waste that are not appropriate for composting. For example, sugary or soupy waste is a challenge to compost, but ideal for biodigestion.
- Businesses typically have loading docks and good site access for trucks to pick up food waste before it is transported to the biodigestion facility.

From an economic development-viewpoint, a biodigester can offer the following advantages:

- Businesses that desire a green solution to waste management can use this fact to offer legitimate green branding to attract and retain customers. Diverting food waste from landfills to a community digester makes business sense.
- A biodigester offers a responsible disposal option to a food production company contemplating a move in the Ann Arbor area. This is an economic development incentive.
- "Clean industries" such as food processing (as opposed to heavy industry) benefit from responsible and cost-effective waste disposal options, and are therefore more likely to expand in the Ann Arbor region.

[i] Biodigesters are also referred to as methane digesters or anaerobic digesters). For simplicity, this Study will use the term "biodigester".

## Recent Food Waste Studies and State-of-the-Industry Investigation

The following is a set of summaries from recent food waste studies.

- A study by BSR, conducted on behalf of the Food Waste Reduction Alliance[2], investigated the quantities and disposal methods of food manufacturing and retail grocery sectors. The study surveyed 13 food manufactures (equating to 17% of U.S. industry represented by revenue) and 13 retail stores (30% of U.S. industry represented by revenue). The results showed that a majority of the food waste, 93% from manufacturing was diverted either to animal feed, land application, or compost. Retail grocery stores diverted a much smaller percentage of total waste generated, 37% was recycled, and 17% was donated. Composting was observed to be the primary recycling option accounting for 43% of all diverted waste.

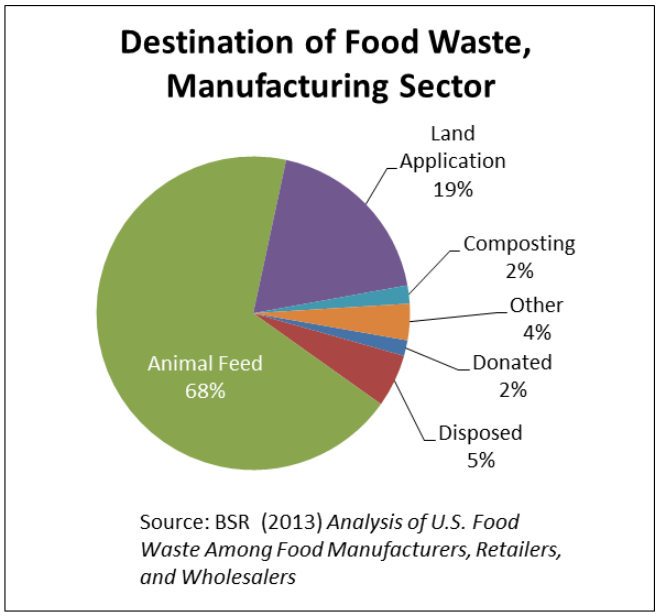


**Figure 1: BSR manufacturing food waste study**

- A study from 2008 for the City of New York estimated 1,640 tons/day of commercial food waste were produced in New York City alone.[3] A second study by the Coalition for Resource Recovery (CoRR) used this data to calculate the primary sources of this waste and the economic feasibility of diverting it from landfills.[4, 5] The breakdown of the sources showed restaurants and hotels being the largest producer (53%) followed by other food establishments and retail stores (20% and 14%). The report also showed that capacity for diverting food waste to compost or to anaerobic digestion facilities was limited. One of the potential diversion options proposed was transporting food waste to the City's wastewater treatment plant (WWTP), similar to the operation currently in practice at East Bay Municipal Utility District (EBMUD).

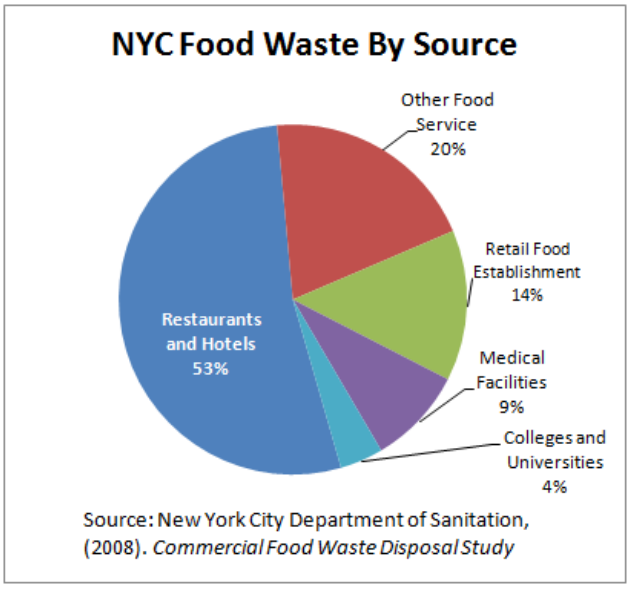


**Figure 2: New York City commercial food waste by source**

- East Bay Municipal Utility District WWTP in Oakland, California currently accepts 40 tons/day of food waste from restaurants and hotels. The WWTP also processes food processing waste and municipal sludge. The result is that the WWTP is able to produce 90% of its onsite power requirements from its anaerobic digesters to produce biogas. Future design of the system and expansion of organic waste acceptance is expected to turn the WWTP into an energy exporter.[6] In the Bay Area, there is approximately 2,100 tons/day of commercial food waste. *Recology*, the waste management company operating in the area, is building a preprocessing plant next to EBMUD's anaerobic digesters to remove non-digestible items from the organic waste stream that it collects.[7] The facility will be able to process up to 600 tons of material per day and feed directly into EMBUD front-end processing facility.[8]

Both EBMUD and the City of New York operate in a vastly different scale to Ann Arbor in terms of population and infrastructure. However, some of the information and lessons learned from these examples can serve as guidance for evaluating the feasibility of a community digester for the City of Ann Arbor. Food waste generation in the retail and food service establishments are expected to be fairly universal in terms of generation on a revenue or per customer basis. What is highly variable is the quantity of production across different types of food service establishments and retail stores. Also, the availability of alternative disposal options varies greatly as well. The comparison to a similar feasibility study effort by AECOM for Dane County, Wisconsin adds valuable insight into a city of comparable size to Ann Arbor.

- The Dane County Phase I feasibility study[9] showed that the diversion of organics from landfill are primarily driven by cost. The food processor waste survey estimated that on average 86% of waste was diverted from landfill. The primary diversion pathways included animal feed, compost, or rendering with only 14% of organics going to landfill. These findings reflect a similar breakdown to the BSR study mentioned previously. Diverting processor waste streams to animal feed and rendering are cost saving, or even revenue generating, opportunities for the food processors in the Dane County area. Another point of interest outlined in the Dane County survey is that waste quantity and disposal data was difficult to generate. This proved to be a similar challenge in Ann Arbor, Michigan.

All of these studies and active projects provide insight into an investigation into the Ann Arbor area. The technology and logistics for operating a community style digester has been proven both on a national and regional level.

## Biodigester Overview

A flowchart for a typical biodigester is shown in Figure 3. The materials on the left (referred to as "feedstocks") are fed into the anaerobic digester at a pre-determined rate. Feedstocks include manure, wastewater treatment plant sludge, food waste, grease and fats from the surrounding community. Unlike a composting operation, biodigesters are anaerobic, which means that the system is sealed in order to eliminate oxygen, which is toxic to the culture of organisms inside the digester that consume the feedstocks to produce biogas and digested solids. As a result, the systems have very little odor, and are highly efficient at extracting biogas.

Feedstocks are held in the digesters for set period of time (typically 20 to 40 days) in order to allow the methanogenic organisms to break down the organic material. The output is then expelled for post-processing (moisture removal). Figure 1 also shows that the digestion process can earn revenues in several ways: direct payment of tipping fees, avoidance of landfill costs, and by the sale of byproducts (compost and bioenergy)

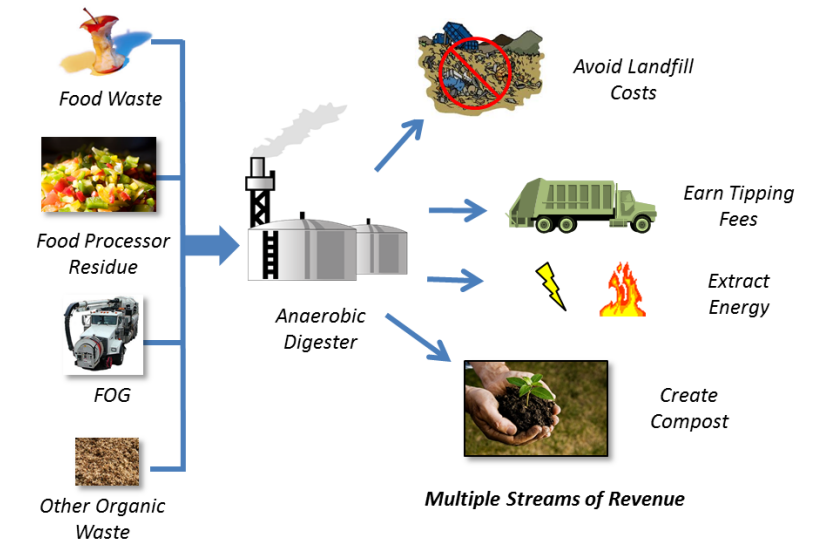


**Figure 3: Multiple Feedstocks can be processed in a biodigester, yielding revenue from multiple sources.**

## Examples of Food Waste Biodigesters

While food-waste biodigesters are common in Germany and Sweden, the specific use of food waste as a feedstock is an emerging technique in the US, motivated by both environmental and fiscal considerations. Several examples of successfully operating food waste digesters are in operation today (see Figure 4.) These include:

***Central Florida Energy Garden:*** The Energy Garden near Orlando is designed to process organic waste from the Central Florida region. The largest supplier of food waste will be Walt Disney World Resort. Other suppliers include restaurants, hotels and food processors in Central Florida. Energy production is 5.4 MW of renewable electrical generation

***ecoCitysystem Columbus, OH:*** The ecoCitysystem processes biosolids from the City of Columbus, regional food waste and FOG (fats, oil and grease) to generate 1 MW of renewable energy.

***South Campus Digester at Michigan State University:*** This facility processes dairy manure, food wastes and food scraps from the MSU dorms and other eating facilities on

campus. The system is also designed as a research asset for MSU, allowing researchers to explore optimum feedstock combinations. Energy production is 400 kW of renewable electricity for the MSU campus.

***Forest County Potawatomi Community, Milwaukee, WI:*** A biodigester at the Potawatomi Bingo Casino accepts food waste from casino food services in addition to soy, whey, and bakery byproducts from local industry. The plant is designed to process 132,000 gallons of material per day and will generate 2 MW of renewable power.


Central Florida Energy Garden
Orlando, FL

South Campus Digester, Michigan State University

ecoCitysystem, Columbus, OH

Potawatomi Casino, Milwaukee WI

**Figure 4: Examples of biodigesters that process food waste and food residues**

Note that all of the digesters shown in Figure 4 are large-scale, centralized facilities. Experience in Europe and the US has shown that large scale facilities are required to achieve the required economies of scale for financial viability.

## Biodigester Feedstocks

While biodigestion is a mature and reliable technology, the key design and operational challenge is to identify a locally available, continuous supply of feedstocks to feed the digester during operation. In addition, the correct mixture of feedstocks must be fed to the biodigester. (This is essentially the "diet" for the biodigester). The following is a list of potential feedstock materials:

- Vegetative: Fruit and vegetable trimmings, spoiled produce
- Non-Vegetative: Meats, dairy, fish
- Industrial/Food Processing: Vegetative or Non-Vegetative (often referred to as food residue).

- Food that has been served but not consumed, e.g., plate scrapings, salad bar contents
- Fats, oils and grease (FOG) from restaurant grease traps and other sources
- Biodiesel by-products (glycerin and oilseed meal)

In addition, biodigesters can readily process animal and human wastes:

- Manure from feedlots, dairies or concentrated animal feeding operations (CAFOs)
- Waste activated sewage sludge from municipal wastewater treatment plants (WWTP).

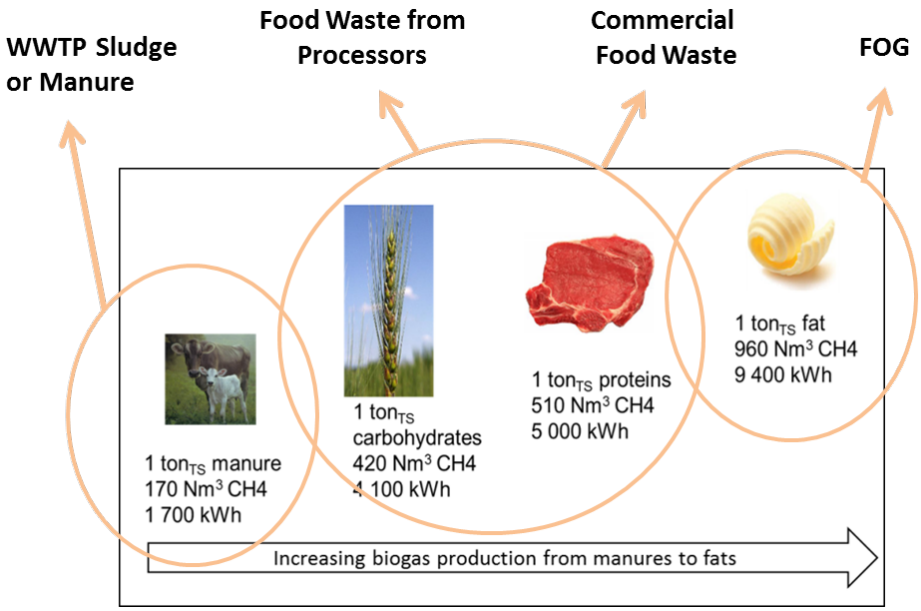


**Figure 5: Energy content in different feedstocks, ranging from manure to fats and greases**

Figure 5 shows the energy content for different types of food wastes. Sludges or manures have the lowest energy content because they are already partially digested. Carbohydrates and proteins (typically found in food waste) have the next highest energy content, and Fats, Oils and Greases (FOG) from cooking oils and greases has the highest energy density.

## Optimizing Digester Performance

In order to generate the maximum amount of biogas and maintain system stability, this Feasibly Study focused on mixing five available feedstocks from the Ann Arbor area (see Figure 6). While the percentage of each feedstock can vary, this blend of feedstocks has been shown in other biodigesters to yield optimum performance and stability. Major feedstocks include:

***Manure, or Sludge:*** The largest fraction of feedstock material in a digester is often manure or sludge because it readily available, and also provides an excellent buffering material for the higher energy organic materials such as food waste and FOG. Use of a manure/sludge buffer results in very stable digester performance, resulting in consistent and uniform

biogas production. This material is sourced from either a local farm, or a wastewater treatment plant (WWTP).

***Pre-Consumer Food Waste:*** Food waste gathered from community sources such as hospitals, universities, restaurants and even consumers provides a higher energy density feedstock. A major advantage is that food waste has a rich, diverse range of nutrients for the organisms inside the digester vessel that produce biogas.

***Food waste from Processors:*** Feedstocks from out-of-spec food, past-date materials and other inedible food materials are excellent digester feedstocks, although they often need to be depackaged to separate the non-digestable wrappers or enclosures from the organic food. A key advantage with a food processor as a feedstock source is that the companies typically have good information on the material characteristics and daily quantity available.

***Milk Waste:*** Dairies routinely need to dispose of spoiled milk, cheese whey, and other non-edible dairy products that are generated during the milk-production process. Because this material is mostly liquid, disposal in a landfill is a particularly poor option. Conversely, disposal in a biodigester is the ideal option. Several dairies near Ann Arbor are candidates to supply milk waste.

***Fats, Oils and Greases (FOG):*** A very desirable feedstock for any biodigester is the grease or oils that comes from cooking food in restaurants, termed FOG. The majority of this material is grease trap waste (GTW), which is accumulated in grease traps and interceptors where nonresidential food preparation activities take place. Due to its high energy content (and low economic value elsewhere), FOG is an excellent material to add to a biodigester in modest quantities.

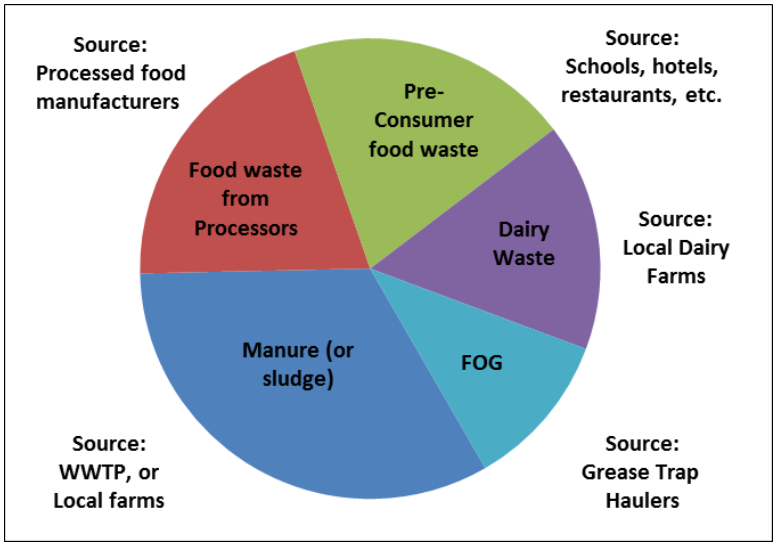


**Figure 6: A biodigester performs best with a diverse range of feedstocks Typical Feedstocks and Sources**

## 3. Food Waste Sources in the Ann Arbor Area

This feasibility study focused on the opportunities to divert food waste generated in the processor, retail and food service sector in Ann Arbor, Michigan. The major focus was on non-residential food waste sources within a distance of 25 miles from Ann Arbor. (This distance was chosen because it is the typical range for a logistics pickup system.) A systematic approach was used to identify the types and quantities of food waste, including: on-site interviews, phone

interviews and data gathered from previous food sorts. A full rollup of the available food waste was compiled using the data gathered.

The primary objectives for reaching out to Ann Arbor food processors, retail stores, and food service establishments were to:

1) Determine if Ann Arbor food waste generation follows similar trends to the national and regional studies.

2) Estimate the quantity of waste production at each type of food service establishment.

3) Assess for the acceptance level among business owners for diverting organic waste streams to a community digester.

The following is an overview of how each sector was evaluated.

## Restaurants

The outreach to local food service establishments provided valuable insight into business practices in Ann Arbor. Owners were willing to talk about the waste produced at their facilities and were, in general, open to further discussion. While most respondents said "Yes, we have food waste and would like a better solution", few owners knew the exact amount of food waste produced at their restaurants.

Seven restaurant managers were interviewed representing over 20 Ann Arbor food service establishments. Preliminary data collected showed that waste generation is highly variable between restaurant types, location, and practices. In spite of the small sample set, three important observations were clear:

***Composting:*** Several restaurant owners already had a composting system implemented to divert pre-consumer "kitchen" waste. This is a particularly popular solution because both pre- and post-consumer waste can be included in the composting bin (including napkins and other paper products). One owner told us "*Don't take my composting away – I love it.*"

***Space constraints:*** For restaurants in high density areas (downtown, for example) the practical consideration arose as to where to place a bin for segregated food waste. Restaurants already separate trash, recyclables (multiple bins) and (sometimes) cooking oil. For many restaurants, the physical space for a dedicated "food waste bin" is simply unavailable.

***Low priority:*** Several restaurant owners estimated the total weekly production of food waste to be relatively marginal and did not see the cost of disposal as a major concern.

Rough estimates of waste production were collected from restaurant managers and compared with documented values from a variety sources. Food service establishments were categorized into three categories, Casual Dining – larger full service restaurants, Fine Dining – smaller atmosphere focused restaurants, and Fast Casual – restaurants not offering full table service, fast food – limited menu, quick service.

Interviews with several fast-food chains yielded little optimism about being able to divert food waste from these locations. Several responses from these organizations considered their waste handling operations to be "proprietary information," and were not open to discuss alternative opportunities at this time. However, our team did speak to a franchisee with 67 outlets for a national fast-food chain. This owner indicated that fast food is a highly efficient food delivery system, with very little pre-consumer food waste produced. The post-consumer waste is typically co-mingled with paper and plastic.

## Grocery Stores

Several local area grocery stores were contacted about their options for surplus food and other organic waste streams. Community food donation is the first priority for these stores. Over 300 food donors in Washtenaw County coordinate with Food Gatherers to take surplus food. The remaining non-edible, food waste/vegetable clippings is generated in the produce department, with a rough estimate of 400 pounds per week from a large grocery store.

Shift managers could not confirm disposal costs but did articulate that the primary pathways for expired food (or near expired) involved donation, composting, or diversion to animal feed. This appears to follow a similar pattern to the BSR study sponsored by the Food Waste Reduction Alliance.[10]

One of the key questions we asked of grocery stores was "*Will your staff be able to segregate food clippings/residues without significant extra work?*" The managers we spoke with said that their staff would be eager to implement more sustainable solutions in their workplace with little additional effort. Another question dealt with the physical space needed for an additional food-waste bin to store food waste before pick-up. Managers said that groceries tend to have ample storage space near loading docks and in the back of stores. However, an important caveat is that the food waste must be stored separately from incoming food stuffs in order to maintain a hygienic environment for incoming food.

## Cafeterias

Large cafeterias were also considered to be potential sources for food waste collection. Schools, hospitals, and community colleges were all possibilities. A key difficulty is the separation of pre- and post-consumer waste. As noted previously, post-consumer waste is typically co-mingled with napkins, straws, flatware and other items that would foul a digester. Composting is the preferred solution for post-consumer food waste for this reason.

**Figure 7: Composting tubs at WCC**

Washtenaw Community College (WCC) was considered to be potential large source of food waste. However, our interview with the Recycling Operations Manager determined that WCC has already made a significant investment in composting equipment, and they plan to divert their pre-and post-consumer food waste into a compost system. WCC has installed two Green Mountain Technology Earth Tubs™ [ii] for composting (see Figure 7). These Earth Tubs™ can process up to 100 lbs per day of food scraps when mixed with a bulking agent such as wood shavings. The composted material will eventually be used as fertilizer for a neighboring greenhouse.

As with most institutions, segregation of pre- and post-consumer food waste remains a challenge for WCC and other cafeteria services. Our team was not successful in determining the available food waste from local public schools; however, other studies show that school food waste is typically both pre- and post-consumer. Given the modest timeframe for this effort, the focus was turned to larger sources of food waste such as food processors, restaurants and the University of Michigan.

## Food Processors

The ideal source for food waste for biodigestion is sourced from local food processors. Food waste (or food residue) from the food production process is typically:

- Available in well-defined, consistent quantities (by product of the food production process),
- Well-characterized in terms of nutrient qualities, and
- Likely to be supplied via long term contract.

To identify the food processors near a proposed Ann Arbor Biodigester, a list of 1800+ active food processors was obtained from the Michigan Department of Agriculture and Rural Development (MDARD). Because most food processors must be permitted to dispose of food materials, the MDARD will issue permits based on the material type and quantity.

This long list was then narrowed down by first removing all "Limited Wholesale Food Producer" license type. [iii] Secondly, a 25 mile radius

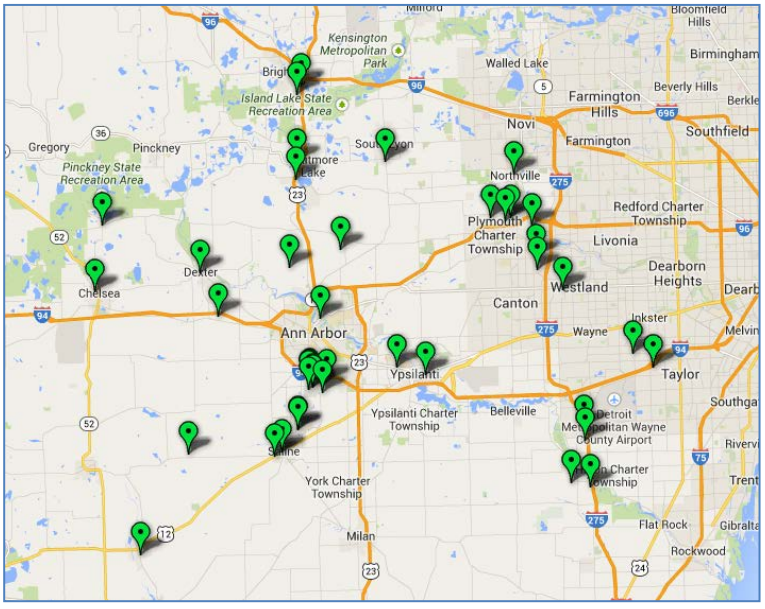


**Figure 8: Wholesale food processors within 25 miles of Ann Arbor**

[ii] http://compostingtechnology.com/products/compost-systems/earth-tub/

[iii] Limited Wholesale Food Producers are defined as $25,000 or less in annual gross wholesale sales

was used to sort by travel distance to Ann Arbor.[iv] The remaining list of 38 processors was vetted by investigating the company websites or by personal phone calls to determine available material.

Our interviews showed that the food processors shown in Figure 8 are only modest producers of food residue/waste. The largest producer was a bagel manufacturer that disposed of 100 to 500 lbs of dough per week. Nearly all companies co-mingle their food waste with trash in a dumpster, and the material is picked up at regular intervals their trash hauler.

As was the case with grocery stores, food processing companies wanted to be sure that the organic materials were quickly removed from the building (to maintain cleanliness) and periodically removed from the site.

The food processors that were interviewed identified the following important opinions about food-waste diversion to a biodigester:

- Nearly every processor we contacted was supportive of the idea of enhanced food-waste diversion, and indicated a willingness to participate in a City program (if implemented).
- While co-mingling food waste with trash for the landfill was considered a poor approach, processors reluctantly do so because it is easy and cost-effective. Optimizing disposal is simply not a core requirement for any company's success.
- Current cost of disposal was not a particular concern, likely because of the small quantities of food waste.
- Low quantities of food waste from processors is based on the fact that companies need to be efficient, and waste material has been engineered out of their production processes.

In summary, the food processors within a reasonable distance of Ann Arbor (approximately 25 miles) produce only small quantities of material. Ideally, a large food processor would be situated near the biodigester, with all the food waste efficiently diverted to the digester on a continual basis. At the current time, however, this notional "large" food processor does not yet exist in the Ann Arbor region.

## 4. Estimation of Available Food Waste

Given the low quantities of food waste from local food processors and grocery stores, this Study focused on estimating available food waste from two key sources:

- Restaurants and food services within Ann Arbor proper, and
- University of Michigan.

Each source is capable of providing pre-consumer food waste that does not conflict with their existing composting of post-consumer food waste. This will result in a very conservative

[iv] A filter of 50 miles was originally used but returned over 200 processors, mostly from the Detroit-metro area, a shorter range filter was necessary before conducting a more targeted outreach.

estimate on the food waste, with any additional quantities from other sources a bonus to the overall system.

## Restaurant Food Waste – Statistical Estimate

A statistical estimate of restaurant food waste was based on a database of 275 Ann Arbor food service establishments using a series of Monte Carlo simulations. This approach is used routinely in engineering and science for determining quantities or instances for a large dataset with a small number of samples within that dataset. The results of the Monte Carlo simulation were then compared to the results of food sorts from other cities in the US in order to validate the results.

**Table 1: Food waste generation by restaurant type**

| Ann Arbor Food Waste Generation Survey by Restaurant Type | | | | |
|---|---|---|---|---|
| | | Generation [lbs/week] | | |
| | Sample Size | Lower Range | Average | Upper Range |
| Casual Dining* | 8 | 500 | 1000 | 2000 |
| Fine Dining** | 3 | 250 | 500 | 1000 |
| Fast Casual*** | 2 | 90 | 180 | 280 |
| *4 yd dumpster 3x week collection @ 80% food waste and 245 lbs yd | | | | |
| **4 yd dumpster 2x week collection @ 80% food waste and 245 lbs yd | | | | |
| ***Based on 50 lbs / day estimate @ 80% food waste | | | | |

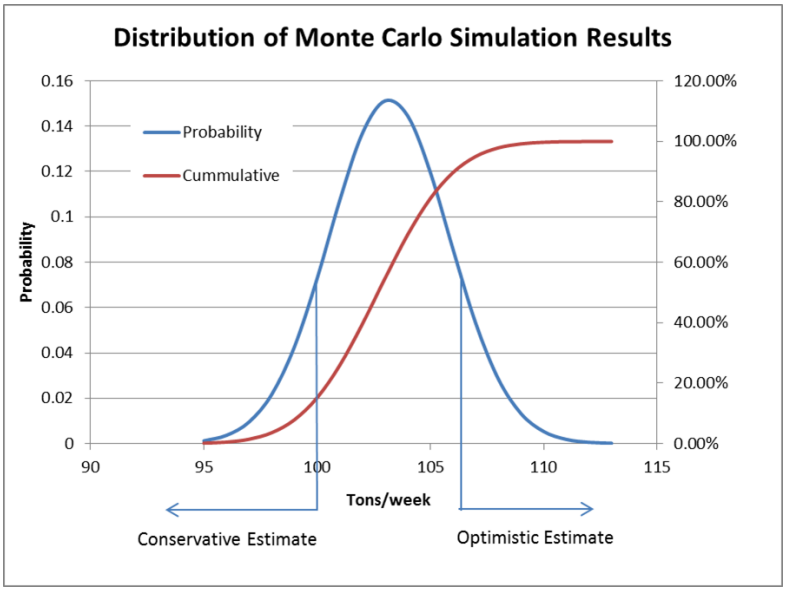


**Figure 9: Results of Monte Carlo Simulations on food waste.**

To construct the Monte Carlo simulations, each food service establishment was geographically referenced and assigned a category; Casual Dining, Fine Dining, and Fast Casual. The 275 restaurant database is not an exhaustive list of restaurants in Ann Arbor however, for the purpose of the simulation, it was considered to be representative of 90-100% of the total food service population in Ann Arbor.[v] For each simulation, a randomly generated food waste production value (in lbs) between the lower and upper range established in Table 1 was assigned to each restaurant. The randomly generated values for all restaurants were summed together to produce a simulation total. The simulation was then run 1000 times. The results are shown in Figure 9, where the peak of the probability distribution represents the amount of food waste (103 tons/week) that is statistically most likely to be available. The

[v] There are potentially more sources of food waste production; however, the researchers felt that considering the 275 restaurant database as 100% of the population allowed for a conservative estimate.

distribution of food waste availability follows a normal distribution ("bell curve"), which is consistent with a large number of samples generated by the Monte Carlo procedure.

To get a sense for how accurate this statistical approach is, a number of other reports/surveys were compared to the Monte Carlo results[11] [12] [13] [14]. This data is shown in Table 2. Results for these surveys show that for 800 meals/day, the upper range for available food waste will be approximately 2000 lbs/week. This compares favorably to the upper range from the Ann Arbor data for "Casual dining" (see Table 1), yielding confidence that the upper and lower values for the Monte Carlo analysis were selected correctly.

**Table 2: Comparable food waste data from other studies and surveys (see text above for references.)**

| Restaurant Waste Production Comparison Table | | | |
|---|---|---|---|
| **Source** | **Metric** | **Upper Range Conversion Factor** | **Comparison** |
| **Recycling Works Massachusetts** | 0.5 lbs/meal | 800 meals/day* x 5 days/week | 2000 lbs/week |
| **EPA Food Waste Management Cost Calculator** | 0.5-1.5 lbs/meal | 800 meals/day x 5 days/week | 2000 – 6000 lbs/week |
| **The Rosenthal Group (incl all discarded waste)** | 1.5 lbs/meal | 800 meals/day x 5 days/week x 30%** | 1800 lbs/week |
| **Cascadia Consulting Group** | 2,900 lbs/employee/yr | 2,900 lbs / 52 weeks/yr | 30 employees = 1600 lbs/week<br>50 employees= 2800 lbs/week |

The results of the Monte Carlo simulation are considered to be representative of the food waste in Ann Arbor restaurants, but conservative.

**Important Note:** The most accurate method for determining available food waste is to conduct a food sort from a series of restaurants, including sufficient restaurants in the effort so that the sample size is statistically valid.

## Geographic Location of Food Waste in Ann Arbor

The results from the Monte Carlo simulation were further broken down into geographical areas within Ann Arbor. Per the recommendations of City staff, this study did not include food establishments outside Ann Arbor city limits on the thesis that access to outside food waste could not be guaranteed to the City. Inside the City, however, the possibility of franchising the collection of food waste exists. This would offer a steady supply of food waste to the biodigester, which is a critical requirement for successful operation. In future studies, food waste outside Ann Arbor proper should also be considered, along with an assessment of how to incentivize the delivery of that material to the biodigester.

Figure 10 shows the geographic area and relative waste production estimates for restaurants in Ann Arbor proper. The physical location of restaurants is shown in the map on the left, and a "heat map" of food waste concentrations is shown on the right.

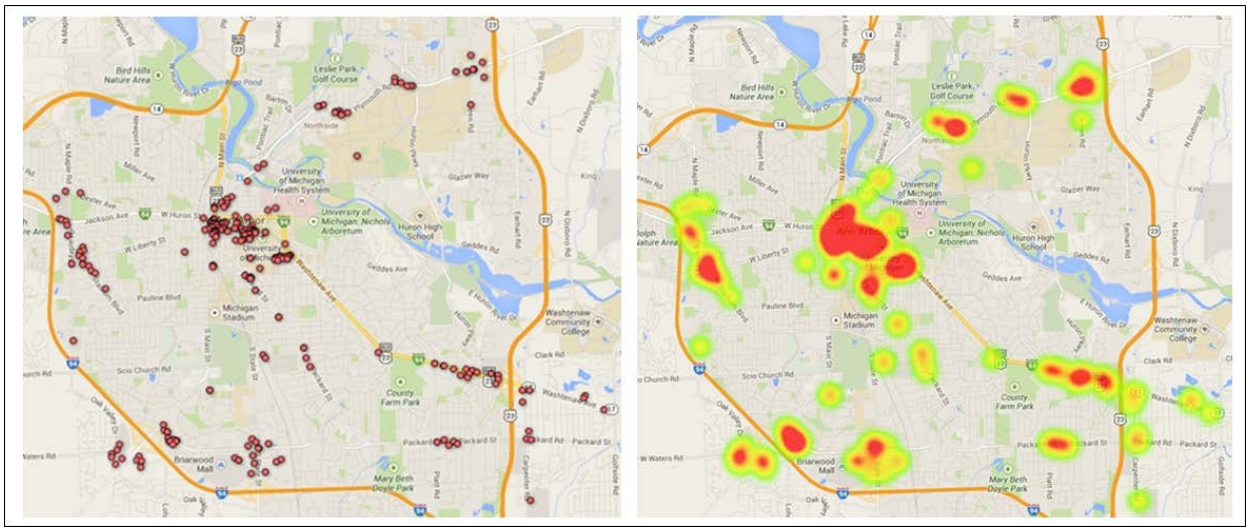

**Figure 10: Geographic location of food service establishments in the restaurant database; geo-code (left) and heat map of food concentrations (right).**

The data in Figure 10 can be further combined to identify "food waste corridors" in the City of Ann Arbor. Figure 10 shows a breakdown of the restaurant database according to location, with estimations of the food waste available from each "corridor In general, the Downtown area is the largest source of food waste, with the other areas roughly equal in food waste generation.

The estimate of 100 tons per week is the value of food waste production used this Study's computer modeling (described in later sections of this report).

| Weekly Food Waste Generation (tons/week) | | | |
|---|---|---|---|
| Area | Low | Med | High |
| Downtown | 39 | 45 | 50 |
| South Ann Arbor | 12 | 16 | 19 |
| Packard/Washtenaw Corridor | 12 | 15 | 19 |
| West Ann Arbor | 7 | 9 | 12 |
| Plymouth Road Corridor | 7 | 9 | 12 |
| South University | 6 | 8 | 10 |
| Totals | 83 | 103 | 122 |

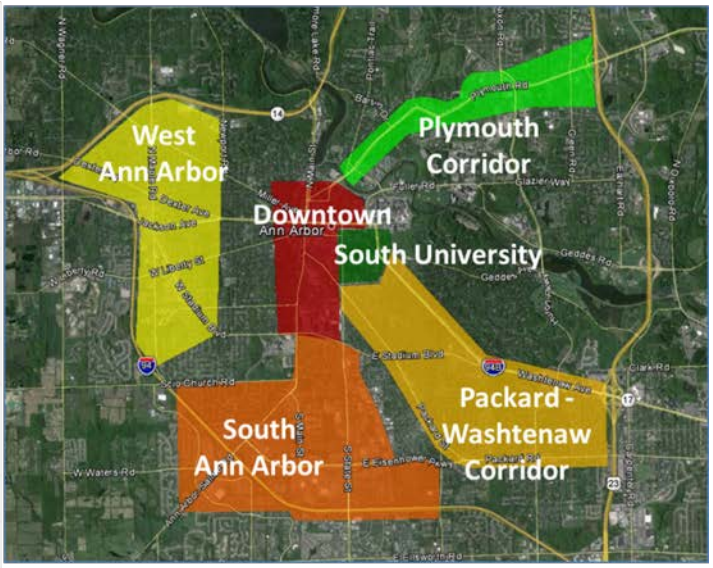


**Figure 11: Restaurant Food Waste Generation by Corridor with map of corridors in Ann Arbor**

## University of Michigan

The University of Michigan conducted a refuse sort in 2013 for the waste generated at several of the University's cafeterias, and also at on-campus food service locations and special events. The data in Figure 12 represents pre-consumer food waste only, which is therefore an accurate representation of the available materials from the University of Michigan for biodigestion[vi].

| 2013 | UM Food Waste [tons/wk] | | | |
|---|---|---|---|---|
| | Housing | Other | Events | Totals |
| Jan | 3.3 | 0.2 | 0.0 | **3.5** |
| Feb | 4.7 | 0.3 | 0.5 | **5.5** |
| Mar | 3.1 | 0.2 | 0.6 | **3.9** |
| Apr | 3.5 | 0.2 | 1.8 | **5.5** |
| May | 0.7 | 0.3 | 0.1 | **1.2** |
| Jun | 1.3 | 0.2 | 0.0 | **1.5** |
| Jul | 1.9 | 0.2 | 0.0 | **2.2** |
| Aug | 1.0 | 0.2 | 0.0 | **1.3** |
| Sep | 4.7 | 0.6 | 1.8 | **7.1** |
| Oct | 5.3 | 0.7 | 1.3 | **7.3** |
| Nov | 5.4 | 0.8 | 1.8 | **8.1** |
| Dec | 3.2 | 0.6 | 0.7 | **4.5** |

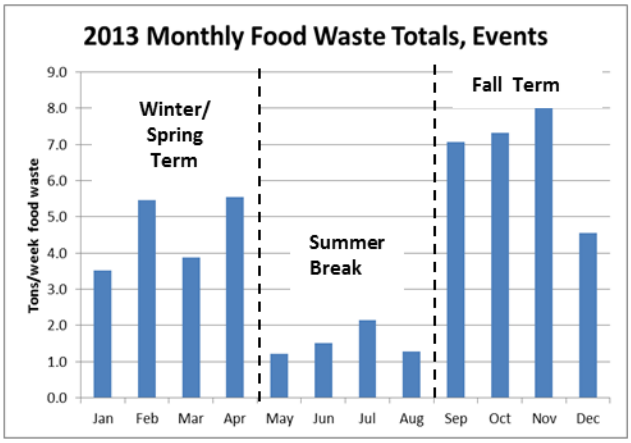


**Figure 12: Pre-consumer food waste from the University of Michigan was tallied in 2013.**

As with most schools, the available food waste from University of Michigan is synchronized with the school calendar. Summer quantities drop to very low values, and peak values are seen in the Fall and Spring terms. The average pre-consumer food waste from the University of Michigan is calculated to be 4.3 tons/week, with a high value of 8.1 tons/week in November and a low of 1.2 tons/week in May.

## Composting vs Biodigestion – Target Pre-consumer waste for Biodigestion

Several of the restaurants interviewed had already established popular composting programs for much of their pre- and post-consumer food waste. From the restaurants interviewed, up to 20% of restaurants in the downtown area may already be diverting food waste to compost.[vii]

A significant challenge is to strip to non-digestable materials out of the total waste stream, and to segregate all materials before transport to either the composting facility or the biodigester. For practical considerations, it is recommended that only pre-consumer food waste be targeted as the feedstock for the biodigester. Pre-consumer waste is typically generated in kitchens where staff can be trained on the correct materials to segregate. Interviews with restaurant owners indicated that this would be a trivial change to the kitchen's workflow, with employees generally willing to support most sustainable disposal options.

[vi] Data courtesy of Ms. Tracy Artley, Sustainability Coordinator for the University of Michigan.

[vii] This percentage could be a result of a biased sample set. It was the experience of the researchers that environmentally focused businesses were more likely to discuss and engage in conversation about their business's waste diversion efforts.

# 5. Non-Food Waste Biodigester Feedstocks

For maximum stability of the ecosystem inside the biodigester, a diverse offering of feedstocks should be fed to the organisms in the digester vessel. In the same way that humans and animals benefit from a diverse diet with carbohydrates, proteins and fats, the methanogenic organisms in a biodigester are enhanced by the addition of secondary feedstocks other than food waste. (These secondary feedstocks are typically referred to as "co-feedstocks".)

For the Ann Arbor Biodigester, the selected co-feedstocks were:

- Fats Oils and Grease, or FOG (from grease traps in restaurants in the Ann Arbor region)
- Sludge from the Ann Arbor Waste Water Treatment Plant

## FOG Co-feedstocks

Fats, oils, and grease (FOG) are generated as part of our daily lives. FOG is produced from residential, commercial, and industrial processes. FOG in the Ann Arbor area is generally broken down into two major categories[viii]:

***Brown Grease:*** flotatable FOG, settled solids (food particles) and associated wastewater retained by grease traps and inceptors. Brown grease is also commonly known as grease trap waste (GTW).

***Yellow Grease:*** inedible or spent FOG removed from Food Service Establishments (FSEs). A major source of yellow grease is deep frying.

Depending on its source, FOG may or may not have a market value. In general, the higher purity of the FOG, the higher value it has for reuse. For example, yellow grease is commonly recycled for reuse at FSEs or collected for biodiesel manufacturing. Of the two major sources of FOG, grease trap waste is most available for the use in an anaerobic digester. Brown Grease is generated through the preparation, serving and cleanup of food. As such, the FOG is discharged through sinks and drains that are connected to the sanitary sewer. Because it is co-mingled with kitchen wastewater, GTW is typically considered to be a waste product with little to no value; however, due to its high energy potential per unit volume and the form that it is collected; GTW is very desirable for use in a biodigester.

**Figure 13: Typical Grease Accumulator near the kitchen sink**

[viii] Another source of grease is the biodiesel manufacturing process, where the glycerin byproduct is an outstanding co-feedstock in a biodigester. However, the closest biodiesel facility is in Sandusky MI, which is too far to be considered a viable glycerin supplier.

***Grease trap waste (GTW):*** Grease trap waste (GTW) is accumulated in grease traps and interceptors where non-residential food preparation activities are performed. Grease traps and interceptors work on the principle that FOG is less dense than water and therefore will accumulated on top of the water, much the same as an oil slick after an oil spill. Periodically, the grease traps are cleaned. Cleaning of the grease trap is performed by the skimming or vacuuming of the grease that is floating on top of the water into a truck. The collected grease is then taken off site for disposal.

**Table 3: Grease trap waste characterization**

| Parameter | Results on Wet Weight Basis |
|---|---|
| Total Solids (%) | 6.0 |
| Total Volatile Solids (%) | 88 |
| Fats, Oils & Grease (%) | 1.1 |
| pH (SU) | 4.4 |

Disposal of the GTW is typically performed through landfilling. Due to the high water content of GTW, landfills in Michigan cannot accept GTW without modifying it through a process called "solidification". Typical characteristics of GTW are provided below in Table 3[ix].

## Access to Grease Trap Market

Grease trap waste is collected by companies that specialize in grease trap and interceptor cleaning. They have specialized trucks that are able to vacuum the GTW from the establishment's collection point. The companies have specific knowledge of the regulations for cleaning, transportation, and disposal of the GTW. Examples of companies in the Ann Arbor area that perform such services include:

- Dover Grease Trap – Fraser, MI
- Power Vac of Michigan, Inc., Novi, Mi
- Great Lakes Grease, Detroit, Mi
- Rooter-Man, various locations in south east Michigan
- Roto Rooter, various locations in south east Michigan

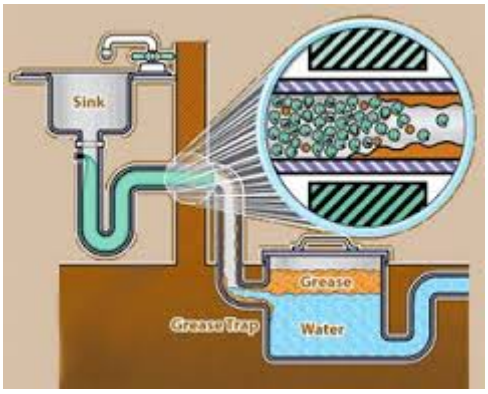


**Figure 14: Under sink grease trap**

FSEs depend on these types of companies to periodically clean grease from their collection points and dispose of it. Without periodic cleaning of grease traps and interceptors, FSE would likely experience sewer backups and or surcharge fees from the local sewer authority. As GTW material is centralized by various collection and disposal companies, the most efficient way to understand the quantity of GTW that is available is to speak directly with these companies.

Another route that may be taken is to speak with the disposal site that ultimately handles the GTW, however, these sites are less likely to collaborate with inventory studies as they are profiting from the disposal of the waste and would not support any diversion.

[ix] Taken from The Pumper, March 2000.

Current cost for GTW disposal is approximately 20 to 30 cents per gallon. Based on the experience of Swedish Biogas in accepting FOG materials at the Flint WWTP, tipping fees of 10 to 15 cents per gallon should be attainable depending on the overall logistics of transportation.

**Important Note:** The sustainable disposal of Grease Trap Waste is an additional selling point that collection companies can offer Food Service Establishment for green branding.

## Sludge from the Ann Arbor WWTP as a co-feedstock

The additional of waste water treatment plant (WWTP) sludges to a digester can provide many benefits. They include:

- Improved digestion via the addition of necessary trace elements and nutrients.
- The creation of stabilized material that meet the standards to CFR 40 Part 503 for reuse.
- A reduction of lime stabilization costs, and also in the expense to landfill the digested material.

Perhaps the major advantage of digesting sludge is that *biodigestion naturally reduces the total amount of material by nearly 40%*. This means 40% lower disposal charges will decrease by approximately 40%, offering the WWTP a very large savings in disposal costs.

The Ann Arbor Wastewater Treatment Plant (WWTP) receives and treats approximately 19.0 million gallons of wastewater per day from the City of Ann Arbor, Pittsfield, Scio, and Ann Arbor Townships. The facility has a total treatment capacity of 29.5 million gallons per day. Sewage sludge is generated at two major locations within the flow regime of the plant:

1) Primary clarifiers where primary sludge is separated from incoming wastewater,

2) Secondary clarifiers where activated sludge is collected and pumped to holding tanks and then thickened to 6% total solids using a gravity belt thickener.

Based on the preliminary data provided by City staff, the quantity and characteristics of sludge that is available is provided in Table 4.

**Table 4: Characteristics of sludge at the Ann Arbor WWTP**

| Description | Primary Sludge | Thickened Waste Activated Sludge (TWAS) |
|---|---|---|
| Quantity, dry tons per year | 2,900 | 3,000 |
| Quantity, avg dry tons per day | 8 | 8.3 |
| Total Solids, % | 5.3% | 6% |
| Volatile Solids, % | 85% | 75% |

The City of Ann Arbor currently uses two processes for reuse and disposal of their biosolids:

***Land Application:*** During allowable time periods of the year, sewage sludge is converted to 40 CFR Class B biosolids using alkalinity (lime) stabilization. The biosolids are then

applied to agricultural lands as a soil amendment. A majority of the sewage sludge generated at the facility is handled in this way. Reuse of the biosolids in this fashion is heavily dependent on permissible weather conditions and availability of agricultural lands.

***Landfilling:*** During time periods that land application of biosolids is not permissible, the sewage sludge is dewatered and sent to a landfill for disposal It was assumed that solids to the landfill and land application were at 27% and 7%, respectively

## Biodigestion of Sewage Sludge

Biodigestion of sewage sludge can provide several benefits to a waste water treatment facility. Benefits include:

- 30 to 40% reduction in overall sludge volumes that require disposal/reuse
- Energy recovery through biogas production
- Obtainment of CFR 40 Class B biosolids without chemical (lime) addition
- Ability to co-mingle existing compost operations to achieve CFR 40 Class A EQ biosolids (soil amendment for unlimited use)
- Greater de-waterability as compared to waste activated sludge
- Nutrient recovery of phosphorus and ammonia
- Reduce odor control requirements as digestion takes place within closed vessel

Biodigestion is not without its drawbacks. The primary concern for the treatment facility would be any streams from the digester that would be diverted back to the treatment plant. The "recycle" stream would be rich in soluble phosphorous and nitrogen which may increase costs of processing.

## Specific Benefits of Adding City of Ann Arbor Sewage Sludge

Discussions with the staff at the Ann Arbor WWTP identified two major benefits of processing some fraction of the incoming sludge into the digester. These include:

- Enhanced Biogas Production, and
- Reduction in disposal costs.

***Enhanced Biogas Production:*** Based on the sewage sludge solids provided by City staff, estimates of biogas production were generated. A common range of biogas production from sewage sludge is between 12 and 17 cubic feet per pound of volatile solids destroyed. Actual biogas production is highly dependent on digester configuration, operation protocols, and actual feed stocks. It is beyond the scope of this study to determine the actual biogas production potential of the sewage sludges generated by the treatment plant. However, estimates from other digester operations can provide typical biogas production (See Table 5).

**Table 5: Estimated biogas production as a function of volatile solids destroyed**

| Volatile Solids Reduction during Biodigestion | 50% volatile Solids reduction | 55% volatile solids reduction | Methane Concentration, % |
|---|---|---|---|
| | Biogas Production, $ft^3$/day | Biogas Production, $ft^3$/day | |
| 12 $ft^3$/lb VS destroyed | 156,403 | 172,043 | 65% |
| 15 $ft^3$/lb VS destroyed | 195,504 | 215,054 | 65% |
| 17 $ft^3$/lb VS destroyed | 221,571 | 243,728 | 65% |

It is recommend as part of further study that laboratory testing be performed to determine more precise estimates of biogas production from the materials available from the WWTP.

***Reduction in solids volume:*** As detailed above, a significant advantage of biodigestion is the reduction in the overall amount of material that has to be handled after the digestion process. Based on conservative rates of volatilization of organic solids, it is estimated the solids will be reduced from approximately 5,900 to 3,600 dry tons per year. The economic value of these biogas production and volume reduction will be detailed in the later section on Economic Modeling.

## 6. Bags and Bins

An underappreciated factor in biodigestion is the need to collect and store food waste before transportation to the biodigester. Typically, trash and waste is collected in plastic bags for transport to final disposal. This is a simple, reliable and robust solution, but unfortunately, bags based on petroleum feedstocks are not a sustainable solution. “Compostable” bags are made from corn starch and can break down in commercial composting operations, but are not “digestable” in a biodigester. The challenge is to find a solution for collection/storage of food waste that offers the convenience and reliability of a plastic trash bag, but fits into the flow of materials into a biodigester.

Other biodigesters have encountered the same problem, with a biodigester in Germany offering a very workable solution. Figure 15 shows the German approach that uses compostable bags to collect and transport food waste, but the bags are stripped away before digestion and routed to a composting operation.

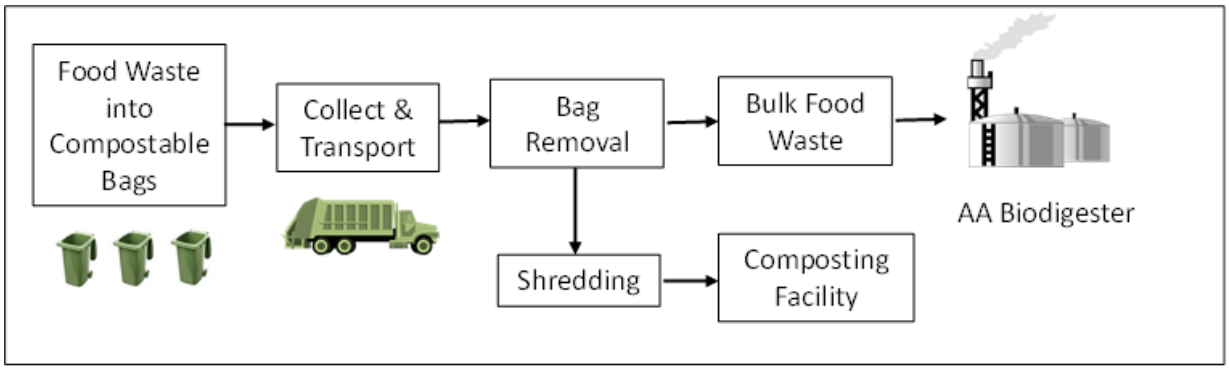


**Figure 15: Use of compostable bags with a biodigester**

The demands on bags for food waste are considerable. For example, restaurant workers will collect food waste in an internal container (see Figure 16) and then move it to a larger bin outside the facility. This bin will be collected once every 2-3 days, so any bag for food waste must be sturdy.

**Figure 16: Rubbermaid Slim Jim is a ubiquitous trash container (23 gallon).**

Using compostable bags in plastic containers makes the process of collecting food waste easier for the restaurant employees and cuts down on the smell and mess in the outside receptacles. However, to collect/store food waste, the bags must have the following characteristics:

**Table 6: High Level Requirements for Food Waste Bags**

| Specification | Justification |
|---|---|
| **Bags must be capable of containing liquids.** | Food waste will be gooey and sludgy. |
| **Bag must be able to withstand elevated temperatures.** | Food waste may be warm or hot when it is disposed of. |
| **Bags must be strong.** | Food waste is dense, and may contain items that can pierce the bag and cause leakage. |

Given the characteristics above, a listing of available compostable bags is shown in Table 7. All of these bags have BPI's seal for compostablility, which means that they meet ASTM 6400. Some of these are available through retail and some of them must be ordered from the manufacturer. Bags that are available for retail purchase are often more expensive than the bags that are ordered direct from the manufacturer in bulk. In addition, ordering bags from the manufacturer gives more options in regards to thickness, size, and shape.

**Table 7: A sampling of compostable bags that meet ASTM 6400**

| Brand | Material | Thickness | Available Sizes? | How to aquire? | Price |
|---|---|---|---|---|---|
| BioBag | Derived from plant starches, compostable polymers | .88 mil | 2-96 gallons | Retail or Direct | 32G liner is $75.60 per case of 120 bags plus shipping |
| BioTuf | Ecoflex (polylactic acid, cellulose, lignin, starch, PHAs) | .88-1.2 mil | 13-64 gallon | Direct or Distributor | $100 per case of 100 bags |
| Bag to Nature | Organic Biopolymers | Unknown | 3-64 gallon | Retail or Direct | Retail price on (10) 33 gallon bags is $12.99 |
| Xylobag | Lignin (byproduct of paper production) | .9-2.5 mil | 33 or 45 gallon | Direct | $30.85 for a 25 bag roll |

## Food Waste Bin Requirements

The second important part of the consumer-end food waste collection system is the large receptacle sitting presumably out back behind the restaurant. This container will house the food waste after it is collected inside. This container will experience the multi-faceted weather of Michigan and also nuisance animals and insects in Ann Arbor. In addition to the environmental concerns, the containers must be user-friendly. Therefore, the following list of specifications has been developed for the food waste collection bin:

**Table 8: High level requirements for food waste bins**

| Specification | Justification |
|---|---|
| Bin must be large enough to accommodate several days worth of food waste. | Food waste will be collected/picked up every 2-3 days. |
| Bin must be compact. | There is limited space in alleys behind restaurants. |
| Bin must be resistant to critters and insects. | Ann Arbor is host to many hungry creatures including, but not limited to, squirrels and raccoons. |
| Bin must contain odors. | Odors are especially challenging in summer. |
| One person must be able to put food waste bag into the bin. | A single restaurant employee will typically carry a bag of food waste outside to the bin. |
| Bin should be able to be cleaned easily. | Food waste may leak from the bags into the bin. |

Few food waste bins on the market meet the specifications in Table 8 because food waste collection is a fairly immature movement. Some food waste collection systems use traditional dumpsters to collect food waste, just like the residential recycling bins of Ann Arbor, but colored green.

### Commercial Food Waste Bins

A good example of a collection bin targeted to the food waste market is made by Taylor International, a UK-based company that designs metal rubbish and recycling containers.

The Taylor Food Waste Bin (see image below) is made of welded steel and has a 500-liter (about 130-gallon) capacity. It has a plastic lid with a lock that can be opened with a foot-pedal. It can be coated with acid resistant coating on the inside and painted on the outside. An ID chip can also be included in a Taylor Food Waste Bin. The Taylor Food Waste Bin costs about $780 US dollars plus freight costs. This is the price for up to 150 bins.


**Figure 17: Taylor Food waste bin is targeted to the growing food-waste collection market.**

The lock on the Taylor Food Waste Bin makes the opening resistant to critters, while the solid steel sides keeps them chewing in from the outside. Not only does the lock keep out critters, it also keeps out passersby who may try to put their trash in the bin behind a restaurant. The lid lock and side materials also help contain the odor. The foot pedal makes it easy for one person to easily put food waste into the bin. In addition, the top of the bin is at about waste height, so bags of food waste are easily lifted up and over the top lip. Because of the shallow depth, the bin is also easily cleaned. Traditional waste bins are deep, which may make them more difficult to clean.

## 7. Cost Model

To assess the magnitude of the financial benefit of a biodigester over time, our team developed several computer models to describe the financial viability of the biodigester over the short-term and the long term. These models were based on financial modeling tools used by our teammate Swedish Biogas to develop accurate bids for digester construction and operation of biogas plants in the US and Europe. The models were populated with data from several key sources:

- Data on available food waste
- Information from the Ann Arbor Wastewater Treatment Plant
- Existing disposal costs for solid waste (from the City of Ann Arbor) and
- Current financial terms available in the public and the private credit markets.
- Experience from actual digester operations in the US and Europe

For this Feasibility Study, several scenarios were modeled, varying key parameters such as:

- Available feedstocks (type and quantity),
- Financial terms (rates, terms), and
- Capital costs (including maintenance and operations costs.)

The ability to compare multiple scenarios can offer the City valuable insight to the potential pros and cons of digester facility over the life span of the project.

## Modeling Assumptions

### *Location*

Based on discussions with City staff, it was decided that for the purposes of modeling digester financial performance that the facility would be installed Near the Materials Recovery Facility on the south side of Ann Arbor (4150 Platt Road, Ann Arbor). While the scope of this Study did not require a Site Assessment, it was logical to select an existing location owned by the City of Ann Arbor. A specific location was also needed in order to calculate the logistics (travel time, mileage, and traffic patterns) of hauling sludge to the site from Ann Arbor WWTP on Old Dixboro Road.

Locating a biodigester near the Material Transfer Station offers a number of advantages:

- Available space for construction and operations,
- Close vicinity to the City's current compost site,
- Existing zoning for industrial use, and
- Adequate ingress and egress for waste hauling vehicles.
- •Supplement existing biogas generator as landfill to maintain full electrical production

### *Feedstock Loading*

As part of the modeling effort, recipes for the biodigestion process were developed based on available feedstocks in the Ann Arbor area identified during the course of this Feasibility Study (See the Background Section for details.) Feedstocks included:

- Food waste from commercial businesses within the City of Ann Arbor. Food waste from the University of Michigan was also included.
- FOG from local grease-trap hauling companies
- Milk waste from local dairies ("Dairy Waste")
- Food waste or residues from food processing facilities ("Sugar Water")
- Primary and Thickened Waste Activated Sludge from the Ann Arbor WWTP

The quantity of each feedstock was based on two criteria:

1) Data from this Feasibility Study, which was then correlated with other feasibility studies/reports from similarly sized cities in the US.
2) Experience of Swedish Biogas in the Midwest region of the US; specifically, the amount of FOG, Dairy Waste and Sugar Waste is typical for the materials delivered on a regular basis a similarly sized biodigester in Southeast Michigan.

Discussions with City staff indicated that the inclusion of WWTP sludge was logical due to Ann Arbor's unique constraints on the existing Ann Arbor WWTP facility. As noted earlier, sludge is easily digestible and is a prime candidate as a buffer feedstock for the digester facility. Moreover, processing of sludge will offer the City cost savings because the digester will convert a significant portion of the sludge to biogas.

## Parameters to Vary in the Model

A number of key parameters were varied in during the modeling process. These include:

### *Fraction of WWTP Sludge, (50% vs 100%)*

Two different fractions of WWTP Sludge were considered:

1) The biodigester will accept 50% of the available sludge from the Ann Arbor WWTP.
2) The biodigester will accept 100% of the available sludge.

The non-sludge feedstock quantities remained constant for each scenario, however, the relative fraction of each non-sludge feedstock changed for each scenario.
Details on the two fractions are shown in Figure 18 and Figure 19.

| Feedstock | Fraction of total | Vin [gpd] | Comment |
|---|---|---|---|
| Food Waste | 11% | 4329 | Commercial businesses in Ann Arbor and University of Michigan |
| FOG | 3% | 1000 | Sourced by FOG hauling companies |
| Dairy Waste | 5% | 2000 | Available from local dairy |
| Sugar Water | 3% | 1000 | Available from local food processor |
| WWTP Sludge | 79% | 30660 | Transported to Biodigester from AA WWTP |

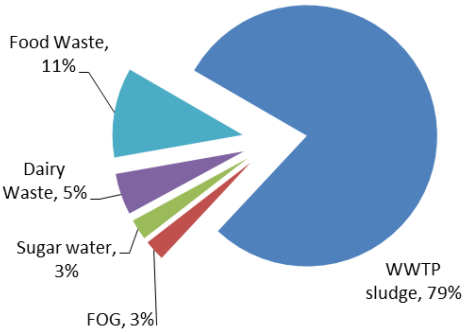


**Figure 18: Feedstock menu using 50% of the available WWTP sludge**

| Feedstock | Fraction of total | Vin [gpd] | Comment |
|---|---|---|---|
| Food Waste | 6.2% | 4329 | Commercial businesses in Ann Arbor and University of Michigan |
| FOG | 1.4% | 1000 | Sourced by FOG hauling companies |
| Dairy Waste | 2.9% | 2000 | Available from local dairy |
| Sugar Water | 1.4% | 1000 | Available from local food processor |
| WWTP Sludge | 88% | 61320 | Transported to Biodigester from AA WWTP |

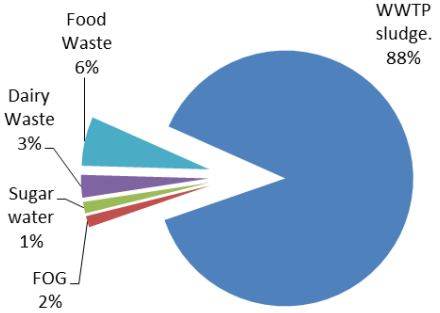


**Figure 19: Feedstock menu using 100% of the available WWTP sludge**

### *Facility Ownership - Public vs. Private*

A key impact on the feasibility of any waste-to-energy facility is the funding source.

- Funding from private sources demand a shorter time period for the return on the investment, a higher carry cost of the capital, a higher discount rate, and a margin for profit.
- Publicly-financed facilities typically have a longer investment term, lower interest rates, and a lower discount rate.

Modeling was performed for both private and public ownership and funding. A public-private partnership was not included in the modeling but should be further investigated by the City. Table 9 shows the financial terms used in the computer model for public[x] and private[xi] investments.

**Table 9: Financial assumptions for public and private financing of the project**

| | Investment Term | Interest Rate | Discount Rate | Payback |
|---|---|---|---|---|
| Public Financing | 20 years | 3.5% | 2.1% | <10 years |
| Private Financing | 10 years | 12% | 10% | < 5 years |

### *Revenue from Electrical Generation, 5.5¢/kWh vs 9¢/kWh*

Biogas produced from the digester is generally used as an energy source in three ways:

- Thermal power (i.e. heat generation in boilers), or
- Conditioned to be used as a natural gas replacement, known as biomethane[xii], or
- Electrical generation using a biogas powered electrical gen-set,

[x] The City of Ann Arbor (AA+ rating) is currently issuing tax exempt debt with the same terms as the US Treasury. We have assumed that public financing term and interest rate will match the US T-bill rate. See http://www.bloomberg.com/markets/rates-bonds/government-bonds/us/

[xi] Terms for private financing of biodigesters were determined via discussions with personnel at DTE Energy Trading (a non-regulated part of DTE Energy). Private investors typically seek shorter investment terms, shorter paybacks and a strong interest rate. The discount rate for renewable energy projects is estimated to be between 10% and 15%.

[xii] Biomethane can be injected into the natural gas utility grid or used as a cleaning burning vehicle fuel.

***Thermal Energy*:** Extracting thermal energy from biogas is a viable approach; however, this is typically best done when a thermally intensive industrial process is located near the biodigester. This is not the case near the Materials Transfer Station, so biogas-for-heat was not considered.

***Biomethane:*** Because of the lack of governmental policy for clean fuels in Michigan, the cost of biogas conditioning equipment, and the relatively low cost of natural gas, converting biogas to biomethane currently cannot economically compete against using biogas to generate electricity. Therefore, biomethane was not considered.

***Electrical Generation:*** Electricity generated by biogas can be used in two ways:

1) Consumed on-site to meet existing electrical demand by City facilities.
2) Sold back to the grid via a Net-metering arrangement with Detroit Edison

The economic models for this Study assumed revenue from electrical generation.

***Self-Consumption:*** City staff has indicated that cost of electricity purchased from Detroit Edison (local utility) at the Wheeler site is approximately 9¢/kWh. Additional information from the City shows that the average electrical consumption at that site is in the range of 170 to 190 kW. This level of power production is well within the range of gensets currently available for biodigesters. It is not clear if the City could take full advantage of the 9¢/kWh for the electrical generation at the digester because of the lack of overall power consumption at the Wheeler site (net meeting). It is recommended that further investigation be performed to determine the actual rate that could be gained through the local utility.

***Net-metering:*** It is understood that Landfill Energy Systems (operator of electrical generation system at the Ann Arbor Landfill) is paid approximately for the electricity generated from biogas collected at the City's landfill. While net-metering program revenue can change over time, it is safe to assume that 5.5¢/kWh is a realistic payment for biogas generated electricity.

**Important Note:** Although electrical generation from the Ann Arbor Biodigester would be eligible for renewable energy credits (RECs), the economic models did not account for them since RECs are not generally not available for sale in the State of Michigan. In addition, the models did not account for the sale of carbon credits. While some estimates put the available value of Carbon Credits at $6-7 per MtCO2e, these markets remain immature. Future economic models can include REC and Carbon Credit revenue if the market improves

### *Capital Expenses based on WWTP Sludge Fraction (50% vs 100%)*

Capital costs for the Biodigester will also vary as a function of the amount of WWTP sludge accepted. For the model, the capital cost estimates were based on Swedish Biogas's past experience of design, building and installing digestion facilities both here in the United States and Sweden. Major differences in the capital expense between the models using 50% and 100% sewage were the size of the digester and electrical generation system. Power production for the 50% sludge-fraction case is assumed to be a 400 kW biogas-powered genset operating with 95% on-time. A 600 kW genset is assumed for the 100% sludge fraction case. Capital cost estimates for the two cases are shown in Table 10.

**Table 10: Capital cost rollup for 50% and 100% sludge models**

| Order of Magnitude Estimation of Capital Expense 100% use of Available Sewage Sludge | |
|---|---|
| Description | Amount |
| Receiving Station | $223,000 |
| Digester | $1,518,000 |
| Dewatering | $552,300 |
| Cogeneration (CHP) System | $954,500 |
| Building | $525,000 |
| Site Civil | $367,000 |
| subtotal | $ 4,139,800 |
| Contingency (25%) | $ 1,034,950 |
| Design Engineering and Construction Management (8%) | $413,980 |
| Project Management (3%) | $155,243 |
| GC OH&P (7.5%) | $388,106 |
| Total Estimated Construction Costs | **$ 6,132,079** |

| Order of Magnitude Estimation of Capital Expense 50% use of Available Sewage Sludge | |
|---|---|
| Description | Amount |
| Receiving Station | $223,000 |
| Digester | $1,116,683 |
| Dewatering | $452,300 |
| Cogeneration (CHP) System | $704,500 |
| Building | $525,000 |
| Site Civil | $367,000 |
| subtotal | $3,388,483 |
| Contingency (25%) | $847,121 |
| Design Engineering and Construction Management (8%) | $338,848 |
| Project Management (3%) | $94,878 |
| GC OH&P (7.5%) | $317,670 |
| Total Estimated Construction Costs | **$ 4,987,000** |

**Important Note:** It should be noted that conversations with waste water treatment plant management staff yield concerns on the practicality of the 50/100% diversion of sewage sludge. A main concern was the potential to have untreated sludge being left in supply pipelines at the plant and being co-mingled with treated sludge. If this were to happen, it would potentially cause an issue with Michigan DEQ biosolids regulations compliance. Staff did believe that it was an issue that would need further attention but did create an overarching obstacle that could not be overcome through amendments to operating protocol or additional infrastructure. It is recommended that this issue be included for further study if the City should decide to perform a higher level of analysis.

## Model Inputs: Revenues and Expenses

The economic model incorporated a set of revenues and expenses for the on-going operation of the biodigester.

Revenue is generated in a variety of ways:

- Cost savings developed as part of the reduction of material inherent in the biodigestion process
- Monies generated from the receipt of tipping fees and
- Production and sale of electricity.

Expense values were developed from various sources that utilized historical data from actual digester capital and operating costs, current consumable material costs, and conservative labor expenses.

### *Revenues from External Waste Tip Fees*

One of the critical ways that the biodigester remains viable is to earn tipping fees by accepting waste organic materials. For all versions of this analysis, the model assumed the following tipping fees:

***FOG:*** $0.10/gallon, delivered to the biodigester via FOG haulers

***Sugar water:*** $0.06/gallon delivered to the biodigester from food processor

***Dairy Waste:*** $0.05/gallon, delivered to the biodigester from local dairy

A roll-up for the tipping fee revenues is shown in Table 11 and Table 12 for 50% sludge and 100% sludge, respectively.

**Table 11: Tipping Fee Revenue when accepting 50% of WWTP sludge**

| Model, 50% WWTP Sludge | Total daily volume of substrate (gpd) | Total weekly volume (gal) | total yearly volume of substrates (gal) | tip fee per gallon of feedstock | Yearly tip Fee Revenue |
|---|---|---|---|---|---|
| WWTP sludge | 30,000 | 214,623 | 10,950,000 | $0.05 | $528,950 |
| FOG | 1,000 | 7,000 | 365,000 | $0.10 | $36,500 |
| Sugar water | 1,000 | 7,000 | 365,000 | $0.06 | $21,900 |
| Dairy Waste | 2,000 | 14,000 | 730,000 | $0.05 | $36,500 |
| Food Waste | 4,300 | 30,100 | 1,569,500 | $0.07 | $113,000 |
| **Net** | **38,989** | **272,723** | **13,979,500** | | **$736,850** |

**Table 12: Tipping Fee Revenue when accepting 100% of WWTP sludge**

| Model, 100% WWTP Sludge | Total daily volume of substrate (gpd) | Total weekly volume (gal) | total yearly volume of substrates (gal) | Tip Fee per gallon of feedstock | Yearly tip Fee Revenue |
|---|---|---|---|---|---|
| WWTP sludge | 60,000 | 429,246 | 21,900,000 | $0.05 | $1,057,900 |
| FOG | 1,000 | 7,000 | 365,000 | $0.10 | $36,500 |
| Sugar water | 1,000 | 7,000 | 365,000 | $0.06 | $21,900 |
| Dairy Waste | 2,000 | 14,000 | 730,000 | $0.05 | $36,500 |
| Food Waste | 4,300 | 30,100 | 1,569,500 | $0.07 | $113,000 |
| **Net** | **68,300** | **487,346** | **24,929,500** | | **$1,265,800** |

### *Revenues from Waste Water Treatment Plant Sludge*

One of the major advantages of the proposed model is that the Ann Arbor WWTP will see substantially decreased disposal costs if sludge is processed in the biodigester. Table 13 uses data obtained from the City staff at the AA WWTP to compare the current costs of processing sludge with the cost of diverting sludge to the biodigester. Table 13 assumes that 100% of the available sewage sludge is used as a feed stock for the digester facility.

For profitability calculations, the model considers the current WWTP operating cost as an avoided cost, and coverts this to a revenue input for the biodigester project. Specifically, $1,057,000 is considered revenue, and $573,700 is allocated as an expense to the biodigester, leaving a net gain of $483,300 annually by processing sludge at the biodigeser.

**Table 13: Comparison of Annual Sludge Processing Costs**

| Cost Comparison for WWTP sludge processing for using landfill, land application, or anaerobic digestion [annual $] | | | | |
|---|---|---|---|---|
| **Description** | Current WWTP Process | | Proposed Process | Notes |
| | Landfill | Land Application | Biodigestion | |
| **Dewatering** | $186,600 | $0 | $107,000 | Polymer purchases 7/1/2013-6/30/2014 |
| **Dewatering Equipment O&M** | $35,000 | $0 | $25,000 | Includes electricity and maintenance |
| **Hauling to site** | $214,000 | $416,700 | $212,000 | From WWTP to Digester |
| **Tip fee** | | | $209,000 | To compost site |
| **Lime for Class B biosolids and odor control** | $46,100 | $125,000 | $0 | No lime required post-digestion |
| **Michigan DEQ Biosolids** | 0 | $34,500 | $20,700 | |
| **Totals** | $481,700 | $576,200 | $573,700 | |
| **Grand Total** | **$1,057,900** | | **$573,700** | |
| | **Processing Costs for WWTP** | | **Processing Costs for BioDigester** | |
| **Net Revenue Gain from Biodigestion** | **$473,300** | | | |

It should be noted that the City staff at the Ann Arbor WWTP were well versed on the potential cost savings via anaerobic digestion. However, the unique landlocked nature of the Ann Arbor WWTP facility on the Old Dixboro Road cannot accommodate this alternative approach, specifically tankage. For this reason, they were open to exploring alternative solutions.

### *Operating Expenses*

Operational costs have been included in each version of the model and are shown in Table 14. Note that the costs associated with the recycle streams from dewatering digestate (and ultimately sent back to the City's waste water treatment plant) were not included in the models as an operational expense. It was assumed that because the majority of any recycle streams sent to the treatment plant would be produced as a result of digesting sewage sludge, a fee to the digester operation would not be assessed.

**Table 14: Operational Expenses used in the Economic Model**

| Annual Operating Costs | |
|---|---|
| **Description** | Amount |
| **Labor (operations, maintenance, admin, management)** | $275,000 |
| **Raw Materials and Consumables (electricity, dewatering polymer, equipment parts, etc.)** | $306,000 |
| **Internal Charges (sludge transfer to digester, lab testing, central cost allocation, etc.)** | $313,000 |
| **External Charges (compost tip fees, external maintenance services, state biosolids fees)** | $274,000 |
| **Long Term Equipment Replacement** | $25,000 |
| **Total** | $1,193,000 |

## Modeling Approach

Figure 20 shows the step-wise approach taken to assessing the economic viability of the proposed Ann Arbor Biodigester.

1. The first step compared the Project Profitability using either 100% of the available sludge from the Ann Arbor WWTP (**Case 1a**), or 50% of the sludge (**Case 1b**).
2. The second step compared Project Profitability using public or private financing**, Case 2a** and **Case 2b**, respectively. The terms for public vs private are shown in Figure 8.
3. Finally, the model compared the Project Profitability using the revenue from two different electrical rates:
    - **Case 3**: An electric Rate of 9 ¢/kWh, which is the current rate paid at the Materials Recovery Facility, and
    - **Case 4**: An electric Rate of 5.5 ¢/kWh, which is approximately the rate paid by DTE Energy under a typical Net-metering arrangement.

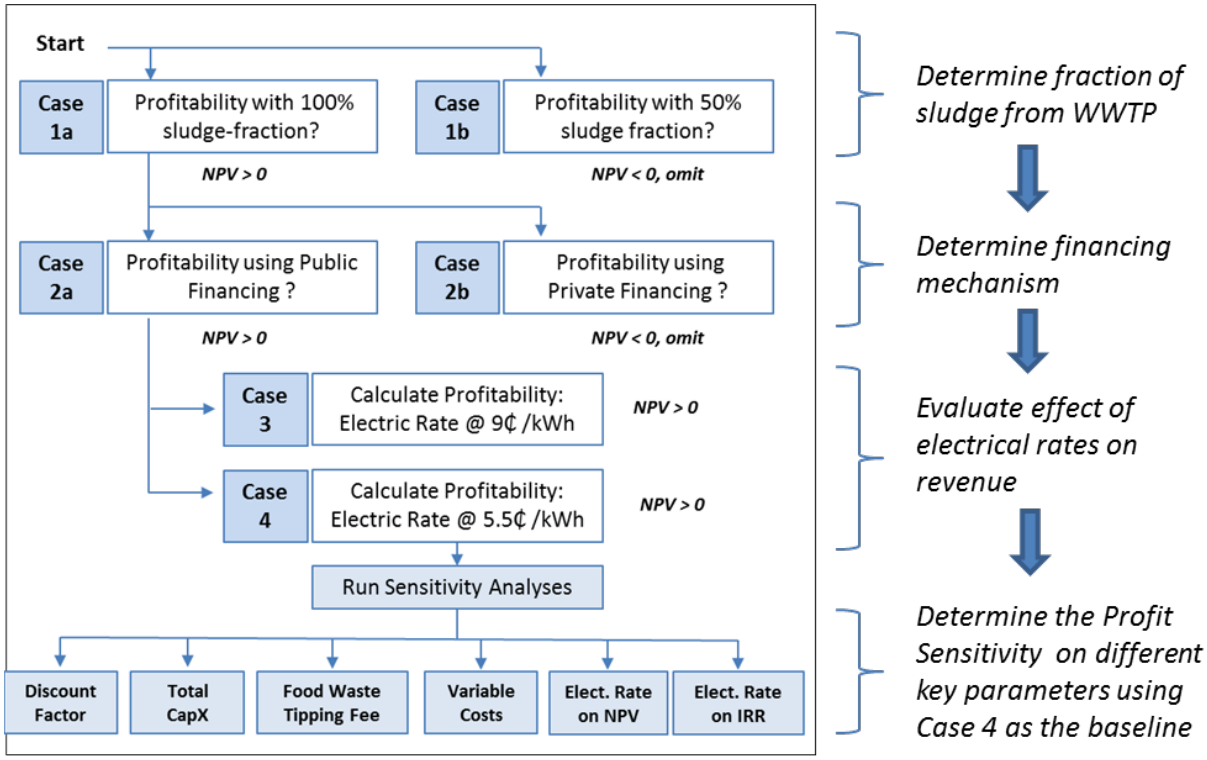


**Figure 20: Modeling Flowchart**

## Model Results

Modeling **Case 1a** and **Case 1b** showed that only **Case 1a** (processing 100% of the sewage sludge) provided a favorable return of investment. For this reason, the balance of the modeling omitted the 50% sludge treatment option since the NPV was negative.

Comparing **Case 2a** and **Case 2b**, the model showed that only **Case 2a** (public financing) would provide financial viability. Project profitability was negative for private financing terms.

The results for **Case 3** and **Case 4** are shown in **Error! Reference source not found.**. Both cases have a positive NPV, with **Case 3** obviously earning more due to a more generous electrical rate. However, to assure that the modeling was not over optimistic, all subsequent modeling used Public financing with 5.5¢/kWh earned from electrical sales.

**Important Note:** Both **Case 3** and **Case 4** assumed the use of 100% of the available sludge fraction and the use of public financing for the bidigester project.
A graphical view of the project profitability is shown in Figure 21. Note that for all subsequent sensitivity analyses, the baseline is **Case 4**, using 100% sludge, public financing and 5.5 ¢/kWh for electrical revenue.

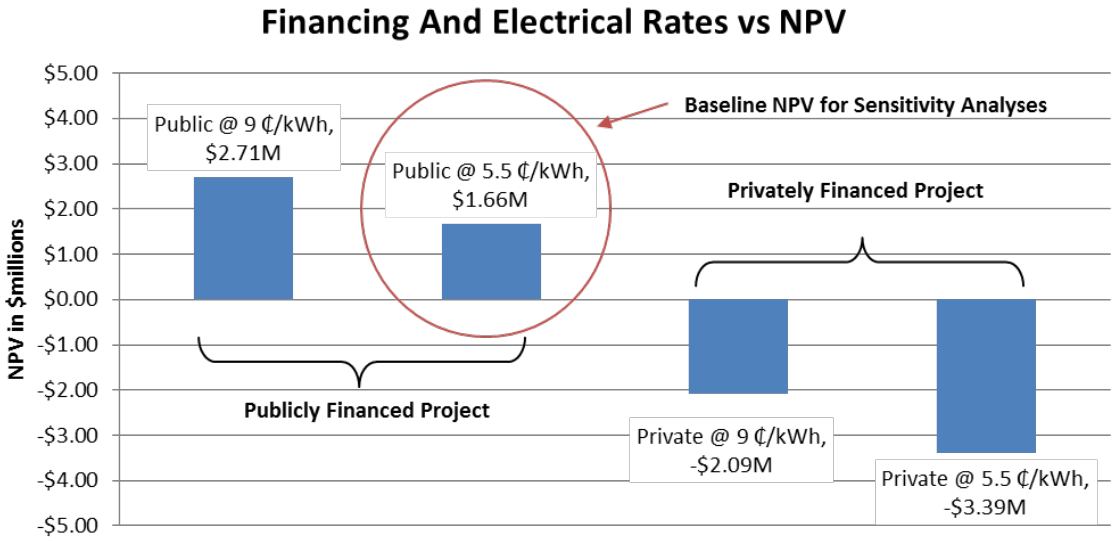


**Figure 21: NPV vs Financing Method**

**Table 15: Model results for Cases 3 and 4**

| Case # | Type of financing | Fraction of sludge | Cost of Electricity ¢/kWh | Discount Rate, % | Cost of Money % | Term, years | Return on Investment, % | Internal Rate of Return, % | NPV |
|---|---|---|---|---|---|---|---|---|---|
| 3 | Public | 100% | 9 ¢/kWh | 2.1% | 3.5% | 10 | 13.5% | 6.06% | $2,705,235 |
| 4 | | | 5.5 ¢/kWh | | | | 15.6% | 4.58% | $1,658,744 |

## Financial Impact of Filtrate Disposal

One variable in the financial model required more in-depth analysis: namely, the potential cost of "dewatering" the material in the digester before final disposal (composting, landfilling or incineration.) Dewatering involves removing the excess water in the digestate using a filter

press in order to separate the liquids and solids in the digested material. After dewatering, two components remain:

1. A cake-like (low moisture) solid material and
2. A nutrient rich, watery material called "filtrate".

The models for Case 3 and Case 4 assumed that the filtrate would be returned to the City's wastewater treatment plant through the sanitary sewer system. Since the raw sludge feedstock had already been paid for upon entering the WWTP via standard user fees, no cost was assigned to the material being sent to Ann Arbor WWTP. (The volume of filtrate generated at the biodigester from sewage sludge nearly the same as the treatment plant sees today.) It should be noted that the existing operations at the WWTP also create a filtrate stream through thickening and dewatering sewage sludge prior to its application to agricultural lands or landfilling.

City staff have indicated that inter-departmental budgeting at the City may not allow the transfer of filtrate between the biodigester to the WWTP at no cost. Therefore, two variations of Case 4 model were developed:

> ***Case 4b:*** In this variation, the biodigester would be charged by the Ann Arbor WWTP for accepting the filtrate from the non-sludge fraction of the feedstocks. The logic behind Case 4b is that the filtrate from the sludge had previously been accepted under a fee-basis at the head of the WWTP, but the other feedstocks had not been paid for. As Figure 19 shows, the fraction of non-sludge feedstock is approximately 12% of the total material.
>
> ***Case 4c:*** This variation modeled the biodigester paying the WWTP for the filtrate from all feedstocks (including sludge).

In both cases, the charge for filtrate accepted at the WWTP was $3.65/ccf.

**Table 16: Financial impact of paying for filtrate sent to the Ann Arbor WWTP**

| Model Parameters: | Case | Case Variations | Internal Rate of Return, % | NPV |
|---|---|---|---|---|
| • Fraction of AA WWTP Sludge = 100%<br>• Cost of Electricity, 5.5 ¢/kWh<br>• Interest Rate = 3.5% for 10 years<br>• Discount Rate = 2.1 % | 4 | Baseline Case 4, no payment for filtrate returned to WWTP | 4.58% | $1,658,744 |
| | 4b | Pay WWTP for filtrate from all non-sludge feedstocks | 4.29% | $1,450,888 |
| | 4c | Pay WWTP for filtrate from all feedstocks (incl. sludge) | 1.95% | $-94,259 |

The results of Case 4, Case 4b and Case 4c are shown in Table 16. The financial performance of Case 4b is only slightly worse than Case 4a, but still profitable. Case 4c is not profitable (NPV<0).

**Technical Note on Filtrate:** The nutrient loading from the filtrate placed on the WWTP will be somewhat different than the filtrate from sludge. A biodigester converts proteins in the feedstock into available ammonium, and also transforms phosphorous into its soluble format (orthophosphate). Both of these nutrients may cause additional attention and treatment at the wastewater treatment plant; however, given the relatively small volume of filtrate in Case 4b, hydraulic and nutrient loading is not expected to negatively impact the wastewater treatment plant. City staff at the Ann Arbor WWTP can readily determine this impact.

As an alternative, the filtrate could be collected from the dewatering process, stored and land applied as a liquid fertilizer. In order to use land application as an alternative to composting, the biodigester would need to be configured to provide storage or alternative disposal methods (composting and or landfilling) during times of the year that land application is not permitted. Utilizing land application as a disposal alternative would increase the capital expense of the project by approximately $950,000 for an installation of a storage tank and a thickener.

It is recommended that further evaluation of filtrate disposal and or reuse be conducted as part of any future biodigester feasibility study.

## Sensitivity Analyses

To determine the impact of specific parameters on the results of the model, a number of sensitivity analyses were calculated for the public financing with 5.5¢/kWh electrical sales. Selected variables include:

### *Sensitivity to Discount Factor*

Table 17 shows the sensitivity of Case 4 to the Discount Factor. The baseline Discount Factor (Public Case) was selected to be 2.1%, which is typical for a project financed with tax-exempt bonds. Note that if the Discount Factor rises to 2.52%, the Net Present Value for the project will decrease by nearly 20%.

**Discount factor's impact on profitability**

| Discount factor | 1.68 % | 1.89 % | 2.10 % | 2.31 % | 2.52 % |
|---|---|---|---|---|---|
| Change, % | -20.0 % | -10.0 % | 0.0 % | +10.0 % | +20.0 % |
| Net Present Value (NPV) | 2,001,277 | 1,827,429 | 1,658,744 | 1,495,042 | 1,336,150 |
| Change, % | +20.7 % | +10.2 % | 0.0 % | -9.9 % | -19.4 % |

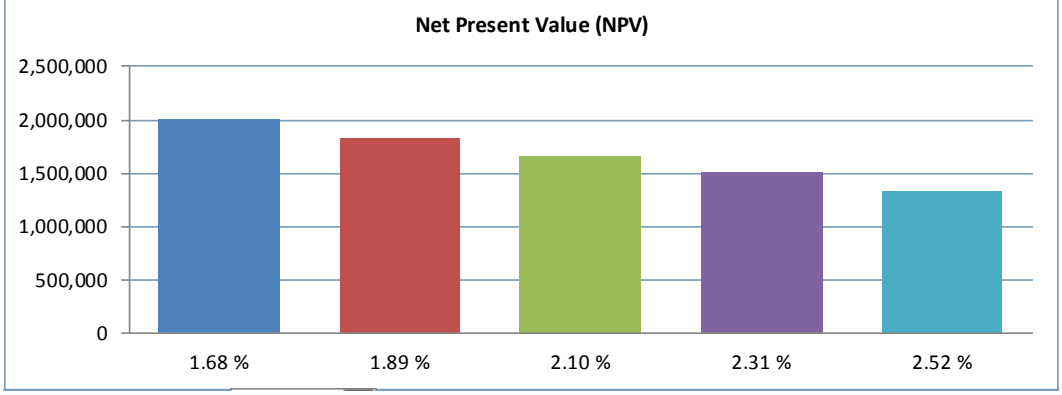


**Table 17: Sensitivity to Discount Factor**

### *Sensitivity to Total Investment*

The total capital investment for Case 4 is calculated to be $6,132,079. The following chart shows the effect on Net Present Value of changing the capital investment by +/- 20%. The effect on profitability is significant, with a decrease of over 70% in the NPV if the cost increases by 20%

**Total investment's impact on profitability**

| Total investment, USD | -4,905,663 | -5,518,871 | -6,132,079 | -6,745,287 | -7,358,495 |
|---|---|---|---|---|---|
| Change, % | -20.0 % | -10.0 % | 0.0 % | +10.0 % | +20.0 % |
| Net Present Value (NPV) | 2,885,159 | 2,271,952 | 1,658,744 | 1,045,536 | 432,328 |
| Change, % | +73.9 % | +37.0 % | 0.0 % | -37.0 % | -73.9 % |

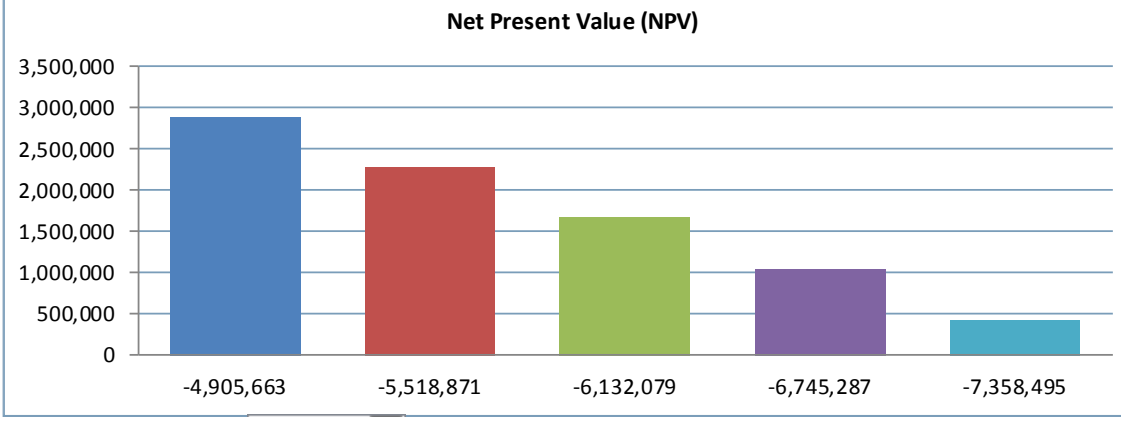


**Table 18: Sensitivity to total capital costs**

### *Sensitivity to changes in the Food Waste Tipping Fee*

The tipping fee for the food waste delivered to the biodigester is assumed to be $21.80/ton. This is a 15% discount from the current transfer and disposal costs for City trash of $25.87/ton.

**Income variable´s impact on profitability**

| Variable | External Substrate - Food Waste Tip Fee, $/ton | | | | |
|---|---|---|---|---|---|
| Change in value, % | -20.0 % | -10.0 % | 0.0 % | +10.0 % | +20.0 % |
| Sample value 12/2016 | 17.5 | 19.6 | 21.8 | 24.0 | 26.2 |
| Net Present Value (NPV) | 1,291,240 | 1,474,992 | 1,658,744 | 1,842,495 | 2,026,247 |
| Change, % | -22.2 % | -11.1 % | 0.0 % | +11.1 % | +22.2 % |

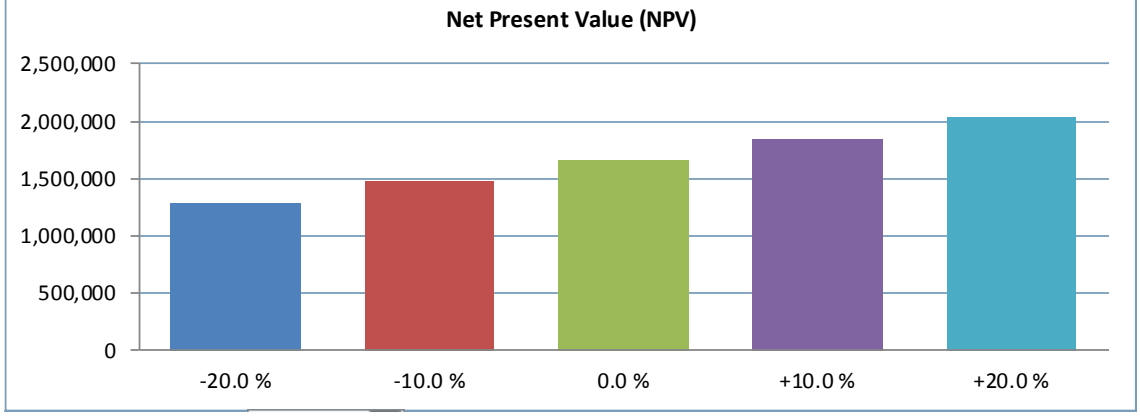


**Table 19: Sensitivity to increases in Food Waste Tipping Fees**

Discussions with City staff indicate that the current T&D costs escalate at 2.3% per year, and are likely to increase substantially when the current disposal contact expires in 2017. For this reason, the Sensitivity Analysis in Table 19 is particularly valuable.

Note that the food waste tipping fee is earned by the biodigester, not the landfill, and is therefore considered revenue in this model. As landfill rates escalate, so does the implicit value of the food waste increase to the biodigester's finances. An increase in 20% in landfill rates yields an increase in NPV of over 22%.

### *Sensitivity to Variable Costs*

The effect of changes in the variable costs for the system is also substantial. Varible charges can come from two main areas: Raw Materials/Consumables used on a daily basis in the plant, and External Charges for items outside the plant. The model assumes that these costs escalate at the rate of inflation for the term of the model (nominally 2% annually.)

| Variable Charges | | | |
|---|---|---|---|
| **Raw materials and consumables** | | **External Charges** | |
| Dewatering Polymer | Equipment O&M | Trucking Fee for WWTP sludge | Building Maintenance (water, heat, repairs) |
| Electricity, kWh/yr | CHP maintenance | Lab Testing, $/year | City Central Cost Allocation |
| Electrical Rate | Gas Cleaning Costs | Centrate disposal fee | External Maintenance |
| Plant Electricity | Replacement of Long Term Equipment | State Biosolids Fee | |

**Table 20: Variable Costs in the Model**

As Table 21 shows, the NPV is highly sensitive to changes in variable cost, where a 20% increase in total variable costs results in the NPV becoming negative (i.e. not economically viable.)

**Variable cost's impact on profitability**

| Change in Variable costs, % | -20.0 % | -10.0 % | 0.0 % | +10.0 % | +20.0 % |
|---|---|---|---|---|---|
| Net Present Value (NPV) | 4,992,950 | 3,325,847 | 1,658,744 | -8,360 | -1,675,463 |
| Change, % | +201.0 % | +100.5 % | 0.0 % | -100.5 % | -201.0 % |

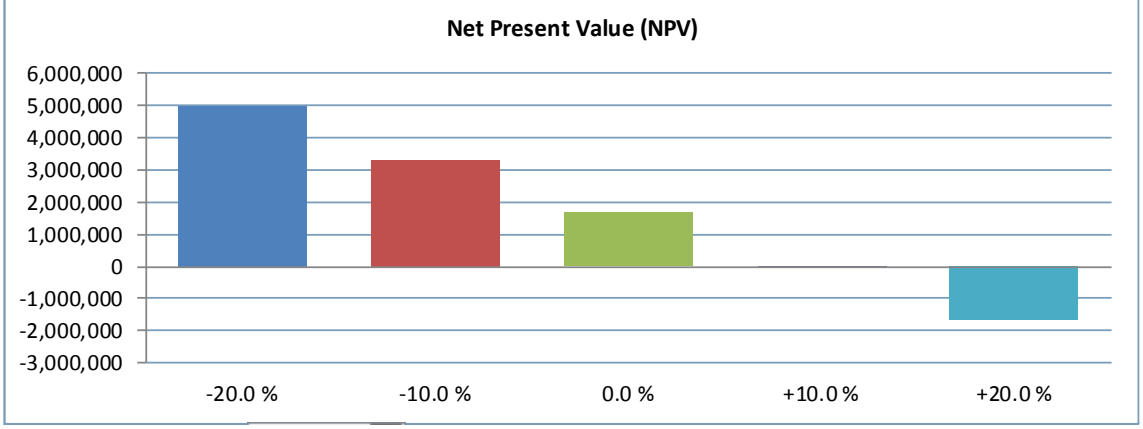


**Table 21: Sensitivity to Variable Cost**

### *Sensitivity of NPV and IRR on changes in electrical rate*

The effect of earning more or less revenue from electrical generation is shown in Table 22 and Table 23. Table 22 shows the sensitivity of NPV on the electrical revenue, where $274,626 is the amount earned at 5.5¢/kWh.

**Income variable´s impact on profitability**

| Variable | Electrical Revenue | | | | |
|---|---|---|---|---|---|
| **Change in value, %** | **-20.0 %** | **-10.0 %** | **0.0 %** | **+10.0 %** | **+20.0 %** |
| Sample value 12/2016 | 219,700.8 | 247,163.4 | 274,626.0 | 302,088.6 | 329,551.2 |
| Net Present Value (NPV) | 541,833 | 1,100,288 | 1,658,744 | 2,217,199 | 2,775,654 |
| Change, % | -67.3 % | -33.7 % | 0.0 % | +33.7 % | +67.3 % |

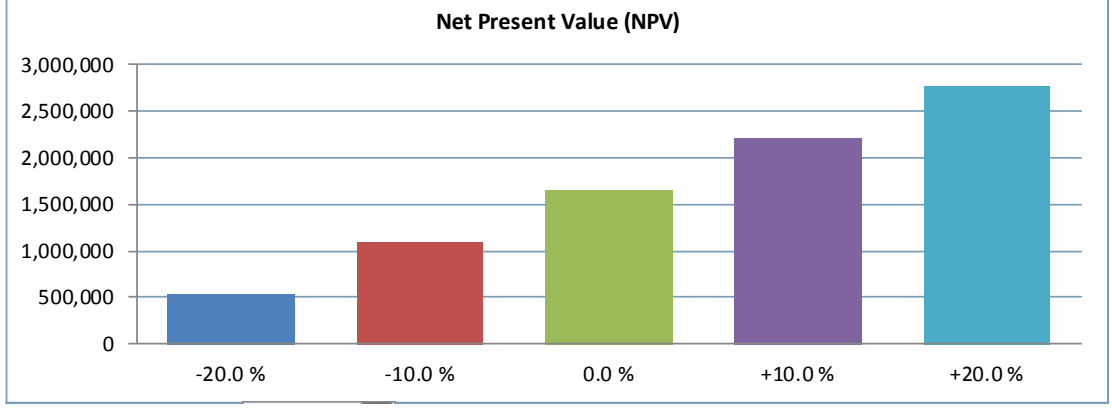


**Table 22: Sensitivity to changes in Electrical Revenue**

The sensitivity of the Internal Rate of Return is shown in Table 23.

**Income variable´s impact on profitability**

| Variable | Electrical Rate, $/kWh | | | | |
|---|---|---|---|---|---|
| **Change in value, %** | **-20.0 %** | **-10.0 %** | **0.0 %** | **+10.0 %** | **+20.0 %** |
| Sample value 12/2016 | 0.044 | 0.050 | 0.055 | 0.061 | 0.066 |
| Internal Rate of Return (IRR) | 3.1% | 3.9% | 4.6% | 5.3% | 6.0% |
| Change, % | -32.4 % | -15.9 % | 0.0 % | +15.3 % | +30.0 % |

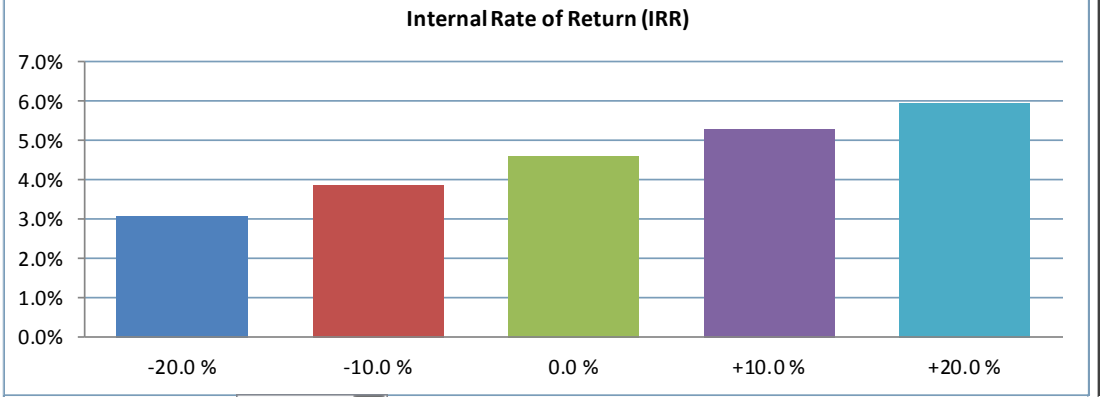


**Table 23: Sensitivity of the system IRR to changes in electrical rate (Netmetering)**

The Sensitivity Analyses on electrical revenue and rates show that the project has a high sensitivity to the revenue earned by electrical production. An increase in electrical revenue to nearly $330k will increase the system's profitability by over 67% Even a modest increase in electrical rates to 6.6¢/kWh will increase the project's IRR by 30%.

### Conclusions: Economic Model

In general, the economic viability of the proposed Ann Arbor Biodigester relies on three critical factors. These are:

1) The availability of an adequate volume of WWTP sludge to achieve a sufficient economy-of-scale. Revenues to the biodigester come from the avoided costs of landfilling or land application of sludge, plus the elimination of expenses for lime, polymer and other required materials if treated sludge is land applied or landfilled.

2) The availability of public money to finance the project. With an estimated capital cost of over $6M, the cost of debt between public and private sources is substantial. Luckily, Ann Arbor has an excellent credit rating (AA+) and can borrow funds on the tax-exempt market at extremely good rates. (See Table 9.)

3) The availability of food waste and other organics to increase biogas production. As the sensitivity analysis on electrical revenue and rates showed (Table 22 and Table 23), the project's profitability has a moderately high sensitivity to revenue from electrical generation. This means that the more food waste/FOG/dairy waste, the better. These feedstocks have much higher biogas production potential than WWTP sludge, so additional quantities have a disproportionally positive impact on project revenue.

If these three factors can be met, then it is recommended that the City of Ann Arbor invest in the development of a biodigester system. The economic modeling in this Study shows that the City will benefit from a profitable waste-to-energy system, assuming the correct feedstock mix.

## 8. Sustainability Benefits of a Biodigester.

In 2011, Ann Arbor developed a Sustainability Framework project started in January 2011 with the goal of creating one unified vision of sustainability for the city. The Sustainability Framework includes 16 high level sustainability goals[xiii]. The following compliance matrix identifies how a biodigester can work to meet specific goals in the framework

[xiii] http://www.a2gov.org/sustainability/Documents/Ann%20Arbor%20Sustainability%20Framework%20051313.pdf

| Framework Goal | Biodigester Feature | Comment |
|---|---|---|
| Sustainable Energy –Increase the use of renewable energy. | Biogas Production for heat, or to generate electricity in a gen-set. Biogas is a byproduct of material decomposition | Using biogas also destroys the methane in biogas. Methane is a powerful greenhouse gas. |
| Clean Air and Water - Eliminate pollutants in our air and water systems | The liquid fraction of the digested material is essentially pathogen-free after digestion. | Digesters are sealed, eliminating leakage of leachate into the groundwater under landfills. |
| Sustainable Systems - Plan for and manage constructed and natural infrastructure systems to meet the current and future needs of our community | The digested solids from biodigesters convert complex food waste material into readily accessible soil nutrients. Water can be used as a liquid fertilizer. | Digestion and composting are part of a continuous cycle of returning nutrients and water back to the environment. |
| Responsible Resource Use - Produce zero waste and optimize the use and reuse of resources in our community | .Biodigestion reduces the volume of material by as much as 40%. Digested solids can be used as a soil amendment. | Diversion of food waste is part of a larger strategy to put all waste products to beneficial use. Ultimately, zero waste goals can be achieved |

**Table 24: Sustainability benefits of biodigestion**

The 2013 Solid Waste Resource Plan[xiv] contains a detailed list of key actions to execute to meet the 16 goals in the Sustainability Framework. One of the Key Actions under ***Responsible Resource Use*** called for the following:

> *"Research options to collect and process all food waste produced within the city, including but not limited to biodigesters. Include a review of options to potentially manage diapers and pet waste. Conduct a feasibility study of the ability of the City's compost facility, operated by WeCare Organics, to handle full-scale food waste composting. Complete feasibility study by January 2014. "*

The RFP 889 issued by the City of Ann Arbor in February of 2014 was focused on the use of a biodigester to process food waste, and this Feasibility Study by Quantalux is the resulting document. Previous work by our firm has researched the processing diapers and pet waste, and has concluded that both items are unsuitable for biodigesters:

> ***Diapers:*** Disposable diapers contain a range of materials, including plastic sheeting to prevent fluids from leaking. While biodigesters can safely process human waste, the plastic sheeting and plastic absorbent material is currently non-biodegradable, and will foul both

[xiv] http://www.a2gov.org/Documents/A2_WasteLessFive-YearPlan_APPENDIX_10-7-13.pdf

compost systems and biodigesters. Furthermore, the mixers in a biodigester will become clogged with disposable diapers.

***Pet Waste:*** Biodigesters can also safely process pet waste, however, the litter that typically accompanies pet waste is made from diatomaceous earth. This clay-like material will settle in biodigester vessels, and will ultimately plug the system's pumps and vessels.

## 9. Conclusions and Next Steps

In conclusion, the deployment of a biodigester in Ann Arbor for food waste and WWTP sludge has the potential to be a good financial investment for the City, but only under certain conditions. These include:

***Large Scale:*** The biodigester must be of adequate scale to be financially viable, and be publically financed using inexpensive monies available to a city like Ann Arbor with excellent credit. The issue of scale requires a judicious selection of available organic feedstocks for optimum performance, with large quantities of feedstocks needed for daily operation.

***Diverse Feedstocks:*** Food waste is an excellent candidate feedstock because of its outstanding biogas production potential. The ideal source of food waste is a food processor because the supply of material is typically well-characterized, and can be delivered on a regular schedule. Large amounts of food waste are also produced in restaurants and at other institutions; however, the efficient collection of food waste from municipal sources is still in its relative infancy, with cheap landfill options remaining a barrier to deployment.

***Sludge as a major feedstock:*** Diversion of a large fraction of the sludge from the Ann Arbor WWTP is a key source of revenue for the Biodigester. This is a viable approach since many wastewater plants across the US routinely use biodigestion to process their sewage sludge. Augmenting the Ann Arbor WWTP with a biodigester offers an alternative processing solution, and can offer both the City's WWTP and the Solid Waste group long-term savings in their disposal costs. This is particularly true if landfill or land application costs continue to escalate.

***Sustainability:*** From a sustainability perspective, biodigestion is far superior to the current disposal for Ann Arbor's sludge (landfilling or land application). Biodigestion generates renewable energy, and also naturally reduces the amount of material for subsequent processing (to compost) or disposal.

***Logistical challenges:*** Collection and transport of food waste is a challenging prospect due to its distributed nature, and the food waste's rapid decomposition. Efficient logistics systems will be needed to cost effectively gather and transport food waste from commercial locations such as restaurants.

### Recommended Next Steps

This initial Feasibility Study shows the potential for a biodigester in the Ann Arbor area. The following items are recommended as key elements to include in any follow-on study:

- The ideal method for determining food waste totals is to conduct a rigorous food sort. A food sort for multiple restaurants is recommended in order to tally the available food-waste feedstock in a structured manner.
- FOG is a valuable feedstock for biodigestion, but is difficult to guarantee as a feedstock since multiple independent haulers mange the pickup and disposal of the material. A franchise model requiring all FOG within Ann Arbor city limits to be diverted to a common location (biodigester) should be explored.
- Similarly, a franchise model for the collection food waste produced within the city limit of Ann Arbor should be explored. A consistent supply of food waste and FOG to the digester will assure maximum biogas production, leading to enhanced financial stability and profitability.
- Further study is recommended to determine more precise estimates of biogas production from the sludge material available from the Ann Arbor WWTP.
- Commercial composting participation should be further evaluated to determine the fraction of food waste diverted to composting, and in turn, the fractions of pre-consumer food waste, and post-consumer food waste.
- A site assessment for the biodigester should be conducted to determine the optimum location based on available feedstocks. Another criterion for site selection will be any limits on renewable electrical production that may exist in Michigan's utility regulations.
- It is critical to determine how the cost-accounting structure at City departments will affect options for filtrate disposal.
- Future economic models should evaluate the addition of REC and Carbon Credit revenues. At the current time, these markets are uncertain. However, there are indications that limits on carbon producers may be imposed by the EPA, meaning that the positive carbon credits earned by the Ann Arbor Biodigester may (at some point) have significant monetary value.

## Appendix A: Pro Forma for Case 4

A full 20 year Pro Forma listing for the Biodigester Case 4 (see Table 15) is listed in the Appendix A following the References.

# 10. References Cited


[1] "Municipal Solid Waste (MSW) in the United States: Facts and Figures 2012."*EPA*. Environmental Protection Agency, Web. 12 June 2014.

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[11] "Food Waste Estimation Guide." *RecyclingWorks Massachusetts*. Web. 12 June 2014. <http://www.recyclingworksma.com/food-waste-estimation-guide/#Jump06>

[12] "Food Waste Management Cost Calculator." *EPA*. Environmental Protection Agency, Web. 12 June 2014. <http://www.epa.gov/waste/conserve/foodwaste/tools/index.htm>.

[13] "Standard Waste Generated in Weight for Building/Business Type." The Rosenthal Group. Web. 12 June 2014. <http://www.the-rosenthal-group.com/Standard%20Waste%20Generated.pdf>.

[14] Cascadia Consulting Group. *Targeted Statewide Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry Groups*. June 2006. Web. 12 June 2014. <http://www.calrecycle.ca.gov/publications/Documents/Disposal/34106006.pdf>.

**INVESTMENTS ( ) / REALIZATIONS (+)**

| Imputed depreciation | 1/2016 | 12/2016 | 12/2017 | 12/2018 | 12/2019 | 12/2020 | 12/2021 | 12/2022 | 12/2023 | 12/2024 | 12/2025 | 12/2026 | 12/2027 | 12/2028 | 12/2029 | 12/2030 | 12/2031 | 12/2032 | 12/2033 | 12/2034 | 12/2035 | Residual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Investments** | **-6,132,079** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | |
| Book value | 6,132,079 | 5,544,143 | 4,956,208 | 4,368,272 | 3,780,337 | 3,192,401 | 2,604,466 | 2,016,530 | 1,700,635 | 1,430,079 | 1,159,524 | 888,968 | 618,413 | 347,857 | 77,302 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**INCOME STATEMENT**

| USD | 1/2016 | 12/2016 | 12/2017 | 12/2018 | 12/2019 | 12/2020 | 12/2021 | 12/2022 | 12/2023 | 12/2024 | 12/2025 | 12/2026 | 12/2027 | 12/2028 | 12/2029 | 12/2030 | 12/2031 | 12/2032 | 12/2033 | 12/2034 | 12/2035 | Residual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months per interval | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | (12/2035) |
| Income specified: | | | | | | | | | | | | | | | | | | | | | | |
| Electrical Generation | | 449,388 | 458,376 | 467,543 | 476,894 | 486,432 | 496,161 | 506,084 | 516,206 | 526,530 | 537,060 | 547,801 | 558,757 | 569,933 | 581,331 | 592,958 | 604,817 | 616,913 | 629,252 | 641,837 | 654,673 | |
| Generator Capacity, kW | | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | |
| Generator availability, % | | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | |
| Electrical Rate, $/kWh | | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.13 | |
| + Electrical Revenue | | 449,388 | 458,376 | 467,543 | 476,894 | 486,432 | 496,161 | 506,084 | 516,206 | 526,530 | 537,060 | 547,801 | 558,757 | 569,933 | 581,331 | 592,958 | 604,817 | 616,913 | 629,252 | 641,837 | 654,673 | |
| External Tip Fees | | 208,364 | 210,189 | 212,060 | 213,977 | 215,942 | 217,957 | 220,022 | 222,138 | 224,307 | 226,531 | 228,810 | 231,146 | 233,541 | 235,995 | 238,511 | 241,090 | 243,733 | 246,442 | 249,219 | 252,065 | |
| Grease Trap Waste Tip Fee, $/gallon | | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.13 | 0.14 | 0.14 | 0.14 | 0.15 | 0.15 | 0.16 | 0.16 | |
| Annual Volume Accepted, gallons | | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | |
| + Annual Tip Fee | | 36,500 | 37,413 | 38,348 | 39,307 | 40,289 | 41,296 | 42,329 | 43,387 | 44,472 | 45,583 | 46,723 | 47,891 | 49,088 | 50,316 | 51,574 | 52,863 | 54,184 | 55,539 | 56,928 | 58,351 | |
| External Substrate Tip Fee, $/gallon | | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | |
| Annual Volume Accepted, gallons | | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | 730,000 | |
| + Annual Tip Fee, $/yr | | 36,500 | 37,413 | 38,348 | 39,307 | 40,289 | 41,296 | 42,329 | 43,387 | 44,472 | 45,583 | 46,723 | 47,891 | 49,088 | 50,316 | 51,574 | 52,863 | 54,184 | 55,539 | 56,928 | 58,351 | |
| External Substrate Tip Fee, $/gallon | | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.10 | |
| Annual Volume Accepted, gallons | | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | 365,000 | |
| + Annual Tip Fee, $/yr | | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 | |
| External Substrate - Food Waste Tip Fee, $/gallon | | 21.82 | 22.366 | 22.925 | 23.498 | 24.085 | 24.687 | 25.305 | 25.937 | 26.586 | 27.250 | 27.931 | 28.630 | 29.345 | 30.079 | 30.831 | 31.602 | 32.392 | 33.202 | 34.032 | 34.883 | |
| Annual Volume Accepted, tons/yr | | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 | |
| + Annual Tip Fee, $/yr | | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | 113,464 | |
| WWTP Cost Savings | | 1,022,507 | 1,048,070 | 1,074,272 | 1,101,129 | 1,128,657 | 1,156,873 | 1,185,795 | 1,215,440 | 1,245,826 | 1,276,972 | 1,308,896 | 1,341,618 | 1,375,159 | 1,409,538 | 1,444,776 | 1,480,895 | 1,517,918 | 1,555,866 | 1,594,762 | 1,634,632 | |
| + Annual Lime Savings | | 171,163 | 175,442 | 179,828 | 184,324 | 188,932 | 193,656 | 198,497 | 203,459 | 208,546 | 213,760 | 219,104 | 224,581 | 230,196 | 235,951 | 241,849 | 247,896 | 254,093 | 260,445 | 266,956 | 273,630 | |
| + Annual Land App Savings | | 416,744 | 427,163 | 437,842 | 448,788 | 460,007 | 471,508 | 483,295 | 495,378 | 507,762 | 520,456 | 533,468 | 546,804 | 560,474 | 574,486 | 588,848 | 603,570 | 618,659 | 634,125 | 649,978 | 666,228 | |
| + Annual Landfill Savings | | 214,000 | 219,350 | 224,834 | 230,455 | 236,216 | 242,121 | 248,174 | 254,379 | 260,738 | 267,257 | 273,938 | 280,787 | 287,806 | 295,001 | 302,376 | 309,936 | 317,684 | 325,626 | 333,767 | 342,111 | |
| + Annual dewatering Polymer savings | | 186,600 | 191,265 | 196,047 | 200,948 | 205,971 | 211,121 | 216,399 | 221,809 | 227,354 | 233,038 | 238,864 | 244,835 | 250,956 | 257,230 | 263,661 | 270,252 | 277,009 | 283,934 | 291,032 | 298,308 | |
| + State Biosolids Fees | | 34,000 | 34,850 | 35,721 | 36,614 | 37,530 | 38,468 | 39,430 | 40,415 | 41,426 | 42,461 | 43,523 | 44,611 | 45,726 | 46,869 | 48,041 | 49,242 | 50,473 | 51,735 | 53,028 | 54,354 | |
| **Income** | **0** | **1,680,259** | **1,716,635** | **1,753,875** | **1,792,000** | **1,831,031** | **1,870,991** | **1,911,901** | **1,953,784** | **1,996,663** | **2,040,563** | **2,085,507** | **2,131,522** | **2,178,632** | **2,226,864** | **2,276,245** | **2,326,802** | **2,378,564** | **2,431,560** | **2,485,818** | **2,541,370** | **0** |
| (cumulative financial year) | | 1,680,259 | 1,716,635 | 1,753,875 | 1,792,000 | 1,831,031 | 1,870,991 | 1,911,901 | 1,953,784 | 1,996,663 | 2,040,563 | 2,085,507 | 2,131,522 | 2,178,632 | 2,226,864 | 2,276,245 | 2,326,802 | 2,378,564 | 2,431,560 | 2,485,818 | 2,541,370 | |
| Other operating income | | | | | | | | | | | | | | | | | | | | | | |
| Variable costs | 0 | -917,409 | -940,850 | -964,896 | -989,565 | -1,014,873 | -1,040,837 | -1,067,473 | -1,094,801 | -1,122,837 | -1,151,601 | -1,181,112 | -1,211,391 | -1,242,456 | -1,274,330 | -1,307,033 | -1,340,588 | -1,375,017 | -1,410,344 | -1,446,592 | -1,483,787 | 0 |
| Raw materials and consumables | | -306,043 | -314,199 | -322,579 | -331,190 | -340,039 | -349,132 | -358,476 | -368,078 | -377,946 | -388,088 | -398,511 | -409,225 | -420,236 | -431,554 | -443,188 | -455,146 | -467,440 | -480,077 | -493,069 | -506,425 | |
| - Dewatering Polymer | | 106,853 | 109,524 | 112,262 | 115,069 | 117,945 | 120,894 | 123,916 | 127,014 | 130,190 | 133,444 | 136,781 | 140,200 | 143,705 | 147,298 | 150,980 | 154,755 | 158,623 | 162,589 | 166,654 | 170,820 | |
| Electrcricity, kWh/yr | | 365,000 | 370,475 | 376,032 | 381,673 | 387,398 | 393,209 | 399,107 | 405,093 | 411,170 | 417,337 | 423,597 | 429,951 | 436,401 | 442,947 | 449,591 | 456,335 | 463,180 | 470,127 | 477,179 | 484,337 | |
| Electrical Rate | | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.13 | 0.14 | 0.14 | 0.14 | |
| - Plant Electricity | | 32,850 | 34,176 | 35,556 | 36,992 | 38,485 | 40,039 | 41,656 | 43,338 | 45,087 | 46,908 | 48,802 | 50,772 | 52,822 | 54,955 | 57,173 | 59,482 | 61,883 | 64,382 | 66,981 | 69,686 | |
| - Equipment O&M | | 30,000 | 30,750 | 31,519 | 32,307 | 33,114 | 33,942 | 34,791 | 35,661 | 36,552 | 37,466 | 38,403 | 39,363 | 40,347 | 41,355 | 42,389 | 43,449 | 44,535 | 45,649 | 46,790 | 47,960 | |
| Misc | | 7,500 | 7,688 | 7,880 | 8,077 | 8,279 | 8,486 | 8,698 | 8,915 | 9,138 | 9,366 | 9,601 | 9,841 | 10,087 | 10,339 | 10,597 | 10,862 | 11,134 | 11,412 | 11,697 | 11,990 | |
| - CHP maintenance | | 78,840 | 80,811 | 82,831 | 84,902 | 87,025 | 89,200 | 91,430 | 93,716 | 96,059 | 98,460 | 100,922 | 103,445 | 106,031 | 108,682 | 111,399 | 114,184 | 117,038 | 119,964 | 122,963 | 126,038 | |
| - Gas Cleaning Costs | | 50,000 | 51,250 | 52,531 | 53,845 | 55,191 | 56,570 | 57,985 | 59,434 | 60,920 | 62,443 | 64,004 | 65,604 | 67,244 | 68,926 | 70,649 | 72,415 | 74,225 | 76,081 | 77,983 | 79,933 | |
| External charges | | -586,367 | -601,026 | -616,051 | -631,453 | -647,239 | -663,420 | -680,006 | -697,006 | -714,431 | -732,292 | -750,599 | -769,364 | -788,598 | -808,313 | -828,521 | -849,234 | -870,465 | -892,226 | -914,532 | -937,395 | |
| - Trucking Fee for WWTP sludge | | 300,000 | 307,500 | 315,188 | 323,067 | 331,144 | 339,422 | 347,908 | 356,606 | 365,521 | 374,659 | 384,025 | 393,626 | 403,467 | 413,553 | 423,892 | 434,489 | 445,352 | 456,485 | 467,898 | 479,595 | |
| - Cake Disposal Cost (compost) | | 238,467 | 244,428 | 250,539 | 256,803 | 263,223 | 269,803 | 276,548 | 283,462 | 290,548 | 297,812 | 305,257 | 312,889 | 320,711 | 328,729 | 336,947 | 345,371 | 354,005 | 362,855 | 371,927 | 381,225 | |
| - Lab Testing, $/year | | 5,000 | 5,125 | 5,253 | 5,384 | 5,519 | 5,657 | 5,798 | 5,943 | 6,092 | 6,244 | 6,400 | 6,560 | 6,724 | 6,893 | 7,065 | 7,241 | 7,423 | 7,608 | 7,798 | 7,993 | |
| - Centrate disposal fee | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - State Biosolids Fee | | 20,400 | 20,910 | 21,433 | 21,969 | 22,518 | 23,081 | 23,658 | 24,249 | 24,855 | 25,477 | 26,114 | 26,767 | 27,436 | 28,122 | 28,825 | 29,545 | 30,284 | 31,041 | 31,817 | 32,612 | |
| - Building Maintenance (water, heat, misc repairs) | | 2,500 | 2,563 | 2,627 | 2,692 | 2,760 | 2,829 | 2,899 | 2,972 | 3,046 | 3,122 | 3,200 | 3,280 | 3,362 | 3,446 | 3,532 | 3,621 | 3,711 | 3,804 | 3,899 | 3,997 | |
| - City Central Cost Allocation | | 7,500 | 7,688 | 7,880 | 8,077 | 8,279 | 8,486 | 8,698 | 8,915 | 9,138 | 9,366 | 9,601 | 9,841 | 10,087 | 10,339 | 10,597 | 10,862 | 11,134 | 11,412 | 11,697 | 11,990 | |
| - External Maintenance | | 12,500 | 12,813 | 13,133 | 13,461 | 13,798 | 14,143 | 14,496 | 14,859 | 15,230 | 15,611 | 16,001 | 16,401 | 16,811 | 17,231 | 17,662 | 18,104 | 18,556 | 19,020 | 19,496 | 19,983 | |
| Long Term Equipment Replacement | | -25,000 | -25,625 | -26,266 | -26,922 | -27,595 | -28,285 | -28,992 | -29,717 | -30,460 | -31,222 | -32,002 | -32,802 | -33,622 | -34,463 | -35,324 | -36,207 | -37,113 | -38,040 | -38,991 | -39,966 | |
| - Long Term Equipment Replacement | | 25,000 | 25,625 | 26,266 | 26,922 | 27,595 | 28,285 | 28,992 | 29,717 | 30,460 | 31,222 | 32,002 | 32,802 | 33,622 | 34,463 | 35,324 | 36,207 | 37,113 | 38,040 | 38,991 | 39,966 | |
| Other variable costs | | | | | | | | | | | | | | | | | | | | | | |
| **Gross margin** | **0** | **762,850** | **775,785** | **788,978** | **802,434** | **816,158** | **830,154** | **844,427** | **858,983** | **873,826** | **888,962** | **904,395** | **920,131** | **936,176** | **952,535** | **969,212** | **986,215** | **1,003,547** | **1,021,216** | **1,039,226** | **1,057,584** | **0** |
| (cumulative financial year) | | 762,850 | 775,785 | 788,978 | 802,434 | 816,158 | 830,154 | 844,427 | 858,983 | 873,826 | 888,962 | 904,395 | 920,131 | 936,176 | 952,535 | 969,212 | 986,215 | 1,003,547 | 1,021,216 | 1,039,226 | 1,057,584 | |
| % (cumulative financial year) | | 45.4% | 45.2% | 45.0% | 44.8% | 44.6% | 44.4% | 44.2% | 44.0% | 43.8% | 43.6% | 43.4% | 43.2% | 43.0% | 42.8% | 42.6% | 42.4% | 42.2% | 42.0% | 41.8% | 41.6% | |
| Fixed costs | 0 | -275,000 | -281,875 | -288,922 | -296,145 | -303,549 | -311,137 | -318,916 | -326,889 | -335,061 | -343,437 | -352,023 | -360,824 | -369,844 | -379,091 | -388,568 | -398,282 | -408,239 | -418,445 | -428,906 | -439,629 | 0 |
| Staff costs | | -275,000 | -281,875 | -288,922 | -296,145 | -303,549 | -311,137 | -318,916 | -326,889 | -335,061 | -343,437 | -352,023 | -360,824 | -369,844 | -379,091 | -388,568 | -398,282 | -408,239 | -418,445 | -428,906 | -439,629 | |
| - Admin (25% utilization) | | 30,000 | 30,750 | 31,519 | 32,307 | 33,114 | 33,942 | 34,791 | 35,661 | 36,552 | 37,466 | 38,403 | 39,363 | 40,347 | 41,355 | 42,389 | 43,449 | 44,535 | 45,649 | 46,790 | 47,960 | |
| - Manager (20% utilization) | | 50,000 | 51,250 | 52,531 | 53,845 | 55,191 | 56,570 | 57,985 | 59,434 | 60,920 | 62,443 | 64,004 | 65,604 | 67,244 | 68,926 | 70,649 | 72,415 | 74,225 | 76,081 | 77,983 | 79,933 | |
| - Operator | | 78,000 | 79,950 | 81,949 | 83,997 | 86,097 | 88,250 | 90,456 | 92,717 | 95,035 | 97,411 | 99,847 | 102,343 | 104,901 | 107,524 | 110,212 | 112,967 | 115,791 | 118,686 | 121,653 | 124,695 | |
| - Operator | | 78,000 | 79,950 | 81,949 | 83,997 | 86,097 | 88,250 | 90,456 | 92,717 | 95,035 | 97,411 | 99,847 | 102,343 | 104,901 | 107,524 | 110,212 | 112,967 | 115,791 | 118,686 | 121,653 | 124,695 | |
| - Mechanic (50% utilization) | | 39,000 | 39,975 | 40,974 | 41,999 | 43,049 | 44,125 | 45,228 | 46,359 | 47,518 | 48,706 | 49,923 | 51,171 | 52,451 | 53,762 | 55,106 | 56,484 | 57,896 | 59,343 | 60,827 | 62,347 | |
| Rents | | | | | | | | | | | | | | | | | | | | | | |
| Other fixed costs | | | | | | | | | | | | | | | | | | | | | | |
| Provisions, increase (-) / decrease (+) | | | | | | | | | | | | | | | | | | | | | | |
| **EBITDA; Operating income before depreciation** | **0** | **487,850** | **493,910** | **500,056** | **506,289** | **512,609** | **519,016** | **525,511** | **532,094** | **538,765** | **545,524** | **552,372** | **559,308** | **566,332** | **573,444** | **580,645** | **587,933** | **595,308** | **602,771** | **610,320** | **617,955** | **0** |
| (cumulative financial year) | | 487,850 | 493,910 | 500,056 | 506,289 | 512,609 | 519,016 | 525,511 | 532,094 | 538,765 | 545,524 | 552,372 | 559,308 | 566,332 | 573,444 | 580,645 | 587,933 | 595,308 | 602,771 | 610,320 | 617,955 | |
| % (cumulative financial year) | | 29.0% | 28.8% | 28.5% | 28.3% | 28.0% | 27.7% | 27.5% | 27.2% | 27.0% | 26.7% | 26.5% | 26.2% | 26.0% | 25.8% | 25.5% | 25.3% | 25.0% | 24.8% | 24.6% | 24.3% | |
| Depreciation | 0 | -587,936 | -587,936 | -587,936 | -587,936 | -587,936 | -587,936 | -587,936 | -315,896 | -270,556 | -270,556 | -270,556 | -270,556 | -270,556 | -270,556 | -77,302 | 0 | 0 | 0 | 0 | 0 | 0 |
| **EBIT; Operating income** | **0** | **-100,086** | **-94,025** | **-87,879** | **-81,646** | **-75,326** | **-68,919** | **-62,424** | **216,199** | **268,210** | **274,969** | **281,816** | **288,752** | **295,776** | **302,889** | **503,343** | **587,933** | **595,308** | **602,771** | **610,320** | **617,955** | **0** |
| (cumulative financial year) | 0 | -100,086 | -94,025 | -87,879 | -81,646 | -75,326 | -68,919 | -62,424 | 216,199 | 268,210 | 274,969 | 281,816 | 288,752 | 295,776 | 302,889 | 503,343 | 587,933 | 595,308 | 602,771 | 610,320 | 617,955 | |
| % (cumulative financial year) | | -6.0% | -5.5% | -5.0% | -4.6% | -4.1% | -3.7% | -3.3% | 11.1% | 13.5% | 13.5% | 13.4% | 13.5% | 13.6% | 13.6% | 22.1% | 25.3% | 25.0% | 24.8% | 24.6% | 24.3% | |
| Financing income and expenses | 0 | -227,500 | -216,125 | -204,750 | -193,375 | -182,000 | -170,625 | -159,250 | -147,875 | -136,500 | -125,125 | -113,750 | -102,375 | -91,000 | -79,625 | -68,250 | -56,875 | -45,500 | -34,125 | -22,750 | -11,375 | 0 |
| Financing income and expenses | 0 | -227,500 | -216,125 | -204,750 | -193,375 | -182,000 | -170,625 | -159,250 | -147,875 | -136,500 | -125,125 | -113,750 | -102,375 | -91,000 | -79,625 | -68,250 | -56,875 | -45,500 | -34,125 | -22,750 | -11,375 | |
| Interest Rate | | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | 3.50% | |
| - Interest, $/A | | 227,500 | 216,125 | 204,750 | 193,375 | 182,000 | 170,625 | 159,250 | 147,875 | 136,500 | 125,125 | 113,750 | 102,375 | 91,000 | 79,625 | 68,250 | 56,875 | 45,500 | 34,125 | 22,750 | 11,375 | |
| **EBT; Income after financing items** | **0** | **-327,586** | **-310,151** | **-292,629** | **-275,021** | **-257,326** | **-239,544** | **-221,674** | **68,324** | **131,709** | **149,844** | **168,066** | **186,377** | **204,776** | **223,264** | **435,093** | **531,058** | **549,808** | **568,646** | **587,570** | **606,580** | **0** |
| Extraordinary income and charges | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Realization profit (-loss) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other extraordinary income (-charges ) | | | | | | | | | | | | | | | | | | | | | | |
| **Income before appropriations and taxes** | **0** | **-327,586** | **-310,151** | **-292,629** | **-275,021** | **-257,326** | **-239,544** | **-221,674** | **68,324** | **131,709** | **149,844** | **168,066** | **186,377** | **204,776** | **223,264** | **435,093** | **531,058** | **549,808** | **568,646** | **587,570** | **606,580** | **0** |
| Change in appropriations | | | | | | | | | | | | | | | | | | | | | | |
| Appropriations, increase (-) / decrease (+) | | | | | | | | | | | | | | | | | | | | | | |
| Income tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deferred tax | | | | | | | | | | | | | | | | | | | | | | |
| Minority interest | | | | | | | | | | | | | | | | | | | | | | |
| **Net income for the period** | **0** | **-327,586** | **-310,151** | **-292,629** | **-275,021** | **-257,326** | **-239,544** | **-221,674** | **68,324** | **131,709** | **149,844** | **168,066** | **186,377** | **204,776** | **223,264** | **435,093** | **531,058** | **549,808** | **568,646** | **587,570** | **606,580** | **0** |
| (cumulative financial year) | 0 | -327,586 | -310,151 | -292,629 | -275,021 | -257,326 | -239,544 | -221,674 | 68,324 | 131,709 | 149,844 | 168,066 | 186,377 | 204,776 | 223,264 | 435,093 | 531,058 | 549,808 | 568,646 | 587,570 | 606,580 | 606,580 |
| % (cumulative financial year) | | -19.5% | -18.1% | -16.7% | -15.3% | -14.1% | -12.8% | -11.6% | 3.5% | 6.6% | 7.3% | 8.1% | 8.7% | 9.4% | 10.0% | 19.1% | 22.8% | 23.1% | 23.4% | 23.6% | 23.9% | |
| **Return on net assets (RONA), %** | | **-1.7 %** | **-1.8 %** | **-1.9 %** | **-2.0 %** | **-2.2 %** | **-2.4 %** | **-2.7 %** | **11.6 %** | **17.1 %** | **21.2 %** | **27.5 %** | **38.3 %** | **61.2 %** | **142.5 %** | **1302.3 %** | - | - | - | - | - | |
| **Economic Value Added (EVA)** | | **-222,686** | **-204,279** | **-185,786** | **-167,207** | **-148,540** | **-129,786** | **-110,945** | **177,168** | **235,337** | **247,778** | **260,307** | **272,925** | **285,630** | **298,425** | **502,531** | **587,933** | **595,308** | **602,771** | **610,320** | **617,955** | **0** |

**WORKING CAPITAL**

| USD | 1/2016 | 12/2016 | 12/2017 | 12/2018 | 12/2019 | 12/2020 | 12/2021 | 12/2022 | 12/2023 | 12/2024 | 12/2025 | 12/2026 | 12/2027 | 12/2028 | 12/2029 | 12/2030 | 12/2031 | 12/2032 | 12/2033 | 12/2034 | 12/2035 | Residual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Change in working capital** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| Net working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**CASH FLOW STATEMENT**

| USD | 1/2016 | 12/2016 | 12/2017 | 12/2018 | 12/2019 | 12/2020 | 12/2021 | 12/2022 | 12/2023 | 12/2024 | 12/2025 | 12/2026 | 12/2027 | 12/2028 | 12/2029 | 12/2030 | 12/2031 | 12/2032 | 12/2033 | 12/2034 | 12/2035 | Residual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months per interval | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | (12/2035) |
| Cash flow from operations | | | | | | | | | | | | | | | | | | | | | | |
| Income | 0 | 1,680,259 | 1,716,635 | 1,753,875 | 1,792,000 | 1,831,031 | 1,870,991 | 1,911,901 | 1,953,784 | 1,996,663 | 2,040,563 | 2,085,507 | 2,131,522 | 2,178,632 | 2,226,864 | 2,276,245 | 2,326,802 | 2,378,564 | 2,431,560 | 2,485,818 | 2,541,370 | 0 |
| Variable costs | 0 | -917,409 | -940,850 | -964,896 | -989,565 | -1,014,873 | -1,040,837 | -1,067,473 | -1,094,801 | -1,122,837 | -1,151,601 | -1,181,112 | -1,211,391 | -1,242,456 | -1,274,330 | -1,307,033 | -1,340,588 | -1,375,017 | -1,410,344 | -1,446,592 | -1,483,787 | 0 |
| Fixed costs | 0 | -275,000 | -281,875 | -288,922 | -296,145 | -303,549 | -311,137 | -318,916 | -326,889 | -335,061 | -343,437 | -352,023 | -360,824 | -369,844 | -379,091 | -388,568 | -398,282 | -408,239 | -418,445 | -428,906 | -439,629 | 0 |
| Extraordinary income & expenses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Income tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Change in working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Cash flow from operations** | **0** | **487,850** | **493,910** | **500,056** | **506,289** | **512,609** | **519,016** | **525,511** | **532,094** | **538,765** | **545,524** | **552,372** | **559,308** | **566,332** | **573,444** | **580,645** | **587,933** | **595,308** | **602,771** | **610,320** | **617,955** | **0** |
| Asset investments and realizations | -6,132,079 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Free cash flow (FCF)** | **-6,132,079** | **487,850** | **493,910** | **500,056** | **506,289** | **512,609** | **519,016** | **525,511** | **532,094** | **538,765** | **545,524** | **552,372** | **559,308** | **566,332** | **573,444** | **580,645** | **587,933** | **595,308** | **602,771** | **610,320** | **617,955** | **0** |
| Discounted free cash flow (DFCF) | -6,132,079 | 477,816 | 473,801 | 469,831 | 465,903 | 462,017 | 458,170 | 454,362 | 450,591 | 446,856 | 443,156 | 439,489 | 435,855 | 432,251 | 428,678 | 425,132 | 421,615 | 418,123 | 414,657 | 411,215 | 407,795 | 0 |
| Cumulative discounted free cash flow | -6,132,079 | -5,654,263 | -5,180,462 | -4,710,631 | -4,244,727 | -3,782,711 | -3,324,541 | -2,870,179 | -2,419,588 | -1,972,731 | -1,529,575 | -1,090,086 | -654,231 | -221,980 | 206,698 | 631,830 | 1,053,445 | 1,471,568 | 1,886,225 | 2,297,440 | 2,705,235 | 2,705,235 |
| Information | | | | | | | | | | | | | | | | | | | | | | |
| Financial cash flow | | | | | | | | | | | | | | | | | | | | | | |
| Financial income and expenses | 0 | -227,500 | -216,125 | -204,750 | -193,375 | -182,000 | -170,625 | -159,250 | -147,875 | -136,500 | -125,125 | -113,750 | -102,375 | -91,000 | -79,625 | -68,250 | -56,875 | -45,500 | -34,125 | -22,750 | -11,375 | 0 |
| Correction of income tax for financial items | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long-term debt, increase (+) / decrease (-) | 0 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | 0 |
| Changes in interest-bearing long-term debt | 0 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | 0 |
| Long-term debt, increase (+) / decrease (-) | 0 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | -325,000 | |
| Long Term Debt | 6,132,079 | 6,500,004 | 6,175,004 | 5,850,003 | 5,525,003 | 5,200,003 | 4,875,003 | 4,550,003 | 4,225,002 | 3,900,002 | 3,575,002 | 3,250,002 | 2,925,002 | 2,600,001 | 2,275,001 | 1,950,001 | 1,625,001 | 1,300,001 | 975,001 | 650,000 | 325,000 | |
| - Amortization (15 years) | | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | 325,000 | |
| Interest Over Contruction | 367,925 | | | | | | | | | | | | | | | | | | | | | |
| Remianing Long Term Debt | | 6,175,004 | 5,850,003 | 5,525,003 | 5,200,003 | 4,875,003 | 4,550,003 | 4,225,002 | 3,900,002 | 3,575,002 | 3,250,002 | 2,925,002 | 2,600,001 | 2,275,001 | 1,950,001 | 1,625,001 | 1,300,001 | 975,001 | 650,000 | 325,000 | 0 | |
| Changes in interest-free long-term debt | | | | | | | | | | | | | | | | | | | | | | |
| Changes in short-term borrowings | | | | | | | | | | | | | | | | | | | | | | |
| Equity, increase (+) / decrease (-) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total cash flow** | **-6,132,079** | **-64,650** | **-47,215** | **-29,694** | **-12,086** | **5,609** | **23,391** | **41,261** | **59,219** | **77,265** | **95,399** | **113,622** | **131,932** | **150,332** | **168,819** | **187,394** | **206,058** | **224,808** | **243,646** | **262,570** | **281,580** | **0** |