TETRA TECH

Consultant Engineering Services
Detailed Assessment Report
Kingston Biosolids and Biogas Master Plan

PRESENTED TO
Utilities Kingston

JULY 2019
ISSUED FOR USE
FILE: 704-SWM.SWOP03442-01

Tetra Tech Canada Inc.
Suite 201 – 111 Farquhar Street
Guelph, ON N1H 3N4 CANADA
Tel 519.803.3042

This page intentionally left blank.

EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) was originally tasked to investigate the potential of utilizing the current assets of Utilities Kingston (UK) to produce Renewable Natural Gas that could then be used to reduce the carbon footprint of the City of Kingston. This report is a follow-up to the "Preliminary Assessment Report," which was used to outline options that could be implemented, and was followed up with a selection of the most viable set of options.

The work was initially triggered by UK's interest to identify alternative systems to: manage biosolids and enhance biogas production, review the alternative sites best suited to undertake the enhancements, and identify the best options (and investment needed to implement the options).

At the outset of the study, the provincial government was promoting two initiatives that impacted this study, namely Cap and Trade and Zero Waste. With the change in government the Cap and Trade regulation has been eliminated and government initiatives regarding waste management are in the preliminary policy stage.

These changes impacted the study, the outcomes are outlined below.

The Detailed Study has included the following steps:

1. A review of the current operations including technologies used and throughput.
2. A review of six options plus the inclusion of dewatering. These are:
   - Do Nothing. – Status quo with upgraded digesters at Catarqui Bay.
   - Option 2A – Expansion of the existing Mesophilic Anaerobic Digestion (MAD) process with capability to operate in Temperature Phased Anaerobic Digestion (TPAD) undertaken at Cataraqui Bay.
   - Option 2B – Expansion of the existing MAD process with the inclusion of Biological Hydrolysis (BH) upfront of MAD undertaken at Cataraqui Bay.
   - Digestion undertaken with BH at Ravensview.
   - Inclusion of Source-Separated Organics (SSO) undertaken with 2B (above).
   - The construction of a new Digestion Facility at Knox Farms (or another City location).

The resultant review of options, both from a technical and financial perspective were:

- Option 2B, Biological Hydrolysis (BH) is recommended regardless of its location (Cataraqui Bay, Ravensview, or another location).
- RNG injection to pipeline is recommended over increased electrical production or Compressed Natural Gas (CNG) as the carbon premium is significantly higher in value.
- Cataraqui Bay is favoured over Ravensview since the summer natural gas consumption downstream of Ravensview is significantly lower than what will be generated.
- Dewatering is recommended for any of the selected sites.
- When comparing upgrading the Cataraqui Bay digesters, the selection of an alternative site is considered equal in terms of financial value.

- The addition of SSO is highly viable in combination with BH with the current waste flow generated from the City of Kingston. Further addition of waste organics increases the financial payback.
- In-house trucking of sludge is recommended to decrease the haulage cost.
- It is highly recommended that UK pursue federal or provincial grant programs as funding from these senior levels of government would have significant impact on the financial viability of the respective options.

In all cases, Tetra Tech recommends that UK start initial talks/negotiations with potential purchasers of the RNG to establish the best possible prices. As part of the Master Plan process UK also needs to proceed with stakeholder engagement to ensure that the public has input in the future direction of UK.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1.0 INTRODUCTION 1
1.1 Project Background 1
1.2 Detailed Assessment Approach and Methodology 2

2.0 DESCRIPTION OF EXISTING CONDITIONS 3
2.1 The Study Area 3
2.1.1 Cataraqui Bay Wastewater Treatment Plant 3
2.1.2 The Ravensview Waste Water Treatment Plant 6
2.1.3 The Cana Wastewater Treatment Plant 7
2.2 Existing Biosolids Management Processes 7
2.2.1 Biosolids Characteristics, Quantities and Projections 7
2.2.2 Existing Biosolids Treatment Capacity 14
2.2.3 Biosolids Storage Requirements 15
2.3 Existing Biogas Management Processes 16
2.3.1 Biogas Characteristics, Quantities and Projections 16
2.3.2 Existing Biogas Treatment Capacity 17
2.4 Pre-Selected Treatment Technologies 18
2.4.1 PSA 18
2.4.2 Membrane Separation 19
2.4.3 Water Wash/Scrubbing 20
2.4.4 Amine Scrubbing 21
2.4.5 Recommended Process 21
2.5 End-Use 21

3.0 ALTERNATIVE BIOSOLIDS AND BIOGAS MANAGEMENT OPTIONS 23
3.1 Option 1 – Do Nothing 23
3.1.1 Description of Alternative 23
3.1.2 Impact on Existing Facilities 24
3.1.3 Cost Analysis 25
3.2 Option 2 – Optimize Infrastructure at Cataraqui Bay 26
3.2.1 Description of Alternative 26
3.2.2 Impact on Existing Facilities 28
3.2.3 Cost Analysis 31
3.3 Option 3 – Optimize Infrastructure at Ravensview 31
3.3.1 Description of Alternative 31
3.3.2 Impact on Existing Facilities 32
3.3.3 Cost Analysis 34
3.4 Option 4 – Incorporate SSO at Cataraqui Bay 34
3.4.1 Description of Alternative 34
3.4.2 Impact on Existing Facilities 35
3.4.3 Cost Analysis 39
3.5 Option 5 – Integrate Processing of Biosolids and SSO at Knox Farms 39

3.5.1 Description of Alternative 39
3.5.2 Impact on Existing Facilities 40
3.5.3 Cost Analysis 43

4.0 FINANCIAL ANALYSIS OF ALTERNATIVES 44
4.1 Alternative Biogas Utilization Options 44
4.2 Analysis of Other Options 45

5.0 CONCLUSIONS AND RECOMMENDATIONS 45
5.1 The Next Steps 46

6.0 CLOSURE 47

LIST OF TABLES IN TEXT

Table 1-1:Further Investigated Technologies 2
Table 2-1: Existing and Upgraded Treatment Technology 3
Table 2-2 Cataraqui Bay and Ravensview WWTP Biosolids Characteristics 8
Table 2-3 Cataraqui Bay and Ravensview WWTP Biosolids Metal Content as Compared to NMA Standards 9
Table 2-4 Cataraqui Bay WWTP and Ravensview WWTP Biosolids Pathogen Content as Compared to NMA Standards 9
Table 2-5 Historical Annual Effluent and Biosolids Quantities in Cataraqui Bay WWTP (2015 – 2017) 10
Table 2-6 Historical Annual Effluent and Biosolids Quantities in Ravensview WWTP (2015 – 2017) ... 10
Table 2-7 Projected Annual Biosolids Production in Cataraqui Bay WWTP up to Year 2037 11
Table 2-8 Projected Annual Biosolids Production in Ravensview WWTP up to Year 2037 13
Table 2-9 Total Annual Biosolids Production in Year 2037 14
Table 2-10 Biosolid Process Design Parameters in Cataraqui Bay WWTP 14
Table 2-11 Biosolid Process Design Parameters in Ravensview WWTP 15
Table 2-12 Biosolids Storage Requirements in Year 2037 15
Table 2-13 On-site biosolids storage capacities at Cataraqui Bay and Ravensivew 16
Table 2-14, Potential Range for Purchase Agreements 22
Table 3-1 Estimated Biosolids Production and Biogas Generation in the Year 2037 24
Table 3-2 Estimated Biosolid and Biogas Production for Options 2A and 2B 29
Table 3-3 Transportation and Footprint Requirements for Option 2A and 2B 30
Table 3-4 Impact on Biosolid Production and Biogas Generation of Option 3 32
Table 3-5 Transportation and Footprint Requirements for Option 3 33
Table 3-6 Impact on Biosolid Production and Biogas Generation 36
Table 3-7 Transportation and Footprint Requirements for Option 4 38
Table 3-8: Change in NPV 39
Table 3-10: Impact on Biosolid Production and Biogas Generation of Option 5 41
Table 3-11: Transportation and Footprint Requirements for Option 5 43
Table 3-12: Comparing 2B with SSO with Knox Farms with SSO Results 43
Table 3-13: Comparison with the Stand Alone 2B Option with and without SSO 44
Table 4-1: Different Generation Rates 44
Table 4-2: Different Generation Rates (SSO with Option 2B) 44
Table 4-3: NPV Results (Electricity Produced) 44

LIST OF FIGURES IN TEXT

Figure 2-1: Upgraded Cataraqui Bay Treatment Flow Diagram 6
Figure 2-2: Ravensview Waste Water Treatment Flow Diagram 6
Figure 2-3 Projected Biosolids Production in Cataraqui Bay WWTP up to Year 2037 12
Figure 2-4 Projected Biosolids Production in Ravensview WWTP to Year 2037 13
Figure 2-5: Ravensview Digester Gas Production 16
Figure 2-6: Cataraqui Bay Digester Gas Production 17
Figure 2-7: Biogas Treatment Technologies 18

Figure 2-8: Pressure Swing Adsorption 19
Figure 2-9: Membrane Separation 19
Figure 2-10: Water Wash 20
Figure 2-11: Amine Scrubbing 21
Figure 3-1 Existing Solid Treatment Process at Cataraqui Bay WWTP 23
Figure 3-2 Existing Solid Treatment Process at Ravensview WWTP 23
Figure 3-3 Upgrades to TPAD at Cataraqui Bay WWTP 27
Figure 3-4 Upgrades with Addition of BHP at Cataraqui Bay WWTP 28
Figure 3-5 Upgrades of TPAD Process with Addition of BH system at Ravensview WWTP 32
Figure 3-6 Incorporate SSO in Cataraqui Bay WWTP 35
Figure 3-7 SSO Resource Recovery and Co-digestion Process at Knox Farm 40
Figure 3-8 Flow chart - Options for Biosolids Residual Management at Knox Farm 42

APPENDIX SECTIONS

TABLES

Table 1 Master Plan Equipment Costs

ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
BAF	Biologically Aerated Filter
BH	Biological Hydrolysis
BH-AD	Biological Hydrolysis-Anaerobic Digestion
CAS	Conventional Activated Sludge
Cataraqui Bay	Cataraqui Bay Wastewater Treatment Plant
CFU	Colony-Forming Units
CH4	Methane
City	City Of Kingston
CM2	Regulated metal content of a NASM exceeds that of CM1 NASM but does not exceed the concentration set out in Table 2 for aqueous or non-aqueous CM2 material, whichever applies
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
CP1	Pathogen-based category based on Origin, typically based on NASM Categories 1 and 2
CP2	Pathogen based classification defined as NASM Category 3 which includes sewage biosolids
EA	Environmental Assessment
H2S	Hydrogen Sulfide
HRT	Hydraulic Retention Time
L&Y	Leaf And Yard Waste
MAD	Mesophilic Anaerobic Digestion
MEA	Municipal Engineers Association
MECP	Ministry Of Environment, Conservation, and Parks
MOP 8	Maximum Operating Pressure
N and N2	Nitrogen
NASM	Non-Agricultural Source Materials
NMA	Ontario Nutrient Management Act
O.Reg.	Ontario Regulation
O2	Oxygen
P	Phosphorous
PSA	Pressure Swing Adsorption
Ravensview	Ravensview Wastewaster Treatment Plant

Acronyms/Abbreviations	Definition
RDT	Rotary Drum Thickeners
RNG	Renewable Natural Gas
SSO	Source-Separated Organics
TAD	Thermophillic Anaerobic Digestion
TPAD	Temperature-Phased Anaerobic Digestion
TS	Total Solids
UK	Utilities Kingston
VS	Volatile Solids
VSD	Volatile Sludge Destruction
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Utilities Kingston and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Utilities Kingston, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

1.1 Project Background

Tetra Tech Canada Inc. (Tetra Tech) was retained by Utilities Kingston (UK) to undertake the review and assessment of options, or strategies, for enhancing biogas generation and managing biosolids production at the Ravensview and Cataraqui Bay wastewater treatment plants (WWTPs) in Kingston, Ontario. UK is a multi-utility provider that is wholly owned by the City of Kingston (the City). The purpose of the assignment is to develop a long-term, environmentally sustainable and cost effective biosolids management program that responds to current and future program challenges. Since this would entail establishing a strategy comprised of integrated systems at, potentially, multiple facilities and locations, UK decided that the study would proceed as a Master Plan conducted in accordance with the requirements of the Municipal Engineers Association (MEA) Class Environmental Assessment (Class EA) document.

Given developments in Ontario regarding: the consideration of wastes as resources within the context of a circular economy; the more effective management of source-separated organics (SSO) with the objective of eliminating the landfilling of these materials and the identification of opportunities for the generation and utilization of renewable natural gas (RNG), UK defined the scope of the study to include alternative systems that would entail the co-digestion of biosolids and SSO collected by the City. In addition, and further to the interest in considering co-digestion systems, UK identified the Knox Farm property as a prospective centralized location which would accept raw feedstocks, i.e., wastewater sludge from the two WWTPs, as well as SSO and leaf and yard (L&Y) waste, transported from the two WWTPs and via SSO and L&Y waste collection vehicles from sources within the City of Kingston.

The study is comprised of three components. The first entailed the completion of a preliminary assessment of alternative technologies and processes to identify a short list for further investigation. The second component has entailed the completion of a detailed assessment of the short-listed technologies and processes, including a financial feasibility evaluation of biogas utilization. This second component is the subject of this report. The third component will entail the completion of the Master Plan in compliance with the MEA Class EA requirements and will be undertaken subject to the results of the Detailed Assessment.

The analytical work undertaken by Tetra Tech in Component 1 of the Study (the Preliminary Assessment) comprised:

- The review and documentation of the existing operations at the Ravensview and Cataraqui Bay WWTPs.
- A comparative evaluation of relative “advantages” and “disadvantages” of technologies and processes associated with the pre-treatment, treatment, stabilization, and management of biosolids together with the co-digestion of biosolids and SSO. This entailed an evaluation of alternatives in the following categories:
  - *Sludge pre-treatment* including: thickening; hydrolysis; conditioning. and stabilization.
  - *Solids stabilization* including: digestion, co-digestion, post-treatment/composting, chemical stabilization; and thermal stabilization.
  - *Biogas utilization* including: on-site combined heat and power; boilers; vehicle fuel station(s); local or regional natural gas pipeline injection, and fuel cell technology.
  - *Dewatering* including: centrifuge, belt-filter press, drying beds, rotary vacuum filters, and enhanced solar.

  - *Side-stream treatment* including the struvite recovery and ANAMMOX recovery processes.
  - *Biosolids management* including: land application, landfill, and utilization as construction material.
- Identification of a recommended "short list" of alternative technologies/systems for more-detailed assessment.

The results of this work were documented in the Preliminary Assessment Report Issued for Use in April 2018, which identified the following field of technologies to be further investigated:

Table 1-1:Further Investigated Technologies

Categories	Technologies
Sludge Pre-Treatment	1. Thickening 2. Biological Hydrolysis
Solids Stabilization	3. Anaerobic Digestion 4. Co-digestion at Ravensview (including SSO) 5. Co-digestion at Cataraqui Bay (including SSO)
Biogas Utilization	6. Microturbines 7. Reciprocating Engines 8. On-Site Boiler 9. Off-Site Vehicle Fueling
Dewatering	10. Centrifuge 11. Belt-Filter Press
Biosolids Management	12. Cake/Slurry Land Application

The results of the second study component, the Detailed Assessment of technologies and processes, are documented in this report.

1.2 Detailed Assessment Approach and Methodology

The scope of the work undertaken for the subject Detailed Assessment included:

- Evaluation of existing wastewater treatment facility data including plant capacity, population served, annual influent and treated effluent, natural gas consumption, biogas generated, and electricity consumption.
- Scenario development of options for improving biogas generation and quality, while decreasing biosolids management requirements for UK.
- Overview of potential end-use options for biogas and biosolids.
- Business case development and cost benefit analysis for each developed scenario.
- Review of funding opportunities available to UK.

The outcome of this Detailed Assessment is to develop a framework for a UK Master Plan. Key factors for success include determining viable end-use options for biogas and biosolids based on current market and incentive programs, as well as cost benefit analysis for capital and operating expenditures.

2.0 DESCRIPTION OF EXISTING CONDITIONS

2.1 The Study Area

The City of Kingston is located on the eastern side of Lake Ontario and is home to 161,175 residents in the metropolitan area with 123,798 residents within the city, according to the 2016 Census. The city's wastewater collection system is split among three regions and services an approximate area of 8,300 ha. The three regions include Kingston West, Kingston Central, and Kingston East with an estimated 90% of the population evenly divided between Kingston West and Kingston Central.

2.1.1 Cataraqui Bay Wastewater Treatment Plant

The Cataraqui Bay WWTP located at 409 Front Street was constructed in 1962. The facility was upgraded in 2002 and is currently undergoing a major expansion to increase plant capacity, improve the quality of treated wastewater and upgrade equipment. Cataraqui Bay receives wastewater, sanitary and extraneous flow from the Kingston West region. The system operates under Environmental Compliance Approval (ECA) Number 2144-87TJYB.

The upgrades currently under construction at the site will increase capacity from 38,800 to 55,000 m^3 per day. This expansion is expected to be completed by 2020 and is based on the outcome of the revised Sewage Infrastructure Master Plan finalized in 2010. The upgrade work includes an expansion of the plant's headworks and primary clarifiers, replacement of the secondary treatment system, electrical and instrumentation upgrades, and site-wide building and process improvements.

The four-year construction project began in October 2016.

The upgrades include:

- Phase 1: Increasing the plant's wastewater treatment capacity from the current 38,800 m^3 per day to 55,000 m^3 per day (average flow), which Includes the redirection of the King-Portsmouth Pumping Station to the Cataraqui Bay WWTP by 2020.
- Phase 2: Increasing the Plant's wastewater treatment capacity to 68,000 m^3 per day (average flow). Projected to be online by 2036.

Table 2-1: Existing and Upgraded Treatment Technology

Treatment Component		Existing	Upgraded
Liquids Train Technology	**Preliminary Treatment**	Preliminary treatment consists of two manually-cleaned aerated grit tanks, followed by two mechanically-cleaned bar screens (bar screens will be replaced by perforated plate fine screens).	The two steps of the existing process will be reversed so that screening will occur before grit removal.
	Primary Treatment	Influent enters primary settling tanks. Primary effluent passes through aeration tanks.	Primary treatment tanks will be extended into the aeration tanks to allow for the additional hydraulic and treatment capacity. Performance will be enhanced through chemically enhanced primary treatment.

Treatment Component		Existing	Upgraded
	Secondary Treatment	Influent passes into secondary clarifiers where it is treated through a conventional activated sludge (CAS) process. Secondary sludge is combined with primary effluent and is aerated to promote biological growth before being passed through a final clarifier to remove sludge.	Primary effluent will be directed to the biologically aerated filter (BAF) system. The BAF process uses submerged media and aeration to promote the growth of biomass in order to achieve BOD removal, TSS removal, and nitrification. The BAF facility also has a chemical treatment system for alkalinity adjustment.
	Disinfection	Secondary effluent passes into a chlorine contact tank, where chlorine is added to the water. Residual chlorine is removed through a dechlorination system before discharge.	Two existing secondary clarifiers will be converted into chlorine contact tanks.
	Dechlorination	Calcium thiosulfate is injected into the plant effluent water downstream of the chlorine contact tank to dechlorinate.	A new dechlorination room will be constructed, however, the process will stay the same.
Solids Train Technology	**Sludge Thickening**	The solids train consists of rotary drum thickeners, anaerobic digesters, sludge holding tanks, dewatering centrifuges, open sludge drying bed, and an open biosolids storage pad. Waste activated secondary sludge is pumped to the Rotary Drum Thickeners RDT) before being pumped to the digesters.	The following processes will be used: ▪ Dedicated thickening process using a gravity thickener. ▪ Co-thickening of the backwash residuals (back-up operation). Two gravity thickener tanks will be retrofitted from the existing secondary clarifiers. Existing secondary clarifiers will be offline so there will be no secondary sludge. Backwash residuals from the BAF process will be thickened using two gravity thickeners retrofitted from two existing secondary clarifiers. Thickened BAF backwash resduals will be pumped to the two existing RDTs before being sent to the digesters. During certain periods of time of construction, the BAF will be online and the RDTs will be offline for electrical upgrades. During this time period the BAF backwash residuals will be co-thickened.
	Anaerobic Digestion	Sludge is anaerobically digested.	Sludge is anaerobically digested. Digester expansion, which was originally recommended in the 2012 Class EA, will be deferred, as the existing digesters have capacity for short-term needs. New digestion capacity is not expected to be needed until 2029. Upgrades to the existing digester mixing systems and heat exchangers will be deferred form upgrades to coincide with a future digester cleanout, re-gas proofing and re-roofing project.
Dewatering and Biosolids Storage	**Dewatering**	Biosolids are dewatered using centrifuges and a biosolids drying bed.	A new Dewatering and Biosolids Storage Facility will be constructed. Digested sludge will be pumped to the new centrifuges by new rotary lobe sludge transfer pumps.
	Biosolids Storage	Dewatered biosolids are stored onsite at the sludge storage pad when land application is not permitted.	The new facility will store dewatered cake in two buildings and will have capacity for 240 days of biosolids cake storage.

Treatment Component		Existing	Upgraded
			The new biosolids cake storage facility (similar to Ravensview WWTP) will be constructed. A key difference from the Ravensview WWTP is that the cake will be moved by gravity, not pumped. This will result in a different consistency than is currently seen at Ravensview.
Digester Gas Utilization		Currently, digester gas is collected from each digester and the sludge holding tank, is compressed, and injected back into the digester for mixing. Excess gas is either routed to the boilers or to the waste gas flare.	The existing mixing system and waste flare system will remain unchanged. A new digester gas booster will be provided to boost the digester gas pressure to the boilers at the BAF facility.

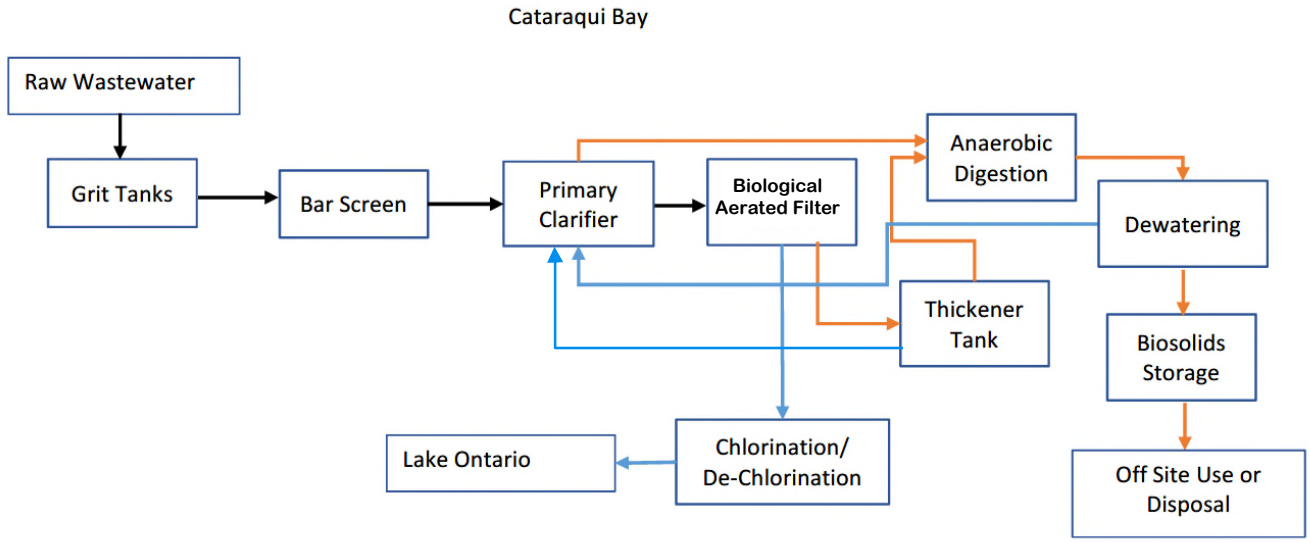
The upgrades to Cataraqui Bay are summarized in the following major components:

- Demolition of the existing Septage Receiving Station;
- A new and expanded Headworks Building to house two fine screens, two vortex grit tanks, and their auxiliary systems;
- Connection of the primary clarifiers and aeration tanks to create four new retrofitted primary clarifiers;
- A new BAF Facility, which will consist of:
  - Six BAF cells;
  - A Primary Effluent Pumping Station;
  - Two BAF backwash residual tanks;
  - Process Equipment Space; and
  - Administration and laboratory functions.
- An expanded chlorine contact tank.
- Diffuser upgrades for the existing two outfalls.
- A new Dewatering and Biosolids Storage Facility to house two centrifuges and two biosolids bunkers.
- A new prefabricated centrate pumping station.
- Two new gravity thickeners to treat BAF backwash residuals retrofitted from the existing secondary clarifiers.
- An expanded Chemical Building to house new chlorinators.
- A retrofitted Dechlorination Building to house chemical storage and dosing equipment.
- A new electrical substation and backup generator located close to the site entrance.
- Two new tunnels to connect to the BAF Facility and Dewatering and Biosolids Storage Facility.

- Decommissioning of Plant C East and the Plant D secondary clarifiers[1].

The upgraded treatment process at Cataraqui Bay is illustrated in Figure 2-1.

Figure 2-1: Upgraded Cataraqui Bay Treatment Flow Diagram

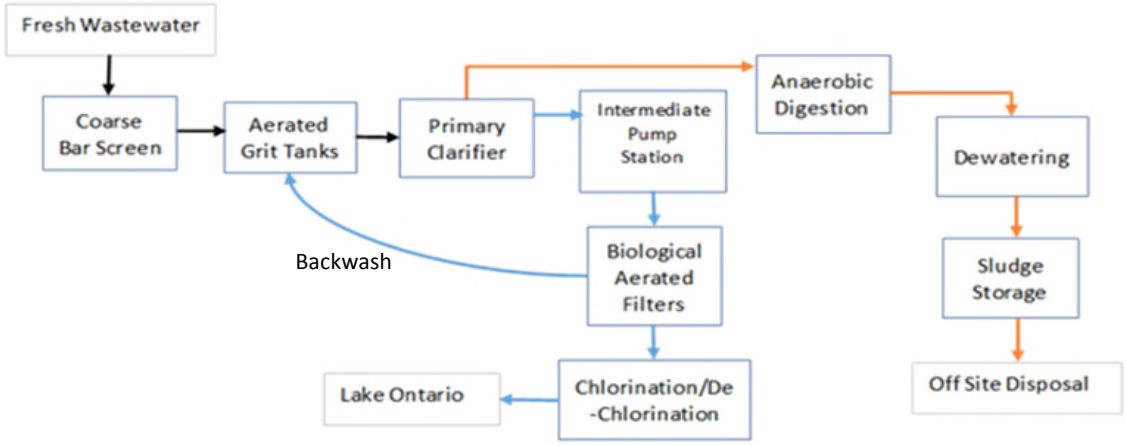


2.1.2 The Ravensview Waste Water Treatment Plant

The Ravensview WWTP, located at 947 County Road #2, was constructed in 1957 as the first waste water treatment plant in Kingston. The plant was upgraded in 1974, in 1993, and most recently between 2006 to 2009 (with a $115,000,000 capital project). The plant is designed to process 95,000 m^3 of waste per day, primarily generated from the Central to East regions of the City.

The current waste water treatment process is illustrated in Figure 2-2.

Figure 2-2: Ravensview Waste Water Treatment Flow Diagram



[1] Cataraqui Bay Wastewater Treatment Plant Upgrades Design Report, January 2016

2.1.3 The Cana Wastewater Treatment Plant

The CANA WWTP was constructed in the early 1970's for the CANA Home-Building Cooperative. In 1991, the City acquired the facility and it is currently maintained and operated by UK. Cana was upgraded to an SBR, completed in 2018 and currently meets all requirements for discharge. Sludge from Cana is currently transported to Ravensview for digesting. The CANA WWTP is not considered a viable option for enhancement.

2.2 Existing Biosolids Management Processes

Both Cataraqui Bay and Ravensview have undergone changes to their respective processes from the time of commissioning. For the purposes of this review, the following descriptions outline the processes for the respective facilities that match the period of background data that is presented in Sections 3.2.2, 3.2.3, and 3.2.4.

The current process at both plants is comprised of primary settling tanks, secondary settling tanks, digesters, primary settling, biological treatment, secondary setting, thickening, digestion, biosolids dewatering and storage.

For biological treatment, both facilities use the BIOSTYR® process, which is an up-flow submerged media BAF. As an attached growth process, BIOSTYR is carried out in a series of individual cells containing submerged buoyant media, which provides surface area for microorganisms to attach and grow. Extra activated sludge falls off of the media and is filtered and removed as waste activated sludge (WAS).

The WAS is then pumped to the Digesters for stabilization and methane production.

For the purpose of describing the biosolid characteristics, for Ravensview and the pre-design of Cataraqui Bay, the following will be detailed:

- Ravensview, two mesophilic, one thermophilic digester and one storage tank.
- Cataraqui Bay, two mesophilic digesters plus one storage tank.
- Dewatering.
- Storage.

2.2.1 Biosolids Characteristics, Quantities and Projections

2.2.1.1 Characteristics

Wastewater biosolids are the residual material from the sludge treatment works after the sludge has been stabilized in the digestion process. Biosolids primarily consist of nutrients, organic matter, and micronutrients, such as copper and zinc. They may also contain trace amounts of other elements, such as arsenic, lead, and mercury.

Table 2-2 Cataraqui Bay and Ravensview WWTP Biosolids Characteristics" summarizes biosolids characteristics from the UK's two WWTPs compared with typical values in the MECP Design Guidelines (2008) and Metcalf and Eddy (2003). Most of the characteristics for UK's biosolids are comparable to typical values in design guidelines and literature.

Table 2-2 Cataraqui Bay and Ravensview WWTP Biosolids Characteristics

Biosolids Type	Parameters	Cataraqui Bay WWTP	Ravensview WWTP	Typical Design Guidelines
Raw Sludge	TS%	3.82	4.15	2-6.5 [1] Ave. 4.0
	VS%	82.8	68.2	60
	TS (mg/L)	38,239	n/a	
	VS (mg/L)	31,497	n/a	
Digested Sludge	TS%	2.32	2.10	2-6 [1] Ave. 4.0
	VS%	64.9	49.1	45
	TS (mg/L)	21,489	n/a	
	VS (mg/L)	13,936	n/a	
Dewatered Cake	TS%	14.0	28.6	15-30 [1]
	VS%	64.5	48.0	
	TS (mg/L)	140,146	n/a	
	VS (mg/L)	90,631	n/a	

Sources: Cataraqui Bay and Ravensivew WWTP Annual Reports, 2015 – 2017.
Notes:
[1] All values are yearly average from monthly data between 2015 and 2017.
Design Guidelines for Sewage Works, MECP (former MOECC) (2008)

The Ontario Nutrient Management Act (NMA) (O.Reg. 267/03) was enacted to minimize the risk to public health and the environment when non-agricultural source materials (NASM), including sewage biosolids, are applied to land. Under the NMA, WWTPs are considered to be generators of Category 3 NASM. Biosolids generated from Category 3 NASM are required to meet CM2 criteria for regulated metals and CP1 or CP2 criteria for pathogens as set out in the Regulation when applied to agricultural land as a nutrient.

Table 2-3 summarizes the concentrations of 11 metals of concern regulated under NMA in biosolids generated from Cataraqui Bay WWTP and Ravensview WWTP as compared with the quality requirements for NASM CM1 and CM2 biosolids.

Table 2-3 Cataraqui Bay and Ravensview WWTP Biosolids Metal Content as Compared to NMA Standards

Element	Cataraqui Bay WWTP (2015 2016)	Ravensview WWTP (2015 2016)	CM1 NASM (1)	CM2 NASM (2)
Arsenic	2.4	4.8	13	170
Cadmium	1.0	0.8	3	34
Chromium	53	75	210	2,800
Cobalt	1.6	4.5	34	340
Copper	**482**	**747**	100	1,700
Lead	16	51	150	1,100
Mercury	0.8	**0.9**	0.8	11
Molybdenum	**7.1**	**8.0**	5	94
Nickel	20	24	62	420
Selenium	**3.6**	**4.3**	2	34
Zinc	**657**	**660**	500	4,200

Notes:
All units are expressed as mg per kg of total solids, dry weight.
Bolded values indicate values exceeding CM1 NASM limits.
Column 3 of Table 1 of Schedule 5 Regulated Metal Content of NASM under Nutrient Management Act, 2002 (O. Reg. 267/03)
Column 3 of Table 2 of Schedule 5 under NMA, 2002 (O. Reg. 267/03)

Based on the data from 2015 - 2016, biosolids generated from both plants are low in above regulated metal concentrations. These biosolids can be used on agricultural land that meet the quality criteria in a manner consistent with the practice acceptable under the NMA. Biosolids from both plants meet the metal requirements for Category CM1, with the exception of copper, mercury, molybdenum, selenium and zinc (bolded) that requires management as CM2C. It is important to ensure that the projected metal concentrations for future productions also remain below the maximum concentrations stated in the regulations.

In addition to metal content, it may also be beneficial to review additional requirements for biosolids quality related to pathogens prior to land application. The pathogen content of NASM that is sewage solids or contains human body waste (CP2 Pathogen Criteria) as compared with the pathogen analysis from plant biosolids samples is summarized in the table below.

Table 2-4 Cataraqui Bay WWTP and Ravensview WWTP Biosolids Pathogen Content as Compared to NMA Standards

Pathogen	Cataraqui Bay WWTP	Ravensview WWTP	CP1 NASM [1]	CP2 NASM [2]
E. coli	9,183 CFU/g	22,203 CFU/g[3]	1,000 CFU per gram of total solids, dry weight	2,000 CFU per gram of total solids, dry weight
Salmonella	Data not available	Data not available	3 CFU or MPN per 4 gram of total solids, dry weight	n/a

Pathogen	Cataraqui Bay WWTP	Ravensview WWTP	CP1 NASM [1]	CP2 NASM [2]
Giardia	Data not available	Data not available	No detectable level in 4 gram of total solids, dry weight	n/a
Cryptosporidium	Data not available	Data not available	No detectable level in 4 gram of total solids, dry weight	n/a

Notes:
[1]CFU refers to colony forming units. This methodology is used for determining number of coliform counts in a given sample.
[2]Column 3 of Table 2 of Schedule 6 Pathogen Content of NASM (O. Reg. 267/03)
[2]Column 3 of Table 3 of Schedule 6 Pathogen Content of NASM (O. Reg. 267/03)
[3]Due to repairs to the Thermophilic and one Mesophilic digesters this does not represent expected quality

2.2.1.2 Quantities

The plant flow and sludge data were obtained from Cataraqui Bay WWTP and Ravensview WWTP Annual Reports for the years 2015 to 2017, and are summarized in Table 2-5 and Table 2-6 below.

Table 2-5 Historical Annual Effluent and Biosolids Quantities in Cataraqui Bay WWTP (2015 – 2017)

Cataraqui Bay		2015	2016	2017	Average
Effluent	Volume (m^3/yr)	9,527,449	9,962,485	10,965,006	10,151,647
Raw Sludge	Volume (m^3/yr)	23,332	25,117	25,267	24,572
Volume of raw sludge generated per volume of effluent	L/m^3	2.4	2.5	2.3	2.4
Dewatered Cake	Volume (m^3/yr)	4,086	4,358	3,734	4,059

Sources: Cataraqui Bay WWTP Annual Report Data, 2015 - 2017

Table 2-6 Historical Annual Effluent and Biosolids Quantities in Ravensview WWTP (2015 – 2017)

Ravensview		2015	2016	2017	Average
Effluent	Volume (m^3/yr)	21,972,284	20,609,884	31,499,468*	21,291,084
Raw Sludge	Volume (m^3/yr)	52,896	55,075	61,106	53,986
Volume of raw sludge generated per volume of effluent	L/m^3	2.4	2.7	1.9*	2.5

Ravensview		2015	2016	2017	Average
Dewatered Cake	Volume (m^3/yr)	4,999	3,816	5,577	4,408

Sources: Ravensview WWTP Annual Report Data, 2015 – 2017
Notes:
* The flows in 2017 were abnormally larger than previous years due to high lake level in 2017 summer. Effluent value in 2017 will be treated as an outlier and excluded in the calculation for projections.

According to Table 2-5 and Table 2-6, the volume (L) of raw sludge generated per volume (m^3) of treated wastewater are 2.4 L/m^3 and 2.5 L/m^3 for Cataraqui Bay WWTP and Ravensview WWTP, respectively. These values are close to, but below the typical value of 3.2 L/m^3 suggested by MECP Guidelines for a primary sedimentation plant with phosphorus removal. The total solids (TS%) of raw sludge are 3.82% and 4.15% for Cataraqui Bay WWTP and Ravensview WWTP, respectively. For the purposes of this analysis, it was assumed that TS% of raw sludge will be the same in the future and the same values of TS% were used for sludge projection. It should be noted that the two plant processes combined sewer and extraneous flow sources, thereby explaining the lower raw sludge generation.

These values were used as the basis for the future biosolids projections up to year 2037.

2.2.1.3 Projections

Sludge production was estimated based on population growth in the City of Kingston (Statistics Canada) and typical human deposit (solids) generated per capita (g/ca/day), in conjunction with the sludge data from the WWTP Annual Reports for 2015 to 2017, inclusive.

City of Kingston's population grew slowly between 2011 and 2016, increasing by 1.03% from 114,928 to 117,660. For the purposes of the analysis, it was assumed that the population growth trends for the City would follow the same rate as in the previous intercensal period to complete the projections from 2022 to 2037. Serviced population was estimated based on the City of Kingston wastewater collection system serviced by the two WWTPs. Cataraqui Bay WWTP services Kingston West (3,953 ha, 44,400 POP), which accounts for 38% of the total population, and Ravensview WWTP collects wastewater flow from Kingston Central (2,919 ha, 54,600 POP) and East (1,386 ha, 10,200 POP), which accounts for 55% of the City's total population. Additionally the Cana WWTP, located north of the Highway 401, services the Cana subdivision, which will not be covered in this detailed analysis.

Future biosolids production, utilizing the projected serviced population and quantity of sludge generated from each of the WWTPs, is summarized in Table 2-7 below.

Table 2-7 Projected Annual Biosolids Production in Cataraqui Bay WWTP up to Year 2037

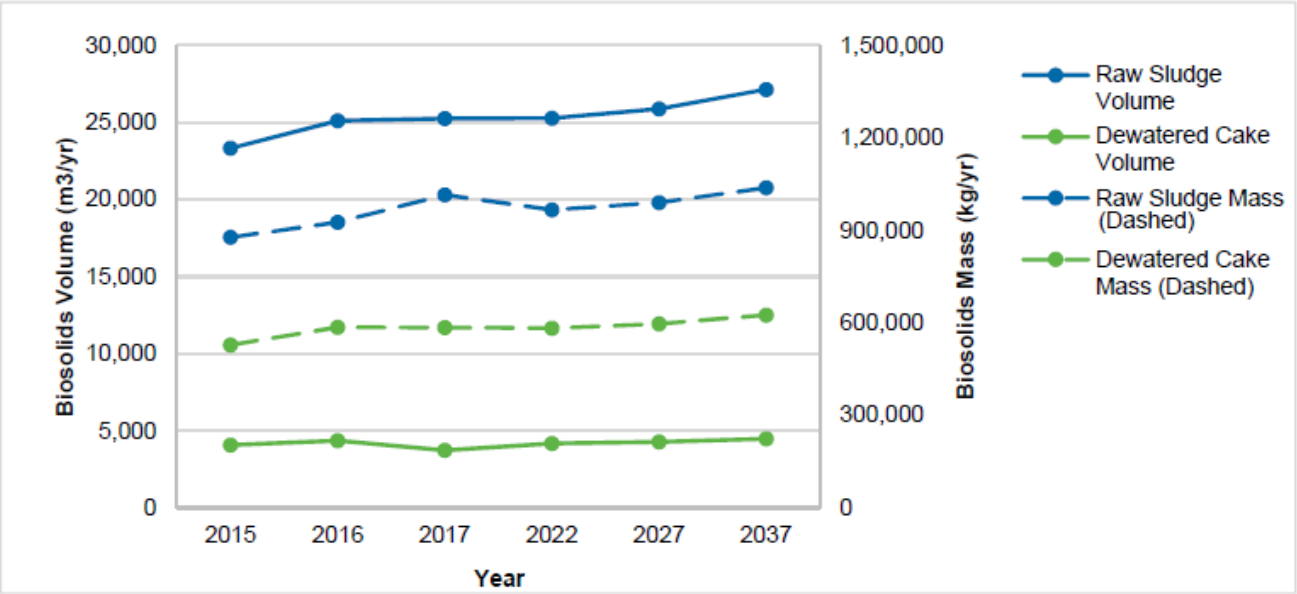
	Year	Serviced Population	Raw Sludge			Dewatered Cake		
			Total Volume	Production Concentration	Total Mass*	Total Volume	Production Concentration	Total Mass**
			(m^3/yr)	(g/cap.d)	(kg/yr)	(m^3/yr)	(g/cap.d)	(kg/yr)
Collected Data	2015	44,200	23,332	54	877,658	4,086	33	528,237
	2016	44,410	25,117	57	926,990	4,358	36	586,002
	2017	44,621	25,267	62	1,015,571	3,734	36	585,120
	2022	45,692	25,278	58	966,993	4,177	35	582,717

	Year	Serviced Population	Raw Sludge			Dewatered Cake		
			Total Volume	Production Concentration	Total Mass*	Total Volume	Production Concentration	Total Mass**
			(m^3/yr)	(g/cap.d)	(kg/yr)	(m^3/yr)	(g/cap.d)	(kg/yr)
Projected Data	2027	46,788	25,885	58	990,199	4,277	35	596,701
	2037	49,061	27,142	58	1,038,296	4,485	35	625,684

Notes:
The average undigested sludge solid concentration over the three years (2015-2017) was 58 g/cap.d, which is below the typical value of 100 g/cap.d for CAS w/P removal suggested by MECP Sewage Works Design Guideline (2008).
The average digested sludge solid concentration over the three years (2015-2017) was 35 g/cap.d, which is below the typical value of 68 g/cap.d for CAS w/P removal suggested by MECP Sewage Works Design Guideline (2008).

Raw sludge and dewatered cake production (in mass) were calculated based on undigested sludge and digested solids production concentration per capita multiplied by the projected population of the same year. It should be noted that the average undigested sludge production concentration per capita of 58 g/cap.d was far below the typical value of 100 g/cap.d for a CAS process as suggested in the MECP Guidelines. As expected, the average digested solids production concentration per capita of 35 g/cap.d was also below the typical value of 68 g/cap.d.

Figure 2-3 Projected Biosolids Production in Cataraqui Bay WWTP up to Year 2037



Note: Raw Water Volume is at +/- 2% solids and Dewatered Cake Volume is +/- 25% solids

Table 2-8 Projected Annual Biosolids Production in Ravensview WWTP up to Year 2037

	Year	Serviced Population	Raw Sludge			Dewatered Cake		
			Total Volume	Production Concentration	Total Mass*	Total Volume	Production Concentration	Total Mass**
			(m^3/yr)	(g/cap.d)	(kg/yr)	(m^3/yr)	(g/cap.d)	(kg/yr)
Collected Data	2015	64,508	52,896	100	2,354,531	4,999	68	1,601,081
	2016	64,814	55,075	100	2,365,725	3,816	68	1,608,693
	2017	65,123	61,106	100	2,376,972	5,577	68	1,616,341
Projected Data	2022	66,685	55,673	100	2,434,016	4,935	68	1,655,131
	2027	68,286	57,009	100	2,492,429	5,054	68	1,694,851
	2037	71,603	59,778	100	2,613,493	5,299	68	1,777,175

Notes:
Plant effluent and raw sludge volume in 2017 was treated as an outlier due to high lake level in 2017 summer, and excluded in the calculation for projections.
Data are not available for Ravensview WWTP. Undigested sludge solid concentration of 100 g/cap.d and digested sludge solid concentration of 68 g/cap.d (CAS w/P removal) were used for projections (MOECC Sewage Works Design Guidelines, 2008).

The same methodology was used to project raw sludge and dewatered cake production for Ravensview WWTP. Typical undigested sludge production concentration of 100 g/cap.d and digested solids production concentration of 68 g/cap.d were used for the calculations.

The projected annual biosolids production from the two plants to 2037 (Table 2-9) were used as a basis for developing and reviewing the various alternative biosolids management options.

Figure 2-4 Projected Biosolids Production in Ravensview WWTP to Year 2037

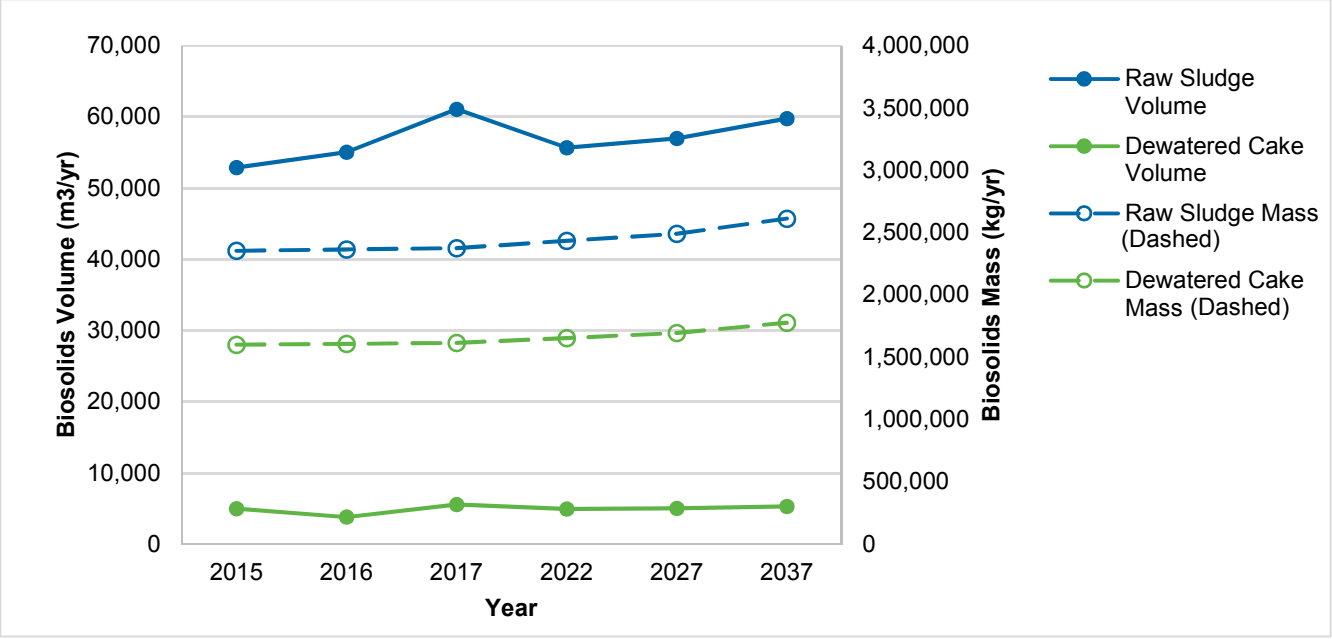


Table 2-9 Total Annual Biosolids Production in Year 2037

Facility	Raw Sludge		Cake	
	Volume (m^3/d)	Mass (kg/d)	Volume (m^3/d)	Mass (kg/d)
Cataraqui Bay	74	2,957	12	2,004
Ravensview	164	7,094	15	5,810
Total	238	10,051	27	7,814

2.2.2 Existing Biosolids Treatment Capacity

2.2.2.1 Cataraqui Bay

Table 2-10 summarizes the treatment capacities of the existing sludge treatment components in Cataraqui Bay WWTP.

Table 2-10 Biosolid Process Design Parameters in Cataraqui Bay WWTP

Unit	Size/Capacity	Description
WAS Holding Tanks (four tanks)	230 m^3 (each) 920 m^3 (total)	The two WAS holding tanks with two positive displacement blowers providing air to the fine bubble membrane diffusers within the tank. Two WAS sludge pumps are rated at 34.7 L/s each.
Rotary Drum Thickener (two thickeners)	125 m^3/hr (each) 1,250 m^3/d (total)	Currently both thickeners are operated approximately five hours per day, seven days per week. WAS is thickened in rotary drum thickeners prior to being pumped to digesters.
Thickened WAS Holding Tanks (two tanks)	590 m^3 (each) 1,180 m^3 (total)	With two TWAS pump each rated at 600 m^3/hr.
Primary Digesters (Digester No. 3)	3,060 m^3	Hydraulic retention time in primary digester is 34 days.
Secondary Digester (Digester No. 2)	1,620 m^3	With capability of operating as a primary digester. Volatile destruction is 54% in secondary digester. Equipped with two digested sludge pumps each rated at 12.6L/s
Digested Sludge Holding Tank (Digester No. 1)	1,540 m^3	
Dewatering Centrifuge (one unit)	10.6 L/s (638 L/min)	Centrifuge is operated 8 hours per day, 2 to 3 days per week. Historically has dewatered digested biosolids to 16% TS with 99% of solids capture.

2.2.2.2 Ravensview

Table 2-11 summarizes the design parameters of key sludge process components in the Ravensview WWTP.

Table 2-11 Biosolid Process Design Parameters in Ravensview WWTP

Unit	Size/Capacity	Description
Mesophilic Digesters (two tanks)	2,465 m^3 (each tank) 4,930 m^3 (total)	Both tanks are equipped with four vertical draft tube mechanical mixers. Tanks are heated by continuous sludge recirculation through hot water tube type heat exchangers. The two primary clarifiers can be operated in series or in parallel, and normally in-series mode operation. Three sludge circulation pumps each rated at 30L/s.
Secondary Digester (one tank)	3,700 m^3	Not heated or continuously mixed. Equipped with external pump recirculation system used to maintain sludge consistency and minimize solids accumulation. Two sludge transfer pumps each rated at 11 L/s.
Thermophilic Anaerobic Digester (one tank)	2,465 m^3	Primary digester with the ability to conduct temperature phased anaerobic digestion. Two sludge circulation pumps each rated at 132 L/s.
Dewatering Centrifuge (two units)	9.1 L/s (each) (546 L/min) 1,092 L/min (total)	Historically has dewatered digested biosolids to 30% TS.

2.2.3 Biosolids Storage Requirements

Biosolids storage requirements were developed based on providing 180 days of storage for biosolids generated at Cataraqui Bay WWTP and Ravensview WWTP. Based on Ontario Regulation 267/03, restricted land application applies from December 1 to March 31 (4 months) when the ground is covered by snow or frozen. Provision of 180 days of storage would allow sufficient storage for the restricted period, while providing some buffering capacity in the event that land application is not possible outside the restriction period. The NMA requires storage capacity for 240 days. This is why Ravensview WWTP includes 180 days storage pus the intent to landfill or direct apply to fields in the event storage is full. The UK management plan includes contingency to landfill if storage capacity is exceeded.

The design biosolids storage requirements for the two plants are provided in Table 2-12. Biosolids generation rates were developed based on standard mesophilic anaerobic digestion. Pre-treatment and stabilization processes will have an impact on the biosolids generation rate and will affect storage requirements and options.

Table 2-12 Biosolids Storage Requirements in Year 2037

Standard Anaerobic Digestion	Cataraqui Bay WWTP	Ravensview WWTP
Biosolids Mass	2,004 kg/d	5,810 kg/d
Generated Cake Volume	12 m^3/d	15 m^3/d
Biosolids Storage Requirements (1)	2,160 m^3	2,700 m^3

Notes:
The Nutrient Management Act stipulates 240 days of required biosolids storage for agricultural uses.

Storage facilities for storage of biosolids cake is provided at the sites of Cataraqui Bay WWTP and Ravensview WWTP. A review of existing storage capacities on site for the two plants is provided in Table 2-13. The existing storage facilities on-site can provide sufficient capacities for sewage generated biosolids to 2037.

Table 2-13 On-site biosolids storage capacities at Cataraqui Bay and Ravensivew

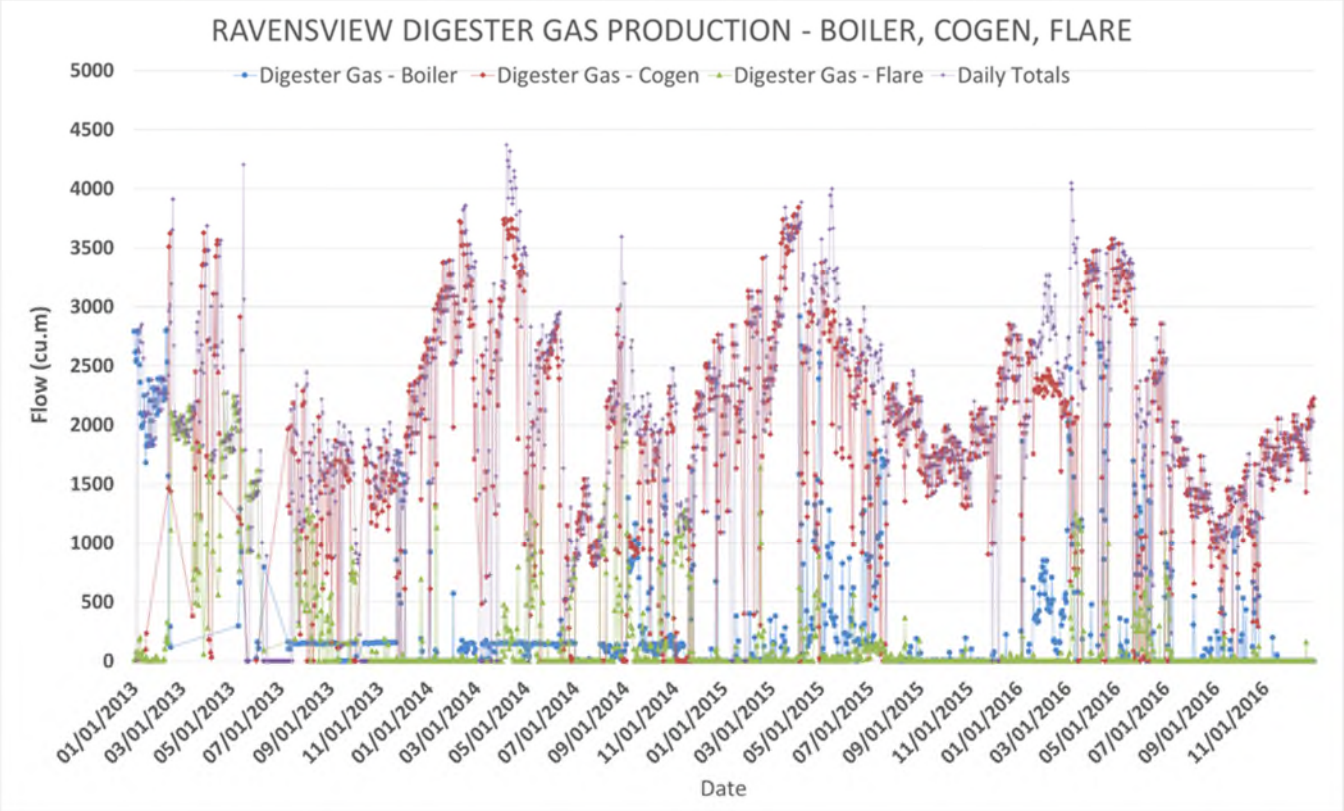
Facility	Unit	Size/Capacity
Cataraqui Bay WWTP	New Enclosed Sludge Drying Beds	5,125 m^3
Ravensview WWTP	Enclosed Cake Storage Facility	6,000 m^3

2.3 Existing Biogas Management Processes

2.3.1 Biogas Characteristics, Quantities and Projections

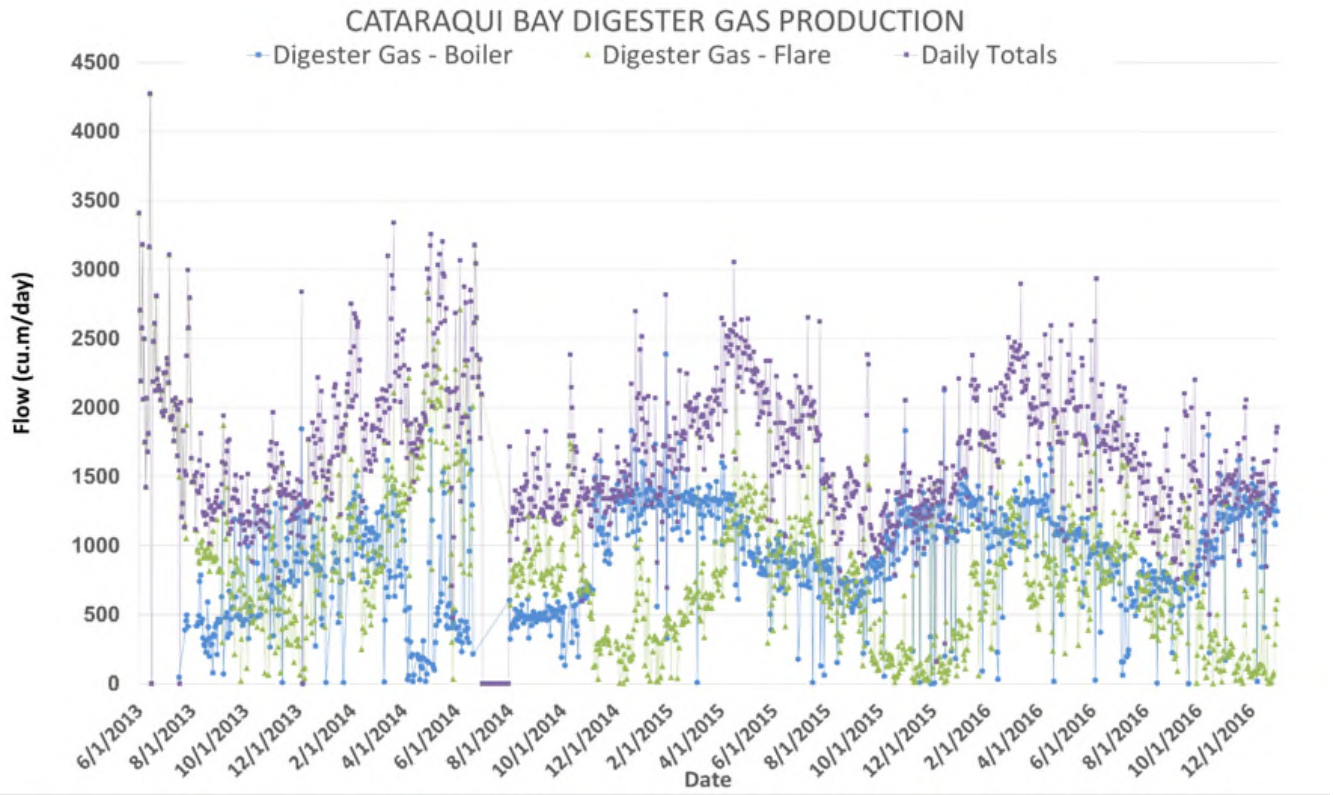
Ravensview's total biogas flow (generator, flare, and boiler) varies from about 1,000 to 4,000 m^3 per day (or 25 to 100 cfm) and is highly variable with consistently more biogas collected in the spring of the year. Figure 2-5 summarizes historic biogas flow in 2013 to 2016 from the Ravensview WWTP. The biogas chemistry data showed that Ravensview biogas has excellent concentration of methane, with no oxygen or nitrogen levels. The data provided is 10 to 12 years old. Siloxane levels were found to be very high and considering the age of these results Tetra Tech recommends re-testing all gas chemistry.At this time no further samples have been taken as the digesters at Ravensview have been down.

Figure 2-5: Ravensview Digester Gas Production



Cataraqui Bay's total biogas flow (flare and boiler) varies from about 1,000 to 3,000 m^3 per day (or 25 to 75 cfm) and is highly variable with consistently more biogas collected in the spring of the year. Figure 2-6 summarizes historic biogas flow in 2013 to 2016 from Cataraqui Bay WWTP.

Figure 2-6: Cataraqui Bay Digester Gas Production



The biogas chemistry data showed that Cataraqui Bay's biogas has an excellent concentration of methane, with no oxygen or nitrogen levels. The data provided is three years old. Siloxane levels were found to be very low so Tetra Tech recommends retesting to confirm the siloxane levels.

With the planned upgrade/enhancements of the Cataraqui Bay digesters, it is expected that the biogas output may change. With the addition of SSO, it is expected that the biogas characterization will change and that O2 and N2 levels will increase. Further, the addition of SSO may introduce aromatics to the biogas. (http://www.biogas-renewable-energy.info/biogas_composition.html)

As will be shown in Section 3, it is expected that some of the technology options will increase the production of biogas, and hence increase the amount of methane that may be available for use.

2.3.2 Existing Biogas Treatment Capacity

Cogeneration of electricity and heat is currently employed at Ravensview WWTP but not at Cataraqui Bay WWTP. Both facilties also dispense generated gas for boilers and flares. This technique to convert biogas to energy is very common at WWTPs throughout Canada and the USA because it reduces the amount of electricity that must be purchased from the grid to operate the WWTP. It is presumed that this self-generation of electricity reduces costs because the cost of self-generated electricity is less compared to purchasing electricity from the grid. This will be reviewed by Utilities Kingston. In addition, the heat from the generation equipment can be harnessed and employed to keep the WWTP digesters operating at peak temperature, especially in the winter months. Additional heat may

also be recovered for use in building heating and meeting other on-site needs. Any excess gas that cannot be used for either electrical production or for heat can otherwise be flared.

2.4 Pre-Selected Treatment Technologies

Cleaning and compression of biogas into RNG has become commonplace in the USA and Canada. Several vendors of gas cleaning equipment are based in Canada, such as Greenlane (BC), Xebec (Quebec), and others. In addition, several USA equipment suppliers deliver their equipment to Canada such as BioCNG. Technologies for cleaning biogas into RNG are shown in Figure 2-7.

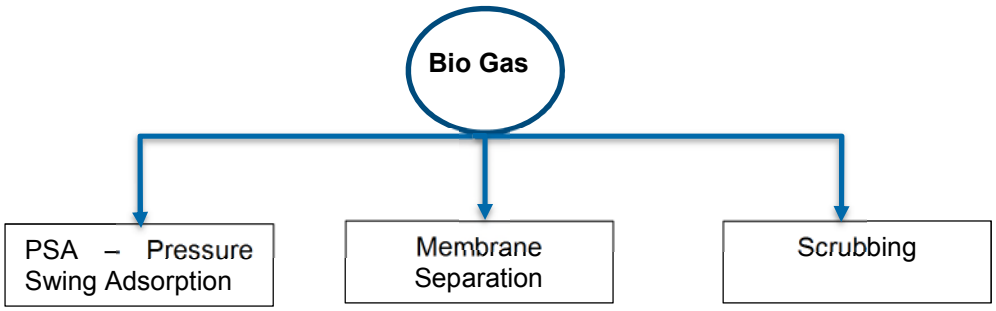


Figure 2-7: Biogas Treatment Technologies

There are four types of biogas treatment that can be contemplated for this application. Pressure Swing Adsorption (PSA), Membrane Separation, Water Scrubbing, and Amine Scrubbing.

2.4.1 PSA

PSA uses a batch of vessels that increase the pressure of the biogas to a point where most non-methogenic compounds (CO2, H2S, Siloxane O2, and aromatics) are adsorbed into a medium and the “cleaned” methane is expelled. When the pressure is reduced, the adsorped compounds are released and expelled. There are several types/versions of PSA systems depending on the manufacturer. PSA is used in many applications including high and low flow applications.

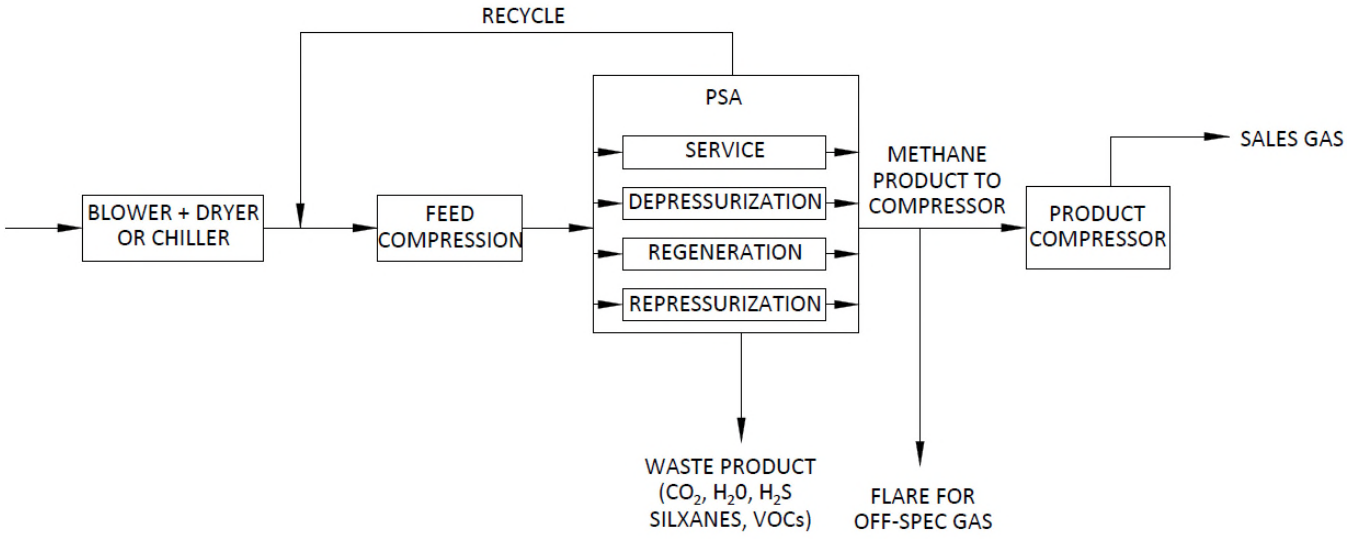


Figure 2-8: Pressure Swing Adsorption

2.4.2 Membrane Separation

Membrane separation is the application of polymeric membranes to separate CO2 from methane as the biogas is subjected to a vessel where the membrane has separate outlets for each of the compounds. One problem is that the membrane can be plugged by other compounds so the biogas is typically cleaned with H2S removal via activated carbon and a water knockout is used prior to entering the membrane chamber.

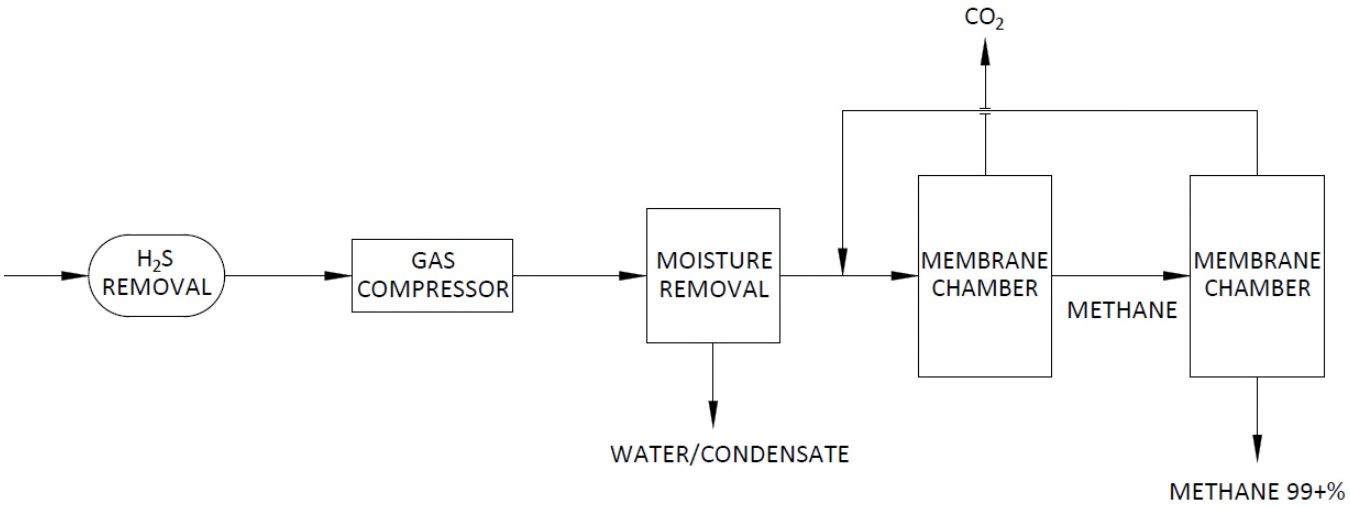


Figure 2-9: Membrane Separation

2.4.3 Water Wash/Scrubbing

The water wash scrubbing process is similar to membrane separation as water is used to dissolve CO2. The process is undertaken in two high and low pressurized vessels where a membrane separates the two compounds in the dissolved state. The process requires H2S and moisture pre-treatment similar to that in membrane separation.

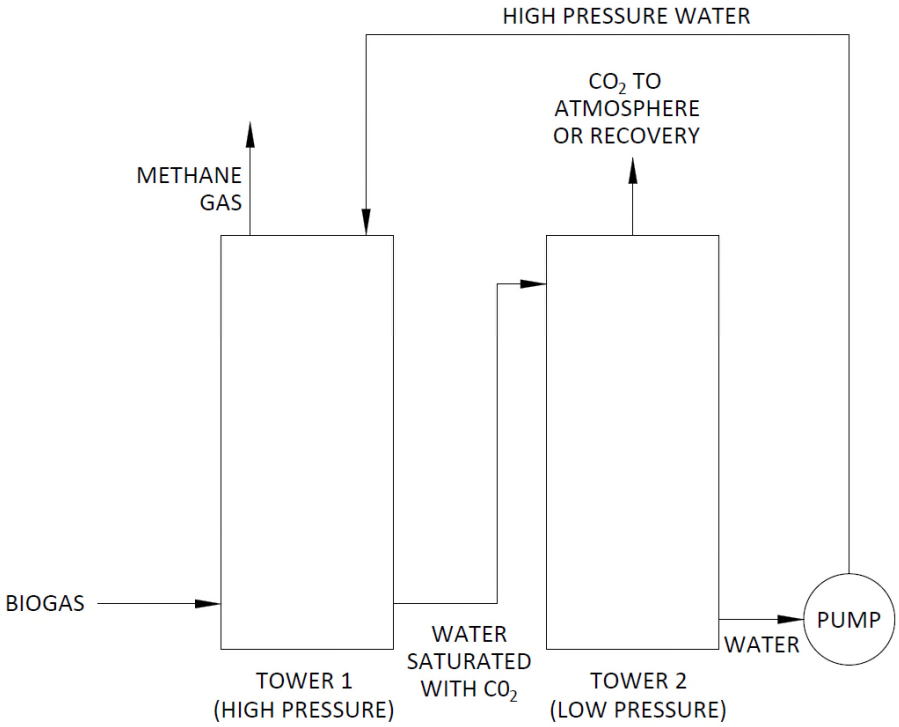


Figure 2-10: Water Wash

2.4.4 Amine Scrubbing

In this process Amine is used to chemically react with CO2 and is adsorped. The methane is then released. The process is undertaken in two towers where the reacted amine and CO2 is heated in a separated tower to release the CO2 and the amine is then recovered with an amine cooling system. Similar to the above-noted processes, the biogas needs to be desulfered prior to processing.

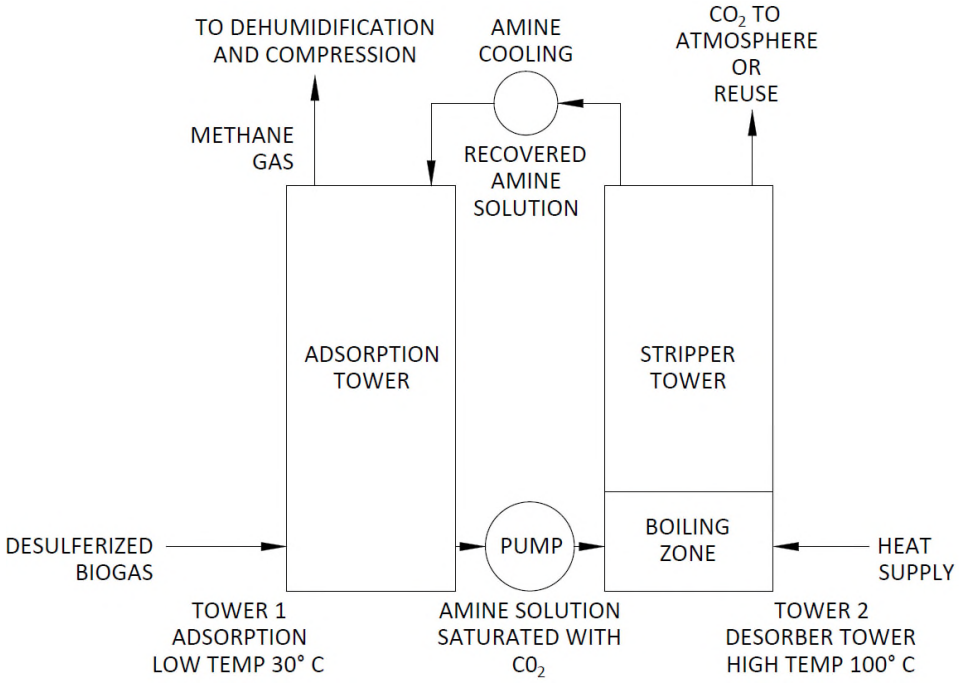


Figure 2-11: Amine Scrubbing

2.4.5 Recommended Process

At this time it is difficult to assess which process is most applicable. Furthermore, if the digesters are modified or changed then the constituent compounds may be different and, in some cases, may require pre-treatment for a specific constituent. With the addition of SSO into the digestion process, the output constituents may be different again. Given the information that is available , including the anticipated flow rates of biogas, versions of PSA may be the most cost beneficial process and can be provided by most gas cleaning suppliers.

It should also be noted that Union/Enbridge (now Enbridge) may offer to install the gas cleaning and compression equipment for testing.

2.5 End-Use

The end use for the RNG generated from the generating site was initially considered to be CNG, with the alternative being either to fuel a Natural Gas fleet, or to ship it to a consolidating station. If done within Ontario, the initial objective was to either offset the gas penalties for the gas distribution system owned by the City, or to take advantage of green fuel credits, both under the auspicies of the Ontario Cap and Trade legislation. This objective became less likely with the current cancellation of the Cap and Trade Legislation but may be resurrected with federal and future provincial green fuel programs.

At this time, the primary driver to attain carbon credits for RNG is to inject the gas into a distribution network such as Union/Enbridge (which are currently the suppliers of natural gas to the two WWTPs). Union/Enbridge has indicated that gas can only flow in one direction so the injected RNG must have enough consumptive capacity downstream from the injection point. Based on information provided by Union/Enbridge the following are the results of their analysis of the pipelines.

- Site 1: Ravensview WWTP 947 Hwy 2, Kingston, ON, K7L 4V1 (44°14'32.5"N 76°25'12.0"W):
  - This pipeline does not have much flow during the summer. Modelled takeaway capacity is 53 m^3/hr at the road on a 420 kPa maximum operating pressure line. During the winter, it is expected to be 3 or 4x flow.
  - There is another higher pressure pipeline close to the St Lawrence River which is 3.7 km away that Union/Enbridge has not yet looked at.
- Site 2: Cataraqui Bay WWTP 80 Sunny Acres Rd, Kingston, ON (44°12'37.0"N 76°33'39.8"W):
  - Inject into the 1210 kPa Union/Enbridge system at a delivery pressure of 1140 kPa.
  - Requires ~1.1km of 4" steel connecting pipe.
  - Modeled low flow scenario is 283 m3/hr and again typically 3 or 4x during winter loads.

In either case, the recommendation is for the injected gas to be wheeled where there are existing or yet to be established RNG purchase programs, namely Quebec and British Columbia. For each of these options there needs to be a connection to the Dawn Wells, which then connects with TransCanada to each of the provinces. Tetra Tech has communicated with both Fortis BC and Energir (previously Gaz Metro) and have attained interest from both groups to potentially purchase RNG generated from the UK facilities. In both cases, the incentive for any agreement would be to have a long-term established cash flow dependent on a range of gas flows. Table 2-14, Below, shows the potential range for purchase agreements.

Table 2-14, Potential Range for Purchase Agreements

Provider	Rate	Duration	Transport to Dawn	Other Transport	Total
Energir	$18 first three years $14 thereafter per GJ (higher rates negotiable)	negotiable	$1 per GJ	none	Estimated $14 to $18 per GJ
Fortis	$25 to $30	20 years	$1 per GJ	$4 per GJ	$20 to $25 per GJ

It should be noted that the range of purchase prices are negotiable and would need to be clarified if and when UK makes a decision on proceeding with the project.

3.0 ALTERNATIVE BIOSOLIDS AND BIOGAS MANAGEMENT OPTIONS

3.1 Option 1 – Do Nothing

3.1.1 Description of Alternative

Under Option 1, sludge treatment, the current practice of processing sewage sludge separately at the WWTPs will continue. Both primary sludge and WAS are passing through thickening, mesophilic anaerobic digestion (MAD), secondary digester settling and dewatering at Cataraqui Bay WWTP (shown in Figure 3-1). Primary sludge and thickened backwash solids are subject to temperature-phased anaerobic digestion (TPAD), secondary digester settling and dewatering at Ravensiview WWTP (shown in Figure 3-2).

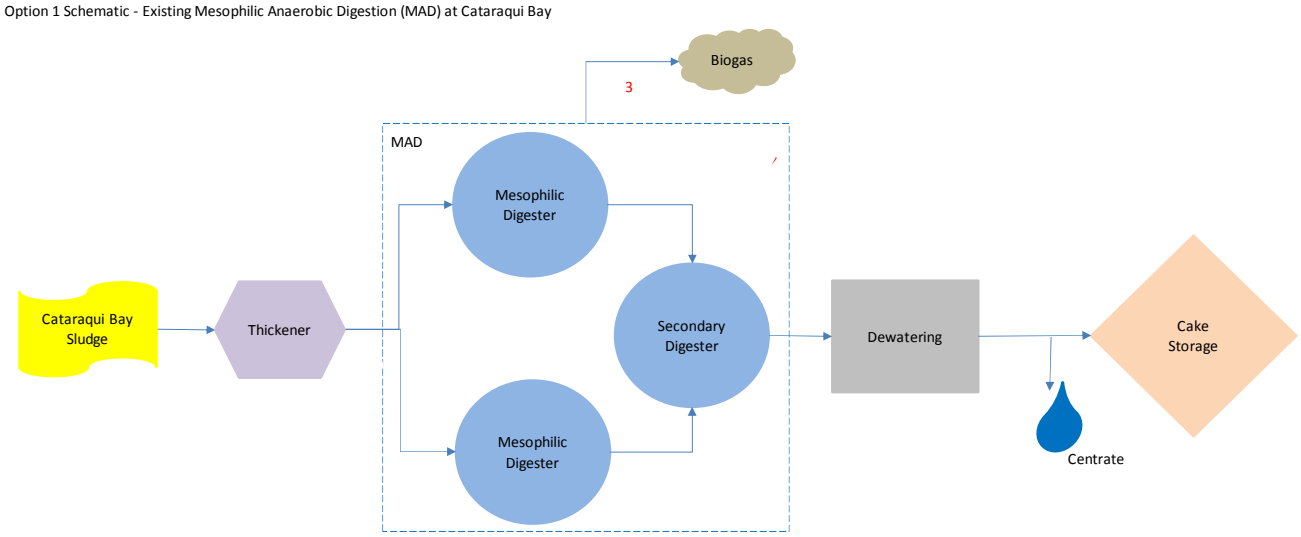


Figure 3-1 Existing Solid Treatment Process at Cataraqui Bay WWTP

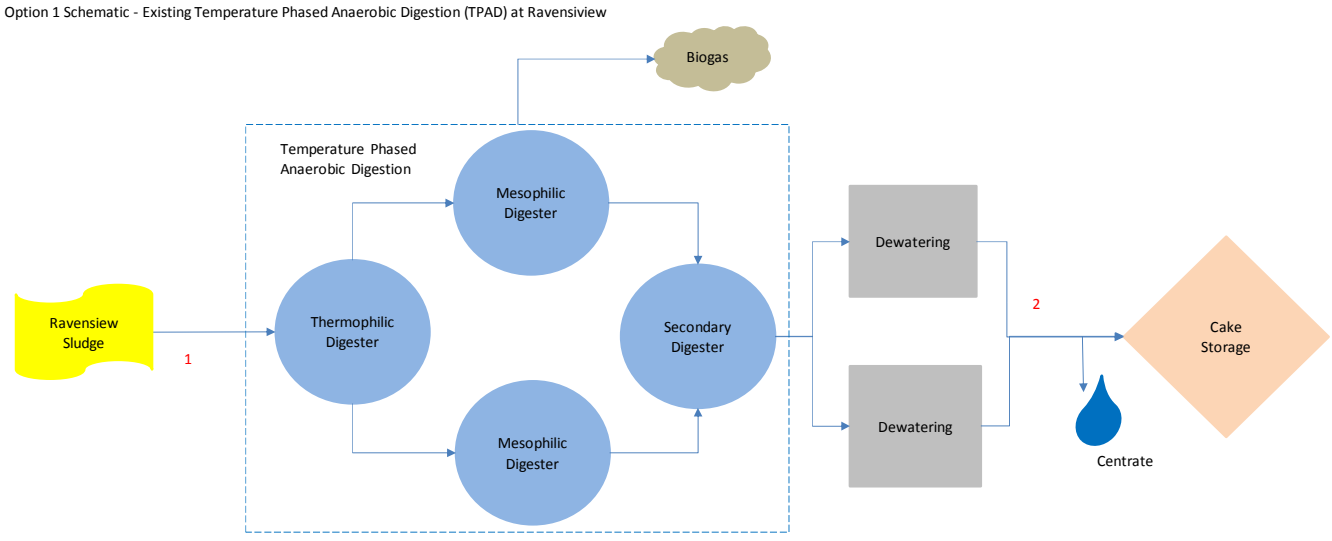


Figure 3-2 Existing Solid Treatment Process at Ravensview WWTP

3.1.2 Impact on Existing Facilities

The following assumptions and approaches were used to estimate biosolid production and biogas generation:

1. Under all the other alternatives (Option 2-5), sludge produced in the UK's two WWTPs will be processed in one centralized location.

2. Solids production and biogas yield estimates are calculated based on mass balance for the entire solid treatment train, consider the solid treatment process system boundary shown on Figure 3-1 and Figure 3-2.

3. Flow fluctuations of the raw sludge production were not considered in the estimation of sludge quantities.

4. Projected values of total sludge produced from both plants in the year 2037, i.e., sludge volume, total solid loading, and volatile solid loading, were used as the process input in all options.

5. Raw sludge from Cataraqui Bay WWTP was assumed to consist of 50% primary sludge and 50% WAS (or Waste Thickened BAF sludge), while sludge from Ravensview WWTP consists of primary sludge and BAF backwash solids.

6. Estimation of cake biosolid production and biogas yield were based on 15-day hydraulic retention time (HRT) in mesophilic digestion phase for all digestion scenarios.

7. Based on plant historical data, convertible COD in volatile solids (VS) of primary sludge and WAS were assumed to be 1.65 kg COD/kg VS and 1.47 kg COD/kg VS, respectively. Convertible COD in the blended sludge was calculated in proportion to the percentages of primary sludge and WAS in the feedstock.

8. Based on industrial experience at similar facilities, volatile sludge destruction (VSD) rates were assumed to be 40% for conventional MAD, 50% for TPAD, and 54% for Biological Hydrolysis – Anaerobic Digestion (BH-AD). Combined VSD was used to estimate VS residual after digestion and biosolid production.

9. The methane (CH_4) converted from COD under anaerobic conditions is 0.4 L CH_4/g COD = (25.29 L/mole)/(64 g COD/mole CH_4). Biogas flow was calculated based on 65% CH_4 in the total gas flow.

10. Nutrient mass loadings (i.e., nitrogen and phosphorus) of the dewatering centrate produced under the current operation condition at each plant were used as the baseline for evaluation. It should be noted that Ravensivew has a larger volume of dewatering centrate with lower concentration of nutrients.

The "Do Nothing" option is presented solely to provide a comparative baseline for the evaluation of alternative options and is not considered a viable strategy for this study.

Table 3-1 Estimated Biosolids Production and Biogas Generation in the Year 2037

	Cataraqui Bay	Ravensview	Total
		Feedstock	
Sludge Volume (m^3/d)	74	164	238
TS Loading (kg/d)	2,957	7,094	10,051
VS Loading (kg/d)	2,448	4,837	7,285
		Biosolids	
Biosolids (m^3/d)	12	15	27 [1]
TS (kg/d)	1,978	5,810	7,788 [1]

	Cataraqui Bay	Ravensview	Total
VS in Cake (kg/d)	1,469	2,792	3,887 [1]
Nitrogen in Cake (kg/d)	59	174	233
Phosphorus in Cake (kg/d)	22	63	85
	Centrate		
Centrate (m^3/d)	62 [2]	147 [3]	209
Nitrogen in Centrate (kg/d)	44 [2]	3 [3]	47
Phosphorus in Centrate (kg/d)	34 [2]	29 [3]	63
	Biogas		
Biogas (m^3/d)	1,061	2,770	3,831 [1]
Methane in Biogas (m^3/d)	611	1,596	2,207 [1]

Notes:
[1]. The baseline for biosolid production and biogas yield under Options 2-5.
[2]. The baseline for dewatering centrate produced under Options 2 and 4.
[3]. The baseline for dewatering centrate produced under Option 3.

3.1.3 Cost Analysis

The Do Nothing scenario sets out the basis for comparison. All base options derived hereafter are compared to the Do Nothing scenario using a change in cash flow over a 20-year period. It is assumed that the cost for Do Nothing will include the cost of upgrading the current digesters and undertaking gas cleaning. This will allow for an apples to apples comparison to the various option presented. The primary changes are then:

- Cost of investment, including engineering costs (15% of capital), permitting costs, the cost of capital and when it would be spent, increase/decrease in operating costs, revenues (primarily carbon based income), avoidance costs (tipping fees) and other cash flow impacts.
- Increase or decrease in the use of vehicles for transport of sludge or cake.
- Use of one set of digesters in any of the three potential locations.
- Diverting the SSO to one of the WWTP instead of contracting out (as one scenario).
- Gas cleaning general cost ($2,700,000).

The cost analysis is done with proformas and the final analytical number is Net Present Value (NPV) using a discount rate of 5%. For all capital work, estimates for installations are considered conservative , and a +- 15% factor has been included. These results are shown in the final NPV calculations Best (lowest cost and highest revenue) and Lowest (highest cost and lowest revenue).

Similarly, as there is a wide variance of carbon based gas prices ($15 to $25 per GJ), these variances have also shown additively in the Best and Lowest results.

Also of note, as many of the options are interlinked, some scenarios have been broken out (i.e., dewatering) to assess whether it is a cost-effective standalone option.

Detailed cash flow statements/pro-formas for all following scenarios are shown in Appendix 1.

3.2 Option 2 – Optimize Infrastructure at Cataraqui Bay

3.2.1 Description of Alternative

Based on the primary assessment of alternative stabilization technologies, the following options were developed for the upgrades to the solids treatment train at Cataraqui Bay WWTP:

- Option 2A – Expansion of the existing MAD process with capability to operate in TPAD.
- Option 2B – Expansion of the existing MAD process with the inclusion of BH ahead of MAD.

Each of the above two options is described further in the following sections. For the purpose of developing alternative sludge treatment options, the following assumptions were made:

- The blended sludge from the two plants was assumed to consist of 80% primary sludge and 20% WAS based on raw sludge generation quantities from the two plants;
- A typical three-day HRT for either thermophilic digester or BH system was assumed in evaluation; and
- The process equipment/footprint will be located on the existing site.

3.2.1.1 Option 2A – Upgrade Existing MAD to TPAD

TPAD utilizes the advantages of the greater thermophilic digestion rate, which is generally four times faster than mesophilic digestion. The process can be operated in either of two modes, thermophilic or mesophilic. The thermophilic phase is designed to operate at 50 - 60°C with a three to five-day HRT. Through greater hydrolysis and biological activity in the thermophilic phase, the system tends to enhance VSD and gas production as compared to single-phase mesophilic digestion. The mesophilic phase is designed to operate at 35°C with a ten-day or greater detention time (Metcalf & Eddy). The mesophilic phase provides additional VSD and conditions the sludge for further processing. TPAD process will also accomplish high pathogen kill to produce CP1 NASM biosolids.

The process upgrades for Option 2A would include:

1. Transporting dewatered primary sludge from Ravensview and blending with sludge generated at Cataraqui Bay.
2. One thermophilic digester with a capacity of 3-day HRT.
3. Two mesophilic digesters with a capacity of 15-day HRT each.
4. Operating the existing secondary digester as digested sludge holding tank.
5. Two dewatering centrifuges to handle digested sludge.

Figure 3-3 presents the process flow schematic of this option.

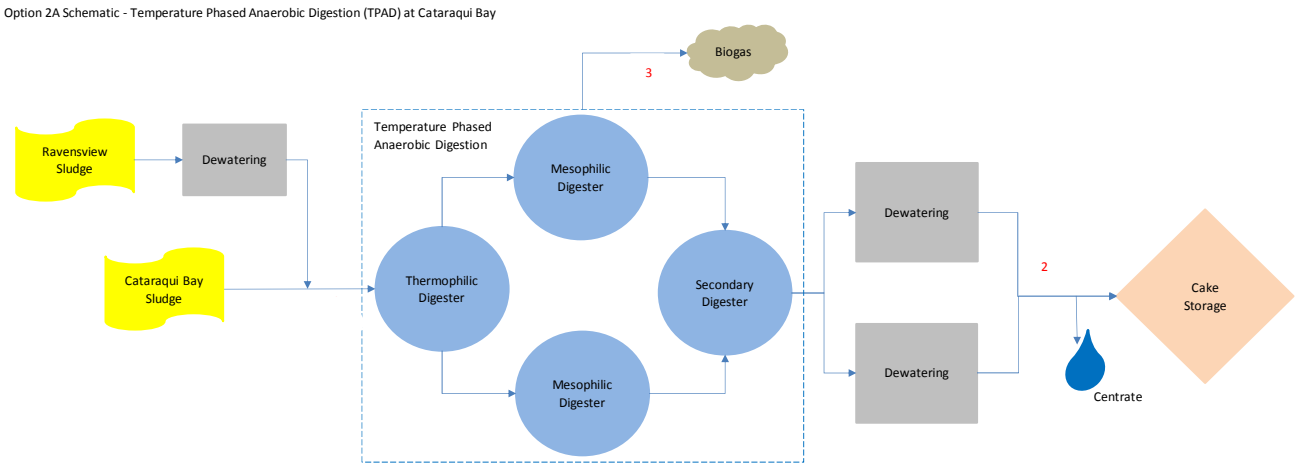


Figure 3-3 Upgrades to TPAD at Cataraqui Bay WWTP

3.2.1.2 Option 2B – Inclusion of BH with MAD

Biological hydrolysis (BH) has been shortlisted as a sludge pre-treatment technology in the preliminary assessment. A BH system provides similar process benefits as thermophilic digesters by breaking down complex compounds into simpler forms to enhance digestion efficiency. BH systems generally increase biogas yield from domestic sewage sludge by 25% or more and increase the capacity of existing digester infrastructure by two to three times. These systems consist of six serial reactor vessels in a plug-flow process (referred to as “Six-Pack” BH systems) whereby sludge is heated to 42°C in the first reactor. Over the course of progression through the remaining reactors, the temperature is reduced to between 35 - 40°C prior to entering into the mesophilic digesters. The overall HRT within the BH system is approximately three days.

To incorporate a BH system upfront of the existing MAD at Cataraqui Bay, Option 2B would require the following upgrades:

1. Transporting dewatered sludge from Ravensview and blending with sludge generated at Cataraqui Bay.
2. One “Six-Pack” BH system upfront of mesophilic digesters.
3. Two mesophilic digesters with a capacity of 15-day HRT each.
4. Operating existing secondary digester as digested sludge holding tank.
5. Two dewatering centrifuges to handle digested sludge.

Figure 3-4 exhibits a process flow schematic of Option 2B.

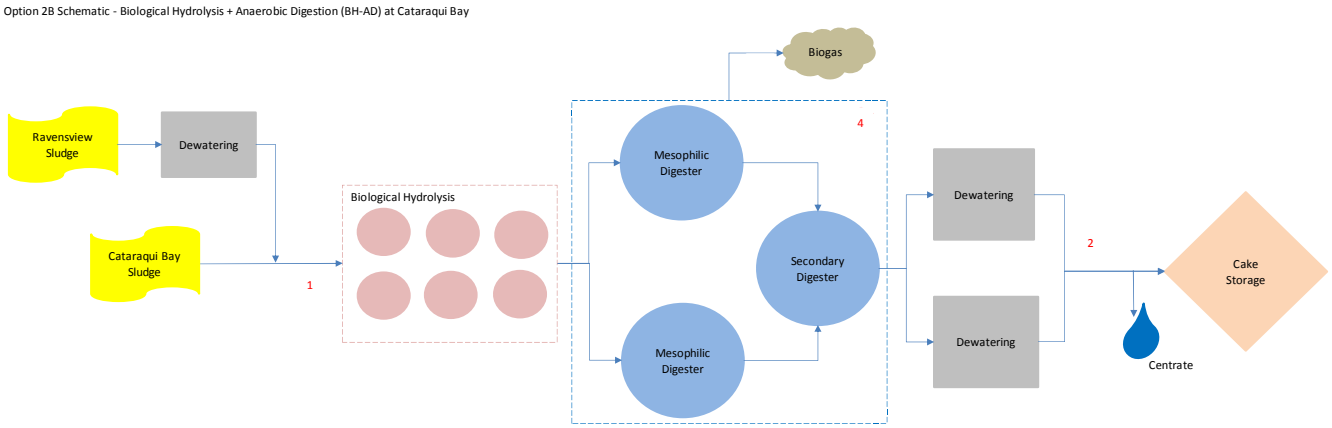


Figure 3-4 Upgrades with Addition of BHP at Cataraqui Bay WWTP

3.2.2 Impact on Existing Facilities

3.2.2.1 Biosolid and Biogas Production

Table 3-2 lists biosolid production and biogas yield under Option 2A and Option 2B side by side. Both processes could enhance downstream digester efficiency and biogas yield. With the multi-phase digestion process, the first step of anaerobic digestion is recognized to be the rate-limiting step. Through enhanced hydrolysis and biological activity in either thermophilic or BH step, the overall digestion tends to have greater VSD and gas production.

Option 2B (BH-AD) is expected to produce less biosolids (24 m^3/d) and more biogas (4,408 m^3/d) than Option 2A (TPAD). Unlike TPAD, which operates as a complete-mixed reactor, the BH system operates in a batch hold process, where only a portion of sludge in each reactor is transferred forward once per hour. This plug-flow fashion within the BH system ensures that all sludge spends the majority of the design HRT within the BH vessels, thereby being fully hydrolyzed and acidified prior to digestion. Thus, BH-AD tends to provide a higher VSD than TPAD. Commercial pilot results and literature data suggest that typical VSD for TPAD is 50% while BH-AD could achieve 54% VSD.

From a mass balance point of view, biogas yield is proportional to the amount of VS destroyed biochemically. The gas production rate of a typical anaerobic digester treating a combination of primary sludge and WAS should be approximately 0.8 to 1 m3/kg of VS destroyed. Specific gas production from the two plants was determined based on the historical plant performance data of VSD, since the amount of gas produced is a function of temperature, HRT, and VS loading. The specific gas production rate of 1.65 m3/kg of VS and 1.47 m3/kg of VS were used for primary sludge and WAS, respectively, to feature the sewage sludge produced in the two plants. The two main constituents of biogas are methane (CH4) and carbon dioxide (CO2). Literature suggests that typical CH4 concentration should be 60% to 70% by volume (MOP 8). Hence, 65% of CH4 in biogas was used for estimating the biogas yield under different options.

Table 3-2 Estimated Biosolid and Biogas Production for Options 2A and 2B

Feedstock	Option 2A TPAD	Option 2B- BH-AD
Volume (m^3/d)	116	116
TS Loading (kg/d)	10,051	10,051
VS Loading (kg/d)	7,285	7,285

Biosolids	Option 2A TPAD	Option 2B
Volume (m^3/d)	26	24
% Decreased Based on Option 1[1]	96%	92%
TS (kg/d)	6,408	6,117
VS in Cake (kg/d)	3,642	3,351
Nitrogen in Cake (kg/d)	192	184
Phosphorus in Cake (kg/d)	70	67

Centrate	Option 2A TPAD	Option 2B
Additional Centrate (m^3/d)[2]	28	29
Additional Nitrogen Loading (kg/d)	113	121
Additional Phosphorus Loading (kg/d)	86	89

Biogas	Option 2A TPAD	Option 2B
Biogas (m^3/d)	3,563	3,857
Methane in Biogas (m^3/d)	2,052	2,507
% Increased Based on Option 1[1]	106%	115%

Notes: [1] The percentages of decreased biosolid production and increased biogas generation are based on the biosolid/biogas production under Option 1 – Do Nothing.
[2] This is based on centrate generated in Catarqui Bay under current operating strategy

3.2.2.2 Operational Impact

With TPAD and BH-AD, the filamentous foaming issue is expected to be improved. The thermophilic step in the TPAD process requires attention to corrosion protection given the high temperature of operation and handling of high ammonia levels in the return flow. BH systems operate under milder conditions (i.e., temperature and pressure).

It should be noted that there would be an additional 28 to 29 m3/d of dewatering centrate from bringing primary sludge from Ravensview to Cataraqui Bay. This additional centrate containing high ammonia and phosphorus content may affect the treatment capacity of the existing plant liquid train. Although not being covered in this report, estimated nitrogen and phosphorus mass loadings are presented in Table 3-2. In the event that the additional organic loadings cannot be managed in the existing liquid treatment train, side-stream processing may be required to provide equalization for the dewatering centrate. This “add-on” side-stream process will need further evaluation based on the specific technology selected and design target VS destruction at the conceptual design stage.

3.2.2.3 Transportation and Footprint Requirements

Sludge generated from Ravensview will be dewatered and then trucked to Cataraqui Bay. Implementing either TPAD or BH-AD would require the same transportation effort. One truck haulage of 15 km per day is expected assuming a 40 m^3 truck is used.

Although the total tankage requirements for a "Six-Pack" BH system and one thermophilic digester are the same, the BH system would require a smaller footprint as compared to one thermophilic digester. The footprint for mesophilic digesters is the same for both systems because the designed HRT was assumed to be 15 days for the mesophilic stage across all options. In addition, as the existing centrifuge is to be decommissioned, two new centrifuges would be required for dewatering.

The following assumption was made for developing the biosolid storage requirements:

- The cake storage capacity is based on 180 days of biosolid storage during restricted land application period as outlined in Section 2.2.3;

The existing biosolids storage pad at Cataraqui Bay has recently been expanded with a capacity of 5,200 m^3 based on average day production. Option 2A and Option 2B would require a storage capacity of 4,680 m^3 and 4,320 m^3 for biosolid cake, respectively. Thus, the existing facility can provide sufficient capacity for biosolids generated under both options.

Table 3-3 Transportation and Footprint Requirements for Option 2A and 2B

	Option 2A TPAD	Option 2B BH-AD
	Transportation	
The volume of Dewatered Sludge	28	28
# of Trucks per Day*	1	1
Mileage (km)	15	15
	Biological Hydrolysis	
HRT (d)	-	3
# of Reactors	-	6
Required Footprint (m^2)	-	821
	Thermophilic Digester	
HRT (d)	3	-
# of Digesters	1	-
Required Footprint (m^2)	1,588	-
	Mesophilic Digester	
HRT (d)	15	15
# of Digesters	1	1
Required Footprint (m^2)	7,292	7,292
	Dewatering	
# of Units	2	2
Footprint (m^2)	600	600

	Option 2A TPAD	Option 2B BH-AD
Notes: * Based on 40m^3 of transportation capacity per truck.		

Based on the above comparison, Option 2B is recommended as a preferred option between these two.

3.2.3 Cost Analysis

Proforma analysis was done on both options (2A and 2B). The capital assumptions range from $9.8M to 13.3M for option 2A and 2B. This capital cost includes dewatering.

The NPV results from these are:

	Option 2A	Option 2B
Best	-$2,312,997	-$16,871
Lowest	-$12,601,479	-$10,870,603

These results confirm that Option 2B is financially stronger than Option 2A.

3.3 Option 3 – Optimize Infrastructure at Ravensview

3.3.1 Description of Alternative

Option 3 has a similar treatment process as Option 2B with the difference being that dewatered raw sludge is transported from the Cataraqui Bay WWTP for processing at Ravensview. This option is designed to serve as a location comparison to Option 2B. The following assumptions were made under Option 3:

- The blended sludge was assumed to consist of 80% primary sludge and 20% WAS based on raw sludge generation quantities from the two plants.
- No pre-thickening process is required prior to BH system.
- A typical three-day HRT for BH system was assumed for evaluation.
- All process equipment/footprint will be located on the existing site.

The process upgrades at Ravensview WWTP would include:

1. Transporting dewatered sludge from Cataraqui Bay and blending with sludge generated at Ravensview;
2. Replacing the existing thermophilic digester with a “Six-Pack” BH system upfront of mesophilic digesters as only two mesophilic digesters are needed;
3. Two mesophilic digesters with a capacity of 15-day HRT each (any two of the existing mesophilic digesters are needed, the rest can be spares); and
4. Operating the existing secondary digester as digested sludge holding tank;

Figure 3-5 represents a process flow schematic of Option 3.

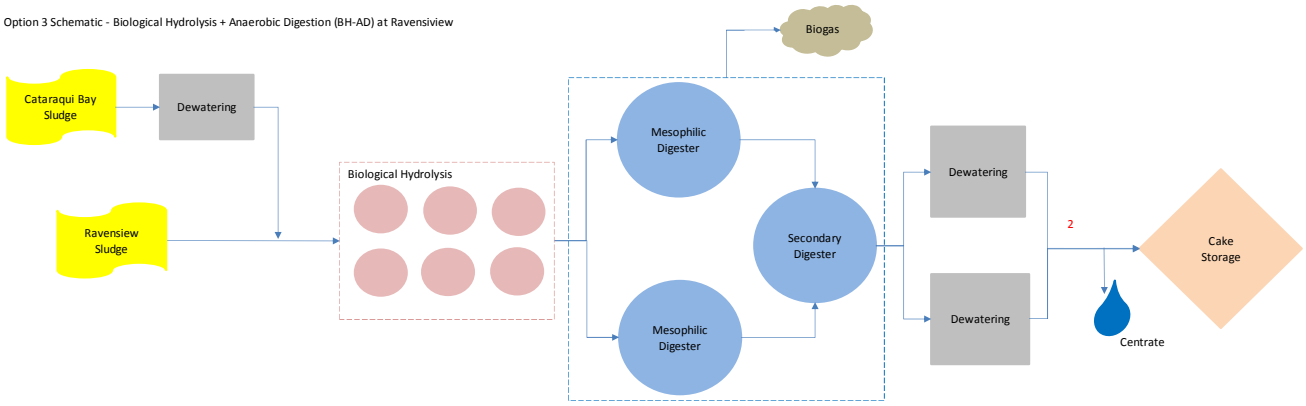


Figure 3-5 Upgrades of TPAD Process with Addition of BH system at Ravensview WWTP

3.3.2 Impact on Existing Facilities

3.3.2.1 Biosolid and Biogas Production

The treatment process of Option 3 is the same as Option 2B, therefore, biosolids production and biogas yield under this option are expected to be the same as Option 2B.

Table 3-4 Impact on Biosolid Production and Biogas Generation of Option 3

	Option 3 BH-AD
Feedstock	
Sludge Volume (m^3/d)	176
TS Loading (kg/d)	10,051
VS Loading (kg/d)	7,285
	Biosolids
Biosolids (m^3/d)	24
% Decreased Based on Option 1[1]	92%
TS (kg/d)	6,117
VS in Cake (kg/d)	3,351
Nitrogen in Cake (kg/d)	184
Phosphorus in Cake (kg/d)	67
Centrate	
Additional Centrate (m^3/d)[2]	4
Additional Nitrogen Loading (kg/d)	168
Additional Phosphorus Loading (kg/d)	91
	Biogas
Biogas (m^3/d)	4,408
Methane in Biogas (m^3/d)	2,865

	Option 3 BH-AD
% Increased Based on Option 1[1]	115%

Notes: [1] The percentages of decreased biosolid production and increased biogas generation are based on the biosolid/biogas production under Option 1 – Do Nothing.
[2] Based on centrate generated at Ravensview under current operating strategies

3.3.2.2 Operational Impact

With BH-AD, filamentous foaming is expected to be improved. BH systems require a lower operating temperature and pressure than the existing TPAD at the plant. Incorporating a BH system with mesophilic digesters could improve the stability of the digestion operation.

Bringing active sludge from Cataraqui Bay to Ravensview would result in an additional 4 m3/d of centrate returning back to the plant headworks. Though this volume is minimal, it contains a high level of nutrients (i.e., 168 kg/d of nitrogen and 91 kg/d of phosphorus) in the dewatering centrate. Managing this additional nutrient loading in the current wastewater treatment processes would pose a challenge to the plant's liquid train capacity. Although not being covered in this report, estimated nitrogen and phosphorus mass loadings are presented in Table 3-4. In the event that the additional organic loading cannot be managed in the existing liquid treatment train, an "add-on" side-stream process may be required as either a pre-treatment or a post-treatment step to handle the extra nutrient loadings from the dewatering centrate. A side-stream process would require further evaluation based on the specific technology selected and design target VS destruction at the conceptual design stage.

3.3.2.3 Transportation and Footprint Requirements

Sludge generated from Cataraqui Bay will be dewatered and trucked to Ravensview. Option 3 would require the same transportation effort as Option 2B. One truck haulage of 15 km per day is expected assuming 40 m^3 truck is used.

Implementation of a BH-AD process at Ravensview would require a larger footprint than Option 2B. Though the total dry solids under the two options is the same, the blended raw sludge at Ravensivew could only achieve 5.4% of TS, which means a much larger volume of feedstock as compared to Option 2B. The tankages for a BH system and mesophilic digesters are expected to be much larger than Option 2B in order to maintain the same HRT for digestion and achieve the same process performance.

The following assumption was made for developing the biosolid storage requirements:

- The cake storage capacity is based on 180 days of biosolid storage during restricted land application period as outlined in Section 2.2.3.

The existing enclosed biosolid cake storage pad at Ravensview has a capacity of 6,000 m^3. Similar to Option 2B, this option would require a storage capacity of 4,320 m^3 for biosolid cake. Thus, the existing facility can provide sufficient capacity for biosolids generated under both options.

Table 3-5 Transportation and Footprint Requirements for Option 3

	Option 3 BH-AD
	Transportation
The volume of Dewatered Sludge	12
# of Trucks per Day*	1

	Option 3 BH-AD
Mileage (km)	15
	Biological Hydrolysis
HRT (d)	3
# of Reactors	6
Required Footprint (m^2)	1,084
	Mesophilic Digester
HRT (d)	15
# of Digesters	1
Required Footprint (m^2)	10,957
	Dewatering
# of Units	2
Footprint (m^2)	600
Notes: * Based on 40m^3 of transportation capacity per truck.	

3.3.3 Cost Analysis

The Ravensview analysis indicates that capital costs range from $10,696,000 to $14,471,000 but operating costs are substantially lower due to decreased hauling cost of sludge from Cataraqui Bay. The NPVs for this option are:

	Ravensview
Best	$1,802,393
Lowest	-$9,363,205

This assumes that all RNG produced at the Ravensview site can be injected into the Union/Enbridge pipeline. As noted in Section 2.5, summer consumption rates of natural gas average 53 m^3 per day. Gas generation rates as noted in Section 3.3.2.1 above would average 2865 m^3/d or 119 m^3/hr. Based on this, the Ravensview location would not be suitable to attain the maximum carbon gas credits and would furthermore be more difficult to be able to absorb the range of peaks that are anticipated to be generated over time. As noted by Union/Enbridge there is a high pressure pipeline located 3.7 km away from Ravenview WWTP. At this time there is no data available on the downstream consumption but should the consumption rate be deemed acceptable then the option to locate at Ravensview (plus the cost of installing the pipe line) Is potentially viable.

3.4 Option 4 – Incorporate SSO at Cataraqui Bay

3.4.1 Description of Alternative

The operators of many WWTPs have found that they can increase the amount of biogas generated by accepting high-strength waste from outside sources that may not currently discharge to the treatment facility. According to the City of Kingston, there are about 4,000 wet tons per year of SSO collected through green bin program.

The following assumptions were made for this Option:

- The blended raw sludge from Cataraqui Bay and Ravensview were assumed to consist of 80% primary sludge and 20% WAS based on raw sludge generation quantities from the two plants.
- Typical values of 20% TS and 95% VS were assumed to determine volatile content in curbside SSO.
- Convertible COD in VS of SSO was assumed to be 1.35 kg COD/kg VS. Convertible COD in the combined feedstock were calculated proportional to the percentages of SSO, primary sludge and WAS in the feedstock.
- A typical three-day HRT for BH system was assumed in evaluation.
- Based on industrial experience at similar facilities, VSD% was assumed to be 80% for SSO. Combined VSD were used to estimate VS residual after digestion and biosolid production.

Based on the preliminary assessment of co-digestion at Cataraqui Bay, the upgrades under Option 4 would include:

1. Transporting dewatered sludge from Ravensview and blending with sludge generated at Cataraqui Bay.
2. One receiving station to pretreat SSO prior to digestion.
3. One “Six-Pack” BH system upfront of mesophilic digesters.
4. Two mesophilic digesters with a capacity of 15-day HRT each.
5. Operating existing secondary digester as digested sludge holding tank.
6. Two dewatering centrifuges to handle digested sludge.

Figure 3-6 represents a process flow schematic for Option 4.

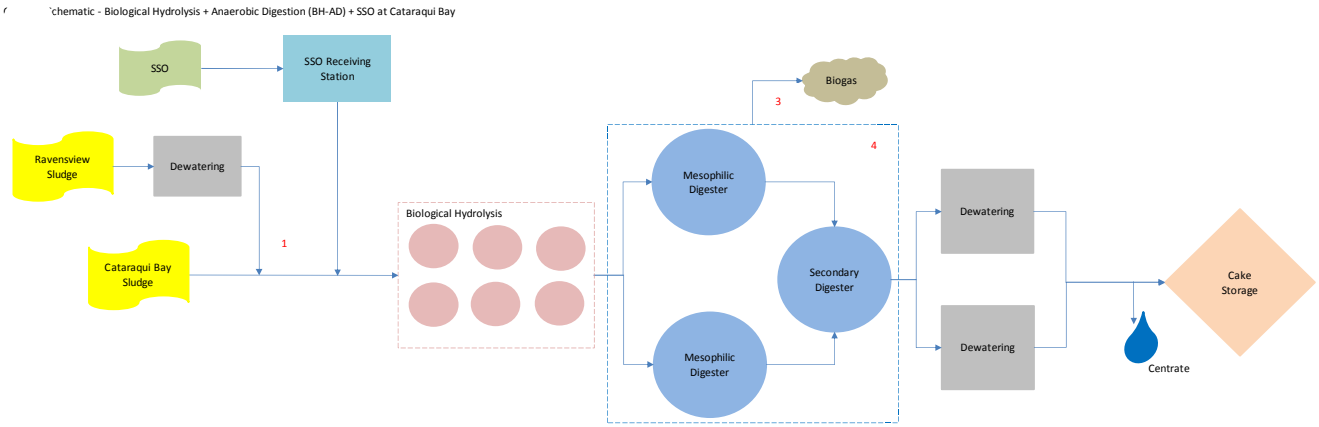


Figure 3-6 Incorporate SSO in Cataraqui Bay WWTP

3.4.2 Impact on Existing Facilities

3.4.2.1 Biosolid and Biogas Production

The BH process reduces the required HRT of sludge within digesters and enables the digesters to operate at a higher solids content. This allows for not only the indigenous sludge treatment to the WWTPs, but also the import of additional organic materials, such as high-strength liquid or food waste, and fats oils and grease. These wastes

have a high organic content and low inert-solids content, which make them ideal for co-digestion and generating biogas with limited effects on solids production.

Further to discussions with technology vendors, typical VSD for the digestion of SSO is about 80%. By co-digestion of SSO with municipal sludge at Cataraqui Bay, the overall VSD is expected to reach 60%. This translates to achieving the same amount of cake biosolid production with a 56% increase in biogas production.

Co-digestion of SSO would result in a further increase in dewatering centrate (36 m^3/d) returning back to the plant headworks. Though this volume is not considerable, it contains a high level of nutrients (i.e., 207 kg/d of nitrogen and 121 kg/d of phosphorus) in the dewatering centrate. Although not being covered in this report, the estimated nitrogen and phosphorus mass loadings are presented in Table 3-6. In the event that the additional organic loading cannot be managed in the existing liquid treatment train, an “add-on” side-stream process may be required as either a pre-treatment or a post-treatment step to handle the extra nutrient loadings from the dewatering centrate. The side-stream process would require further evaluation based on the specific technology selected and design target VS destruction at the conceptual design stage.

Table 3-6 Impact on Biosolid Production and Biogas Generation

Option 4 BH-AD + SSO		
	Feedstock	
	SSO	Sludge
Volume (m^3/d)	9	116
TS Loading (kg/d)	2,192	10,051
VS Loading (kg/d)	2,082	7,285
	Biosolids	
Biosolids (m^3/d)	27	
% Increased Based on Option 1*	0%	
TS (kg/d)	6,643	
VS in Cake (kg/d)	3,767	
Nitrogen in Cake (kg/d)	199	
Phosphorus in Cake (kg/d)	73	
	Centrate	
Additional Centrate (m^3/d)	36	
Additional Nitrogen Loading (kg/d)	160	
Additional Phosphorus Loading (kg/d)	88	
	Biogas	
Biogas (m^3/d)	5,969	
Methane in Biogas (m^3/d)	3,880	
% Increased Based on Option 1*	156%	

Notes: * The percentages of decreased biosolid production and increased biogas generation are based on the biosolid/biogas production under Option 1 – Do Nothing.

3.4.2.2 Operational Impact

1. Receiving Station

Co-digestion of SSO can add significant operational complexity for operators and facility managers. A receiving station with solids handling and pretreatment equipment for SSO will be required. Typically, this pretreatment equipment includes a tipping floor, loaders, feed hoppers, conveyors, bag breakers, screens, a magnetic separator, etc. In most circumstances, preparatory equipment, i.e., preprocessing units are also required to pulp SSO organics prior to entry into the digesters. One alternative may be to have this activity undertaken at another facility (privately or publicly owned and operated), and to have the pulped material shipped to the WWTP.

Operating a receiving facility presents a unique staffing requirement for operation and maintenance because of the nature of the materials. Management starts with scheduling deliveries, supervising off-loading, and tipping off non-organic compounds – all potential time-consuming tasks. Especially for grease trap wastes, it can be challenging for operators. Grease not only clogs pipes, heat exchangers, and pumps but also adheres to inert debris, making it difficult to use screening for removal. It may require extra staffing efforts for SSO screening prior to acceptance.

2. Infrastructure Maintenance

Maintenance requirements increase because of the nature of SSO. For example, pipes, heat exchangers, and other equipment need to be cleaned more frequently. The short-and long-term capacity of the treatment facility to receive additional material will require further evaluation prior to implementation of this option.

3. Nutrient Handling

Typically, SSO comes with high-protein fraction which can significantly increase ammonia concentrations in the dewatering liquid. Additional treatment processing may be required as either a pretreatment or a posttreatment step to handle the additional loadings and volumes from dewatering centrate. High phosphorus concentration in SSO may contribute to struvite formation and increase chemical consumption for the additional phosphorus removal. SSO with a high sulfur content can result in more hydrogen sulfide produced in the digester and can complicate gas cleaning.

4. Odor Control

Odors originating from the SSO and digested gas is one of the most important yet challenging aspects of a solids handling facility. In solid treatment processes, the biosolids commonly undergo extreme turbulence, pH adjustment and/or thermal treatment. Depending on the nature of the SSO and the solid treatment used, the odor compounds released can consist of any combination of ammonia, amines, hydrogen sulfide, and organic sulfides in a wide range of concentrations.

Although SSO organics will remain in a contained environment, strategies for odor management are required to reduce additional odor concerns to the neighborhood. In any evaluation of the treatment of odor, many factors need to be taken into consideration: loadings of “organic” odors, variability, process conditions and labor costs.

3.4.2.3 Transportation and Footprint Requirements

It has been assumed that the dewatered sludge from Ravensview and the SSO collected from curbside wastes would be trucked to Cataraqui Bay to one centralized solid treatment facility. Based on potential SSO quantities, additional transportation and traffic management efforts would be required including: hours of operation, truck accessibility; on-site traffic management; and storage capacity requirements.

This option would require a SSO receiving station to house the pre-processing equipment/system. A typical SSO receiving station consists of a tipping floor, pre-processing system which opens plastic bags, hydrapulper and grit removal system, and buffer tank.

Compared with Option 2B, mesophilic digesters will require an additional 1,500m^2 to accommodate the co-digestion with SSO. The increase of the footprint would be negligible.

In addition, as the existing centrifuge is to be decommissioned, two new centrifuges would be required for dewatering.

The existing biosolid storage pad at Cataraqui Bay has recently been expanded with a capacity of 8,200 m^3. Option 4 would require a storage capacity of 4,860 m^3 for biosolid cake. Thus, the existing facility can provide sufficient capacity for biosolids generated under this option.

Table 3-7 Transportation and Footprint Requirements for Option 4

Option 4 BH-AD + SSO	
Transportation	
Volume of Dewatered Sludge	37
# of Trucks per Day [1]	1
Mileage (km)	15
SSO Receiving Station	
Required Footprint (m^2)	2,000
Biological Hydrolysis	
HRT (d)	3
# of Reactors	6
Required Footprint (m^2)	861
Mesophilic Digester	
HRT (d)	15
# of Digesters	1
Required Footprint (m^2)	8,832
Dewatering	
# of Units	2
Footprint (m^2)	600
Cake Storage [2]	
Volume (m^3)	4,860
Additional Footprint (m^2)	Not Required

Notes:
[1] Based on 40m^3 of transportation capacity per truck.
[2] The cake storage capacity is based on 180 days of biosolid storage during restricted land application period as outlined in Section 3.2.3.

3.4.3 Cost Analysis

This analysis was done with the most favourable candidate (2B), but the results of the analysis can be applied to any of the options.

The added SSO capital cost for this option is $7,594,000, and there are added costs for personnel and utilities. The initial quantity of SSO that was used for comparison is 4,000 tonnes per year, which represents the amount of SSO generated from Kingston's curbside collection. This option assumes the cost of disposal for SSO would be diverted to the project revenue. The change in NPV is shown below:

Table 3-8: Change in NPV

	Option 2B with SSO	Option 2B
Best	$1,898,944	-$16,871
Lowest	-$12,456,670	-$10,870,603

Based on this comparison, the addition of 4,000 tonnes of curbside-generated SSO is recommended, primarily due to the offset cost of processing SSO with the existing contract. If this quantity is increased, from other potential sources (i.e. ICI streams within Kingston), the outcome would be:

Table 3-9: Outcome from Potential other Sources

	2B with 4000 Tonnes SSO	2B with 5000 Tonnes SSO	2B with 6000 Tonnes SSO	2B with 8000 Tonnes SSO	2B with 10,000 Tonnes SSO	2B with 12,000 Tonnes SSO
Best	$1,898,944	$1,898,944	$8,161,047	$14,423150	$20,685,253	$26,947,356
Lowest	-$12,456,670	-$9,980,184	-$7,503,699	-$2,550,727	$2,402,244	$7,355,216

The improvement of NPV is derived from two incremental factors. These are revenue derived from tipping fees, and an increase in the generation of RNG. No increase in capital is required for the incremental throughput. The comparisons assume that the increased tonnages carry tipping fees similar to that of the current cost to dispose SSO.

3.5 Option 5 – Integrate Processing of Biosolids and SSO at Knox Farms

3.5.1 Description of Alternative

Option 5 involves the "green-field" construction of a new SSO resource recovery and co-digestion facility at Knox Farms. Option 5 has the same process flow as Option 4 but lacking an existing liquid treatment process train.

The following assumptions were applied to this Option:

- The blended dewatered sludge from Cataraqui Bay and Ravensview was assumed to consist of 80% primary sludge and 20% WAS based on raw sludge generation quantities from the two plants.
- Typical values of 20% TS and 95% VS were assumed to determine volatile content in curbside SSO.
- Convertible COD in VS of SSO was assumed to be 1.35 kg COD/kg VS. Convertible COD in the combined feedstock were calculated proportional to the percentages of SSO, primary sludge and WAS in feedstock.
- A typical three-day HRT for BH system was assumed in evaluation.

- Based on industrial experience at similar facilities, VSD% was assumed to be 80% for SSO. Combined VSD were used to estimate VS residual after digestion and biosolid production.
- All process equipment/footprint will be located within the property boundary of Knox Farm.

The major process components at Knox Farms would include:

1) One receiving station for pre-processing of SSO.
2) Transporting SSO and dewatered sludge from WWTPs to Knox Farm and blending it in a sludge blending tank.
3) An optional “Six-Pack” BH system upfront of mesophilic digestion.
4) Two mesophilic digesters with a capacity of 15-day HRT each.
5) One secondary digester served as digested sludge holding tank.
6) Two dewatering centrifuges to handle digested sludge and store biosolid cake on site.
7) Transporting out dewatering centrate to WWTPs.

Alternatively, after digestion (Step 5 above), the digested sludge would be utilized by local farmers in a liquid form (see process flow in red dashed line shown in Figure 3-8).

Figure 3-7 illustrates a process flow schematic for Option 5.

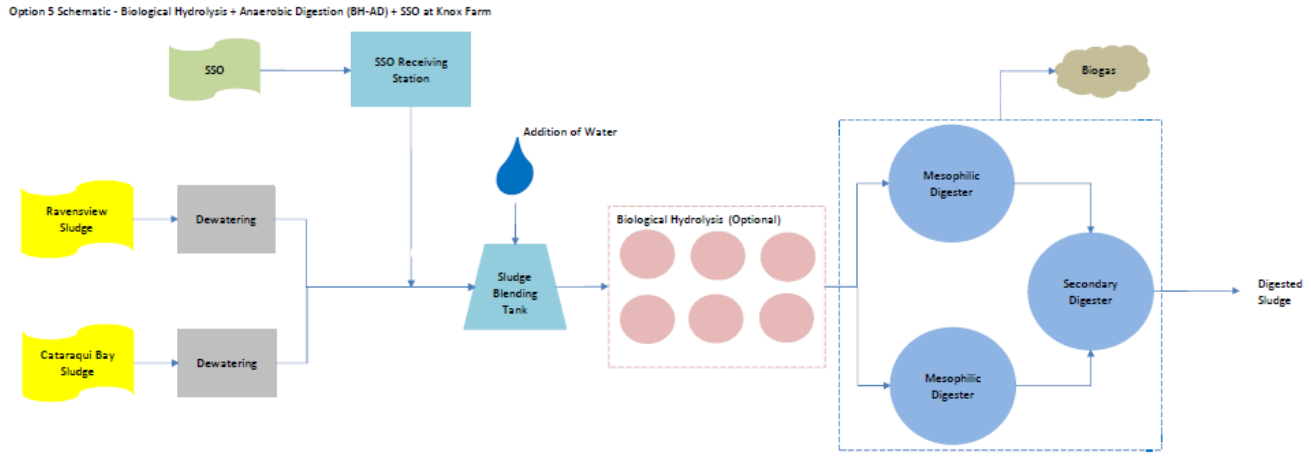


Figure 3-7 SSO Resource Recovery and Co-digestion Process at Knox Farm

3.5.2 Impact on Existing Facilities

3.5.2.1 Biosolids and Biogas Production

The co-digestion process is similar to Option 4, therefore, biosolids production and biogas yield under this option are expected to be similar with same biosolids production and a 56% increase in the generation of biogas.

The 4,000 wet tonnes of SSO collected within the City of Kinston only accounts for a small portion of the whole feedstock. The overall VSD could not be improved significantly. Higher VSD and greater biogas yield would be anticipated if increase the percentage of SSO in the feedstock.

As shown in Table 3-, 75 m^3/d of liquid would be used for pulping and solid mixing. It can be recirculated through the system to minimize the use of potable water. Additionally, rainwater from the facility's downspouts could be harvest for process water needs, further reducing the use of potable water.

Table 3-10: Impact on Biosolid Production and Biogas Generation of Option 5

Option 5 BH-AD + SSO			
	Feedstock		
	SSO	Dewatered Sludge	Liquids
Volume (m^3/d)	9	40	75
TS Loading (kg/d)	2,192	10,051	-
VS Loading (kg/d)	2,082	7,285	-
	Biosolids		
Biosolids (m^3/d)	27		
% Increased Based on Option 1*	0%		
TS (kg/d)	6,643		
VS in Cake (kg/d)	3,767		
Nitrogen in Cake (kg/d)	199		
Phosphorus in Cake (kg/d)	73		
	Centrate		
Additional Centrate (m^3/d)	98		
Additional Nitrogen Loading (kg/d)	207		
Additional Phosphorus Loading (kg/d)	121		
	Biogas		
Biogas (m^3/d)	5,969		
Methane in Biogas (m^3/d)	3,880		
% Increased Based on Option 1*	156%		

Notes: * The percentages of decreased biosolid production and increased biogas generation are based on the biosolid/biogas production under Option 1 – Do Nothing.

3.5.2.2 Operational Impact

Co-digestion of SSO with sewage sludge would result in the substantial amount of N & P loadings from the facility dewatering liquid, i.e., 207 kg/d of nitrogen and 121 kg/d of phosphorus. There is no liquid treatment on site. As shown on Figure 3-8, three options are available to manage the digested sludge and potential high strength centrate:

1. Option 1: Distribute the digested sludge as liquid fertilizer for local land application. Experiences collected from other municipalities in Ontario, e.g., Halton Region, City of Barrie, and Brantford, suggest that liquid digestate

is one of the favorable options for many farmers due to the ease of handling. In some cases, digestates are distributed and stored in individual farms due the demand exceeds the supply.

2. Option 2a: Dewater digestate and store the digested sludge as biosolids cake. The centrate from dewatering process can be trucked out to one of the two existing WWTPs for further treatment. Additional loading to the existing treatment plant(s) must be evaluated.

3. Option 2b: Dewater digestate and store the digested sludge as biosolids cake. Construct a complete on-site wastewater treatment process to treat the liquid stream and discharge it to local sewer.

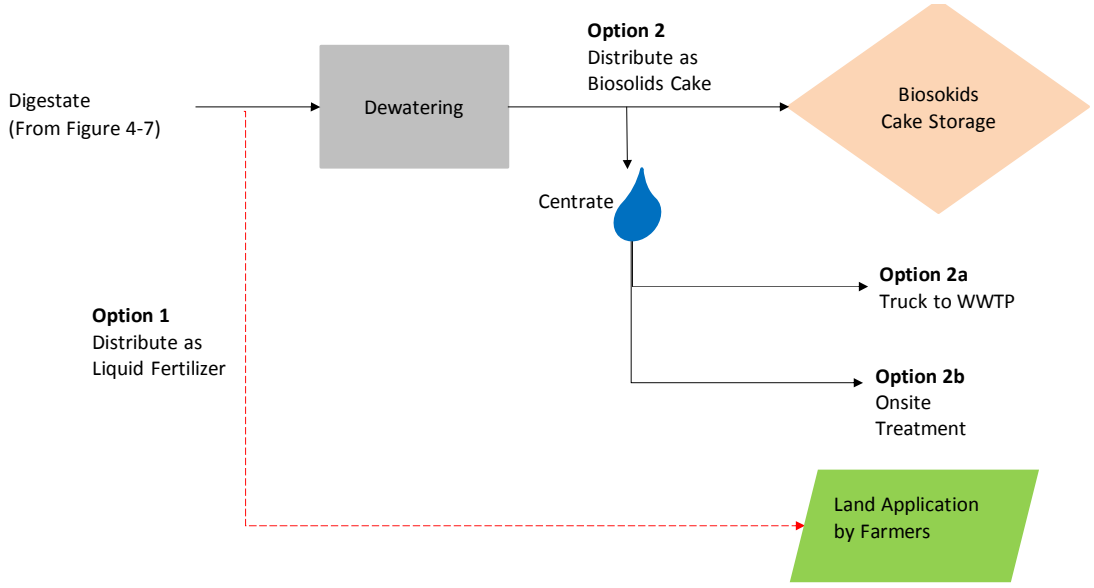


Figure 3-8 Flow chart - Options for Biosolids Residual Management at Knox Farm

3.5.2.3 Transportation and Footprint Requirements

This centralized treatment site could have a large impact on the overall disposal and transportation costs. The dewatered sludge from Ravensview and Cataraqui Bay would require two trucks per day and additional distance by hauling SSO and dewatered sludge to this location. Similar as Option 4, additional transportation effort and traffic management will be required for curbside wastes collection and process: the potential SSO quantities, the necessary hours of operation, truck accessibility issue, on-site traffic management needs, and storage capacity requirements.

Similar as in Option 4, co-digestion of SSO at a different location would require the same footprint for BH system and mesophilic digesters.

If the digested sludge is stored as biosolid cake, storage capacity is based on 180 days of biosolid storage during restricted land application period. The new facility would provide a storage facility with a capacity of 4,860 m^3 for biosolid cake.

Table 3-11: Transportation and Footprint Requirements for Option 5

Option 5 BH-AD + SSO	
	Transportation
Volume of Dewatered Sludge	40
# of Trucks per Day [1]	2
Mileage (km)	30
	SSO Receiving Station
Required Footprint (m^2)	2,000
	Biological Hydrolysis
HRT (d)	3
# of Reactors	6
Required Footprint (m^2)	861
	Mesophilic Digester
HRT (d)	15
# of Digesters	1
Required Footprint (m^2)	8,832
	Dewatering
# of Units	2
Footprint (m^2)	600
	Cake Storage [2]
Additional capacity (m^3)	4,860
Footprint (m^2)	1,800

Notes:
[1]Based on 40m^3 of transportation capacity per truck.
[2]Storage capacity is based on 180 days of biosolid storage during restricted land application period as outlined in Section 2.2.3.

3.5.3 Cost Analysis

The cost of constructing a new plant, initially thought to be located at the city owned Knox Farms site would include new digesters, a new office/maintenance/personnel building, a cake storage building, and some civil works. This cost was compared to Option 2B, with the addition of an estimated $10M in retrofit costs of the digesters located at Cataraqui Bay. The result of comparing 2B with SSO with Knox Farms with SSO (both at 4000 tpy) is as follows:

Table 3-12: Comparing 2B with SSO with Knox Farms with SSO Results

	Option 2B with retrofit	Option 5 (alternative site)
Best	-$7,820,876	-$8,149,455
Lowest	-$25,607,015	-$25,467,796

This comparison indicates that when one includes the cost of the digester upgrade at Catarqui Bay to building a new plant, the outcome is very similar. While Knox Farms was originally contemplated as the alternative site, a

more suitable site may be close to the existing Kingston MRF as it will be close to existing utilities (sewer/water). The cost to bring the utilities to Knox Farms was not included in the comparison.

4.0 FINANCIAL ANALYSIS OF ALTERNATIVES

Tetra Tech also undertook analysis of other options outside the technical alternatives noted above. One option that was included in the scenarios noted above was the aspect of dewatering. Dewatering can be undertaken with all the noted options , including the "Do Nothing" Option. To understand the impact of dewatering a comparison was done with the stand alone 2B option with and without SSO. The NPV results were:

Table 3-13: Comparison with the Stand Alone 2B Option with and without SSO

	2B w Dewatering	2B w/o Dewatering	2B w SSO and Dewatering	2B w SSO and w/o Dewatering
Best	-$16,871	-$5,885,313	$1,898,944	-$4,668,403
Lowest	-$10,870,603	-$15,335,648	-$12,456,670	-$17,620,621

These results indicate that dewatering has a significant positive impact on the options, primarily due to the decreased cost of transport with the current hauler by the cubic meter.

In addition to the analysis done for the specific alternatives noted above, analysis was done on other alternatives/initiatives which can be done in addition to or independent of the specific selection of an option. These are shown below.

4.1 Alternative Biogas Utilization Options

As has been shown, methane generation for all the options is dependent on technology improvements and the addition of more organics (SSO). The following shows the different generation rates:

Table 4-1: Different Generation Rates

	Option 1 Do Nothing	Option 2A TPAD	Option 2B BH-AD	Option 3 Ravensview	Option 4 SSO added (4000 tpy)	Option 5 Alternative Site
Methane Generation m^3/day	2,201	2,346	2,865	2,865	3,880	3,880

The variable addition of SSO also has an impact on Methane Generation as shown below (with Option 2B):

Table 4-2: Different Generation Rates (SSO with Option 2B)

	No SSO	4000 tpy	5000 tpy	6000 tpy	8000 tpy	10,000 tpy	12,000 tpy
Methane Generation m^3/day	2,865	3,880	4,133	4,387	4,895	5,402	5,910

Tetra Tech also reviewed the alternative of producing electricity instead of RNG pipeline injection. This would include the installation of a larger or additional gas engine (i.e., at Ravensview). The NPV results of this were:

Table 4-3: NPV Results (Electricity Produced)

Level	2B RNG to pipeline	2B Electrical Production
Best	-$16,871	-$4,733,623
Lowest	-$10,870,603	-$15,587,355

Based on this comparison, pipeline injection is the favoured option over the implementation of new electrical production.

4.2 Analysis of Other Options

Tetra Tech also reviewed other options that should be considered. As an example, if UK could attain grants from federal and/or provincial programs, this could make any of the options more attractive. As an example, using the Option 2B scenario with SSO (4,000 tpy) the following was the outcome with incremental grants of $1M.

Table 4-4: Attaing Grants (Option 2B Scenario)

Level	2B with SSO	2B with SSO and $1M grant	2B with SSO and $2M grant	2B with SSO and $4M grant
Best	$1,898,944	$2,938,497	$3,978,050	$6,057,156
Lowest	-$12,456,670	-$11,417,117	-$10,377,564	-$8,298,458

With the recommendation to consolidate gas production in one facility, another initiative that was investigated was to have UK haul both sludge and cake (if required) between facilities. The initiative would involve the purchase of a new dedicated hauling truck, hiring of two drivers, and included the cost of fuel and maintenance for the vehicle if driven five days a week. The outcome of this analysis was:

Table 4-5: Consolidation into One Facility

Level	2B with Contract Haulage	2B with Truck Purchase	2B with 4000 T SSO with Contract Haulage	2B with 4000 T SSO with Truck Purchase
Best	-$16,871	$1,668,856	$1,898,944	$5,138,564
Lowest	-$10,870,603	-$9,314,989	-$12,456,670	-$9,347,164

In all cases, the financial impact is positive where in-house trucking is undertaken. The financial impact of dewatering will change if internalized trucking is implemented.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the technical and financial analysis Tetra Tech can provide recommendations toward potentially attractive scenarios for UK. As can be noted, the scenarios can be complex and interweave with alternatives. The key points that are drawn from the analysis are:

- Option 2B, Biological Hydrolysis is recommended regardless of its location (Cataraqui Bay, Ravensview, or another location). The process generates more gas, less cake, and allows SSO to be added effectively into the digestion process. This process, also known as the Suez/GE process, has shown great success in other locations, and is currently being installed in Stratford Ontario.

- RNG injection to pipeline is recommended over increased electrical production or CNG as the carbon premium is significantly higher in value. Both BC's and Quebec's utility groups have indicated interest in purchasing the

RNG carbon value. If UK determines to pursue this, negotiations with the two respective utilities should commence as soon as possible.

- Cataraqui Bay is favoured over Ravensview since the summer natural gas consumption downstream of Ravensview is significantly lower than what will be generated.
- Continuing dewatering is recommended for any of the selected sites.
- When comparing upgrading the Cataraqui Bay digesters, the selection of an alternative site is considered equal in terms of financial value. Knox Farms is not recommended due to the lack of utilities at the site.
- The addition of SSO is financially viable for the organics generated from curbside in Kingston. Higher financial returns are forecast for the receipt of other organics such as ICI organics generated from the Kingston area.. If SSO is included in the process, UK will have to undergo a standard EA/ECA process normally associated with solid waste faculties.
- Consideration should be given to use the Ravensview digestors in the interim while the decision to repair the Catarqui Bay digestors is made. If the high pressure gas line near Ravensview is deemed appropriate with load capacity, this may become the most feasible long-term option.
- In-house trucking of sludge is recommended to decrease the haulage cost.
- It is highly recommended that UK pursue federal or provincial grant programs as funding from these senior levels of government would have significant impact on the financial viability of the respective options.

5.1 The Next Steps

Tetra Tech has laid out the most favourable options based on both practical and fiscally advantageous analysis. These recommendations should then be balanced against the objectives of the city and UK itself. Key to having the best outcome would be to ascertain how to gain the best financial results for any decision made by UK. These then are:

- Determine what federal and provincial programs may be available to offset both capital investment and continuing operating costs. Its has been shown that any potentially green grant programs will improve the return on investment that the utility may incur.
- Start discussions with both Fortis and Energis to determine how UK can gain the best potential price for RNG to be injected into the pipeline. Similarly, while the Cap and Trade program has potentially decreased the impetus for the Ontario Union/Enbridge drive to increase RNG content in its pipeline, the utility has indicated an interest to potentially partner on RNG projects or parts thereof.
- Undertake stakeholder discussions within the City of Kingston to ascertain how the outcome of this study align with the direction that the City has developed with the new council.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01

Prepared by:
Rob Hegedus
Project Manager
Solid Waste Management Practice
Direct Line: 226.34.4381
Rob.Hegedus@tetratech.com

FILE: 704-SWM.SW OP03442-01
FILE: 704-SWM. SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SW OP03442-01
FILE: 704-SWM. SWOP03442-01
FILE: 704-SWM.SWOP03442-01

Reviewed by:
Peter Klaassen, P.Eng.
Vice President – Ontario Division
Solid Waste Management Practice
Direct Line: 226.203.5209
Peter.Klaassen@tetratech.com

FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01

Reviewed by:
José Velazquez
Senior Engineer
Biosolids Technical Lead
Direct Line: 720.931.9345
Jose.Velazquez @tetratech.com

FILE: 704-SWM.SW OP03442-01
FILE: 704-SWM. SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01
FILE: 704-SWM.SWOP03442-01

Reviewed by:
David Walmsley, RPP, MCIP, EP
Senior Consultant – Ontario Division
Solid Waste Management Practice
Direct Line: 519.803.1783
David.Walmsley@tetratech.com

/mj

APPENDIX 1

MASTER PLAN EQUIPMENT COSTS

1.0 INTRODUCTION TO SCENARIOS

A financial analysis was completed on the possible treatment scenarios. The scenarios included in the analysis are presented in Table 1. The assumptions that were used to create these scenarios are further described in Table 2.

Table 1: Scenario Descriptions

Scenario Number	Scenario Name	Description
1	Do Nothing	No new treatment technologies but upgrade digesters and bring dewatered sludge from Ravensview
2A	Cataraqui Bay TPAD	Bring dewatered sludge from Ravensview to Cataraqui Bay, and treat blended sludge at Cataraqui Bay
2B	Cataraqui Bay BH-AD	Bring dewatered sludge from Ravensview to Cataraqui Bay, and treat blended sludge at Cataraqui Bay (same as 2A)
3	Ravensview BH-AD	Bring dewatered sludge from Cataraqui Bay to Ravensivew, and treat blended sludge at Ravensview (need additional dewatering before AD process)
4	Cataraqui Bay c/w SSO	Bring dewatered sludge from Ravensview and SSO to Cataraqui Bay, and treat blended sludge at Cataraqui Bay
5	Knox Farm c/w SSO	Bring dewatered sludge from Ravensview and Cataraqui Bay, and SSO to Knox Farm, and treat blended sludge at Knox Farm (need to dilute the dewatered sludge before AD process)

Table 2: Facility Costs and Assumptions

	Option 1 - Do Nothing	Option 2A - Cataraqui Bay TPAD	Option 2B - Cataraqui Bay BH-AD	Option 3 - Ravensview BH-AD	Option 4 - Cataraqui Bay c/w SSO	Option 5 - Knox Farm c/w SSO
	Treat sludge at two plants separately (as-is now)	Bring dewatered sludge from Ravensview to Cat Bay, and treat blended sludge at Cat Bay	Same as 2A	Bring dewatered sludge from Cat Bay to Ravensivew, and treat blended sludge at Ravensview (need additional dewatering before AD process)	Bring dewatered sludge from Ravensview and SSO to Cat Bay, and treat blended sludge at Cat Bay	Bring dewatered sludge from Ravensview and Cat Bay, and SSO to Knox Farm, and treat blended sludge at Knox Farm (need to dilute the dewatered sludge before AD process)
Feed Stock (sludge + SSO)						
TS%	4.0	8.0	8.0	5.4	8.0	20.0
TS (kg/d)	10,051	10,051	10,051	10,051	12,242	12,242
VS%	72.5	72.5	72.5	72.5	76.5	76.5
VS (kg/d)	7,285	7,285	7,285	7,285	9,367	9,367
Transportation						
Volume of dewatered sludge	-	28	28	12	37	40
Volume of Truck (m3)		40	40	40	40	40
Milage (km)		15	15	15	15	30
# of Trucks/d	-	1	1	1	1	2
SSO Receiving Station						
Footprint (m2)	-	-	-	-	2000 (50 x 40 m)	2000 (50 x 40 m)
Capital Cost ($) - Equipment Only	-	-	-	-	$ 2,400,000	$ 2,400,000
Capital Cost ($) - Civil and Structural					$ 4,500,000	$ 4,500,000
Operating Cost ($/y)	-	-	-	-	$ 420,000	$ 420,000
BHP (6 packs)						
HRT (d)	-	-	3	3	3	3
# of Units	-	-	6	6	6	6
Footprint (m2)	-	-	821	1084	861	861
Thermophilic Digesters						
HRT (d)	-	3	-	-	-	-
# of Units	-	1	-	-	-	-
Footprint (m2)	-	1588	-	-	-	-
Mesophilic Digesters						
HRT (d)	15	15	15	15	17	17
VSD%	47%	50%	54%	54%	60%	60%
Biogas Volume (m3/d)	3,831	4,071	4,408	4,408	5,969	5,969
% Increased	100%	106%	115%	115%	156%	156%
CH4 generated (m3/d)	2,207	2,346	2,865	2,865	3,880	3,880
# of Digesters	-	1	1	1	1	1
Footprint (m2)	-	7,292	7,292	10,957	8,832	8,832
Capital Cost ($) - Equipment Only	-	$ 1,600,000	$ 1,600,000	$ 2,000,000	$ 1,800,000	$ 1,800,000
Capital Cost ($) - Civil and Structural		$ 2,400,000	$ 2,400,000	$ 3,000,000	$ 2,700,000	$ 2,700,000
Operating Cost ($/y)	$ 200,000	$ 250,000	$ 230,000	$ 250,000	$ 240,000	$ 240,000
After Dewatering						
Cake TS (kg/d)	7,788	6,408	6,117	6,117	6,643	6,643
% Decreased	100%	96%	92%	92%	100%	100%
Volume of Cake (m3/d)	27	26	24	24	27	27
Cake VS (kg/d)	3,887	3,642	3,351	3,351	3,767	3,767
Supertenant (m3/d)	209	90	91	152	98	98
Additional Supertenant (m3/d)	-	28	29	4	36	98
Additional Loading as N (kg/d)	-	113	121	168	160	207
Additional Loading as P (kg/d)	-	86	89	91	88	121
# of Units	-	2	2	2	2	2
Footprint (m2)	-	1200 (40x 30m)	1200 (40x 30m)	1200 (40x 30m)	1200 (40x 30m)	1200 (40x 30m)
Capital Cost ($) - Equipment Only	-	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
Capital Cost ($) - Civil and Structural		$ 3,000,000	$ 3,000,000	$ 3,000,000	$ 3,000,000	$ 3,000,000
Operating Cost ($/y)	-	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
Cake Storage						
Footprint (m2)	-	-	-	-	-	1,800
Capital Cost ($)	-	-	-	-	-	$ 4,500,000
Operating Cost ($/y)	-	-	-	-	-	$ 6,000

2.0 DESCRIPTION OF PRO FORMA ANALYSIS

A Pro Forma analysis was completed to compare the change in cash flow over a 20-year period for all scenarios. Specific comparisons were also completed, which compared the following variables:

- SSO Quantity;
- Using generated gas for gas revenue versus to offset electricity costs;
- Dewatering sludge and not dewatering sludge;
- Using external hauling company to haul sludge versus purchasing a truck and employing drivers; and
- Reduction and augmentation of capital costs (as described for specific scenarios).

All completed scenarios are presented in Section 3.0. The Net Present Value (NPV) for the comparative analyses are presented in Section 2.1.

2.1 Scenario Comparisons

All scenario comparisons are described in Table 3. The best-case and worst-case NPVs for each scenario are presented for comparison purposed in Table 4 to Table 9. All analyses for the cases in Table 4 to Table 9 are presented in Section 3.0. The 'scenario code' listed in the tables corresponds to the header of each Pro Forma analysis in Section 3.0.

Table 3: Description of Scenario Comparisons

Comparison Name	Scenarios Included for Comparison	Description of Comparison	Variable	Assumptions
Comparison 1 - 1-5	1, 2A, 2B, 3, 4, 5	Compares Scenarios 1 to 5 with 4,000 and 8,000 SSO	SSO quantity: 4,000 and 8,000	With gas revenue, with dewatering
Comparison 2 – 2b vs 4	2B, 4	Looks at the SSO that would be required for Scenario 4 to have similar NPV to 2b	SSO quantity: 4,000 tonnes to 12,000 tonnes	With gas revenue, with dewatering
Comparison 3 – Truck	2B, 3, 4, 5	Compares cost of intra-facility dewatered sludge hauling on a per-tonne basis with purchasing of truck	Transportation costs	SSO quantity = 4,000 tonnes With gas revenue, with dewatering
Comparison 4 - 2b and 4 dewatering	2B, 4	Compare 2B and 4, with and without dewatering	With and without dewatering SSO quantity: 4,000 and 8,000 tonnes	With gas revenue
Comparison 5 - 4 vs 5 with additional capital	4, 5	Assumes additional capital would be necessary for Scenario 4 (Cataraqui Bay) and Scenario 5 (Knox Farm)	Adds 11M to Cat Bay and 6M to Knox Farm	With gas revenue, with dewatering
Comparison 6 - 2b vs 4 with $1 million grants	2B, 4	Assumes that costs would be subsidized by grants (multiples of $1,000,000)	Adds 1M grants to Cat Bay option	With gas revenue, with dewatering

Table 4: COMPARISON 1 - 1-5

SSO Quantity (tonnes)	4000					
	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4	Scenario 5
Scenario Code	1-0-DW-SELLGAS	2A-0-DW-SELLGAS	2B-0-DW-SELLGAS	3-0-DW-SELLGAS	4-4K-DW-SELLGAS	5-4K-DW-SELLGAS
Best Case NPV	$ (2,921,742)	$ (2,312,997)	$ (16,871)	$ 1,802,393	$ 1,898,944	$ (2,691,802)
Worst Case NPV	$ (13,275,472)	$ (12,601,479)	$ (10,870,603)	$ (9,363,205)	$ (12,456,670)	$ (18,450,813)

SSO Quantity (tonnes)	8000					
	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3	Scenario 4	Scenario 5
Scenario Code	1-0-DW-SELLGAS	2A-0-DW-SELLGAS	2B-0-DW-SELLGAS	3-0-DW-SELLGAS	4-8K-DW-SELLGAS	5-8K-DW-SELLGAS
Best Case NPV	$ (2,921,742)	$ (2,312,997)	$ (16,871)	$ 1,802,393	$ 14,423,150	$ 9,832,403
Worst Case NPV	$ (13,275,472)	$ (12,601,479)	$ (10,870,603)	$ (9,363,205)	$ (2,550,727)	$ (8,544,870)

Description	Compares Scenarios 1 to 5 with 4000 and 8000 SSO
Variables	SSO quantity: 4,000 and 8,000
Assumptions	With gas revenue, with dewatering

Table 5: COMPARISON 2 - 2B VS 4

Qty SSO	0	4000	5000	6000	8000	10000	12000
	Scenario 2B	Scenario 4	Scenario 4	Scenario 4	Scenario 4	Scenario 4	Scenario 4
Scenario Code	2B-0-DW-SELLGAS	4-4K-DW-SELLGAS	4-5K-DW-SELLGAS	4-6K-DW-SELLGAS	4-8K-DW-SELLGAS	4-10K-DW-SELLGAS	4-12K-DW-SELLGAS
Best Case NPV	$ (16,871)	$ 1,898,944	$ 5,029,996	$ 8,161,047	$ 14,423,150	$ 20,685,253	$ 26,947,356
Worst Case NPV	$ (10,870,603)	$ (12,456,670)	$ (9,980,184)	$ (7,503,699)	$ (2,550,727)	$ 2,402,244	$ 7,355,216

Description	Looks at the SSO that would be required for Scenario 4 to have similar NPV to 2b
Variables	SSO quantity: 4,000 tonnes to 12,000 tonnes
Assumptions	With gas revenue, with dewatering

Table 6: COMPARISON 3 - TRANSPORTATION COSTS

	Scenario 2B		Scenario 3		Scenario 4		Scenario 5	
Scenario Code	2B-0-DW-SELLGAS	COMPARE3-2B-0-DW-SELLGAS	3-0-DW-SELLGAS	COMPARE3-3-0-DW-SELLGAS	4-4K-DW-SELLGAS	COMPARE3-4-4K-DW-SELLGAS	5-4K-DW-SELLGAS	COMPARE3-5-4K-DW-SELLGAS
Best Case NPV	$ (16,871)	$ 1,668,856	$ 1,802,393	$ 538,466	$ 1,898,944	$ 5,138,564	$ (2,691,802)	$ 1,088,243
Worst Case NPV	$ (10,870,603)	$ (9,314,989)	$ (9,363,205)	$ (10,757,245)	$ (12,456,670)	$ (9,347,164)	$ (18,450,813)	$ (14,800,881)

Description	Compares cost of intra-facility dewatered sludge hauling on a per-tonne basis with purchasing of truck
Variables	Transportation costs
Assumptions	SSO quantity = 4,000 tonnes

Table 7: COMPARISON 4 - 2B AND 4 DEWATERING

SSO Quantity (tonnes)	4000			
	Scenario 2B		Scenario 4	
	With Dewatering	Without Dewatering	With Dewatering	Without Dewatering
Scenario Code	2B-0-DW-SELLGAS	2B-0-NDW-SELLGAS	4-4K-DW-SELLGAS	4-4K-NDW-SELLGAS
Best Case NPV	$ (16,871)	$ (5,885,313)	$ 1,898,944	$ (4,668,403)
Worst Case NPV	$ (10,870,603)	$ (15,335,648)	$ (12,456,670)	$ (17,620,621)

SSO Quantity (tonnes)	8000			
	Scenario 2B		Scenario 4	
	With Dewatering	Without Dewatering	With Dewatering	Without Dewatering
Scenario Code	2B-0-DW-SELLGAS	2B-0-NDW-SELLGAS	4-8K-DW-SELLGAS	4-8K-NDW-SELLGAS
Best Case NPV	$ (16,871)	$ (5,885,313)	$ 14,423,150	$ 7,156,897
Worst Case NPV	$ (10,870,603)	$ (15,335,648)	$ (2,550,727)	$ (8,413,583)

Description	Compare 2B and 4, with and without dewatering
Variables	With and without dewatering
Assumptions	With gas revenue

Table 8: COMPARISON 5 - 4 VS W WITH ADDITIONAL CAPITAL COSTS

	Scenario 4	Scenario 5
	Added 11 million	Added 6 million
Scenario Code	COMPARE5-4-4K-DW-SELLGA	COMPARE5-5-4K-DW-SELLGAS
Best Case NPV	$ (7,820,876)	$ (8,149,455)
Worst Case NPV	$ (25,607,015)	$ (25,467,796)

Description	Assumes additional capital would be necessary for Scenario 4 (Cataraqui Bay) and Scenario 5 (Knox Farm)
Variables	Adds 11M to Cat Bay and 6M to Knox Farm
Assumptions	SSO quantity = 4,000 tonnes With gas revenue, with dewatering

Table 9: COMPARISON 6 - 2B VS 4 WITH $1 MILLION GRANTS

	Scenario 2B	Scenario 4 - No Grant	Scenario 4 - 1M Grant	Scenario 4 - 2M Grant	Scenario 4 - 3M Grant	Scenario 4 - 4M Grant
Scenario Code	2B-0-DW-SELLGAS	4-4K-DW-SELLGAS	COMPARE6-4-4K-DW-SELLGAS-1M	COMPARE6-4-4K-DW-SELLGAS-2M	COMPARE6-4-4K-DW-SELLGAS-3M	COMPARE6-4-4K-DW-SELLGAS-4M
Best Case NPV	$ (16,871)	$ 1,898,944	$ 2,938,497	$ 3,978,050	$ 5,017,603	$ 6,057,156
Worst Case NPV	$ (10,870,603)	$ (12,456,670)	$ (11,417,117)	$ (10,377,564)	$ (9,338,011)	$ (8,298,458)

Description	Assumes that costs would be subsidized by grants (multiples of $1,000,000)
Variables	Adds 1M grants to Cat Bay option
Assumptions	SSO quantity = 4,000 tonnes With gas revenue, with dewatering

3.0 PRO FORMA ANALYSES

All Pro Forma analyses are attached in this section.

3.1 Scenario 1 Pro Forma Analyses

Option 1		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	4.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	0	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Thermophilic Digesters		
HRT (d)		d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	47%	%
Biogas Volume (m3/d)	3,831	m3/d
# of Digesters	-	# of Units
Footprint (m2)	-	m2
Capital Cost ($) - Equipment Only	$ 10,000,000.00	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ 200,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	0	kg/d
Footprint (m2)	0	m2
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 10,404,000																	
	Capital Cost ($) - Civil and Structural			$ -																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 15,069,600**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 11,138,400**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 1,086,332	$ 1,108,059																		
Engineering costs	Low (based on low capital cost)	$ 802,941	$ 819,000																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 215,499	$ 439,617	$ 448,410	$ 457,378	$ 466,525	$ 475,856	$ 485,373	$ 495,081	$ 504,982	$ 515,082	$ 525,383	$ 535,891	$ 546,609	$ 557,541	$ 568,692	$ 580,066	$ 591,667	$ 603,500
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 104,040	$ 212,242	$ 216,486	$ 220,816	$ 225,232	$ 229,737	$ 234,332	$ 239,019	$ 243,799	$ 248,675	$ 253,648	$ 258,721	$ 263,896	$ 269,174	$ 274,557	$ 280,048	$ 285,649	$ 291,362
Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
High		$ 1,086,332	$ 1,108,059	$ 15,578,566	$ 1,038,290	$ 1,059,055	$ 1,080,237	$ 1,101,841	$ 1,123,878	$ 1,146,356	$ 1,169,283	$ 1,192,668	$ 1,216,522	$ 1,240,852	$ 1,265,669	$ 1,290,983	$ 1,316,802	$ 1,343,138	$ 1,370,001	$ 1,397,401	$ 1,425,349
Low		$ 802,941	$ 819,000	$ 11,647,366	$ 1,038,290	$ 1,059,055	$ 1,080,237	$ 1,101,841	$ 1,123,878	$ 1,146,356	$ 1,169,283	$ 1,192,668	$ 1,216,522	$ 1,240,852	$ 1,265,669	$ 1,290,983	$ 1,316,802	$ 1,343,138	$ 1,370,001	$ 1,397,401	$ 1,425,349
Revenues																					
Gas Generation	Best			$ 855,004	$ 1,744,208	$ 1,779,092	$ 1,814,674	$ 1,850,967	$ 1,887,987	$ 1,925,746	$ 1,964,261	$ 2,003,547	$ 2,043,617	$ 2,084,490	$ 2,126,180	$ 2,168,703	$ 2,212,077	$ 2,256,319	$ 2,301,445	$ 2,347,474	$ 2,394,424
	Lowest			$ 584,090	$ 1,191,544	$ 1,215,375	$ 1,239,682	$ 1,264,476	$ 1,289,765	$ 1,315,561	$ 1,341,872	$ 1,368,709	$ 1,396,083	$ 1,424,005	$ 1,452,485	$ 1,481,535	$ 1,511,166	$ 1,541,389	$ 1,572,217	$ 1,603,661	$ 1,635,734
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	**$ -**	**$ -**	**$ 855,004**	**$ 1,744,208**	**$ 1,779,092**	**$ 1,814,674**	**$ 1,850,967**	**$ 1,887,987**	**$ 1,925,746**	**$ 1,964,261**	**$ 2,003,547**	**$ 2,043,617**	**$ 2,084,490**	**$ 2,126,180**	**$ 2,168,703**	**$ 2,212,077**	**$ 2,256,319**	**$ 2,301,445**	**$ 2,347,474**	**$ 2,394,424**
	Lowest	**$ -**	**$ -**	**$ 584,090**	**$ 1,191,544**	**$ 1,215,375**	**$ 1,239,682**	**$ 1,264,476**	**$ 1,289,765**	**$ 1,315,561**	**$ 1,341,872**	**$ 1,368,709**	**$ 1,396,083**	**$ 1,424,005**	**$ 1,452,485**	**$ 1,481,535**	**$ 1,511,166**	**$ 1,541,389**	**$ 1,572,217**	**$ 1,603,661**	**$ 1,635,734**
Total																					
	Best	$ (802,941)	$ (819,000)	$ (10,792,362)	$ 705,918	$ 720,037	$ 734,437	$ 749,126	$ 764,109	$ 779,391	$ 794,979	$ 810,878	$ 827,096	$ 843,638	$ 860,510	$ 877,721	$ 895,275	$ 913,180	$ 931,444	$ 950,073	$ 969,074
	Lowest	$ (1,086,332)	$ (1,108,059)	$ (14,994,475)	$ 153,254	$ 156,319	$ 159,446	$ 162,635	$ 165,887	$ 169,205	$ 172,589	$ 176,041	$ 179,562	$ 183,153	$ 186,816	$ 190,552	$ 194,363	$ 198,251	$ 202,216	$ 206,260	$ 210,385
NPV	Best	($2,921,742)																			
	Lowest	($13,275,472)																			

3.2 Scenario 2A Pro Forma Analyses

Option 2A		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	0	d
# of Units	0	# of Units
Footprint (m2)	0	m2
Thermophilic Digesters		
HRT (d)	3	d
# of Units	1	# of Units
Footprint (m2)	1588	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	50%	%
Biogas Volume (m3/d)	4,071	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 250,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	26	m3/d
# of Units	2	kg/d
Footprint (m2)	1200	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$	$/y

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation			1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																						
SSO Receiving Station	Capital Cost ($) - High				$ -																	
	Capital Cost ($) - Low				$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only				$ 1,664,640																	
	Capital Cost ($) - Civil and Structural				$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only				$ 1,560,600																	
	Capital Cost ($) - Civil and Structural				$ 3,121,200																	
Cake Storage	Capital Cost				$ -																	
Gas Cleaning	Capital Cost				$ 2,700,000																	
Total Capital Costs	**High (+15%)**		**$ -**	**$ -**	**$ 13,274,910**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**		**$ -**	**$ -**	**$ 9,811,890**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)		$ 956,957	$ 976,096																		
Engineering costs	Low (based on low capital cost)		$ 707,316	$ 721,463																		
Operating Costs																						
Disposal of Lights/Heavies/Grits	Disposal Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost				$ 212,658	$ 433,822	$ 442,498	$ 451,348	$ 460,375	$ 469,583	$ 478,974	$ 488,554	$ 498,325	$ 508,291	$ 518,457	$ 528,826	$ 539,403	$ 550,191	$ 561,195	$ 572,419	$ 583,867	$ 595,544
SSO Receiving Station	Operating Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost				$ 130,050	$ 265,302	$ 270,608	$ 276,020	$ 281,541	$ 287,171	$ 292,915	$ 298,773	$ 304,749	$ 310,844	$ 317,060	$ 323,402	$ 329,870	$ 336,467	$ 343,196	$ 350,060	$ 357,062	$ 364,203
Dewatering	Operating Cost				$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost				$ 182,411	$ 372,118	$ 379,561	$ 387,152	$ 394,895	$ 402,793	$ 410,849	$ 419,066	$ 427,447	$ 435,996	$ 444,716	$ 453,610	$ 462,682	$ 471,936	$ 481,375	$ 491,002	$ 500,822	$ 510,839
Electricity Cost Offset	Electricity Cost Offset				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																						
	High		$ 956,957	$ 976,096	$ 13,867,655	$ 1,209,199	$ 1,233,383	$ 1,258,051	$ 1,283,212	$ 1,308,876	$ 1,335,054	$ 1,361,755	$ 1,388,990	$ 1,416,770	$ 1,445,105	$ 1,474,007	$ 1,503,487	$ 1,533,557	$ 1,564,228	$ 1,595,513	$ 1,627,423	$ 1,659,972
	Low		$ 707,316	$ 721,463	$ 10,404,635	$ 1,209,199	$ 1,233,383	$ 1,258,051	$ 1,283,212	$ 1,308,876	$ 1,335,054	$ 1,361,755	$ 1,388,990	$ 1,416,770	$ 1,445,105	$ 1,474,007	$ 1,503,487	$ 1,533,557	$ 1,564,228	$ 1,595,513	$ 1,627,423	$ 1,659,972
Revenues																						
Gas Generation	Best				$ 908,567	$ 1,853,477	$ 1,890,546	$ 1,928,357	$ 1,966,925	$ 2,006,263	$ 2,046,388	$ 2,087,316	$ 2,129,062	$ 2,171,644	$ 2,215,077	$ 2,259,378	$ 2,304,566	$ 2,350,657	$ 2,397,670	$ 2,445,623	$ 2,494,536	$ 2,544,427
	Lowest				$ 620,681	$ 1,266,190	$ 1,291,514	$ 1,317,344	$ 1,343,691	$ 1,370,565	$ 1,397,976	$ 1,425,936	$ 1,454,455	$ 1,483,544	$ 1,513,215	$ 1,543,479	$ 1,574,348	$ 1,605,835	$ 1,637,952	$ 1,670,711	$ 1,704,125	$ 1,738,208
Tipping Fees					$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**		**$ -**	**$ -**	**$ 908,567**	**$ 1,853,477**	**$ 1,890,546**	**$ 1,928,357**	**$ 1,966,925**	**$ 2,006,263**	**$ 2,046,388**	**$ 2,087,316**	**$ 2,129,062**	**$ 2,171,644**	**$ 2,215,077**	**$ 2,259,378**	**$ 2,304,566**	**$ 2,350,657**	**$ 2,397,670**	**$ 2,445,623**	**$ 2,494,536**	**$ 2,544,427**
	Lowest		**$ -**	**$ -**	**$ 620,681**	**$ 1,266,190**	**$ 1,291,514**	**$ 1,317,344**	**$ 1,343,691**	**$ 1,370,565**	**$ 1,397,976**	**$ 1,425,936**	**$ 1,454,455**	**$ 1,483,544**	**$ 1,513,215**	**$ 1,543,479**	**$ 1,574,348**	**$ 1,605,835**	**$ 1,637,952**	**$ 1,670,711**	**$ 1,704,125**	**$ 1,738,208**
Total																						
	Best		$ (707,316)	$ (721,463)	$ (9,496,068)	$ 644,278	$ 657,163	$ 670,306	$ 683,713	$ 697,387	$ 711,335	$ 725,561	$ 740,072	$ 754,874	$ 769,971	$ 785,371	$ 801,078	$ 817,100	$ 833,442	$ 850,111	$ 867,113	$ 884,455
	Lowest		$ (956,957)	$ (976,096)	$ (13,246,973)	$ 56,991	$ 58,131	$ 59,293	$ 60,479	$ 61,689	$ 62,923	$ 64,181	$ 65,465	$ 66,774	$ 68,109	$ 69,472	$ 70,861	$ 72,278	$ 73,724	$ 75,198	$ 76,702	$ 78,236
NPV	Best		($2,312,997)																			
	Lowest		($12,601,479)																			

3.3 Scenario 2B Pro Forma Analyses

Option 2B		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	821	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 230,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	24	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,664,640																	
	Capital Cost ($) - Civil and Structural			$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 13,274,910**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 9,811,890**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 956,957	$ 976,096																		
Engineering costs	Low (based on low capital cost)	$ 707,316	$ 721,463																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 215,499	$ 439,617	$ 448,410	$ 457,378	$ 466,525	$ 475,856	$ 485,373	$ 495,081	$ 504,982	$ 515,082	$ 525,383	$ 535,891	$ 546,609	$ 557,541	$ 568,692	$ 580,066	$ 591,667	$ 603,500
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 119,646	$ 244,078	$ 248,959	$ 253,939	$ 259,017	$ 264,198	$ 269,482	$ 274,871	$ 280,369	$ 285,976	$ 291,696	$ 297,530	$ 303,480	$ 309,550	$ 315,741	$ 322,056	$ 328,497	$ 335,067
Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 168,379	$ 343,494	$ 350,364	$ 357,371	$ 364,519	$ 371,809	$ 379,245	$ 386,830	$ 394,567	$ 402,458	$ 410,507	$ 418,717	$ 427,092	$ 435,633	$ 444,346	$ 453,233	$ 462,298	$ 471,544
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
High		$ 956,957	$ 976,096	$ 13,846,060	$ 1,165,146	$ 1,188,449	$ 1,212,218	$ 1,236,462	$ 1,261,192	$ 1,286,416	$ 1,312,144	$ 1,338,387	$ 1,365,154	$ 1,392,458	$ 1,420,307	$ 1,448,713	$ 1,477,687	$ 1,507,241	$ 1,537,386	$ 1,568,133	$ 1,599,496
Low		$ 707,316	$ 721,463	$ 10,383,040	$ 1,165,146	$ 1,188,449	$ 1,212,218	$ 1,236,462	$ 1,261,192	$ 1,286,416	$ 1,312,144	$ 1,338,387	$ 1,365,154	$ 1,392,458	$ 1,420,307	$ 1,448,713	$ 1,477,687	$ 1,507,241	$ 1,537,386	$ 1,568,133	$ 1,599,496
Revenues																					
Gas Generation	Best			$ 983,779	$ 2,006,909	$ 2,047,047	$ 2,087,988	$ 2,129,748	$ 2,172,343	$ 2,215,790	$ 2,260,105	$ 2,305,308	$ 2,351,414	$ 2,398,442	$ 2,446,411	$ 2,495,339	$ 2,545,246	$ 2,596,151	$ 2,648,074	$ 2,701,035	$ 2,755,056
	Lowest			$ 672,062	$ 1,371,006	$ 1,398,426	$ 1,426,395	$ 1,454,923	$ 1,484,021	$ 1,513,702	$ 1,543,976	$ 1,574,855	$ 1,606,352	$ 1,638,479	$ 1,671,249	$ 1,704,674	$ 1,738,767	$ 1,773,543	$ 1,809,014	$ 1,845,194	$ 1,882,098
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	**$ -**	**$ -**	**$ 983,779**	**$ 2,006,909**	**$ 2,047,047**	**$ 2,087,988**	**$ 2,129,748**	**$ 2,172,343**	**$ 2,215,790**	**$ 2,260,105**	**$ 2,305,308**	**$ 2,351,414**	**$ 2,398,442**	**$ 2,446,411**	**$ 2,495,339**	**$ 2,545,246**	**$ 2,596,151**	**$ 2,648,074**	**$ 2,701,035**	**$ 2,755,056**
	Lowest	**$ -**	**$ -**	**$ 672,062**	**$ 1,371,006**	**$ 1,398,426**	**$ 1,426,395**	**$ 1,454,923**	**$ 1,484,021**	**$ 1,513,702**	**$ 1,543,976**	**$ 1,574,855**	**$ 1,606,352**	**$ 1,638,479**	**$ 1,671,249**	**$ 1,704,674**	**$ 1,738,767**	**$ 1,773,543**	**$ 1,809,014**	**$ 1,845,194**	**$ 1,882,098**
Total																					
	Best	$ (707,316)	$ (721,463)	$ (9,399,261)	$ 841,763	$ 858,598	$ 875,770	$ 893,285	$ 911,151	$ 929,374	$ 947,962	$ 966,921	$ 986,259	$ 1,005,984	$ 1,026,104	$ 1,046,626	$ 1,067,559	$ 1,088,910	$ 1,110,688	$ 1,132,902	$ 1,155,560
	Lowest	$ (956,957)	$ (976,096)	$ (13,173,998)	$ 205,860	$ 209,977	$ 214,177	$ 218,460	$ 222,830	$ 227,286	$ 231,832	$ 236,469	$ 241,198	$ 246,022	$ 250,942	$ 255,961	$ 261,080	$ 266,302	$ 271,628	$ 277,061	$ 282,602
NPV	Best	($16,871)																			
	Lowest	($10,870,603)																			

Option 2B		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	821	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 230,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	24	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,664,640																	
	Capital Cost ($) - Civil and Structural			$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 13,274,910**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 9,811,890**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 956,957	$ 976,096																		
Engineering costs	Low (based on low capital cost)	$ 707,316	$ 721,463																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 215,499	$ 439,617	$ 448,410	$ 457,378	$ 466,525	$ 475,856	$ 485,373	$ 495,081	$ 504,982	$ 515,082	$ 525,383	$ 535,891	$ 546,609	$ 557,541	$ 568,692	$ 580,066	$ 591,667	$ 603,500
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 119,646	$ 244,078	$ 248,959	$ 253,939	$ 259,017	$ 264,198	$ 269,482	$ 274,871	$ 280,369	$ 285,976	$ 291,696	$ 297,530	$ 303,480	$ 309,550	$ 315,741	$ 322,056	$ 328,497	$ 335,067
Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 168,379	$ 343,494	$ 350,364	$ 357,371	$ 364,519	$ 371,809	$ 379,245	$ 386,830	$ 394,567	$ 402,458	$ 410,507	$ 418,717	$ 427,092	$ 435,633	$ 444,346	$ 453,233	$ 462,298	$ 471,544
Electricity Cost Offset	Electricity Cost Offset			$ (5,624)	$ (11,474)	$ (11,703)	$ (11,937)	$ (12,176)	$ (12,420)	$ (12,668)	$ (12,921)	$ (13,180)	$ (13,443)	$ (13,712)	$ (13,987)	$ (14,266)	$ (14,552)	$ (14,843)	$ (15,139)	$ (15,442)	$ (15,751)
Total Costs																					
High		$ 956,957	$ 976,096	$ 13,840,436	$ 1,153,672	$ 1,176,746	$ 1,200,281	$ 1,224,286	$ 1,248,772	$ 1,273,748	$ 1,299,222	$ 1,325,207	$ 1,351,711	$ 1,378,745	$ 1,406,320	$ 1,434,447	$ 1,463,135	$ 1,492,398	$ 1,522,246	$ 1,552,691	$ 1,583,745
Low		$ 707,316	$ 721,463	$ 10,377,416	$ 1,153,672	$ 1,176,746	$ 1,200,281	$ 1,224,286	$ 1,248,772	$ 1,273,748	$ 1,299,222	$ 1,325,207	$ 1,351,711	$ 1,378,745	$ 1,406,320	$ 1,434,447	$ 1,463,135	$ 1,492,398	$ 1,522,246	$ 1,552,691	$ 1,583,745
Revenues																					
Gas Generation	Best			$ 779,293	$ 1,589,757	$ 1,621,552	$ 1,653,983	$ 1,687,063	$ 1,720,804	$ 1,755,220	$ 1,790,324	$ 1,826,131	$ 1,862,653	$ 1,899,907	$ 1,937,905	$ 1,976,663	$ 2,016,196	$ 2,056,520	$ 2,097,650	$ 2,139,603	$ 2,182,395
	Lowest			$ 467,576	$ 953,854	$ 972,931	$ 992,390	$ 1,012,238	$ 1,032,482	$ 1,053,132	$ 1,074,195	$ 1,095,678	$ 1,117,592	$ 1,139,944	$ 1,162,743	$ 1,185,998	$ 1,209,718	$ 1,233,912	$ 1,258,590	$ 1,283,762	$ 1,309,437
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	**$ -**	**$ -**	**$ 779,293**	**$ 1,589,757**	**$ 1,621,552**	**$ 1,653,983**	**$ 1,687,063**	**$ 1,720,804**	**$ 1,755,220**	**$ 1,790,324**	**$ 1,826,131**	**$ 1,862,653**	**$ 1,899,907**	**$ 1,937,905**	**$ 1,976,663**	**$ 2,016,196**	**$ 2,056,520**	**$ 2,097,650**	**$ 2,139,603**	**$ 2,182,395**
	Lowest	**$ -**	**$ -**	**$ 467,576**	**$ 953,854**	**$ 972,931**	**$ 992,390**	**$ 1,012,238**	**$ 1,032,482**	**$ 1,053,132**	**$ 1,074,195**	**$ 1,095,678**	**$ 1,117,592**	**$ 1,139,944**	**$ 1,162,743**	**$ 1,185,998**	**$ 1,209,718**	**$ 1,233,912**	**$ 1,258,590**	**$ 1,283,762**	**$ 1,309,437**
Total																					
	Best	$ (707,316)	$ (721,463)	$ (9,598,123)	$ 436,084	$ 444,806	$ 453,702	$ 462,776	$ 472,032	$ 481,472	$ 491,102	$ 500,924	$ 510,942	$ 521,161	$ 531,584	$ 542,216	$ 553,060	$ 564,122	$ 575,404	$ 586,912	$ 598,650
	Lowest	$ (956,957)	$ (976,096)	$ (13,372,860)	$ (199,818)	$ (203,815)	$ (207,891)	$ (212,049)	$ (216,290)	$ (220,616)	$ (225,028)	$ (229,528)	$ (234,119)	$ (238,801)	$ (243,577)	$ (248,449)	$ (253,418)	$ (258,486)	$ (263,656)	$ (268,929)	$ (274,308)
NPV	Best	($4,733,623)																			
	Lowest	($15,587,355)																			

Option 2B		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	821	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 230,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	93	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,664,640																	
	Capital Cost ($) - Civil and Structural			$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 7,890,840**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 5,832,360**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 568,832	$ 580,209																		
Engineering costs	Low (based on low capital cost)	$ 420,441	$ 428,850																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 215,499	$ 439,617	$ 448,410	$ 457,378	$ 466,525	$ 475,856	$ 485,373	$ 495,081	$ 504,982	$ 515,082	$ 525,383	$ 535,891	$ 546,609	$ 557,541	$ 568,692	$ 580,066	$ 591,667	$ 603,500
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 119,646	$ 244,078	$ 248,959	$ 253,939	$ 259,017	$ 264,198	$ 269,482	$ 274,871	$ 280,369	$ 285,976	$ 291,696	$ 297,530	$ 303,480	$ 309,550	$ 315,741	$ 322,056	$ 328,497	$ 335,067
Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 651,067	$ 1,328,177	$ 1,354,740	$ 1,381,835	$ 1,409,472	$ 1,437,661	$ 1,466,414	$ 1,495,742	$ 1,525,657	$ 1,556,170	$ 1,587,294	$ 1,619,040	$ 1,651,421	$ 1,684,449	$ 1,718,138	$ 1,752,501	$ 1,787,551	$ 1,823,302
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
High		$ 568,832	$ 580,209	$ 8,877,052	$ 2,011,872	$ 2,052,109	$ 2,093,151	$ 2,135,014	$ 2,177,715	$ 2,221,269	$ 2,265,694	$ 2,311,008	$ 2,357,228	$ 2,404,373	$ 2,452,460	$ 2,501,510	$ 2,551,540	$ 2,602,571	$ 2,654,622	$ 2,707,714	$ 2,761,869
Low		$ 420,441	$ 428,850	$ 6,818,572	$ 2,011,872	$ 2,052,109	$ 2,093,151	$ 2,135,014	$ 2,177,715	$ 2,221,269	$ 2,265,694	$ 2,311,008	$ 2,357,228	$ 2,404,373	$ 2,452,460	$ 2,501,510	$ 2,551,540	$ 2,602,571	$ 2,654,622	$ 2,707,714	$ 2,761,869
Revenues																					
Gas Generation	Best			$ 983,779	$ 2,006,909	$ 2,047,047	$ 2,087,988	$ 2,129,748	$ 2,172,343	$ 2,215,790	$ 2,260,105	$ 2,305,308	$ 2,351,414	$ 2,398,442	$ 2,446,411	$ 2,495,339	$ 2,545,246	$ 2,596,151	$ 2,648,074	$ 2,701,035	$ 2,755,056
	Lowest			$ 672,062	$ 1,371,006	$ 1,398,426	$ 1,426,395	$ 1,454,923	$ 1,484,021	$ 1,513,702	$ 1,543,976	$ 1,574,855	$ 1,606,352	$ 1,638,479	$ 1,671,249	$ 1,704,674	$ 1,738,767	$ 1,773,543	$ 1,809,014	$ 1,845,194	$ 1,882,098
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	**$ -**	**$ -**	**$ 983,779**	**$ 2,006,909**	**$ 2,047,047**	**$ 2,087,988**	**$ 2,129,748**	**$ 2,172,343**	**$ 2,215,790**	**$ 2,260,105**	**$ 2,305,308**	**$ 2,351,414**	**$ 2,398,442**	**$ 2,446,411**	**$ 2,495,339**	**$ 2,545,246**	**$ 2,596,151**	**$ 2,648,074**	**$ 2,701,035**	**$ 2,755,056**
	Lowest	**$ -**	**$ -**	**$ 672,062**	**$ 1,371,006**	**$ 1,398,426**	**$ 1,426,395**	**$ 1,454,923**	**$ 1,484,021**	**$ 1,513,702**	**$ 1,543,976**	**$ 1,574,855**	**$ 1,606,352**	**$ 1,638,479**	**$ 1,671,249**	**$ 1,704,674**	**$ 1,738,767**	**$ 1,773,543**	**$ 1,809,014**	**$ 1,845,194**	**$ 1,882,098**
Total																					
	Best	$ (420,441)	$ (428,850)	$ (5,834,793)	$ (4,963)	$ (5,062)	$ (5,163)	$ (5,267)	$ (5,372)	$ (5,479)	$ (5,589)	$ (5,701)	$ (5,815)	$ (5,931)	$ (6,050)	$ (6,171)	$ (6,294)	$ (6,420)	$ (6,548)	$ (6,679)	$ (6,813)
	Lowest	$ (568,832)	$ (580,209)	$ (8,204,990)	$ (640,865)	$ (653,683)	$ (666,756)	$ (680,092)	$ (693,693)	$ (707,567)	$ (721,719)	$ (736,153)	$ (750,876)	$ (765,894)	$ (781,211)	$ (796,836)	$ (812,772)	$ (829,028)	$ (845,608)	$ (862,521)	$ (879,771)
NPV	Best	($5,885,313)																			
	Lowest	($15,335,648)																			

Option 2B		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	821	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 230,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	93	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,664,640																	
	Capital Cost ($) - Civil and Structural			$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 7,890,840**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 5,832,360**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 568,832	$ 580,209																		
Engineering costs	Low (based on low capital cost)	$ 420,441	$ 428,850																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 215,499	$ 439,617	$ 448,410	$ 457,378	$ 466,525	$ 475,856	$ 485,373	$ 495,081	$ 504,982	$ 515,082	$ 525,383	$ 535,891	$ 546,609	$ 557,541	$ 568,692	$ 580,066	$ 591,667	$ 603,500
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 119,646	$ 244,078	$ 248,959	$ 253,939	$ 259,017	$ 264,198	$ 269,482	$ 274,871	$ 280,369	$ 285,976	$ 291,696	$ 297,530	$ 303,480	$ 309,550	$ 315,741	$ 322,056	$ 328,497	$ 335,067
Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 651,067	$ 1,328,177	$ 1,354,740	$ 1,381,835	$ 1,409,472	$ 1,437,661	$ 1,466,414	$ 1,495,742	$ 1,525,657	$ 1,556,170	$ 1,587,294	$ 1,619,040	$ 1,651,421	$ 1,684,449	$ 1,718,138	$ 1,752,501	$ 1,787,551	$ 1,823,302
Electricity Cost Offset	Electricity Cost Offset			$ (5,624)	$ (11,474)	$ (11,703)	$ (11,937)	$ (12,176)	$ (12,420)	$ (12,668)	$ (12,921)	$ (13,180)	$ (13,443)	$ (13,712)	$ (13,987)	$ (14,266)	$ (14,552)	$ (14,843)	$ (15,139)	$ (15,442)	$ (15,751)
Total Costs																					
High		$ 568,832	$ 580,209	$ 8,871,427	$ 2,000,398	$ 2,040,406	$ 2,081,214	$ 2,122,838	$ 2,165,295	$ 2,208,601	$ 2,252,773	$ 2,297,828	$ 2,343,785	$ 2,390,661	$ 2,438,474	$ 2,487,243	$ 2,536,988	$ 2,587,728	$ 2,639,483	$ 2,692,272	$ 2,746,118
Low		$ 420,441	$ 428,850	$ 6,812,947	$ 2,000,398	$ 2,040,406	$ 2,081,214	$ 2,122,838	$ 2,165,295	$ 2,208,601	$ 2,252,773	$ 2,297,828	$ 2,343,785	$ 2,390,661	$ 2,438,474	$ 2,487,243	$ 2,536,988	$ 2,587,728	$ 2,639,483	$ 2,692,272	$ 2,746,118
Revenues																					
Gas Generation	Best			$ 779,293	$ 1,589,757	$ 1,621,552	$ 1,653,983	$ 1,687,063	$ 1,720,804	$ 1,755,220	$ 1,790,324	$ 1,826,131	$ 1,862,653	$ 1,899,907	$ 1,937,905	$ 1,976,663	$ 2,016,196	$ 2,056,520	$ 2,097,650	$ 2,139,603	$ 2,182,395
	Lowest			$ 467,576	$ 953,854	$ 972,931	$ 992,390	$ 1,012,238	$ 1,032,482	$ 1,053,132	$ 1,074,195	$ 1,095,678	$ 1,117,592	$ 1,139,944	$ 1,162,743	$ 1,185,998	$ 1,209,718	$ 1,233,912	$ 1,258,590	$ 1,283,762	$ 1,309,437
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	**$ -**	**$ -**	**$ 779,293**	**$ 1,589,757**	**$ 1,621,552**	**$ 1,653,983**	**$ 1,687,063**	**$ 1,720,804**	**$ 1,755,220**	**$ 1,790,324**	**$ 1,826,131**	**$ 1,862,653**	**$ 1,899,907**	**$ 1,937,905**	**$ 1,976,663**	**$ 2,016,196**	**$ 2,056,520**	**$ 2,097,650**	**$ 2,139,603**	**$ 2,182,395**
	Lowest	**$ -**	**$ -**	**$ 467,576**	**$ 953,854**	**$ 972,931**	**$ 992,390**	**$ 1,012,238**	**$ 1,032,482**	**$ 1,053,132**	**$ 1,074,195**	**$ 1,095,678**	**$ 1,117,592**	**$ 1,139,944**	**$ 1,162,743**	**$ 1,185,998**	**$ 1,209,718**	**$ 1,233,912**	**$ 1,258,590**	**$ 1,283,762**	**$ 1,309,437**
Total																					
	Best	$ (420,441)	$ (428,850)	$ (6,033,655)	$ (410,641)	$ (418,854)	$ (427,231)	$ (435,776)	$ (444,491)	$ (453,381)	$ (462,449)	$ (471,698)	$ (481,132)	$ (490,754)	$ (500,569)	$ (510,581)	$ (520,792)	$ (531,208)	$ (541,832)	$ (552,669)	$ (563,722)
	Lowest	$ (568,832)	$ (580,209)	$ (8,403,852)	$ (1,046,544)	$ (1,067,475)	$ (1,088,824)	$ (1,110,601)	$ (1,132,813)	$ (1,155,469)	$ (1,178,578)	$ (1,202,150)	$ (1,226,193)	$ (1,250,717)	$ (1,275,731)	$ (1,301,246)	$ (1,327,271)	$ (1,353,816)	$ (1,380,892)	$ (1,408,510)	$ (1,436,680)
NPV	Best	($10,602,065)																			
	Lowest	($20,052,401)																			

3.4 Scenario 3 Pro Forma Analyses

Option 3		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	5.4	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	12	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	1084	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	10,957	m2
Capital Cost ($) - Equipment Only	$ 2,000,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 250,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	24	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ -																	
	Capital Cost ($) - Low			$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 2,080,800																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	$ 14,471,370	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	$ 10,696,230	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,043,207	$ 1,064,071																		
Engineering costs	Low (based on low capital cost)	$ 771,066	$ 786,488																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost			$ 91,139	$ 185,924	$ 189,642	$ 193,435	$ 197,304	$ 201,250	$ 205,275	$ 209,380	$ 213,568	$ 217,839	$ 222,196	$ 226,640	$ 231,173	$ 235,796	$ 240,512	$ 245,322	$ 250,229	$ 255,233
SSO Receiving Station	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost			$ 130,050	$ 265,302	$ 270,608	$ 276,020	$ 281,541	$ 287,171	$ 292,915	$ 298,773	$ 304,749	$ 310,844	$ 317,060	$ 323,402	$ 329,870	$ 336,467	$ 343,196	$ 350,060	$ 357,062	$ 364,203
Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost			$ 168,379	$ 343,494	$ 350,364	$ 357,371	$ 364,519	$ 371,809	$ 379,245	$ 386,830	$ 394,567	$ 402,458	$ 410,507	$ 418,717	$ 427,092	$ 435,633	$ 444,346	$ 453,233	$ 462,298	$ 471,544
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
High		$ 1,043,207	$ 1,064,071	$ 14,928,564	$ 932,677	$ 951,330	$ 970,357	$ 989,764	$ 1,009,559	$ 1,029,750	$ 1,050,345	$ 1,071,352	$ 1,092,779	$ 1,114,635	$ 1,136,928	$ 1,159,666	$ 1,182,859	$ 1,206,517	$ 1,230,647	$ 1,255,260	$ 1,280,365
Low		$ 771,066	$ 786,488	$ 11,153,424	$ 932,677	$ 951,330	$ 970,357	$ 989,764	$ 1,009,559	$ 1,029,750	$ 1,050,345	$ 1,071,352	$ 1,092,779	$ 1,114,635	$ 1,136,928	$ 1,159,666	$ 1,182,859	$ 1,206,517	$ 1,230,647	$ 1,255,260	$ 1,280,365
Revenues																					
Gas Generation	Best			$ 983,779	$ 2,006,909	$ 2,047,047	$ 2,087,988	$ 2,129,748	$ 2,172,343	$ 2,215,790	$ 2,260,105	$ 2,305,308	$ 2,351,414	$ 2,398,442	$ 2,446,411	$ 2,495,339	$ 2,545,246	$ 2,596,151	$ 2,648,074	$ 2,701,035	$ 2,755,056
	Lowest			$ 672,062	$ 1,371,006	$ 1,398,426	$ 1,426,395	$ 1,454,923	$ 1,484,021	$ 1,513,702	$ 1,543,976	$ 1,574,855	$ 1,606,352	$ 1,638,479	$ 1,671,249	$ 1,704,674	$ 1,738,767	$ 1,773,543	$ 1,809,014	$ 1,845,194	$ 1,882,098
Tipping Fees				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**	$ -	$ -	$ 983,779	$ 2,006,909	$ 2,047,047	$ 2,087,988	$ 2,129,748	$ 2,172,343	$ 2,215,790	$ 2,260,105	$ 2,305,308	$ 2,351,414	$ 2,398,442	$ 2,446,411	$ 2,495,339	$ 2,545,246	$ 2,596,151	$ 2,648,074	$ 2,701,035	$ 2,755,056
	Lowest	$ -	$ -	$ 672,062	$ 1,371,006	$ 1,398,426	$ 1,426,395	$ 1,454,923	$ 1,484,021	$ 1,513,702	$ 1,543,976	$ 1,574,855	$ 1,606,352	$ 1,638,479	$ 1,671,249	$ 1,704,674	$ 1,738,767	$ 1,773,543	$ 1,809,014	$ 1,845,194	$ 1,882,098
Total																					
	Best	$ (771,066)	$ (786,488)	$ (10,169,646)	$ 1,074,232	$ 1,095,717	$ 1,117,631	$ 1,139,984	$ 1,162,784	$ 1,186,039	$ 1,209,760	$ 1,233,955	$ 1,258,634	$ 1,283,807	$ 1,309,483	$ 1,335,673	$ 1,362,386	$ 1,389,634	$ 1,417,427	$ 1,445,775	$ 1,474,691
	Lowest	$ (1,043,207)	$ (1,064,071)	$ (14,256,503)	$ 438,330	$ 447,096	$ 456,038	$ 465,159	$ 474,462	$ 483,951	$ 493,630	$ 503,503	$ 513,573	$ 523,844	$ 534,321	$ 545,008	$ 555,908	$ 567,026	$ 578,367	$ 589,934	$ 601,733
NPV	Best	$1,802,393																			
	Lowest	($9,363,205)																			

3.5 Scenario 4 Pro Forma Analyses

Option 4		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	37	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High**	$ -	$ -	**$ 18,034,740**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low**	$ -	$ -	**$ 13,687,380**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 281,012	$ 573,265	$ 584,730	$ 596,424	$ 608,353	$ 620,520	$ 632,930	$ 645,589	$ 658,501	$ 671,671	$ 685,104	$ 698,806	$ 712,782	$ 727,038	$ 741,579	$ 756,410	$ 771,539	$ 786,969
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Transportation	Disposal Cost			$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
	High	$ 1,300,082	$ 1,326,084	$ 18,928,726	$ 1,823,731	$ 1,860,205	$ 1,897,410	$ 1,935,358	$ 1,974,065	$ 2,013,546	$ 2,053,817	$ 2,094,893	$ 2,136,791	$ 2,179,527	$ 2,223,118	$ 2,267,580	$ 2,312,932	$ 2,359,190	$ 2,406,374	$ 2,454,502	$ 2,503,592
	Low	$ 986,691	$ 1,006,425	$ 14,581,366	$ 1,823,731	$ 1,860,205	$ 1,897,410	$ 1,935,358	$ 1,974,065	$ 2,013,546	$ 2,053,817	$ 2,094,893	$ 2,136,791	$ 2,179,527	$ 2,223,118	$ 2,267,580	$ 2,312,932	$ 2,359,190	$ 2,406,374	$ 2,454,502	$ 2,503,592
Revenues																					
Gas Generation	Best			$ 1,332,163	$ 2,717,613	$ 2,771,966	$ 2,827,405	$ 2,883,953	$ 2,941,632	$ 3,000,465	$ 3,060,474	$ 3,121,683	$ 3,184,117	$ 3,247,799	$ 3,312,755	$ 3,379,011	$ 3,446,591	$ 3,515,523	$ 3,585,833	$ 3,657,550	$ 3,730,701
	Lowest			$ 910,058	$ 1,856,519	$ 1,893,649	$ 1,931,522	$ 1,970,153	$ 2,009,556	$ 2,049,747	$ 2,090,742	$ 2,132,557	$ 2,175,208	$ 2,218,712	$ 2,263,086	$ 2,308,348	$ 2,354,515	$ 2,401,605	$ 2,449,638	$ 2,498,630	$ 2,548,603
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	$ -	$ -	**$ 1,550,647**	**$ 3,163,321**	**$ 3,226,587**	**$ 3,291,119**	**$ 3,356,941**	**$ 3,424,080**	**$ 3,492,562**	**$ 3,562,413**	**$ 3,633,661**	**$ 3,706,334**	**$ 3,780,461**	**$ 3,856,070**	**$ 3,933,192**	**$ 4,011,856**	**$ 4,092,093**	**$ 4,173,934**	**$ 4,257,413**	**$ 4,342,561**
	Lowest	$ -	$ -	**$ 1,128,542**	**$ 2,302,226**	**$ 2,348,271**	**$ 2,395,236**	**$ 2,443,141**	**$ 2,492,004**	**$ 2,541,844**	**$ 2,592,681**	**$ 2,644,535**	**$ 2,697,425**	**$ 2,751,374**	**$ 2,806,401**	**$ 2,862,529**	**$ 2,919,780**	**$ 2,978,175**	**$ 3,037,739**	**$ 3,098,494**	**$ 3,160,464**
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,030,718)	$ 1,339,590	$ 1,366,382	$ 1,393,709	$ 1,421,584	$ 1,450,015	$ 1,479,015	$ 1,508,596	$ 1,538,768	$ 1,569,543	$ 1,600,934	$ 1,632,953	$ 1,665,612	$ 1,698,924	$ 1,732,902	$ 1,767,560	$ 1,802,912	$ 1,838,970
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (17,800,183)	$ 478,496	$ 488,066	$ 497,827	$ 507,783	$ 517,939	$ 528,298	$ 538,864	$ 549,641	$ 560,634	$ 571,847	$ 583,284	$ 594,949	$ 606,848	$ 618,985	$ 631,365	$ 643,992	$ 656,872
NPV	Best	$1,898,944																			
	Lowest	($12,456,670)																			

Option 4		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	37	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High**	**$ -**	**$ -**	**$ 18,034,740**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low**	**$ -**	**$ -**	**$ 13,687,380**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 281,012	$ 573,265	$ 584,730	$ 596,424	$ 608,353	$ 620,520	$ 632,930	$ 645,589	$ 658,501	$ 671,671	$ 685,104	$ 698,806	$ 712,782	$ 727,038	$ 741,579	$ 756,410	$ 771,539	$ 786,969
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Transportation	Disposal Cost			$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset			$ (7,616)	$ (15,537)	$ (15,848)	$ (16,165)	$ (16,488)	$ (16,818)	$ (17,154)	$ (17,497)	$ (17,847)	$ (18,204)	$ (18,568)	$ (18,940)	$ (19,318)	$ (19,705)	$ (20,099)	$ (20,501)	$ (20,911)	$ (21,329)
Total Costs																					
High		$ 1,300,082	$ 1,326,084	$ 18,921,109	$ 1,808,194	$ 1,844,358	$ 1,881,245	$ 1,918,870	$ 1,957,247	$ 1,996,392	$ 2,036,320	$ 2,077,046	$ 2,118,587	$ 2,160,959	$ 2,204,178	$ 2,248,262	$ 2,293,227	$ 2,339,091	$ 2,385,873	$ 2,433,591	$ 2,482,263
Low		$ 986,691	$ 1,006,425	$ 14,573,749	$ 1,808,194	$ 1,844,358	$ 1,881,245	$ 1,918,870	$ 1,957,247	$ 1,996,392	$ 2,036,320	$ 2,077,046	$ 2,118,587	$ 2,160,959	$ 2,204,178	$ 2,248,262	$ 2,293,227	$ 2,339,091	$ 2,385,873	$ 2,433,591	$ 2,482,263
Revenues																					
Gas Generation	Best			$ 1,055,263	$ 2,152,736	$ 2,195,790	$ 2,239,706	$ 2,284,500	$ 2,330,190	$ 2,376,794	$ 2,424,330	$ 2,472,816	$ 2,522,273	$ 2,572,718	$ 2,624,173	$ 2,676,656	$ 2,730,189	$ 2,784,793	$ 2,840,489	$ 2,897,299	$ 2,955,245
	Lowest			$ 633,158	$ 1,291,641	$ 1,317,474	$ 1,343,824	$ 1,370,700	$ 1,398,114	$ 1,426,076	$ 1,454,598	$ 1,483,690	$ 1,513,364	$ 1,543,631	$ 1,574,504	$ 1,605,994	$ 1,638,113	$ 1,670,876	$ 1,704,293	$ 1,738,379	$ 1,773,147
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	**$ -**	**$ -**	**$ 1,273,747**	**$ 2,598,443**	**$ 2,650,412**	**$ 2,703,420**	**$ 2,757,488**	**$ 2,812,638**	**$ 2,868,891**	**$ 2,926,269**	**$ 2,984,794**	**$ 3,044,490**	**$ 3,105,380**	**$ 3,167,487**	**$ 3,230,837**	**$ 3,295,454**	**$ 3,361,363**	**$ 3,428,590**	**$ 3,497,162**	**$ 3,567,105**
	Lowest	**$ -**	**$ -**	**$ 851,642**	**$ 1,737,349**	**$ 1,772,096**	**$ 1,807,538**	**$ 1,843,688**	**$ 1,880,562**	**$ 1,918,173**	**$ 1,956,537**	**$ 1,995,668**	**$ 2,035,581**	**$ 2,076,292**	**$ 2,117,818**	**$ 2,160,175**	**$ 2,203,378**	**$ 2,247,446**	**$ 2,292,395**	**$ 2,338,243**	**$ 2,385,007**
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,300,003)	$ 790,249	$ 806,054	$ 822,175	$ 838,619	$ 855,391	$ 872,499	$ 889,949	$ 907,748	$ 925,903	$ 944,421	$ 963,309	$ 982,575	$ 1,002,227	$ 1,022,271	$ 1,042,717	$ 1,063,571	$ 1,084,843
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (18,069,468)	$ (70,845)	$ (72,262)	$ (73,707)	$ (75,181)	$ (76,685)	$ (78,219)	$ (79,783)	$ (81,379)	$ (83,006)	$ (84,666)	$ (86,360)	$ (88,087)	$ (89,849)	$ (91,646)	$ (93,479)	$ (95,348)	$ (97,255)
NPV	Best	($4,488,146)																			
	Lowest	($18,843,761)																			

Option 4		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	37	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	100	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High**	**$ -**	**$ -**	**$ 12,650,670**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low**	**$ -**	**$ -**	**$ 9,707,850**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 911,957	$ 930,196																		
Engineering costs	Low (based on low capital cost)	$ 699,816	$ 713,813																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 281,012	$ 573,265	$ 584,730	$ 596,424	$ 608,353	$ 620,520	$ 632,930	$ 645,589	$ 658,501	$ 671,671	$ 685,104	$ 698,806	$ 712,782	$ 727,038	$ 741,579	$ 756,410	$ 771,539	$ 786,969
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Transportation	Disposal Cost			$ 701,581	$ 1,431,225	$ 1,459,849	$ 1,489,046	$ 1,518,827	$ 1,549,204	$ 1,580,188	$ 1,611,791	$ 1,644,027	$ 1,676,908	$ 1,710,446	$ 1,744,655	$ 1,779,548	$ 1,815,139	$ 1,851,442	$ 1,888,471	$ 1,926,240	$ 1,964,765
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
	High	$ 911,957	$ 930,196	$ 13,989,184	$ 2,730,568	$ 2,785,179	$ 2,840,883	$ 2,897,700	$ 2,955,654	$ 3,014,767	$ 3,075,063	$ 3,136,564	$ 3,199,295	$ 3,263,281	$ 3,328,547	$ 3,395,118	$ 3,463,020	$ 3,532,281	$ 3,602,926	$ 3,674,985	$ 3,748,484
	Low	$ 699,816	$ 713,813	$ 11,046,364	$ 2,730,568	$ 2,785,179	$ 2,840,883	$ 2,897,700	$ 2,955,654	$ 3,014,767	$ 3,075,063	$ 3,136,564	$ 3,199,295	$ 3,263,281	$ 3,328,547	$ 3,395,118	$ 3,463,020	$ 3,532,281	$ 3,602,926	$ 3,674,985	$ 3,748,484
Revenues																					
Gas Generation	Best			$ 1,332,163	$ 2,717,613	$ 2,771,966	$ 2,827,405	$ 2,883,953	$ 2,941,632	$ 3,000,465	$ 3,060,474	$ 3,121,683	$ 3,184,117	$ 3,247,799	$ 3,312,755	$ 3,379,011	$ 3,446,591	$ 3,515,523	$ 3,585,833	$ 3,657,550	$ 3,730,701
	Lowest			$ 910,058	$ 1,856,519	$ 1,893,649	$ 1,931,522	$ 1,970,153	$ 2,009,556	$ 2,049,747	$ 2,090,742	$ 2,132,557	$ 2,175,208	$ 2,218,712	$ 2,263,086	$ 2,308,348	$ 2,354,515	$ 2,401,605	$ 2,449,638	$ 2,498,630	$ 2,548,603
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	**$ -**	**$ -**	**$ 1,550,647**	**$ 3,163,321**	**$ 3,226,587**	**$ 3,291,119**	**$ 3,356,941**	**$ 3,424,080**	**$ 3,492,562**	**$ 3,562,413**	**$ 3,633,661**	**$ 3,706,334**	**$ 3,780,461**	**$ 3,856,070**	**$ 3,933,192**	**$ 4,011,856**	**$ 4,092,093**	**$ 4,173,934**	**$ 4,257,413**	**$ 4,342,561**
	Lowest	**$ -**	**$ -**	**$ 1,128,542**	**$ 2,302,226**	**$ 2,348,271**	**$ 2,395,236**	**$ 2,443,141**	**$ 2,492,004**	**$ 2,541,844**	**$ 2,592,681**	**$ 2,644,535**	**$ 2,697,425**	**$ 2,751,374**	**$ 2,806,401**	**$ 2,862,529**	**$ 2,919,780**	**$ 2,978,175**	**$ 3,037,739**	**$ 3,098,494**	**$ 3,160,464**
Total																					
	Best	$ (699,816)	$ (713,813)	$ (9,495,716)	$ 432,753	$ 441,408	$ 450,236	$ 459,241	$ 468,426	$ 477,794	$ 487,350	$ 497,097	$ 507,039	$ 517,180	$ 527,523	$ 538,074	$ 548,835	$ 559,812	$ 571,008	$ 582,428	$ 594,077
	Lowest	$ (911,957)	$ (930,196)	$ (12,860,641)	$ (428,341)	$ (436,908)	$ (445,646)	$ (454,559)	$ (463,650)	$ (472,923)	$ (482,382)	$ (492,030)	$ (501,870)	$ (511,908)	$ (522,146)	$ (532,589)	$ (543,240)	$ (554,105)	$ (565,187)	$ (576,491)	$ (588,021)
NPV	Best	($4,668,403)																			
	Lowest	($17,620,621)																			

Option 4		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	37	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	100	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ -																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High**	$ -	$ -	**$ 12,650,670**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low**	$ -	$ -	**$ 9,707,850**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 911,957	$ 930,196																		
Engineering costs	Low (based on low capital cost)	$ 699,816	$ 713,813																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 281,012	$ 573,265	$ 584,730	$ 596,424	$ 608,353	$ 620,520	$ 632,930	$ 645,589	$ 658,501	$ 671,671	$ 685,104	$ 698,806	$ 712,782	$ 727,038	$ 741,579	$ 756,410	$ 771,539	$ 786,969
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Transportation	Disposal Cost			$ 701,581	$ 1,431,225	$ 1,459,849	$ 1,489,046	$ 1,518,827	$ 1,549,204	$ 1,580,188	$ 1,611,791	$ 1,644,027	$ 1,676,908	$ 1,710,446	$ 1,744,655	$ 1,779,548	$ 1,815,139	$ 1,851,442	$ 1,888,471	$ 1,926,240	$ 1,964,765
Electricity Cost Offset	Electricity Cost Offset			$ (7,616)	$ (15,537)	$ (15,848)	$ (16,165)	$ (16,488)	$ (16,818)	$ (17,154)	$ (17,497)	$ (17,847)	$ (18,204)	$ (18,568)	$ (18,940)	$ (19,318)	$ (19,705)	$ (20,099)	$ (20,501)	$ (20,911)	$ (21,329)
Total Costs																					
High		$ 911,957	$ 930,196	$ 13,981,567	$ 2,715,031	$ 2,769,331	$ 2,824,718	$ 2,881,212	$ 2,938,837	$ 2,997,613	$ 3,057,566	$ 3,118,717	$ 3,181,091	$ 3,244,713	$ 3,309,607	$ 3,375,799	$ 3,443,315	$ 3,512,182	$ 3,582,425	$ 3,654,074	$ 3,727,155
Low		$ 699,816	$ 713,813	$ 11,038,747	$ 2,715,031	$ 2,769,331	$ 2,824,718	$ 2,881,212	$ 2,938,837	$ 2,997,613	$ 3,057,566	$ 3,118,717	$ 3,181,091	$ 3,244,713	$ 3,309,607	$ 3,375,799	$ 3,443,315	$ 3,512,182	$ 3,582,425	$ 3,654,074	$ 3,727,155
Revenues																					
Gas Generation	Best			$ 1,055,263	$ 2,152,736	$ 2,195,790	$ 2,239,706	$ 2,284,500	$ 2,330,190	$ 2,376,794	$ 2,424,330	$ 2,472,816	$ 2,522,273	$ 2,572,718	$ 2,624,173	$ 2,676,656	$ 2,730,189	$ 2,784,793	$ 2,840,489	$ 2,897,299	$ 2,955,245
	Lowest			$ 633,158	$ 1,291,641	$ 1,317,474	$ 1,343,824	$ 1,370,700	$ 1,398,114	$ 1,426,076	$ 1,454,598	$ 1,483,690	$ 1,513,364	$ 1,543,631	$ 1,574,504	$ 1,605,994	$ 1,638,113	$ 1,670,876	$ 1,704,293	$ 1,738,379	$ 1,773,147
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	$ -	$ -	**$ 1,273,747**	**$ 2,598,443**	**$ 2,650,412**	**$ 2,703,420**	**$ 2,757,488**	**$ 2,812,638**	**$ 2,868,891**	**$ 2,926,269**	**$ 2,984,794**	**$ 3,044,490**	**$ 3,105,380**	**$ 3,167,487**	**$ 3,230,837**	**$ 3,295,454**	**$ 3,361,363**	**$ 3,428,590**	**$ 3,497,162**	**$ 3,567,105**
	Lowest	$ -	$ -	**$ 851,642**	**$ 1,737,349**	**$ 1,772,096**	**$ 1,807,538**	**$ 1,843,688**	**$ 1,880,562**	**$ 1,918,173**	**$ 1,956,537**	**$ 1,995,668**	**$ 2,035,581**	**$ 2,076,292**	**$ 2,117,818**	**$ 2,160,175**	**$ 2,203,378**	**$ 2,247,446**	**$ 2,292,395**	**$ 2,338,243**	**$ 2,385,007**
Total																					
	Best	$ (699,816)	$ (713,813)	$ (9,765,001)	$ (116,588)	$ (118,920)	$ (121,298)	$ (123,724)	$ (126,198)	$ (128,722)	$ (131,297)	$ (133,923)	$ (136,601)	$ (139,333)	$ (142,120)	$ (144,962)	$ (147,862)	$ (150,819)	$ (153,835)	$ (156,912)	$ (160,050)
	Lowest	$ (911,957)	$ (930,196)	$ (13,129,926)	$ (977,682)	$ (997,236)	$ (1,017,180)	$ (1,037,524)	$ (1,058,275)	$ (1,079,440)	$ (1,101,029)	$ (1,123,049)	$ (1,145,510)	$ (1,168,421)	$ (1,191,789)	$ (1,215,625)	$ (1,239,937)	$ (1,264,736)	$ (1,290,031)	$ (1,315,831)	$ (1,342,148)
NPV	Best	($11,055,494)																			
	Lowest	($24,007,712)																			

3.6 Scenario 5 Pro Forma Analyses

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation			1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																						
SSO Receiving Station	Capital Cost ($) - High				$ 4,161,600.00																	
	Capital Cost ($) - Low				$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only				$ 1,872,720																	
	Capital Cost ($) - Civil and Structural				$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only				$ 1,560,600																	
	Capital Cost ($) - Civil and Structural				$ 3,121,200																	
Cake Storage	Capital Cost				$ 4,681,800																	
Gas Cleaning	Capital Cost				$ 2,700,000																	
Total Capital Costs	**High (+15%)**		**$ -**	**$ -**	**$ 23,418,810**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**		**$ -**	**$ -**	**$ 17,666,910**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)		$ 1,688,207	$ 1,721,971																		
Engineering costs	Low (based on low capital cost)		$ 1,273,566	$ 1,299,038																		
Operating Costs																						
Disposal of Lights/Heavies/Grits	Disposal Cost				$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost				$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost				$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost				$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost				$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost				$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost				$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																						
	High		$ 1,688,207	$ 1,721,971	$ 24,338,702	$ 1,876,579	$ 1,914,111	$ 1,952,393	$ 1,991,441	$ 2,031,269	$ 2,071,895	$ 2,113,333	$ 2,155,599	$ 2,198,711	$ 2,242,686	$ 2,287,539	$ 2,333,290	$ 2,379,956	$ 2,427,555	$ 2,476,106	$ 2,525,628	$ 2,576,141
	Low		$ 1,273,566	$ 1,299,038	$ 18,586,802	$ 1,876,579	$ 1,914,111	$ 1,952,393	$ 1,991,441	$ 2,031,269	$ 2,071,895	$ 2,113,333	$ 2,155,599	$ 2,198,711	$ 2,242,686	$ 2,287,539	$ 2,333,290	$ 2,379,956	$ 2,427,555	$ 2,476,106	$ 2,525,628	$ 2,576,141
Revenues																						
Gas Generation	Best				$ 1,332,163	$ 2,717,613	$ 2,771,966	$ 2,827,405	$ 2,883,953	$ 2,941,632	$ 3,000,465	$ 3,060,474	$ 3,121,683	$ 3,184,117	$ 3,247,799	$ 3,312,755	$ 3,379,011	$ 3,446,591	$ 3,515,523	$ 3,585,833	$ 3,657,550	$ 3,730,701
	Lowest				$ 910,058	$ 1,856,519	$ 1,893,649	$ 1,931,522	$ 1,970,153	$ 2,009,556	$ 2,049,747	$ 2,090,742	$ 2,132,557	$ 2,175,208	$ 2,218,712	$ 2,263,086	$ 2,308,348	$ 2,354,515	$ 2,401,605	$ 2,449,638	$ 2,498,630	$ 2,548,603
Tipping Fees					$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**		**$ -**	**$ -**	**$ 1,550,647**	**$ 3,163,321**	**$ 3,226,587**	**$ 3,291,119**	**$ 3,356,941**	**$ 3,424,080**	**$ 3,492,562**	**$ 3,562,413**	**$ 3,633,661**	**$ 3,706,334**	**$ 3,780,461**	**$ 3,856,070**	**$ 3,933,192**	**$ 4,011,856**	**$ 4,092,093**	**$ 4,173,934**	**$ 4,257,413**	**$ 4,342,561**
	Lowest		**$ -**	**$ -**	**$ 1,128,542**	**$ 2,302,226**	**$ 2,348,271**	**$ 2,395,236**	**$ 2,443,141**	**$ 2,492,004**	**$ 2,541,844**	**$ 2,592,681**	**$ 2,644,535**	**$ 2,697,425**	**$ 2,751,374**	**$ 2,806,401**	**$ 2,862,529**	**$ 2,919,780**	**$ 2,978,175**	**$ 3,037,739**	**$ 3,098,494**	**$ 3,160,464**
Total																						
	Best		$ (1,273,566)	$ (1,299,038)	$ (17,036,154)	$ 1,286,742	$ 1,312,477	$ 1,338,726	$ 1,365,501	$ 1,392,811	$ 1,420,667	$ 1,449,080	$ 1,478,062	$ 1,507,623	$ 1,537,775	$ 1,568,531	$ 1,599,902	$ 1,631,900	$ 1,664,538	$ 1,697,828	$ 1,731,785	$ 1,766,421
	Lowest		$ (1,688,207)	$ (1,721,971)	$ (23,210,159)	$ 425,648	$ 434,160	$ 442,844	$ 451,701	$ 460,735	$ 469,949	$ 479,348	$ 488,935	$ 498,714	$ 508,688	$ 518,862	$ 529,239	$ 539,824	$ 550,620	$ 561,633	$ 572,866	$ 584,323
NPV	Best		($2,691,802)																			
	Lowest		($18,450,813)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	**$ 23,418,810**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	**$ 17,666,910**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,688,207	$ 1,721,971																		
Engineering costs	Low (based on low capital cost)	$ 1,273,566	$ 1,299,038																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset			$ (7,616)	$ (15,537)	$ (15,848)	$ (16,165)	$ (16,488)	$ (16,818)	$ (17,154)	$ (17,497)	$ (17,847)	$ (18,204)	$ (18,568)	$ (18,940)	$ (19,318)	$ (19,705)	$ (20,099)	$ (20,501)	$ (20,911)	$ (21,329)
Total Costs																					
	High	$ 1,688,207	$ 1,721,971	$ 24,331,085	$ 1,861,042	$ 1,898,263	$ 1,936,228	$ 1,974,953	$ 2,014,452	$ 2,054,741	$ 2,095,835	$ 2,137,752	$ 2,180,507	$ 2,224,117	$ 2,268,600	$ 2,313,972	$ 2,360,251	$ 2,407,456	$ 2,455,605	$ 2,504,717	$ 2,554,812
	Low	$ 1,273,566	$ 1,299,038	$ 18,579,185	$ 1,861,042	$ 1,898,263	$ 1,936,228	$ 1,974,953	$ 2,014,452	$ 2,054,741	$ 2,095,835	$ 2,137,752	$ 2,180,507	$ 2,224,117	$ 2,268,600	$ 2,313,972	$ 2,360,251	$ 2,407,456	$ 2,455,605	$ 2,504,717	$ 2,554,812
Revenues																					
Gas Generation	Best			$ 1,055,263	$ 2,152,736	$ 2,195,790	$ 2,239,706	$ 2,284,500	$ 2,330,190	$ 2,376,794	$ 2,424,330	$ 2,472,816	$ 2,522,273	$ 2,572,718	$ 2,624,173	$ 2,676,656	$ 2,730,189	$ 2,784,793	$ 2,840,489	$ 2,897,299	$ 2,955,245
	Lowest			$ 633,158	$ 1,291,641	$ 1,317,474	$ 1,343,824	$ 1,370,700	$ 1,398,114	$ 1,426,076	$ 1,454,598	$ 1,483,690	$ 1,513,364	$ 1,543,631	$ 1,574,504	$ 1,605,994	$ 1,638,113	$ 1,670,876	$ 1,704,293	$ 1,738,379	$ 1,773,147
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	$ -	$ -	**$ 1,273,747**	**$ 2,598,443**	**$ 2,650,412**	**$ 2,703,420**	**$ 2,757,488**	**$ 2,812,638**	**$ 2,868,891**	**$ 2,926,269**	**$ 2,984,794**	**$ 3,044,490**	**$ 3,105,380**	**$ 3,167,487**	**$ 3,230,837**	**$ 3,295,454**	**$ 3,361,363**	**$ 3,428,590**	**$ 3,497,162**	**$ 3,567,105**
	Lowest	$ -	$ -	**$ 851,642**	**$ 1,737,349**	**$ 1,772,096**	**$ 1,807,538**	**$ 1,843,688**	**$ 1,880,562**	**$ 1,918,173**	**$ 1,956,537**	**$ 1,995,668**	**$ 2,035,581**	**$ 2,076,292**	**$ 2,117,818**	**$ 2,160,175**	**$ 2,203,378**	**$ 2,247,446**	**$ 2,292,395**	**$ 2,338,243**	**$ 2,385,007**
Total																					
	Best	$ (1,273,566)	$ (1,299,038)	$ (17,305,439)	$ 737,401	$ 752,149	$ 767,192	$ 782,536	$ 798,187	$ 814,150	$ 830,433	$ 847,042	$ 863,983	$ 881,262	$ 898,888	$ 916,865	$ 935,203	$ 953,907	$ 972,985	$ 992,445	$ 1,012,293
	Lowest	$ (1,688,207)	$ (1,721,971)	$ (23,479,444)	$ (123,693)	$ (126,167)	$ (128,690)	$ (131,264)	$ (133,890)	$ (136,567)	$ (139,299)	$ (142,085)	$ (144,926)	$ (147,825)	$ (150,781)	$ (153,797)	$ (156,873)	$ (160,010)	$ (163,211)	$ (166,475)	$ (169,804)
NPV	Best	($9,078,893)																			
	Lowest	($24,837,904)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	132	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	$ 18,034,740	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	$ 13,687,380	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 926,087	$ 1,889,217	$ 1,927,001	$ 1,965,541	$ 2,004,852	$ 2,044,949	$ 2,085,848	$ 2,127,565	$ 2,170,116	$ 2,213,518	$ 2,257,789	$ 2,302,944	$ 2,349,003	$ 2,395,983	$ 2,443,903	$ 2,492,781	$ 2,542,637	$ 2,593,490
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
	High	$ 1,300,082	$ 1,326,084	$ 19,623,665	$ 3,241,408	$ 3,306,236	$ 3,372,361	$ 3,439,808	$ 3,508,604	$ 3,578,776	$ 3,650,352	$ 3,723,359	$ 3,797,826	$ 3,873,782	$ 3,951,258	$ 4,030,283	$ 4,110,889	$ 4,193,107	$ 4,276,969	$ 4,362,508	$ 4,449,758
	Low	$ 986,691	$ 1,006,425	$ 15,276,305	$ 3,241,408	$ 3,306,236	$ 3,372,361	$ 3,439,808	$ 3,508,604	$ 3,578,776	$ 3,650,352	$ 3,723,359	$ 3,797,826	$ 3,873,782	$ 3,951,258	$ 4,030,283	$ 4,110,889	$ 4,193,107	$ 4,276,969	$ 4,362,508	$ 4,449,758
Revenues																					
Gas Generation	Best			$ 1,332,163	$ 2,717,613	$ 2,771,966	$ 2,827,405	$ 2,883,953	$ 2,941,632	$ 3,000,465	$ 3,060,474	$ 3,121,683	$ 3,184,117	$ 3,247,799	$ 3,312,755	$ 3,379,011	$ 3,446,591	$ 3,515,523	$ 3,585,833	$ 3,657,550	$ 3,730,701
	Lowest			$ 910,058	$ 1,856,519	$ 1,893,649	$ 1,931,522	$ 1,970,153	$ 2,009,556	$ 2,049,747	$ 2,090,742	$ 2,132,557	$ 2,175,208	$ 2,218,712	$ 2,263,086	$ 2,308,348	$ 2,354,515	$ 2,401,605	$ 2,449,638	$ 2,498,630	$ 2,548,603
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	$ -	$ -	$ 1,550,647	$ 3,163,321	$ 3,226,587	$ 3,291,119	$ 3,356,941	$ 3,424,080	$ 3,492,562	$ 3,562,413	$ 3,633,661	$ 3,706,334	$ 3,780,461	$ 3,856,070	$ 3,933,192	$ 4,011,856	$ 4,092,093	$ 4,173,934	$ 4,257,413	$ 4,342,561
	Lowest	$ -	$ -	$ 1,128,542	$ 2,302,226	$ 2,348,271	$ 2,395,236	$ 2,443,141	$ 2,492,004	$ 2,541,844	$ 2,592,681	$ 2,644,535	$ 2,697,425	$ 2,751,374	$ 2,806,401	$ 2,862,529	$ 2,919,780	$ 2,978,175	$ 3,037,739	$ 3,098,494	$ 3,160,464
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,725,658)	$ (78,087)	$ (79,649)	$ (81,242)	$ (82,867)	$ (84,524)	$ (86,215)	$ (87,939)	$ (89,698)	$ (91,492)	$ (93,321)	$ (95,188)	$ (97,092)	$ (99,033)	$ (101,014)	$ (103,034)	$ (105,095)	$ (107,197)
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (18,495,123)	$ (939,181)	$ (957,965)	$ (977,124)	$ (996,667)	$ (1,016,600)	$ (1,036,932)	$ (1,057,671)	$ (1,078,824)	$ (1,100,401)	$ (1,122,409)	$ (1,144,857)	$ (1,167,754)	$ (1,191,109)	$ (1,214,931)	$ (1,239,230)	$ (1,264,014)	$ (1,289,295)
NPV	Best	($14,584,142)																			
	Lowest	($28,939,757)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	132	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 18,034,740**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 13,687,380**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 926,087	$ 1,889,217	$ 1,927,001	$ 1,965,541	$ 2,004,852	$ 2,044,949	$ 2,085,848	$ 2,127,565	$ 2,170,116	$ 2,213,518	$ 2,257,789	$ 2,302,944	$ 2,349,003	$ 2,395,983	$ 2,443,903	$ 2,492,781	$ 2,542,637	$ 2,593,490
Electricity Cost Offset	Electricity Cost Offset			$ (7,616)	$ (15,537)	$ (15,848)	$ (16,165)	$ (16,488)	$ (16,818)	$ (17,154)	$ (17,497)	$ (17,847)	$ (18,204)	$ (18,568)	$ (18,940)	$ (19,318)	$ (19,705)	$ (20,099)	$ (20,501)	$ (20,911)	$ (21,329)
Total Costs																					
High		$ 1,300,082	$ 1,326,084	$ 19,616,049	$ 3,225,871	$ 3,290,388	$ 3,356,196	$ 3,423,320	$ 3,491,786	$ 3,561,622	$ 3,632,854	$ 3,705,512	$ 3,779,622	$ 3,855,214	$ 3,932,319	$ 4,010,965	$ 4,091,184	$ 4,173,008	$ 4,256,468	$ 4,341,597	$ 4,428,429
Low		$ 986,691	$ 1,006,425	$ 15,268,689	$ 3,225,871	$ 3,290,388	$ 3,356,196	$ 3,423,320	$ 3,491,786	$ 3,561,622	$ 3,632,854	$ 3,705,512	$ 3,779,622	$ 3,855,214	$ 3,932,319	$ 4,010,965	$ 4,091,184	$ 4,173,008	$ 4,256,468	$ 4,341,597	$ 4,428,429
Revenues																					
Gas Generation	Best			$ 1,055,263	$ 2,152,736	$ 2,195,790	$ 2,239,706	$ 2,284,500	$ 2,330,190	$ 2,376,794	$ 2,424,330	$ 2,472,816	$ 2,522,273	$ 2,572,718	$ 2,624,173	$ 2,676,656	$ 2,730,189	$ 2,784,793	$ 2,840,489	$ 2,897,299	$ 2,955,245
	Lowest			$ 633,158	$ 1,291,641	$ 1,317,474	$ 1,343,824	$ 1,370,700	$ 1,398,114	$ 1,426,076	$ 1,454,598	$ 1,483,690	$ 1,513,364	$ 1,543,631	$ 1,574,504	$ 1,605,994	$ 1,638,113	$ 1,670,876	$ 1,704,293	$ 1,738,379	$ 1,773,147
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	**$ -**	**$ -**	**$ 1,273,747**	**$ 2,598,443**	**$ 2,650,412**	**$ 2,703,420**	**$ 2,757,488**	**$ 2,812,638**	**$ 2,868,891**	**$ 2,926,269**	**$ 2,984,794**	**$ 3,044,490**	**$ 3,105,380**	**$ 3,167,487**	**$ 3,230,837**	**$ 3,295,454**	**$ 3,361,363**	**$ 3,428,590**	**$ 3,497,162**	**$ 3,567,105**
	Lowest	**$ -**	**$ -**	**$ 851,642**	**$ 1,737,349**	**$ 1,772,096**	**$ 1,807,538**	**$ 1,843,688**	**$ 1,880,562**	**$ 1,918,173**	**$ 1,956,537**	**$ 1,995,668**	**$ 2,035,581**	**$ 2,076,292**	**$ 2,117,818**	**$ 2,160,175**	**$ 2,203,378**	**$ 2,247,446**	**$ 2,292,395**	**$ 2,338,243**	**$ 2,385,007**
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,994,943)	$ (627,428)	$ (639,976)	$ (652,776)	$ (665,832)	$ (679,148)	$ (692,731)	$ (706,586)	$ (720,717)	$ (735,132)	$ (749,834)	$ (764,831)	$ (780,128)	$ (795,730)	$ (811,645)	$ (827,878)	$ (844,435)	$ (861,324)
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (18,764,408)	$ (1,488,522)	$ (1,518,293)	$ (1,548,658)	$ (1,579,632)	$ (1,611,224)	$ (1,643,449)	$ (1,676,318)	$ (1,709,844)	$ (1,744,041)	$ (1,778,922)	$ (1,814,500)	$ (1,850,790)	$ (1,887,806)	$ (1,925,562)	$ (1,964,073)	$ (2,003,355)	$ (2,043,422)
NPV	Best	($20,971,233)																			
	Lowest	($35,326,847)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	4000	tpy
Capital Cost ($) - High	$ 5,000,000.00	$
Capital Cost ($) - Low	$ 4,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	5,969	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 6,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	27	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 5,202,000.00																	
	Capital Cost ($) - Low			$ 4,473,720.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 7,074,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 30,441,510**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 23,129,010**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 2,194,457	$ 2,238,346																		
Engineering costs	Low (based on low capital cost)	$ 1,667,316	$ 1,700,663																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 17,791	$ 36,293	$ 37,019	$ 37,760	$ 38,515	$ 39,285	$ 40,071	$ 40,872	$ 41,690	$ 42,523	$ 43,374	$ 44,241	$ 45,126	$ 46,029	$ 46,949	$ 47,888	$ 48,846	$ 49,823
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 189,427	$ 386,431	$ 394,159	$ 402,042	$ 410,083	$ 418,285	$ 426,651	$ 435,184	$ 443,887	$ 452,765	$ 461,820	$ 471,057	$ 480,478	$ 490,088	$ 499,889	$ 509,887	$ 520,085	$ 530,486
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
	High	$ 2,194,457	$ 2,238,346	$ 31,361,402	$ 1,876,579	$ 1,914,111	$ 1,952,393	$ 1,991,441	$ 2,031,269	$ 2,071,895	$ 2,113,333	$ 2,155,599	$ 2,198,711	$ 2,242,686	$ 2,287,539	$ 2,333,290	$ 2,379,956	$ 2,427,555	$ 2,476,106	$ 2,525,628	$ 2,576,141
	Low	$ 1,667,316	$ 1,700,663	$ 24,048,902	$ 1,876,579	$ 1,914,111	$ 1,952,393	$ 1,991,441	$ 2,031,269	$ 2,071,895	$ 2,113,333	$ 2,155,599	$ 2,198,711	$ 2,242,686	$ 2,287,539	$ 2,333,290	$ 2,379,956	$ 2,427,555	$ 2,476,106	$ 2,525,628	$ 2,576,141
Revenues																					
Gas Generation	Best			$ 1,332,163	$ 2,717,613	$ 2,771,966	$ 2,827,405	$ 2,883,953	$ 2,941,632	$ 3,000,465	$ 3,060,474	$ 3,121,683	$ 3,184,117	$ 3,247,799	$ 3,312,755	$ 3,379,011	$ 3,446,591	$ 3,515,523	$ 3,585,833	$ 3,657,550	$ 3,730,701
	Lowest			$ 910,058	$ 1,856,519	$ 1,893,649	$ 1,931,522	$ 1,970,153	$ 2,009,556	$ 2,049,747	$ 2,090,742	$ 2,132,557	$ 2,175,208	$ 2,218,712	$ 2,263,086	$ 2,308,348	$ 2,354,515	$ 2,401,605	$ 2,449,638	$ 2,498,630	$ 2,548,603
Tipping Fees				$ 218,484	$ 445,707	$ 454,622	$ 463,714	$ 472,988	$ 482,448	$ 492,097	$ 501,939	$ 511,978	$ 522,217	$ 532,662	$ 543,315	$ 554,181	$ 565,265	$ 576,570	$ 588,101	$ 599,863	$ 611,861
Total Revenues	**Best**	**$ -**	**$ -**	**$ 1,550,647**	**$ 3,163,321**	**$ 3,226,587**	**$ 3,291,119**	**$ 3,356,941**	**$ 3,424,080**	**$ 3,492,562**	**$ 3,562,413**	**$ 3,633,661**	**$ 3,706,334**	**$ 3,780,461**	**$ 3,856,070**	**$ 3,933,192**	**$ 4,011,856**	**$ 4,092,093**	**$ 4,173,934**	**$ 4,257,413**	**$ 4,342,561**
	Lowest	**$ -**	**$ -**	**$ 1,128,542**	**$ 2,302,226**	**$ 2,348,271**	**$ 2,395,236**	**$ 2,443,141**	**$ 2,492,004**	**$ 2,541,844**	**$ 2,592,681**	**$ 2,644,535**	**$ 2,697,425**	**$ 2,751,374**	**$ 2,806,401**	**$ 2,862,529**	**$ 2,919,780**	**$ 2,978,175**	**$ 3,037,739**	**$ 3,098,494**	**$ 3,160,464**
Total																					
	Best	$ (1,667,316)	$ (1,700,663)	$ (22,498,254)	$ 1,286,742	$ 1,312,477	$ 1,338,726	$ 1,365,501	$ 1,392,811	$ 1,420,667	$ 1,449,080	$ 1,478,062	$ 1,507,623	$ 1,537,775	$ 1,568,531	$ 1,599,902	$ 1,631,900	$ 1,664,538	$ 1,697,828	$ 1,731,785	$ 1,766,421
	Lowest	$ (2,194,457)	$ (2,238,346)	$ (30,232,859)	$ 425,648	$ 434,160	$ 442,844	$ 451,701	$ 460,735	$ 469,949	$ 479,348	$ 488,935	$ 498,714	$ 508,688	$ 518,862	$ 529,239	$ 539,824	$ 550,620	$ 561,633	$ 572,866	$ 584,323
NPV	Best	($8,149,455)																			
	Lowest	($25,467,796)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	8000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	7,530	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	30	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	**$ -**	**$ -**	**$ 23,418,810**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**	**$ -**	**$ -**	**$ 17,666,910**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)	$ 1,688,207	$ 1,721,971																		
Engineering costs	Low (based on low capital cost)	$ 1,273,566	$ 1,299,038																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 35,582	$ 72,587	$ 74,038	$ 75,519	$ 77,030	$ 78,570	$ 80,142	$ 81,744	$ 83,379	$ 85,047	$ 86,748	$ 88,483	$ 90,252	$ 92,057	$ 93,899	$ 95,777	$ 97,692	$ 99,646
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 210,474	$ 429,367	$ 437,955	$ 446,714	$ 455,648	$ 464,761	$ 474,056	$ 483,537	$ 493,208	$ 503,072	$ 513,134	$ 523,396	$ 533,864	$ 544,542	$ 555,433	$ 566,541	$ 577,872	$ 589,429
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
High		$ 1,688,207	$ 1,721,971	$ 24,377,540	$ 1,955,809	$ 1,994,925	$ 2,034,824	$ 2,075,520	$ 2,117,031	$ 2,159,371	$ 2,202,559	$ 2,246,610	$ 2,291,542	$ 2,337,373	$ 2,384,120	$ 2,431,803	$ 2,480,439	$ 2,530,047	$ 2,580,648	$ 2,632,261	$ 2,684,907
Low		$ 1,273,566	$ 1,299,038	$ 18,625,640	$ 1,955,809	$ 1,994,925	$ 2,034,824	$ 2,075,520	$ 2,117,031	$ 2,159,371	$ 2,202,559	$ 2,246,610	$ 2,291,542	$ 2,337,373	$ 2,384,120	$ 2,431,803	$ 2,480,439	$ 2,530,047	$ 2,580,648	$ 2,632,261	$ 2,684,907
Revenues																					
Gas Generation	Best			$ 1,680,548	$ 3,428,318	$ 3,496,884	$ 3,566,822	$ 3,638,158	$ 3,710,921	$ 3,785,140	$ 3,860,843	$ 3,938,059	$ 4,016,821	$ 4,097,157	$ 4,179,100	$ 4,262,682	$ 4,347,936	$ 4,434,895	$ 4,523,592	$ 4,614,064	$ 4,706,346
	Lowest			$ 1,148,055	$ 2,342,032	$ 2,388,873	$ 2,436,650	$ 2,485,383	$ 2,535,091	$ 2,585,793	$ 2,637,508	$ 2,690,259	$ 2,744,064	$ 2,798,945	$ 2,854,924	$ 2,912,022	$ 2,970,263	$ 3,029,668	$ 3,090,261	$ 3,152,067	$ 3,215,108
Tipping Fees				$ 436,968	$ 891,415	$ 909,243	$ 927,428	$ 945,976	$ 964,896	$ 984,194	$ 1,003,878	$ 1,023,955	$ 1,044,434	$ 1,065,323	$ 1,086,630	$ 1,108,362	$ 1,130,529	$ 1,153,140	$ 1,176,203	$ 1,199,727	$ 1,223,721
Total Revenues	**Best**	**$ -**	**$ -**	**$ 2,117,516**	**$ 4,319,732**	**$ 4,406,127**	**$ 4,494,250**	**$ 4,584,135**	**$ 4,675,817**	**$ 4,769,334**	**$ 4,864,720**	**$ 4,962,015**	**$ 5,061,255**	**$ 5,162,480**	**$ 5,265,730**	**$ 5,371,044**	**$ 5,478,465**	**$ 5,588,034**	**$ 5,699,795**	**$ 5,813,791**	**$ 5,930,067**
	Lowest	**$ -**	**$ -**	**$ 1,585,023**	**$ 3,233,447**	**$ 3,298,116**	**$ 3,364,078**	**$ 3,431,360**	**$ 3,499,987**	**$ 3,569,986**	**$ 3,641,386**	**$ 3,714,214**	**$ 3,788,498**	**$ 3,864,268**	**$ 3,941,553**	**$ 4,020,385**	**$ 4,100,792**	**$ 4,182,808**	**$ 4,266,464**	**$ 4,351,794**	**$ 4,438,829**
Total																					
	Best	$ (1,273,566)	$ (1,299,038)	$ (16,508,124)	$ 2,363,923	$ 2,411,202	$ 2,459,426	$ 2,508,614	$ 2,558,787	$ 2,609,962	$ 2,662,162	$ 2,715,405	$ 2,769,713	$ 2,825,107	$ 2,881,609	$ 2,939,242	$ 2,998,026	$ 3,057,987	$ 3,119,147	$ 3,181,530	$ 3,245,160
	Lowest	$ (1,688,207)	$ (1,721,971)	$ (22,792,517)	$ 1,277,638	$ 1,303,190	$ 1,329,254	$ 1,355,839	$ 1,382,956	$ 1,410,615	$ 1,438,828	$ 1,467,604	$ 1,496,956	$ 1,526,895	$ 1,557,433	$ 1,588,582	$ 1,620,354	$ 1,652,761	$ 1,685,816	$ 1,719,532	$ 1,753,923
NPV	Best	$9,832,403																			
	Lowest	(58,544,870)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	8000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	7,530	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	30	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ 1,560,600																	
	Capital Cost ($) - Civil and Structural			$ 3,121,200																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	**$ 23,418,810**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	**$ 17,666,910**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,688,207	$ 1,721,971																		
Engineering costs	Low (based on low capital cost)	$ 1,273,566	$ 1,299,038																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 35,582	$ 72,587	$ 74,038	$ 75,519	$ 77,030	$ 78,570	$ 80,142	$ 81,744	$ 83,379	$ 85,047	$ 86,748	$ 88,483	$ 90,252	$ 92,057	$ 93,899	$ 95,777	$ 97,692	$ 99,646
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 210,474	$ 429,367	$ 437,955	$ 446,714	$ 455,648	$ 464,761	$ 474,056	$ 483,537	$ 493,208	$ 503,072	$ 513,134	$ 523,396	$ 533,864	$ 544,542	$ 555,433	$ 566,541	$ 577,872	$ 589,429
Electricity Cost Offset	Electricity Cost Offset			$ (9,608)	$ (19,600)	$ (19,992)	$ (20,392)	$ (20,800)	$ (21,216)	$ (21,640)	$ (22,073)	$ (22,514)	$ (22,965)	$ (23,424)	$ (23,893)	$ (24,370)	$ (24,858)	$ (25,355)	$ (25,862)	$ (26,379)	$ (26,907)
Total Costs																					
	High	$ 1,688,207	$ 1,721,971	$ 24,367,932	$ 1,936,209	$ 1,974,933	$ 2,014,432	$ 2,054,720	$ 2,095,815	$ 2,137,731	$ 2,180,486	$ 2,224,095	$ 2,268,577	$ 2,313,949	$ 2,360,228	$ 2,407,432	$ 2,455,581	$ 2,504,693	$ 2,554,786	$ 2,605,882	$ 2,658,000
	Low	$ 1,273,566	$ 1,299,038	$ 18,616,032	$ 1,936,209	$ 1,974,933	$ 2,014,432	$ 2,054,720	$ 2,095,815	$ 2,137,731	$ 2,180,486	$ 2,224,095	$ 2,268,577	$ 2,313,949	$ 2,360,228	$ 2,407,432	$ 2,455,581	$ 2,504,693	$ 2,554,786	$ 2,605,882	$ 2,658,000
Revenues																					
Gas Generation	Best			$ 1,331,232	$ 2,715,714	$ 2,770,029	$ 2,825,429	$ 2,881,938	$ 2,939,576	$ 2,998,368	$ 3,058,335	$ 3,119,502	$ 3,181,892	$ 3,245,530	$ 3,310,441	$ 3,376,649	$ 3,444,182	$ 3,513,066	$ 3,583,327	$ 3,654,994	$ 3,728,094
	Lowest			$ 798,739	$ 1,629,429	$ 1,662,017	$ 1,695,257	$ 1,729,163	$ 1,763,746	$ 1,799,021	$ 1,835,001	$ 1,871,701	$ 1,909,135	$ 1,947,318	$ 1,986,264	$ 2,025,990	$ 2,066,509	$ 2,107,840	$ 2,149,996	$ 2,192,996	$ 2,236,856
Tipping Fees				$ 436,968	$ 891,415	$ 909,243	$ 927,428	$ 945,976	$ 964,896	$ 984,194	$ 1,003,878	$ 1,023,955	$ 1,044,434	$ 1,065,323	$ 1,086,630	$ 1,108,362	$ 1,130,529	$ 1,153,140	$ 1,176,203	$ 1,199,727	$ 1,223,721
Total Revenues	**Best**	$ -	$ -	**$ 1,768,200**	**$ 3,607,129**	**$ 3,679,272**	**$ 3,752,857**	**$ 3,827,914**	**$ 3,904,472**	**$ 3,982,562**	**$ 4,062,213**	**$ 4,143,457**	**$ 4,226,327**	**$ 4,310,853**	**$ 4,397,070**	**$ 4,485,012**	**$ 4,574,712**	**$ 4,666,206**	**$ 4,759,530**	**$ 4,854,721**	**$ 4,951,815**
	Lowest	$ -	$ -	**$ 1,235,707**	**$ 2,520,843**	**$ 2,571,260**	**$ 2,622,685**	**$ 2,675,139**	**$ 2,728,642**	**$ 2,783,215**	**$ 2,838,879**	**$ 2,895,657**	**$ 2,953,570**	**$ 3,012,641**	**$ 3,072,894**	**$ 3,134,352**	**$ 3,197,039**	**$ 3,260,980**	**$ 3,326,199**	**$ 3,392,723**	**$ 3,460,578**
Total																					
	Best	$ (1,273,566)	$ (1,299,038)	$ (16,847,831)	$ 1,670,920	$ 1,704,339	$ 1,738,425	$ 1,773,194	$ 1,808,658	$ 1,844,831	$ 1,881,728	$ 1,919,362	$ 1,957,749	$ 1,996,904	$ 2,036,842	$ 2,077,579	$ 2,119,131	$ 2,161,513	$ 2,204,744	$ 2,248,839	$ 2,293,815
	Lowest	$ (1,688,207)	$ (1,721,971)	$ (23,132,224)	$ 584,635	$ 596,327	$ 608,254	$ 620,419	$ 632,827	$ 645,484	$ 658,393	$ 671,561	$ 684,993	$ 698,692	$ 712,666	$ 726,920	$ 741,458	$ 756,287	$ 771,413	$ 786,841	$ 802,578
NPV	Best	$1,774,975																			
	Lowest	($16,602,299)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	8000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	7,530	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	139	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	$ 18,034,740	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	$ 13,687,380	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 35,582	$ 72,587	$ 74,038	$ 75,519	$ 77,030	$ 78,570	$ 80,142	$ 81,744	$ 83,379	$ 85,047	$ 86,748	$ 88,483	$ 90,252	$ 92,057	$ 93,899	$ 95,777	$ 97,692	$ 99,646
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 976,600	$ 1,992,265	$ 2,032,110	$ 2,072,752	$ 2,114,207	$ 2,156,491	$ 2,199,621	$ 2,243,614	$ 2,288,486	$ 2,334,256	$ 2,380,941	$ 2,428,560	$ 2,477,131	$ 2,526,673	$ 2,577,207	$ 2,628,751	$ 2,681,326	$ 2,734,953
Electricity Cost Offset	Electricity Cost Offset			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																					
	High	$ 1,300,082	$ 1,326,084	$ 19,691,970	$ 3,380,749	$ 3,448,364	$ 3,517,332	$ 3,587,678	$ 3,659,432	$ 3,732,620	$ 3,807,273	$ 3,883,418	$ 3,961,087	$ 4,040,308	$ 4,121,115	$ 4,203,537	$ 4,287,608	$ 4,373,360	$ 4,460,827	$ 4,550,043	$ 4,641,044
	Low	$ 986,691	$ 1,006,425	$ 15,344,610	$ 3,380,749	$ 3,448,364	$ 3,517,332	$ 3,587,678	$ 3,659,432	$ 3,732,620	$ 3,807,273	$ 3,883,418	$ 3,961,087	$ 4,040,308	$ 4,121,115	$ 4,203,537	$ 4,287,608	$ 4,373,360	$ 4,460,827	$ 4,550,043	$ 4,641,044
Revenues																					
Gas Generation	Best			$ 1,680,548	$ 3,428,318	$ 3,496,884	$ 3,566,822	$ 3,638,158	$ 3,710,921	$ 3,785,140	$ 3,860,843	$ 3,938,059	$ 4,016,821	$ 4,097,157	$ 4,179,100	$ 4,262,682	$ 4,347,936	$ 4,434,895	$ 4,523,592	$ 4,614,064	$ 4,706,346
	Lowest			$ 1,148,055	$ 2,342,032	$ 2,388,873	$ 2,436,650	$ 2,485,383	$ 2,535,091	$ 2,585,793	$ 2,637,508	$ 2,690,259	$ 2,744,064	$ 2,798,945	$ 2,854,924	$ 2,912,022	$ 2,970,263	$ 3,029,668	$ 3,090,261	$ 3,152,067	$ 3,215,108
Tipping Fees				$ 436,968	$ 891,415	$ 909,243	$ 927,428	$ 945,976	$ 964,896	$ 984,194	$ 1,003,878	$ 1,023,955	$ 1,044,434	$ 1,065,323	$ 1,086,630	$ 1,108,362	$ 1,130,529	$ 1,153,140	$ 1,176,203	$ 1,199,727	$ 1,223,721
Total Revenues	**Best**	$ -	$ -	$ 2,117,516	$ 4,319,732	$ 4,406,127	$ 4,494,250	$ 4,584,135	$ 4,675,817	$ 4,769,334	$ 4,864,720	$ 4,962,015	$ 5,061,255	$ 5,162,480	$ 5,265,730	$ 5,371,044	$ 5,478,465	$ 5,588,034	$ 5,699,795	$ 5,813,791	$ 5,930,067
	Lowest	$ -	$ -	$ 1,585,023	$ 3,233,447	$ 3,298,116	$ 3,364,078	$ 3,431,360	$ 3,499,987	$ 3,569,986	$ 3,641,386	$ 3,714,214	$ 3,788,498	$ 3,864,268	$ 3,941,553	$ 4,020,385	$ 4,100,792	$ 4,182,808	$ 4,266,464	$ 4,351,794	$ 4,438,829
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,227,094)	$ 938,983	$ 957,763	$ 976,918	$ 996,456	$ 1,016,385	$ 1,036,713	$ 1,057,447	$ 1,078,596	$ 1,100,168	$ 1,122,172	$ 1,144,615	$ 1,167,507	$ 1,190,858	$ 1,214,675	$ 1,238,968	$ 1,263,748	$ 1,289,023
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (18,106,947)	$ (147,303)	$ (150,249)	$ (153,254)	$ (156,319)	$ (159,445)	$ (162,634)	$ (165,887)	$ (169,204)	$ (172,588)	$ (176,040)	$ (179,561)	$ (183,152)	$ (186,815)	$ (190,552)	$ (194,363)	$ (198,250)	$ (202,215)
NPV	Best	($2,758,842)																			
	Lowest	($19,732,719)																			

Option 5		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	ffset electricity cos	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	20.0	%
TS (kg/d)	12,242	kg/d
VS%	76.5	%
VS (kg/d)	9,367	kg/d
Transportation		
Volume of dewatered sludge	40	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	30	km
# of Trucks/d	2	trucks/d
Cost to haul sludge	$ 40	$/m3
SSO Receiving Station		
Footprint (m2)	2000 (50 x 40 m)	m2
Qty SSO	8000	tpy
Capital Cost ($) - High	$ 4,000,000.00	$
Capital Cost ($) - Low	$ 3,300,000.00	$
Operating Cost ($/y)	$ 410,000	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	6	# of Units
Footprint (m2)	861	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	17	d
VSD%	60%	%
Biogas Volume (m3/d)	7,530	m3/d
# of Digesters	1	# of Units
Footprint (m2)	8,832	m2
Capital Cost ($) - Equipment Only	$ 1,800,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,700,000.00	$
Operating Cost ($/y)	$ 240,000.00	$/y
After Dewatering		
Dewatering? (Yes/No)	No	N/A
Volume of biosolids for hauling (m3/d)	139	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40x 30m)	m2
Capital Cost ($) - Equipment Only		$
Capital Cost ($) - Civil and Structural		$
Operating Cost ($/y)		$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	1800	m2
Capital Cost ($)	$ 4,500,000.00	$
Operating Cost ($/y)	$ 6,000	$/y

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																					
SSO Receiving Station	Capital Cost ($) - High			$ 4,161,600.00																	
	Capital Cost ($) - Low			$ 3,433,320.00																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only			$ 1,872,720																	
	Capital Cost ($) - Civil and Structural			$ 2,809,080																	
After Dewatering	Capital Cost ($) - Equipment Only			$ -																	
	Capital Cost ($) - Civil and Structural			$ -																	
Cake Storage	Capital Cost			$ 4,681,800																	
Gas Cleaning	Capital Cost			$ 2,700,000																	
Total Capital Costs	**High (+15%)**	$ -	$ -	**$ 18,034,740**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Costs	**Low (-15%)**	$ -	$ -	**$ 13,687,380**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Engineering Costs	High (based on high capital cost)	$ 1,300,082	$ 1,326,084																		
Engineering costs	Low (based on low capital cost)	$ 986,691	$ 1,006,425																		
Operating Costs																					
Disposal of Lights/Heavies/Grit	Disposal Cost			$ 35,582	$ 72,587	$ 74,038	$ 75,519	$ 77,030	$ 78,570	$ 80,142	$ 81,744	$ 83,379	$ 85,047	$ 86,748	$ 88,483	$ 90,252	$ 92,057	$ 93,899	$ 95,777	$ 97,692	$ 99,646
Transportation of Feedstock	Transportation Cost			$ 303,797	$ 619,745	$ 632,140	$ 644,783	$ 657,679	$ 670,832	$ 684,249	$ 697,934	$ 711,893	$ 726,131	$ 740,653	$ 755,466	$ 770,576	$ 785,987	$ 801,707	$ 817,741	$ 834,096	$ 850,778
SSO Receiving Station	Operating Cost			$ 213,282	$ 435,095	$ 443,797	$ 452,673	$ 461,727	$ 470,961	$ 480,380	$ 489,988	$ 499,788	$ 509,783	$ 519,979	$ 530,379	$ 540,986	$ 551,806	$ 562,842	$ 574,099	$ 585,581	$ 597,293
Mesophilic Digesters	Operating Cost			$ 124,848	$ 254,690	$ 259,784	$ 264,979	$ 270,279	$ 275,685	$ 281,198	$ 286,822	$ 292,559	$ 298,410	$ 304,378	$ 310,466	$ 316,675	$ 323,008	$ 329,469	$ 336,058	$ 342,779	$ 349,635
After Dewatering	Operating Cost			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cake Storage	Operating Cost			$ 3,121	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,314	$ 7,460	$ 7,609	$ 7,762	$ 7,917	$ 8,075	$ 8,237	$ 8,401	$ 8,569	$ 8,741
Cake Transportation	Disposal Cost			$ 976,600	$ 1,992,265	$ 2,032,110	$ 2,072,752	$ 2,114,207	$ 2,156,491	$ 2,199,621	$ 2,243,614	$ 2,288,486	$ 2,334,256	$ 2,380,941	$ 2,428,560	$ 2,477,131	$ 2,526,673	$ 2,577,207	$ 2,628,751	$ 2,681,326	$ 2,734,953
Electricity Cost Offset	Electricity Cost Offset			$ (9,608)	$ (19,600)	$ (19,992)	$ (20,392)	$ (20,800)	$ (21,216)	$ (21,640)	$ (22,073)	$ (22,514)	$ (22,965)	$ (23,424)	$ (23,893)	$ (24,370)	$ (24,858)	$ (25,355)	$ (25,862)	$ (26,379)	$ (26,907)
Total Costs																					
	High	$ 1,300,082	$ 1,326,084	$ 19,682,362	$ 3,361,149	$ 3,428,372	$ 3,496,940	$ 3,566,878	$ 3,638,216	$ 3,710,980	$ 3,785,200	$ 3,860,904	$ 3,938,122	$ 4,016,884	$ 4,097,222	$ 4,179,166	$ 4,262,750	$ 4,348,005	$ 4,434,965	$ 4,523,664	$ 4,614,137
	Low	$ 986,691	$ 1,006,425	$ 15,335,002	$ 3,361,149	$ 3,428,372	$ 3,496,940	$ 3,566,878	$ 3,638,216	$ 3,710,980	$ 3,785,200	$ 3,860,904	$ 3,938,122	$ 4,016,884	$ 4,097,222	$ 4,179,166	$ 4,262,750	$ 4,348,005	$ 4,434,965	$ 4,523,664	$ 4,614,137
Revenues																					
Gas Generation	Best			$ 1,331,232	$ 2,715,714	$ 2,770,029	$ 2,825,429	$ 2,881,938	$ 2,939,576	$ 2,998,368	$ 3,058,335	$ 3,119,502	$ 3,181,892	$ 3,245,530	$ 3,310,441	$ 3,376,649	$ 3,444,182	$ 3,513,066	$ 3,583,327	$ 3,654,994	$ 3,728,094
	Lowest			$ 798,739	$ 1,629,429	$ 1,662,017	$ 1,695,257	$ 1,729,163	$ 1,763,746	$ 1,799,021	$ 1,835,001	$ 1,871,701	$ 1,909,135	$ 1,947,318	$ 1,986,264	$ 2,025,990	$ 2,066,509	$ 2,107,840	$ 2,149,996	$ 2,192,996	$ 2,236,856
Tipping Fees				$ 436,968	$ 891,415	$ 909,243	$ 927,428	$ 945,976	$ 964,896	$ 984,194	$ 1,003,878	$ 1,023,955	$ 1,044,434	$ 1,065,323	$ 1,086,630	$ 1,108,362	$ 1,130,529	$ 1,153,140	$ 1,176,203	$ 1,199,727	$ 1,223,721
Total Revenues	**Best**	$ -	$ -	**$ 1,768,200**	**$ 3,607,129**	**$ 3,679,272**	**$ 3,752,857**	**$ 3,827,914**	**$ 3,904,472**	**$ 3,982,562**	**$ 4,062,213**	**$ 4,143,457**	**$ 4,226,327**	**$ 4,310,853**	**$ 4,397,070**	**$ 4,485,012**	**$ 4,574,712**	**$ 4,666,206**	**$ 4,759,530**	**$ 4,854,721**	**$ 4,951,815**
	Lowest	$ -	$ -	**$ 1,235,707**	**$ 2,520,843**	**$ 2,571,260**	**$ 2,622,685**	**$ 2,675,139**	**$ 2,728,642**	**$ 2,783,215**	**$ 2,838,879**	**$ 2,895,657**	**$ 2,953,570**	**$ 3,012,641**	**$ 3,072,894**	**$ 3,134,352**	**$ 3,197,039**	**$ 3,260,980**	**$ 3,326,199**	**$ 3,392,723**	**$ 3,460,578**
Total																					
	Best	$ (986,691)	$ (1,006,425)	$ (13,566,802)	$ 245,980	$ 250,899	$ 255,917	$ 261,036	$ 266,257	$ 271,582	$ 277,013	$ 282,554	$ 288,205	$ 293,969	$ 299,848	$ 305,845	$ 311,962	$ 318,201	$ 324,565	$ 331,057	$ 337,678
	Lowest	$ (1,300,082)	$ (1,326,084)	$ (18,446,655)	$ (840,306)	$ (857,112)	$ (874,254)	$ (891,739)	$ (909,574)	$ (927,766)	$ (946,321)	$ (965,247)	$ (984,552)	$ (1,004,243)	$ (1,024,328)	$ (1,044,815)	$ (1,065,711)	$ (1,087,025)	$ (1,108,766)	$ (1,130,941)	$ (1,153,560)
NPV	Best	($10,816,271)																			
	Lowest	($27,790,148)																			

Option 2B		
Assumptions		Unit
Cost of Capital	5%	%
Inflation	2%	%
Engineering Costs	15%	of capital
Gas Cleaning Costs	$ 2,700,000.00	$
Days Operation per Year	365	days
Cost of Electricity	$ 65.86	$/GJ
Gas Usage	Sell gas	N/A
Carbon Revenue		
high	$ 25	per GJ
low	$ 15	per GJ
Gas Revenue	$ 6.56	per GJ
GJ/m3 Conversion	0.037243948	GJ/m3
Feed Stock (sludge + SSO)		
TS%	8.0	%
TS (kg/d)	10,051	kg/d
VS%	72.5	%
VS (kg/d)	7,285	kg/d
Transportation		
Volume of dewatered sludge	28	m3/d
Volume of Truck (m3)	40	m3
One-way mileage (km)	15	km
# of Trucks/d	1	trucks/d
Cost of truck	$ 210,000	$
Cost to haul sludge	$ 40	$/m3
Fuel costs for truck	$ 250	$/week
Maintenance costs per truck	$ 10,000	$/year
Truck driver labour cost	$ 55	$/hour
Staff hours	$ 40	Hours/week
Number of staff	$ 2	FTE
SSO Receiving Station		
Footprint (m2)	-	m2
Qty SSO	0	tpy
Capital Cost ($) - Equipment Only	$ -	$
Capital Cost ($) - Civil and Structural	$ -	$
Operating Cost ($/y)	$ -	$/y
Tipping Fees	$ 105	$/tonne
BHP (6 packs)		
HRT (d)	3	d
# of Units	5	# of Units
Footprint (m2)	821	m2
Thermophilic Digesters		
HRT (d)	-	d
# of Units	-	# of Units
Footprint (m2)	-	m2
Mesophilic Digesters		
HRT (d)	15	d
VSD%	54%	%
Biogas Volume (m3/d)	4,408	m3/d
# of Digesters	1	# of Units
Footprint (m2)	7,292	m2
Capital Cost ($) - Equipment Only	$ 1,600,000.00	$
Capital Cost ($) - Civil and Structural	$ 2,400,000.00	$
Operating Cost ($/y)	$ 230,000.00	$/y
Dewatering		
Dewatering? (Yes/No)	Yes	N/A
Volume of biosolids for hauling (m3/d)	24	m3/d
# of Units	2	kg/d
Footprint (m2)	1200 (40 x 30m)	m2
Capital Cost ($) - Equipment Only	$ 1,500,000.00	$
Capital Cost ($) - Civil and Structural	$ 3,000,000.00	$
Operating Cost ($/y)	$ 130,000.00	$/y
Cost to haul dewatered biosolids	$ 36.95	$/m3
Cake Storage		
Footprint (m2)	-	m2
Capital Cost ($)	$ -	$
Operating Cost ($/y)	$ -	$/y

Disposal Costs from SSO Pre-treatment		
Quantity of Heavies/Lights	8%	% of SSO
Quantity of Grits	1%	% of SSO
Cost to dispose lights/heavies/grits	$ 95	$

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inflation			1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46
Capital Costs																						
SSO Receiving Station	Capital Cost ($) - High				$ -																	
	Capital Cost ($) - Low				$ -																	
Mesophilic Digesters	Capital Cost ($) - Equipment Only				$ 1,664,640																	
	Capital Cost ($) - Civil and Structural				$ 2,496,960																	
After Dewatering	Capital Cost ($) - Equipment Only				$ 1,560,600																	
	Capital Cost ($) - Civil and Structural				$ 3,121,200																	
Cake Storage	Capital Cost				$ -																	
Gas Cleaning	Capital Cost				$ 2,700,000																	
Truck	Capital Cost				$ 210,000							$ 200,776							$ 230,628			
Total Capital Costs	**High (+15%)**		**$ -**	**$ -**	**$ 13,516,410**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 230,892**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 265,222**	**$ -**	**$ -**	**$ -**
Total Capital Costs	**Low (-15%)**		**$ -**	**$ -**	**$ 9,990,390**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 170,659**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 196,034**	**$ -**	**$ -**	**$ -**
Engineering Costs	High (based on high capital cost)		$ 974,366	$ 993,854																		
			$ 720,183.82	$ 734,587.50																		
Permitting Costs	???																					
Operating Costs																						
Disposal of Lights/Heavies/Grits	Disposal Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transportation of Feedstock	Transportation Cost				$ 130,522	$ 265,804	$ 270,660	$ 275,614	$ 280,666	$ 285,819	$ 291,076	$ 296,437	$ 301,906	$ 307,484	$ 313,174	$ 318,977	$ 324,897	$ 330,935	$ 337,093	$ 343,375	$ 349,783	$ 356,318
SSO Receiving Station	Operating Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mesophilic Digesters	Operating Cost				$ 119,646	$ 244,078	$ 248,959	$ 253,939	$ 259,017	$ 264,198	$ 269,482	$ 274,871	$ 280,369	$ 285,976	$ 291,696	$ 297,530	$ 303,480	$ 309,550	$ 315,741	$ 322,056	$ 328,497	$ 335,067
Dewatering	Operating Cost				$ 67,626	$ 137,957	$ 140,716	$ 143,531	$ 146,401	$ 149,329	$ 152,316	$ 155,362	$ 158,469	$ 161,639	$ 164,871	$ 168,169	$ 171,532	$ 174,963	$ 178,462	$ 182,031	$ 185,672	$ 189,385
Cake Storage	Operating Cost				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Transportation	Disposal Cost				$ 168,379	$ 343,494	$ 350,364	$ 357,371	$ 364,519	$ 371,809	$ 379,245	$ 386,830	$ 394,567	$ 402,458	$ 410,507	$ 418,717	$ 427,092	$ 435,633	$ 444,346	$ 453,233	$ 462,298	$ 471,544
Electricity Cost Offset	Electricity Cost Offset				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Costs																						
	High		$ 974,366	$ 993,854	$ 14,002,583	$ 991,333	$ 1,010,700	$ 1,030,454	$ 1,050,603	$ 1,071,155	$ 1,092,118	$ 1,344,392	$ 1,135,310	$ 1,157,557	$ 1,180,248	$ 1,203,393	$ 1,227,001	$ 1,251,081	$ 1,540,864	$ 1,300,695	$ 1,326,249	$ 1,352,314
	Low		$ 720,184	$ 734,588	$ 10,476,563	$ 991,333	$ 1,010,700	$ 1,030,454	$ 1,050,603	$ 1,071,155	$ 1,092,118	$ 1,284,160	$ 1,135,310	$ 1,157,557	$ 1,180,248	$ 1,203,393	$ 1,227,001	$ 1,251,081	$ 1,471,676	$ 1,300,695	$ 1,326,249	$ 1,352,314
Revenues																						
Gas Generation	Best				$ 983,779	$ 2,006,909	$ 2,047,047	$ 2,087,988	$ 2,129,748	$ 2,172,343	$ 2,215,790	$ 2,260,105	$ 2,305,308	$ 2,351,414	$ 2,398,442	$ 2,446,411	$ 2,495,339	$ 2,545,246	$ 2,596,151	$ 2,648,074	$ 2,701,035	$ 2,755,056
	Lowest				$ 672,062	$ 1,371,006	$ 1,398,426	$ 1,426,395	$ 1,454,923	$ 1,484,021	$ 1,513,702	$ 1,543,976	$ 1,574,855	$ 1,606,352	$ 1,638,479	$ 1,671,249	$ 1,704,674	$ 1,738,767	$ 1,773,543	$ 1,809,014	$ 1,845,194	$ 1,882,098
Tipping Fees					$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**Best**		**$ -**	**$ -**	**$ 983,779**	**$ 2,006,909**	**$ 2,047,047**	**$ 2,087,988**	**$ 2,129,748**	**$ 2,172,343**	**$ 2,215,790**	**$ 2,260,105**	**$ 2,305,308**	**$ 2,351,414**	**$ 2,398,442**	**$ 2,446,411**	**$ 2,495,339**	**$ 2,545,246**	**$ 2,596,151**	**$ 2,648,074**	**$ 2,701,035**	**$ 2,755,056**
	Lowest		**$ -**	**$ -**	**$ 672,062**	**$ 1,371,006**	**$ 1,398,426**	**$ 1,426,395**	**$ 1,454,923**	**$ 1,484,021**	**$ 1,513,702**	**$ 1,543,976**	**$ 1,574,855**	**$ 1,606,352**	**$ 1,638,479**	**$ 1,671,249**	**$ 1,704,674**	**$ 1,738,767**	**$ 1,773,543**	**$ 1,809,014**	**$ 1,845,194**	**$ 1,882,098**
Total																						
	Best		$ (720,184)	$ (734,588)	$ (9,492,784)	$ 1,015,576	$ 1,036,347	$ 1,057,534	$ 1,079,145	$ 1,101,188	$ 1,123,672	$ 975,946	$ 1,169,997	$ 1,193,857	$ 1,218,194	$ 1,243,018	$ 1,268,338	$ 1,294,165	$ 1,124,475	$ 1,347,379	$ 1,374,786	$ 1,402,742
	Lowest		$ (974,366)	$ (993,854)	$ (13,330,521)	$ 379,673	$ 387,727	$ 395,941	$ 404,320	$ 412,866	$ 421,584	$ 199,583	$ 439,545	$ 448,796	$ 458,232	$ 467,856	$ 477,673	$ 487,687	$ 232,678	$ 508,319	$ 518,945	$ 529,784
NPV	Best		$1,668,856																			
	Lowest		(59,314,989)																			