Oil and Grease Value Assessment Tool

FINAL REPORT

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1.0 EXECUTIVE SUMMARY

Oil and grease (O&G) in meat processing wastewater has long been considered a difficult contaminant that must be separated in the primary wastewater treatment system, usually using a Dissolved Air Flotation (DAF) system, and trucked off-site to landfill and/or treated in open anaerobic ponds. In recent years, there has been growing interest by processors in resource recovery or reuse, particularly with regards to the O&G. There have been a number of options available to processors, including the following:

- Rendering of the recovered O&G into second grade-tallow (low and high temperature rendering).
- Processing of the DAF float to second grade-tallow using a tricanter system.
- Anaerobic digestion of the O&G into biogas using a Covered Anaerobic Lagoon (or similar).
- Burning DAF float rich in O&G with paunch in boilers. (This option was excluded from the calculator).

As the most suitable option for a particular processor is highly depended on site-specific variables, there is no one definitive option that is the best. For this reason, a calculator has been developed in Microsoft Excel for use by Australian meat processors through this project. The calculator investigates the beneficial use of O&G within a facility to produce additional revenue by conversion into a saleable product, or reduced expenditure on fossil fuels via electricity, steam or hot water generation.

The calculator enables processors to consider the available options and assess decisions regarding the capture and processing of the O&G in their wastewater. The calculator has been designed with functionality to allow processors to input site-specific variables, which greatly impact the outputs. It generates an estimate of revenue/savings as well as costs for each option, on an annualised basis. To help ensure that the calculator is not simply a GIGO (Garbage In, Garbage Out), typical ranges of values have been provided to guide the appropriate selection of input information.

Note that capital and maintenance costs are not included in the calculator, since these will vary significantly from site to site and depend on many factors not easily included in a calculator. However, they can be readily obtained from vendors, or from in-house knowledge and combined with the outcomes of the calculator to inform a feasibility analysis.

Some simple sensitivity analyses were performed using the calculator. These reveal the surprising sensitivity of the outcomes to site-specific issues. Wastewater flow and composition, the type of fuel used for steam generation and its cost, solids disposal costs and spare CAL capacity are some of the factors that have a large impact on the calculator outcomes.

With this calculator, processors have the ability to examine the sensitivity and feasibility of the various options for processing O&G with respect to a large range of site-specific variables for their facility, making it a powerful tool for informing future decisions.

2.0 INTRODUCTION

Oil and grease (O&G) is a major constituent of meat processing wastewater (Jensen & Batstone, 2012) and typically makes up a significant fraction of the organic load that requires treatment before discharge from the facility. This is a costly exercise, adding substantially to the capital and operating expenses of an on-site wastewater treatment system. O&G is challenging to treat since it tends to emulsify readily into the wastewater and subsequently forms scums and crusts on downstream treatment units such as ponds, activated sludge systems or sewers as the water cools. Historically, processors have dealt with O&G by removing it in save-alls, Dissolved Air Flotation (DAF) units (with or without coagulants), hydrocyclones (GHD, 2003) or by digesting it in an anaerobic pond into biogas, although in open anaerobic ponds, O&G often formed a floating crust.

The oil & grease is useful. Tallow (liquid O&G) is valuable and contains a high calorific value useful for fuels, feeds and other products. In recent years, processors have increasingly looked at ways to capture or recover this value from their waste streams. For several decades, many processors have cooked the O&G recovered from wastewater to produce low quality second-grade tallow. Recent industry-funded studies have considered the benefit of using O&G-rich DAF sludges and paunch solids as boiler fuel (Bridle, 2012) or recovering tallow using tricanter technology (Olmstead, 2015). Some facilities have implemented these approaches. Alternatively the case has been made for anaerobically converting O&G-rich waste streams into biogas for use as fuel (Boyer, 2013). In general, these concepts have two key benefits; a reduction in wastewater treatment expenditure and either generation of additional revenue, or cost savings elsewhere in the facility (typically by displacing fossil fuels).

The most common options are:

- Capture of the O&G with a DAF unit followed by rendering of the float in the facility's on-site render system to produce second-grade tallow and/or meat meal.
- Capture of the O&G with a DAF unit followed by heating and separation of the float in a dedicated tricanter system to produce second-grade tallow and/or meat meal.
- Digestion of the O&G in a Covered Anaerobic Lagoon (CAL) to produce biogas that can be utilized as fuel for cogeneration, or steam or hot water production.

The challenge is determining which of these options, if any, is most suitable for any given facility.

3.0 PROJECT OBJECTIVES

The objective of this research project is to provide a desktop modelling tool with a simple user interface that calculates the value of recovering O&G from wastewater in the form of tallow OR forming biogas given site specific information and current market values.

4.0 METHODOLOGY

4.1 Structure of the O&G Assessment Model

A Microsoft Excel calculator was developed to compare the suitability of three technical options for capturing and utilizing oil & grease from meat processing liquid wastewater streams. The options are:

- Rendering. Capture of the O&G with a DAF unit followed by rendering of the float in the facility's on-site render system to produce second-grade tallow.
- Tricanter. Capture of the O&G with a DAF unit followed by heating and separation of the float in a dedicated tricanter system to produce second-grade tallow.
- Biogas. Digestion of the O&G in a Covered Anaerobic Lagoon (CAL) to produce biogas that can be utilized as fuel for cogeneration, or steam or hot water production.

Process flow diagrams for each of the 3 options have been developed and embedded into the calculator. They are also included in this report (See Appendix 1).

The framework and structure of the tool has been developed in Microsoft Excel to ensure that it is readily available to the majority of AMPC members. A number of parameters have been included in the calculator to allow for site specific variability. Processors are able to input values for these that affect the overall outcomes of the calculator, such as:

- Number of operating hours per day, days per week and weeks per year.
- Which fuel they use to generate steam and hot water (coal, natural gas or electricity).
- The cost of these fuels.
- The sale price of second grade tallow.
- Typical daily wastewater flows.
- COD, TSS and O&G concentrations in their raw wastewater (prior to any treatment).
- DAF efficiency at removing O&G.

As well, many other parameters that are critical for determining the amount of O&G in the processors' wastewater and conversion yields to tallow or biogas are included. Cells containing these adjustable variables have been highlighted in yellow in the spreadsheet model to indicate that they are site specific inputs. Typical industry-specific values have been provided alongside many of these input cells to provide a guide to the user as to reasonable values. Where the user-entered value is outside the recommended range, the outcome may not be realistic. For the tricanter option, the majority of the recommended values are sourced from Olmstead (2015).

Cells containing other variables that are mathematic constants, or calculations based on formulae (eg. energy content of biogas, latent heat of vaporisation of steam) have been locked to ensure that they are not accidentally amended. Where necessary, these constants have been sourced from appropriate literature.

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Upon entering the required inputs for each of the three options, the tool calculates the net revenue and operating costs for each of them and a dollar value (net income per year) is assigned on this basis. Table 1 of each sheet calculates the revenue/savings and Table 2 calculates the operating costs associated with that particular option.

On a separate Summary sheet, the outcomes are graphed for comparison, allowing the processor to make an informed decision regarding how they should proceed with processing their oil and grease. Processors can adjust the variables in each of the options and see the effect on the Summary sheet outcome graph. In this sense, the processors can perform a sensitivity analysis on any of the editable variables.

4.2 Assumptions and Exclusions

Assumptions inherent in the scenarios and calculations have been listed on a separate sheet in the Excel file. It is important that the user carefully familiarises themselves with these and ensures that they apply to their particular situation and facility.

An important limitation to applying the model outcomes is the degree to which a facility has the available capacity for each of the options. The model assumes that the equipment capacity required is available already. Clearly, this may not be the case in the majority of instances and capital investment to permit a given solution may be needed (see exclusions below). For example, for the rendering option, there may be insufficient steam production to remove the required water from all the DAF float produced. For the biogas option, there may be insufficient CAL capacity for the full float COD load. Consequently, specific professional advice may be needed to advise whether there is available capacity to implement the desired outcome.

The model has the following exclusions:

- Capital costs for the equipment necessary to capture the O&G and process it via any of the three options are not incorporated into the model costs. If the processor does not possess the required equipment capacity for each of the options (DAF, tricanter, biogas boiler etc.) they can use the revenue and costs from this tool to inform an additional in-house time-step based cost benefit analysis (not supplied as part of this project) that would consider the payback of capital in addition to the annual net benefit. This would provide insight into whether the purchase of additional equipment is justified.

- The model does not include the equipment maintenance costs for each option, since these are usually estimated based on direct equipment cost. Typically, sufficient vendor, or in-house knowledge is usually available to add this cost into the analysis.

- The model does not include any costs associated with carbon emissions, since at this time there is no agreed national system of doing so. Carbon emissions have a large impact on option choice (Johns, 2013), but can be incorporated in future as required.

- The model does not consider whether the site has the available spare capacity to process the additional O&G. The processor will need to evaluate whether the rendering system, CAL, biogas boiler etc. can handle the increase loading. For example, it is generally not recommended that 100% of the DAF float is sent to the CAL as this is likely to overload it and cause crusting under the cover.

- No provision has been allowed for the possibility that a site may not be able to use any additional steam or hot water that is produced from combusting biogas. High temperature render sites in particular may already have ample supply of hot water and any additional hot water would be of no value.
- The model assumes that the biogas is not scrubbed before it is fed to the biogas boiler. Scrubbing would represent an additional cost.
- The model cannot consider all aspects of the processors site. This calculator should be taken as a guide and used in conjunction with professional advice.

5.0 PROJECT OUTCOMES

This project has resulted in the generation of a simple, easy to use desktop calculator that provides red meat processors with powerful information to help them make decisions regarding wastewater treatment, energy production and resource recovery at their facility. It will help inform future capital decisions and has the potential to save processors hundreds of thousands of dollars each year.

6.0 DISCUSSION

A brief sensitivity analysis has been performed on the effect that adjusting the fuel source used to produce steam has on the output/recommendations of the calculator. This has been done to demonstrate what processors can do with the calculator and how it can help them with decision making.

The following two graphs represents the net annual cashflow from each option for a site that generates steam from coal and natural gas respectively.

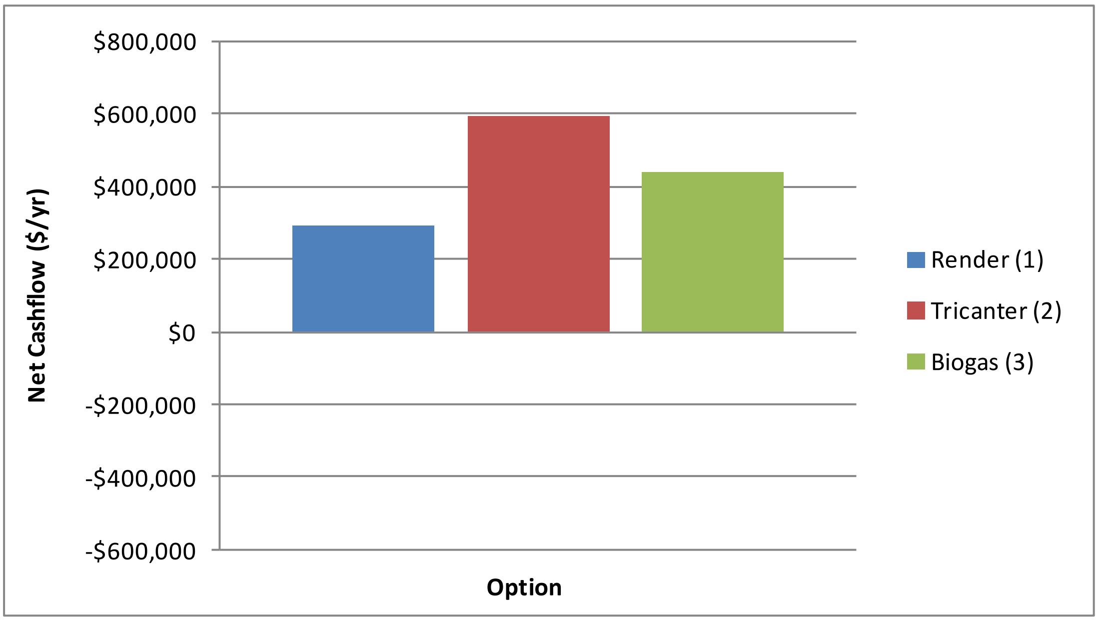

Figure 1. Net cashflow ($/yr) for each option for a processor with high temperature rendering that uses coal for steam generation

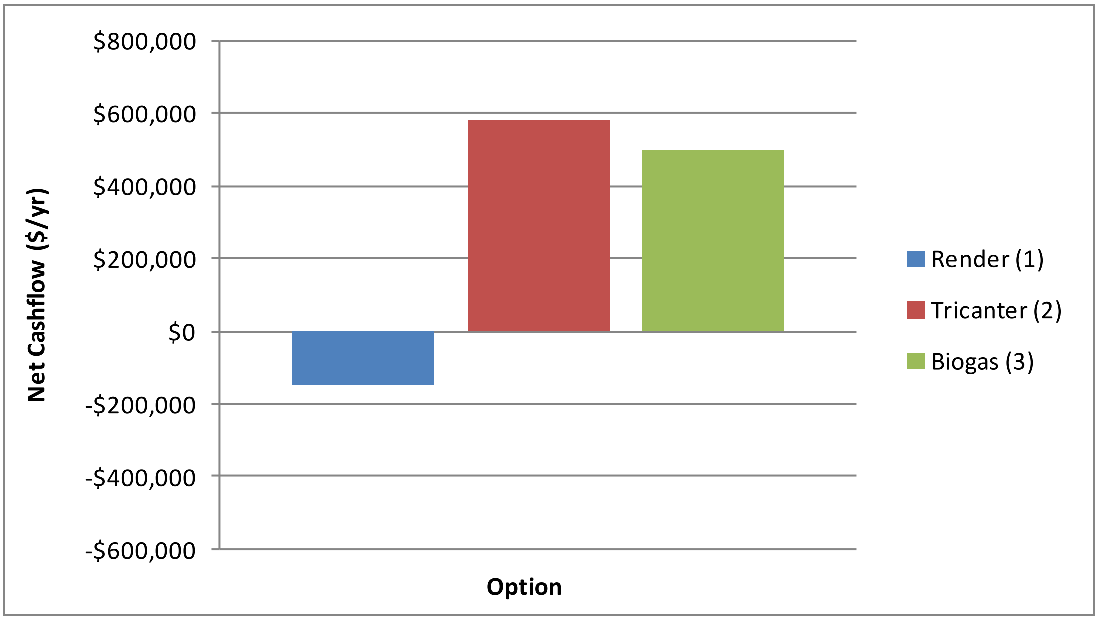

Figure 2. Net cashflow ($/yr) for each option for a processor with high temperature rendering that uses natural gas for steam generation

Note that the render option in both of these graphs are for a high temperature rendering operation. High temperature rendering of the DAF float is very energy intensive, as a large quantity of water must be vaporised from the float in the cooker. Natural gas is typically a more expensive fuel than coal on an energy intensity basis, so the first figure represents a more favourable outcome for the rendering option (although still less favourable than both the tricanter and biogas options).

For a processor with a low temperature rendering system with coal as the fuel of choice for steam production, the rendering outcome is more favourable, as seen below. This is due to the fact that the majority of the water content in the DAF float is separated mechanically in low temperature rendering systems, rather than thermally (vaporising) in high temperature rendering systems.

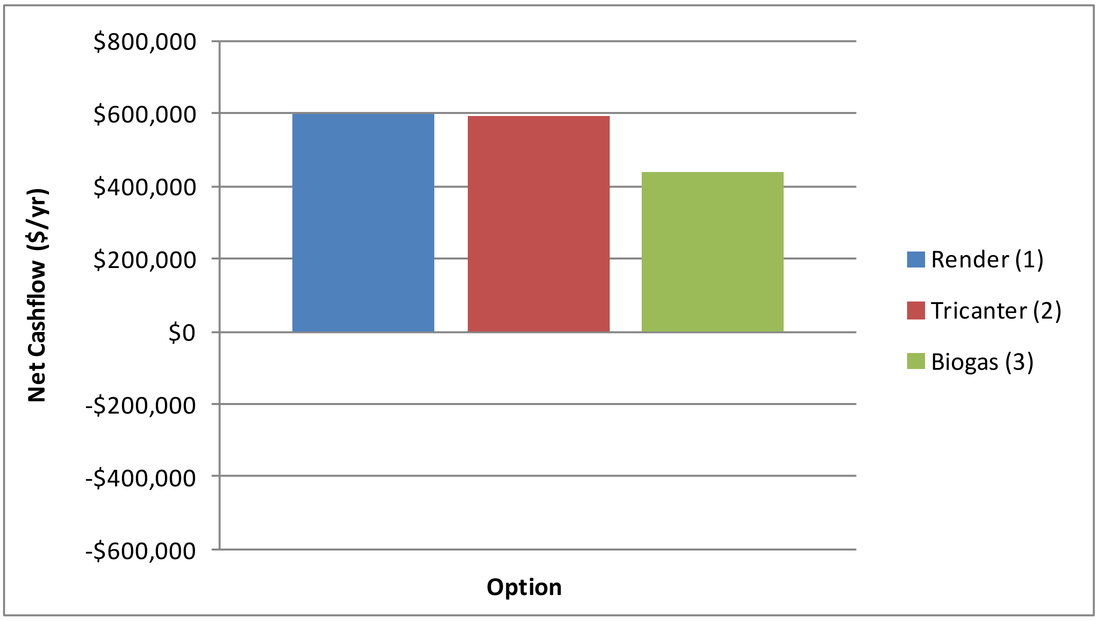

Figure 3. Net cashflow ($/yr) for each option for a processor with low temperature rendering that uses coal for steam generation

Sensitivity analyses such as these can be done on a diverse range of variables, such as those outlined in the methodology and many others.

7.0 CONCLUSIONS/RECOMMENDATIONS

The calculator generated from this project is able to compare three options for processing O&G recovered from DAF float into useful product. A site has the ability to customize the calculator to its specific circumstances and provide a comparison of the relative benefits of the three options. A sensitivity analysis can be readily performed with the impact easily seen graphically in the summary sheet.

8.0 BIBLIOGRAPHY

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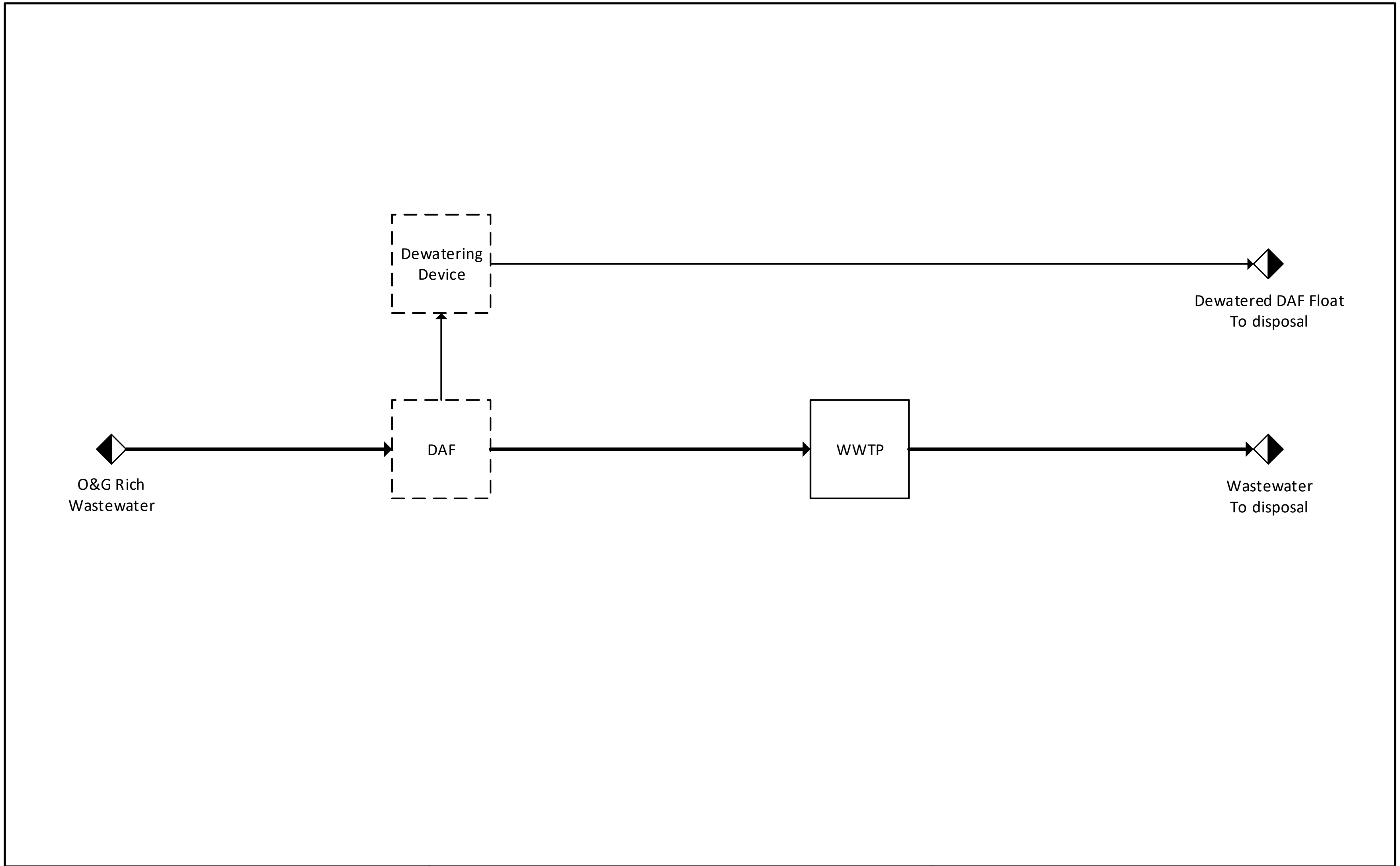
9.0 APPENDICES

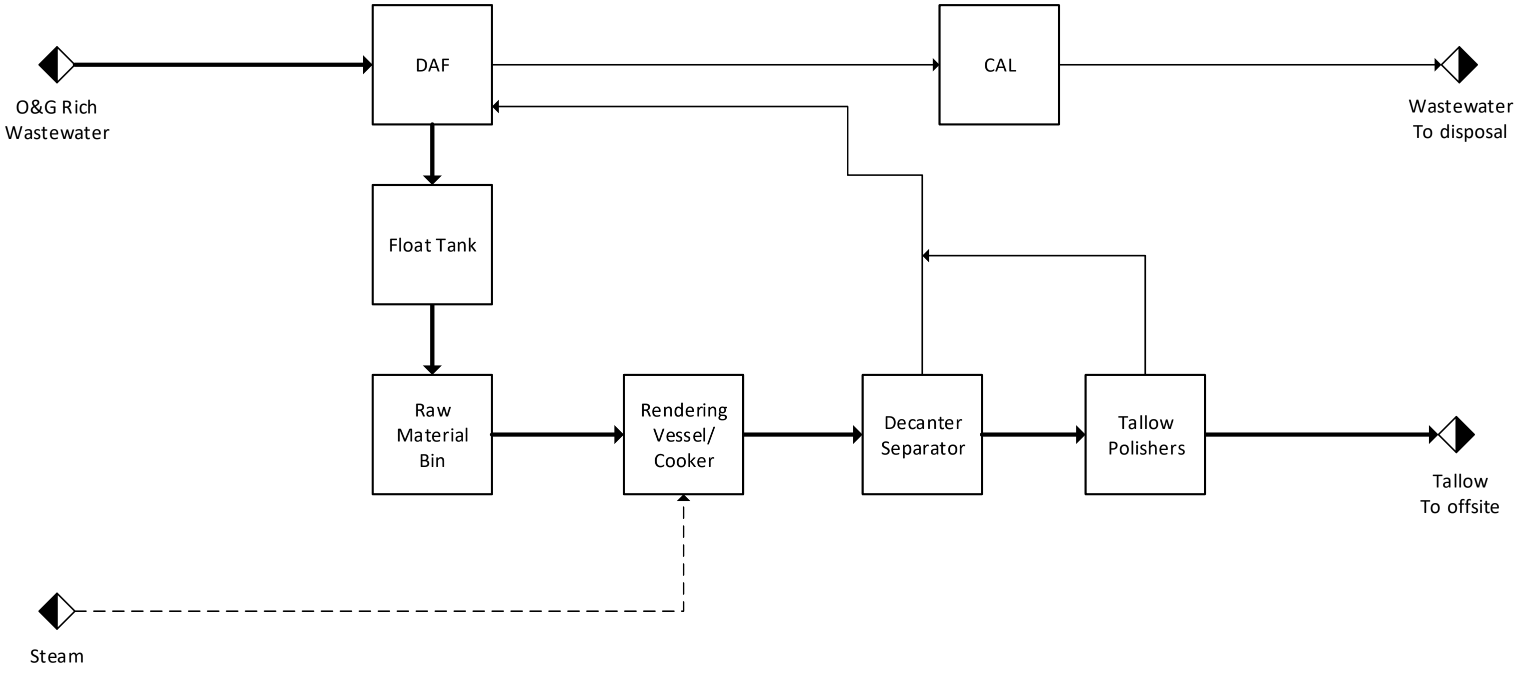
9.1 Appendix 1 – Process Flow Diagrams

Process flow diagrams for the base case scenario and each of the options are shown below.



Australian Meat Processor Corporation Suite 1 Level 5 110 Walker Street North Sydney NSW 2060	**Johns Environmental Group** Ph 07 3863 0051 PO Box 534 ASPLEY Q 4034 This drawing © Johns Environmental 2018	**Base Scenario Process Flow Diagram** Date: 28 June 2018 Dwg No: 40-004 Revision : 0

Figure 4. Base Case Scenario Process Flow Diagram



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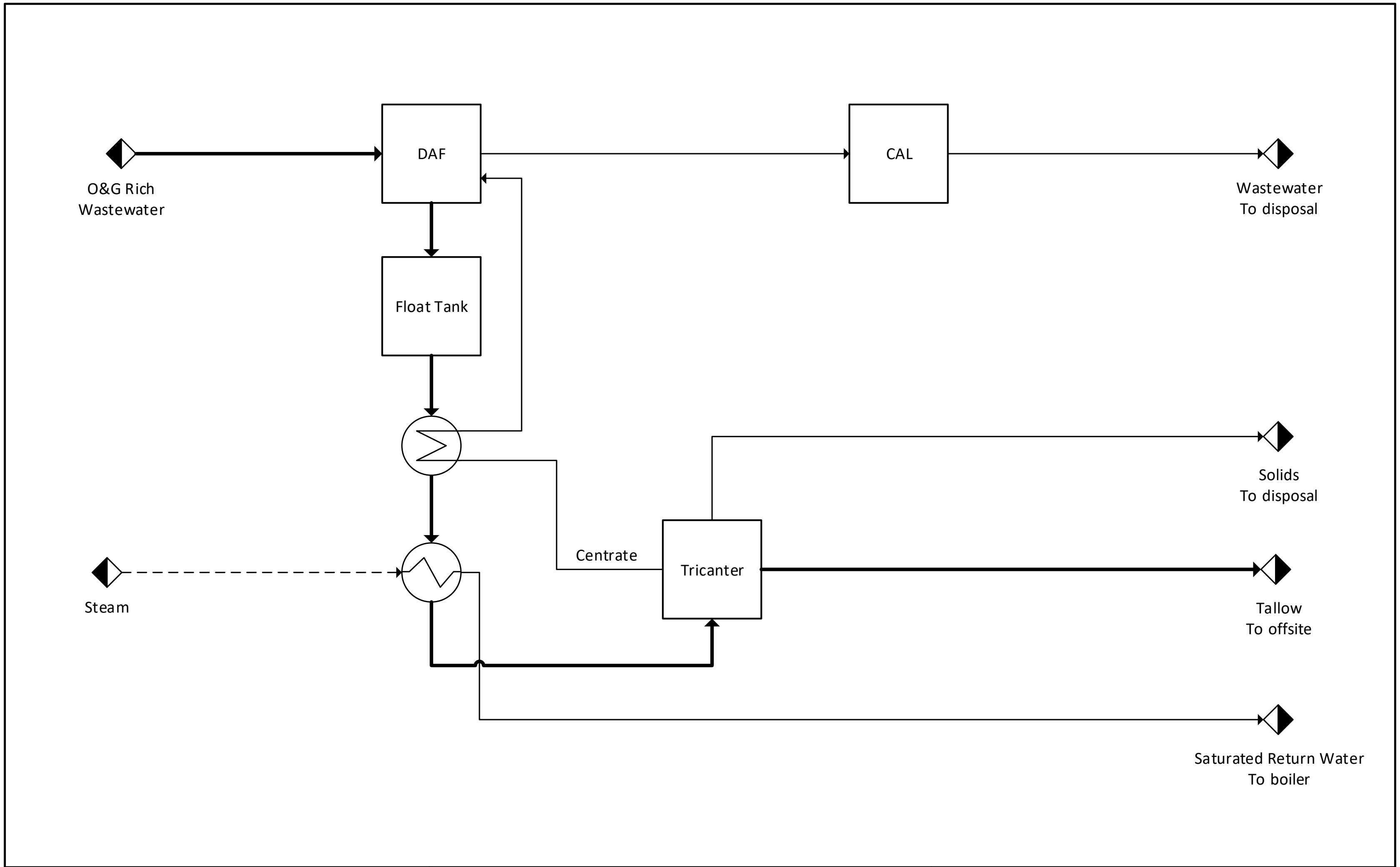
Render Process Flow Diagram
Date: 16 January 2018
Dwg No: 40-001 Revision : 0

Figure 5. Render Option (1) Process Flow Diagram



Australian Meat Processor Corporation Suite 1 Level 5 110 Walker Street North Sydney NSW 2060	**Johns Environmental Group** Ph 07 3863 0051 PO Box 534 ASPLEY Q 4034 This drawing © Johns Environmental 2018	**Tricanter Process Flow Diagram** Date: 19 February 2018 Dwg No: 40-003 Revision : 0

Figure 6. Tricanter Option (2) Process Flow Diagram

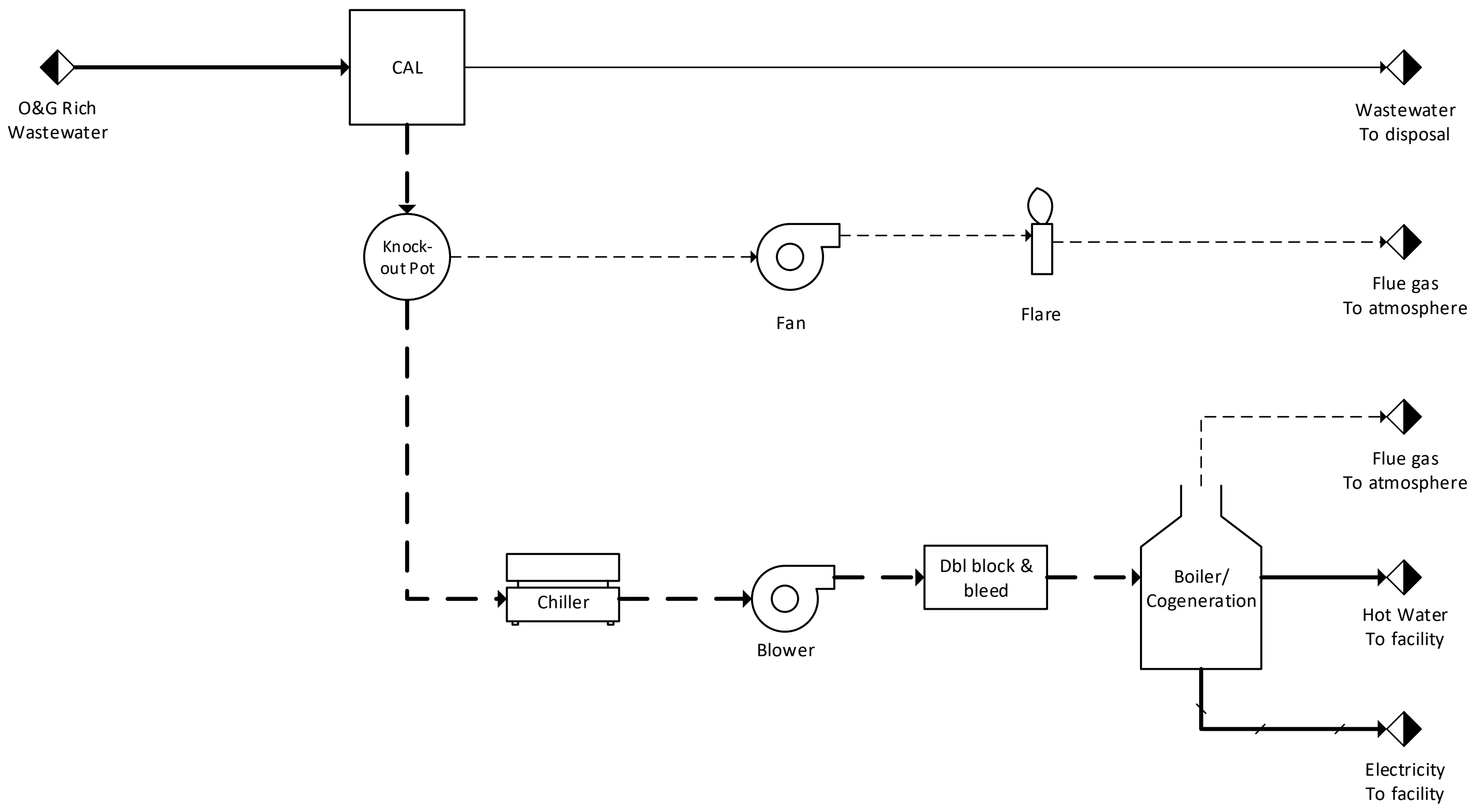


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Figure 7. Biogas Option (3) Process Flow Diagram