Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Zero Wastewater Discharge

Zero Waste from Site – Liquid Stream, Stage 1 concept design and unit operation identification

Project Code
2020-1032

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1.0 Executive Summary

Introduction

The availability of freshwater is one of the most critical challenges faced in today's society. Freshwater scarcity poses a major threat to economic growth, water security and ecosystem health (Tong & Elimelech, 2016). The challenge of providing adequate freshwater to the public and industrial sector is exacerbated by climate change and economic development. The industrial sector consumes huge amounts of freshwater daily and intern produces large volumes of wastewater. Reducing freshwater use and wastewater discharge has become one of the main targets in business and process optimisation systems (Deng & Feng, 2009) not only for economic reasons but also because the of industry's social and environmental responsibilities. Through reuse, wastewater is no longer considered a waste product that potentially harms the environment, but rather an additional resource that can be harnessed to achieve water sustainability (Tong & Elimelech, 2016).
This study looks at a meat processing facility which already has a dissolved air floatation (DAF) treatment plant on site as well as a reverse osmosis (RO) plant. The study will break down all the different streams of wastewater entering the treatment plant and determine which streams will be suitable for reuse without pre-treatment, and what technology is available to further treat the wastewater, post DAF treatment, to a point that it can be put back through the RO and made potable again.

Objectives

Midfield will take the time to reclassify the current wastewater streams at Midfield to develop a new zero wastewater discharge strategy. This Stage will also include reviewing and evaluating (desk top study) current technologies for inclusion in the strategy, that have not been previously considered by industry. These include –

- Classification of liquid wastes, along with review of available global handling/treatment solutions.
- Zero Waste (liquid) Strategy and budget, and a Stage 2 submission for R&D components of the Strategy.

Methodology

Classification of Wastewater Streams

Midfield has three processing floors and two boning rooms. In order to understand the water requirements and use on each floor meters needed to be installed on as many separate streams as possible.

Each new meter is entered into the company's ignition system for real time monitoring.

Wastewater Quality Profiling

The below wastewater streams were tested for BOD, Total Suspended Solids, Ammonia and Conductivity.

- Steriliser water from Beef processing floor, small stock processing floor, beef boning room and small stock cutting room
- Hot wash cabinet water
- Pre-treatment wastewater
- DAF treated wastewater
- Mixed DAF with RO brine

Development of a Zero Wastewater Disposal Strategy

Midfield looked into several options for capture and reuse, and tertiary treatment methods. After consultation with water treatment experts, it was decided that two technologies would be focused on.

Membrane Bioreactor (MBR)

MBR is a known method of water treatment. It is currently being used in chicken processing facilities but bas far as this researcher could tell, not in the red meat industry.

MBR is a combination of membrane filtration system and a biological treatment system. When utilised correctly an MBR system can treat wastewater to a point where it can be disposed of safely into the environment, used for irrigation purposed or further treated with an RO system, chlorinated, and deemed potable again.

Titanium Membrane Filter

Titanium Membrane filtration is an innovative technology currently being used in the wine industry. The process is filtering through 0.1micron ultrafiltration however the benefits of the titanium filters is that the don't break down. The unit is self-cleaning and therefore will not get blocked.

Project Outcomes

Classification of Water Streams

Installing the meters on the water supply and return streams allowed Midfield to determine how much water was being consumed on each floor. The data collected was trended and enabled the monitoring team to set up minimum and maximum consumptions volumes per hour. If at any point the meter recorded above the maximum for an extended period of time the monitoring group is now alerted to the issue and can resolve quickly, minimalizing any unnecessary waste.

Wastewater Quality Profiling

Over several weeks daily composite samples were taken from specific streams and analysed for BOD, TSS, Ammonia and Conductivity. From this an average quality was able to be determined (tables 1).

The results show that the Steriliser water and hotwash water are of a quality which is suitable for capture and reuse on site, where non potable water can be used, without any further treatment.

The DAF results show that the treatment system in place is reducing the organic and suspended solid load significantly. This bring the wastewater to a point where it is ideal for tertiary treatment.

Development of Zero Wastewater Disposal Strategy

Membrane Bioreactor (MBR)

MBR is a known method of water treatment. It is currently being used in chicken processing facilities but has far as this researcher could tell, not in the red meat industry.

Titanium Membrane Filtration

This technology is a true R&D project. It has never been tested in a meat processing facility and whilst the technology is sound it requires vigorous testing.

Discussion

Classification of Water Streams

Installing the meters on the water supply and return streams allowed Midfield to determine how much water was being consumed on each floor. The data collected was trended and enabled the monitoring team to set up minimum

and maximum consumptions volumes per hour. If at any point the meter recorded above the maximum for an extended period of time the monitoring group is now alerted to the issue and can resolve quickly, minimalizing any unnecessary waste.

Water Quality Profiling

The results of the water quality testing allowed Midfield to determine that there were several capture points that would be ideal for reuse on site without further treatment. There were several opportunities for using reuse water, such as pen wash down, initial cattle rinse and yard rinsing.

Titanium Membrane Filtration

As there is no precedent set for what would be expected from this technology when treating meat processing wastewater, a trial conducted using this technology would be completely R&D. There have been promising trials completed where the removal of contaminants has been significant which give confidence in the technology.

Midfield proposes to undergo a considerable trial testing the titanium's capabilities on several different streams of the processing facilities wastewater from the dirtiest untreated was water to the cleanest captured reuse water. This will enable us to fully understand the unit's capabilities and determine where it might sit best in the treatment process.

Conclusions / Recommendations

From this study it was seen that the benefits of installing an integrated monitoring system which can be monitored and trended has upfront financial benefits. Understanding the quality of each stream and being able to capture specific wastewater streams for reuse can decrease the volume of wastewater going to trade waste significantly which also has a financial benefit.

ZWD is the way forward which industry as a whole must adopt in order to ensure its sustainability as an industry

2.0 Introduction

The availability of freshwater is one of the most critical challenges faced in today's society. Freshwater scarcity poses a major threat to economic growth, water security and ecosystem health (Tong & Elimelech, 2016). The challenge of providing adequate freshwater to the public and industrial sector is exacerbated by climate change and economic development. The industrial sector consumes huge amounts of freshwater daily and intern produces large volumes of wastewater. Reducing freshwater use and wastewater discharge has become one of the main targets in business and process optimisation systems (Deng & Feng, 2009) not only for economical reasons but also because the of industry's social and environmental responsibilities. Through reuse, wastewater is no longer considered a waste product that potentially harms the environment, but rather an additional resource that can be harnessed to achieve water sustainability (Tong & Elimelech, 2016).
Zero wastewater discharge (ZWD) is a waste management strategy that eliminates any wastewater leaving the facility as a waste product and instead, as a product that has the ability to be recycled and reused on or off site. This strategy reduces the risk of pollution from wastewater discharge and extends water use efficiency. Although ZWD is a good wastewater management strategy, putting it into actions can proves difficult. High capital costs, varying degrees of wastewater quality and consumer scepticism has been but a few inhibitors preventing industry uptake.

Abattoir operations, including slaughter, boning, and processing produced a wastewater highly charged in soluble and insoluble inorganic matter. This equates to high loading biological oxygen demand (BOD) due to blood content and high loadings of total suspended solids (TSS) due to particulates accumulated from the slaughter process (Rabah *et.al.* 2014). Abattoirs in Australian generally discharge their waste to municipal water treatment facilities as trade waste. The driving factor for processing facilities to move to ZWD is the ever-increasing costs from trade waste disposal. Many businesses have integrated some sort of wastewater pre-treatment in order improve the quality prior to trade waste disposal and save costs.
This study looks at a meat processing facility which already has a dissolved air floatation (DAF) treatment plant on site as well as a reverse osmosis (RO) plant. The study will break down all the different streams of wastewater entering the treatment plant and determine which streams will be suitable for reuse without pre-treatment, and what technology is available to further treat the wastewater, post DAF treatment, to a point that it can be put back through the RO and made potable again.

3.0 Project Objectives

Midfield currently process 1,200 cattle and 8,000 small stock per shift. Each shift is 7.6 hours in duration and both species have dual chains, operating over the same single shift. Midfield's has a strategic intent to increase this to 2,000 and 14,000 respectively, over two shifts, with the second shift designed, where possible, to attract a new labour force non-typical of the current single shift labour force (for example, primary care givers).

To achieve this vision Midfield are undergoing an entire site wide innovation program to debottleneck the process (from livestock receivals to cartons leaving the facility), reduce waste leaving the site (including being more resource/services efficient), and to change the nature of the work to both reduce the per head/hour labour requirement (as a KPI) and ensure that those resulting jobs are designed in a way to be open to both a wider physical stature workforce and hours of operations that suit varying employment demographics within the available labour pool draw.

Current Situation

Although Midfield has invested heavily over the past 10-15 years in reducing, reusing, and treating liquid waste on site, Midfield still considers itself a high waste producer. Midfield believes that although they have extracted

benefits from the standard industry approach to reducing liquid waste it is time for a complete change in mindset about how to eliminate waste with an aim to be a zero-waste emitter.

Whilst work to date is leading Midfield in the right direction, Midfield have come to a point where simply reducing consumption has become difficult due to the nature of our business and the requirements Midfield must adhere to. Therefore, Midfield must look to innovation and design specific to Midfield's unique waste streams to enable Midfield to meet their target of zero waste.

Through the reduce, reuse and recycling scheme Midfield is committed turn our waste produced into commodities and adapting a circular economy business plan to ensure sustainability of the company.

Past Improvement Programs

- In three years, wastewater has reduced from 8.3L per kg of meat produced to 5.4.
- Midfield has halved its waste to landfill in just over a year.
- Cardboard has been redirected from landfill to compost and,
- Paunch is pressed and sent to compost.

Midfield's daily waste footprint is characterized as:

- 2.2ML of wastewater,
- 1100kg of general waste (predominantly plastic),
- 500kg of waste cardboard and
- 20ton of paunch

This is likely to only increase as the site's processing capacity reaches its new targets over the next few years. Whilst these figures appear high, through the work of dedicated staff, Midfield has reduced its waste outputs significantly.

- In three years, wastewater has reduced from 8.3L/kg of meat produced to 5.4.
- Even with the inclusion of plastic film, which was going to the recycling industry but was rejected when China closed its doors to Australian waste, Midfield has halved its waste to landfill in just over a year.
- Cardboard, which again has been rejected by the recycling industry, has been redirected from landfill to compost and,
- Paunch is filtered from the wastewater stream, which has improved the quality of Trade Waste, is pressed, and sent to compost.

With the construction of the new 260kL Reuse Water tank, treated water which is currently being drawn from aquifers or municipal supplies and then used in areas that does not require potable water can be replaced with water captured and reused from process. This will again reduce Midfield's water demand and wastewater production.

This Stage

This stage will take the time to reclassify the current wastewater streams at Midfield to develop a new zero wastewater discharge strategy. This Stage will also include reviewing and evaluating (desk top study) current technologies for inclusion in the strategy, that have not been previously considered by industry.

Intended Situation

Midfield's wastewater is treated through a DAF system. The intent is to further treat the water to a point that it can be used safely for irrigation purposes or to be put back through our RO system and chlorinated to ensure potability. At this point, with approvals from DAWR, Midfield would be able to reuse the water in all areas of production.

At the completion of this study (Stage 1) Midfield will have an accurate profile of our wastewater stream that we can take to companies who can then suggest a treatment system specifically designed to Midfield (and wider industry) needs.

After reclassification of current liquid waste streams implement a zero waste (liquid) strategy that incorporates further treatment for reuse through:

- Irrigation
- Livestock drinking water
- Put through existing RO Plant and recycled back into production

Objectives

- Classification of liquid wastes, along with review of available global handling/treatment solutions.
- Zero Waste (liquid) Strategy and budget, and a Stage 2 submission for R&D components of the Strategy.

4.0 Methodology

Classification of Wastewater Streams

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5.0 Project Outcomes

Classification of Wastewater Streams

Several meters were placed on all incoming and outgoing water streams on all floors. An example of this can be seen in figure 1. This supplied monitors with full access of water usage on each floor.

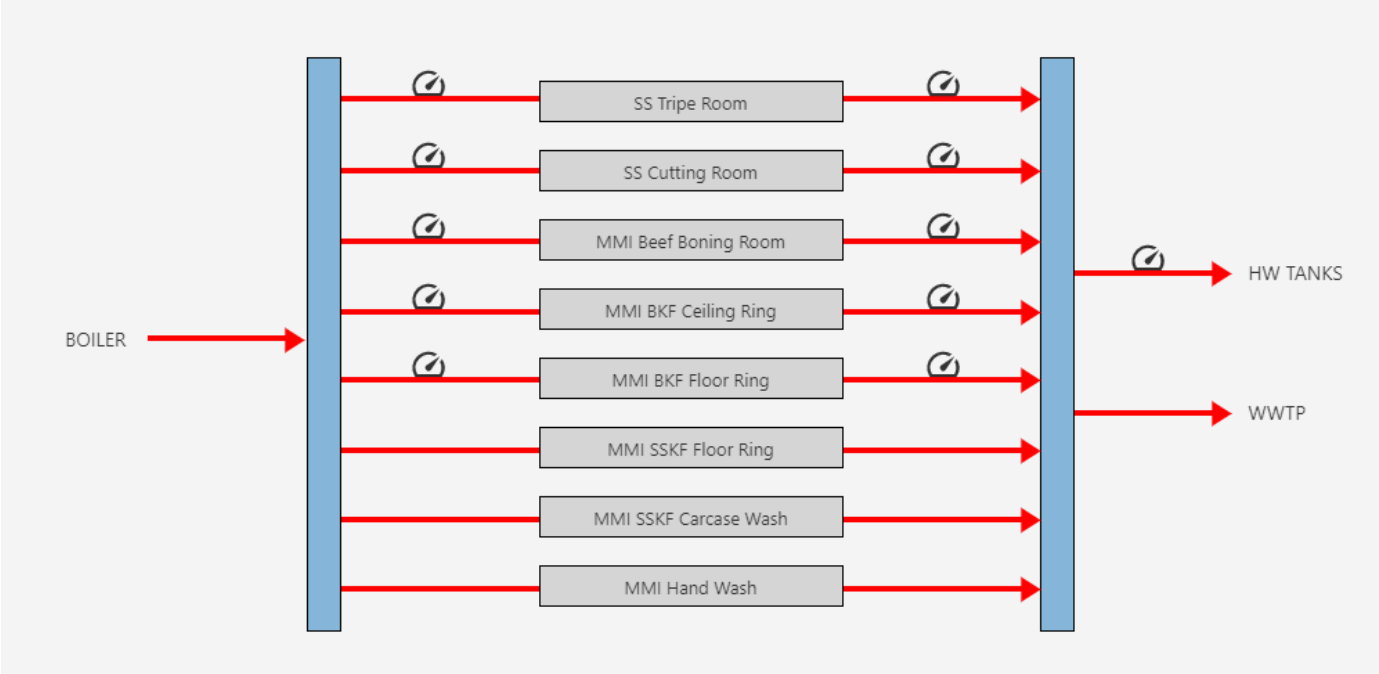

Figure 1. Hot water in and out of MMI complex

Wastewater Quality Profiling

Over several weeks daily composite samples were taken from specific streams and analysed for BOD, TSS, Ammonia and Conductivity. From this an average quality was able to be determined (tables 1).

Table 1. Average wastewater results from several streams inside the processing facility

Stream	BOD (mg/L)	TSS (mg/L)	Ammonia (mg/L)	Conductivity (µS/cm)
Steriliser Water	17	25	3	240
Hot wash cabinet water	15	15	2	160
Pre-treatment Wastewater	1500	17000	72	9000
DAF Treated Wastewater	740	450	30	14227

The results show that the Steriliser water and hotwash water are of a quality which is suitable for capture and reuse on site, where non potable water can be used, without any further treatment.

The DAF results show that the treatment system in place is reducing the organic and suspended solid load significantly. This bring the wastewater to a point where it is ideal for tertiary treatment.

Development of a Zero Wastewater Disposal Strategy

Membrane Bioreactor

The preliminary results in table one show that the DAF treated water fall within the feed water requirements for an MBR system. This is a straightforward approach and would be expected to produce high quality water post treatment.

Table 2. Ideal water conditions for MBR system

Component	Units	Feed Water	Treated Water
pH	pH	5.5 to 8.5	**6.0 to 9.0**
Oil & Grease	mg/L	20	**<1.0**
TSS	mg/L	600	**<10**
BOD	mg/L	1000	**20**
COD	mg/L	2000	**50**
Total Nitrogen	mg/L	200	**10**
Total Phosphorous	mg/L	35	**10**
Temperature	°C	35 - 55	**35 - 55**

Titanium Membrane Filtration

A titanium membrane filtration system has recently undergone trials and a rendering facility that found it reduced 98% of the suspended solids from the wastewater stream. In discussion with the company providing the technology it is believed that it would also be able to filter a significant amount of other contaminants such as BOD, oil and grease and sodium.

This technology is a true R&D project. It has never been tested in a meat processing facility and whilst the technology is sound it requires vigorous testing.

6.0 Discussion

Classification of Water Streams

Installing the meters on the water supply and return streams allowed Midfield to determine how much water was being consumed on each floor. The data collected was trended and enabled the monitoring team to set up minimum and maximum consumptions volumes per hour. If at any point the meter recorded above the maximum for an extended period of time the monitoring group is now alerted to the issue and can resolve quickly, minimalizing any unnecessary waste.

Since the integration into the ignition program several areas have been highlighted as “problem” areas in which need to be focused on for repairs or water reduction techniques.

Water Quality Profiling

The results of the water quality testing allowed Midfield to determine that there were several capture points that would be ideal for reuse on site without further treatment. There were several opportunities for using reuse water, such as pen wash down, initial cattle rinse and yard rinsing. Capture points were put in place to capture “clean” wastewater streams and redirect them to areas where then could be used. This took Midfields daily wastewater volume down from 2.2ML each day to 1.8ML. This is a significant reduction in volume which equated to a large savings in trade waste charges.

Development of Zero Wastewater Disposal Strategy

Midfield engaged HydroScience, a water treatment company specialising in MBR technology. As this technology is off the shelf the cost analysis was fairly straight forward. The facility recommended (Figure 2.) had a design capacity of 2.ML per day. This allowed for future growth of the company. The set up involved serval a holding tank, an anerobic tank, an aerobic tank, and the membrane filtration container.

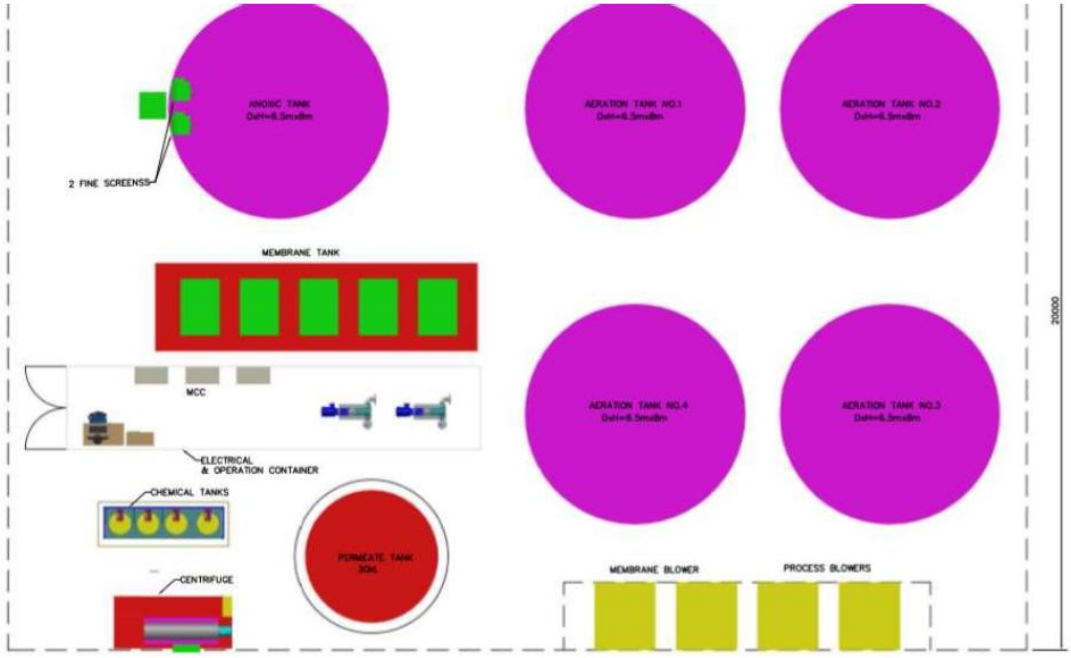

Figure 2. MBR treatment plant – general layout

The process in with the water is treated to the aforementioned quality (table 2) can be seen in figure 3. Once the water has completed the DAF treatment it entera a holding tank in order to control the flow into the screening processes. Once screened the water undergoes biological treatment and finally filtered through the membranes.

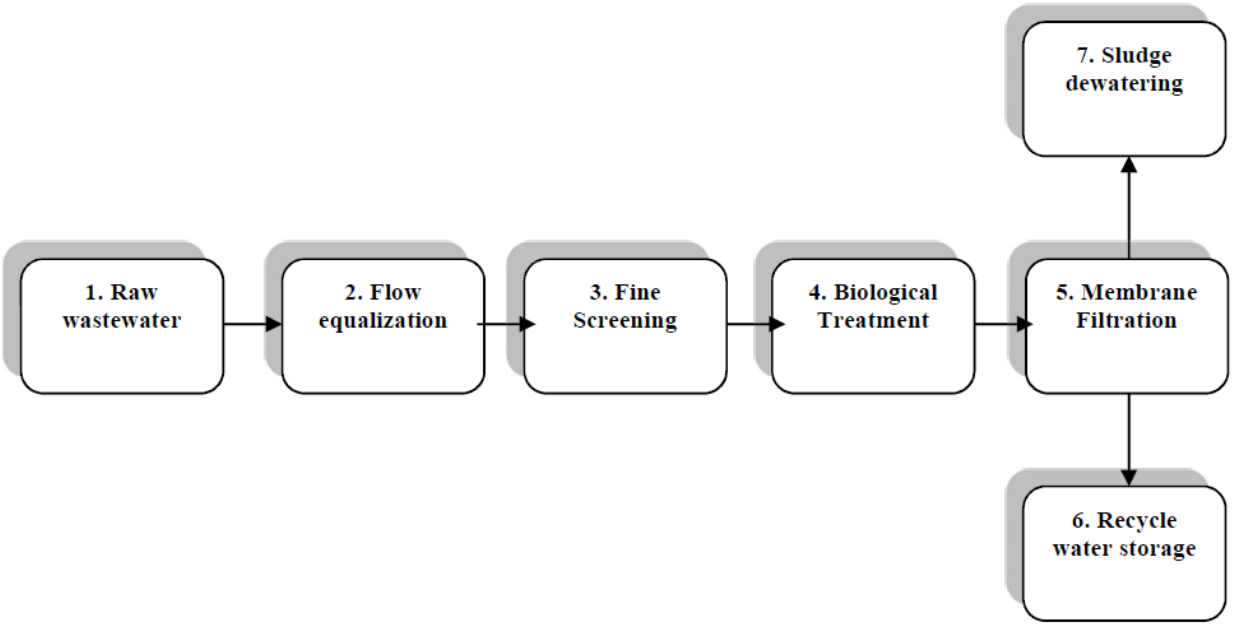

Figure 3. MR process flow chart

This technology is not new. It has been trialled and testing in similar processing facilities and is used overseas. Constructing and implementing and MBR water treatment plant requires large capital costs and available footprint.

The Midfield Facility is located in an industrial area which is surrounded by residential buildings and is therefore confined by boundaries. Whilst an MBR would work at this facility the footprint requirements are high.

Titanium Membrane Filtration

As there is no precedent set for what would be expected from this technology when treating meat processing wastewater, a trial conducted using this technology would be completely R&D. There have been promising trials completed where the removal of contaminants has been significant which give confidence in the technology.

Midfield proposes to undergo a considerable trial testing the titanium's capabilities on several different streams of the processing facilities wastewater from the dirtiest untreated was water to the cleanest captured reuse water. This will enable us to fully understand the unit's capabilities and determine where it might sit best in the treatment process.

Below is a set of 4 trials that midfield wishes to complete with costings associated. The data collected from the four trials would be analysed and used to put together the next steps to Midfields Zero Wastewater Disposal Strategy.

Trial 1, Abattoir Effluent Post Balance tank **$ 59,538.00**

Potential to replace DAF Treatment (chemical cost)

Item Description	Amount	Quantity	Total	Comments
Titanium Unit Hire (weekly)	$ 4,670.00	4	$ 18,680.00	Hire includes technical support & 1 week changeover
Titanium Unit set up and connections	$ 1,850.00	1	$ 1,850.00	
Trial Supervision	$ 6,475.00	4	$ 25,900.00	Includes checks and recording parameters and water sampling
Analysis Weekly	$ 682.00	4	$ 2,728.00	SS and BOD on in and out weekly test
Analysis Fortnightly	$ -	0	$ -	
Report	$ 8,880.00	1	$ 8,880.00	
Other Miscellaneous CIP etc			$ 1,500.00	

Trial 2, Recycled Water **$ 32,274.00**

Item Description	Amount	Quantity	Total	Comments
Titanium Unit Hire	$ 4,670.00	2	$ 9,340.00	Hire includes technical support & 1 week changeover
Titanium Unit set up and connections	$ 1,200.00	1	$ 1,200.00	
Trial Supervision	$ 6,475.00	2	$ 12,950.00	Includes checks and recording parameters and water sampling
Analysis Weekly	$ 682.00	2	$ 1,364.00	
Analysis Fortnightly	$ -	0	$ -	
Report	$ 5,920.00	1	$ 5,920.00	
Other Miscellaneous CIP etc			$ 1,500.00	

Trial 3, Abattoir effluent post DAF **$ 21,129.00**

Item Description	Amount	Quantity	Total	Comments
Titanium Unit Hire	$ 4,670.00	1	$ 4,670.00	Hire includes technical support & 1 week changeover
Titanium Unit set up and connections	$ 1,200.00	1	$ 1,200.00	
Trial Supervision	$ 6,475.00	1	$ 6,475.00	Includes checks and recording parameters and water sampling
Analysis Weekly	$ 682.00	2	$ 1,364.00	
Analysis Fortnightly	$ -	0	$ -	
Report	$ 5,920.00	1	$ 5,920.00	
Other Miscellaneous CIP etc			$ 1,500.00	

Trial 3, Storm Water **$ 21,129.00**

Item Description	Amount	Quantity	Total	Comments
Titanium Unit Hire	$ 4,670.00	1	$ 4,670.00	Hire includes technical support & 1 week changeover
Titanium Unit set up and connections	$ 1,200.00	1	$ 1,200.00	
Trial Supervision	$ 6,475.00	1	$ 6,475.00	Includes checks and recording parameters and water sampling
Analysis Weekly	$ 682.00	2	$ 1,364.00	
Analysis Fortnightly	$ -	0	$ -	
Report	$ 5,920.00	1	$ 5,920.00	
Other Miscellaneous CIP etc			$ 1,500.00	

7.0 Conclusions / Recommendations

From this study it was seen that the benefits of installing an integrated monitoring system which can be monitored and trended has upfront financial benefits. Understanding the quality of each stream and being able to capture specific wastewater streams for reuse can decrease the volume of wastewater going to trade waste significantly which also has a financial benefit.

Midfield believe that the best strategy to follow to achieve their ZWD goal is to complete a trial using Titanium Membrane technology which is an innovate approach yet to be seen working in the meat industry. The trial would cost approximately $134,000 to complete and would leave Midfield and industry with a clear pathway forward.

ZWD is the way forward which industry as a whole must adopt in order to ensure its sustainability as an industry.

8.0 Bibliography

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