final report

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Prepared by: Micheal Fogarty
Katestone Environmental Pty Ltd

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Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Development of a prototype odour test rig concept to characterise and manage odour

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Abstract

An Australian red meat processor has a strategic business imperative to increase production and move towards seven-day beef production. Current waste stream management are at full capacity. The processor is adopting a number of initiatives in waste management to accommodate their business strategy for ramped production. The first initiative will map current odour emissions and develop new standard odour monitoring procedures to allow the processor to proactively manage their odour emissions. Therefore, it is envisaged that the company requires access to tools and their own capabilities to determine odour emissions rapidly and repeatedly to be used routinely to manage odour emissions as production is ramped up over time. This project proposed to quantify odour emissions from odour sources including waste water ponds used in beef processing using a prototype test rig calibrated against standardised odour sampling test methods (i.e. tested off site in laboratories). This project was also designed to develop internal company skills and capabilities within the company to manage odour emissions using a simple, repeatable and real-time odour test method. This method may also be adopted as a standard method for odour sampling from aerators in other waste water treatment systems in meat processing across Australia.

The aim of this study was to determine the odour emission rates from various parts of the Waste Water Treatment Plant (WWTP) at a processing plant in South East Queensland. A test rig was designed, built and commissioned at a red meat processing site (see Photo 1). The use of the test rig in this application demonstrated the emission rate from additional aerators can be managed cost-effectively with real time test methods and capabilities without having to outsource capability and external test methods when production is ramped up. This project also demonstrated that internal company skills and capabilities were developed at the company to manage odour emissions using a simple, repeatable and real-time odour test method.

Photo 1: Test odour rig designed, built and commissioned at a processing site

Executive Summary

Current waste stream management at a SE Queensland processing plant is at full capacity. The processor is adopting a number of initiatives in waste management to accommodate their business strategy for ramped production. The first initiative will map current odour emissions and develop new standard odour monitoring procedures to allow a processor to proactively manage their odour emissions. Therefore, it is envisaged that the processor requires access to tools and their own capabilities to determine odour emissions rapidly and repeatedly to be used routinely to manage odour emissions as production is ramped up over time.

This project proposed to quantify odour emissions from odour sources including waste water ponds used in beef processing using a prototype test rig calibrated against standardised odour sampling test methods (i.e. tested off site in laboratories). The project involved:

- Baseline measurement of current odour emissions from specified odour sources including waste water ponds at a SE Qld beef processing site
- Build a prototype test rig (from specification and engineering drawings developed through extensive internal research)
- Commission the prototype test rig to validate aerobic pond emissions
- Collect data to quantify the accuracy of the test rig
- Provide recommendations for a commercial odour test rig suitable for meat processing
- Access to managed tools and capabilities that can be used as required to demonstrate compliance in influent and odour management
- Data to support upgrade of existing aerobic ponds or invest in alternative effluent management technologies for ramped production rates

The current project successfully proved a test rig pilot could be used to routinely measure factory odour sources including located over the aerobic waste water ponds. The use of the test rig in this application demonstrated the emission rate from additional aerators can be managed cost-effectively with real time test methods and capabilities without having to outsource capability and external test methods when production is ramped up. This project also demonstrated that internal company skills and capabilities were developed at a red meat processor to manage odour emissions using a simple, repeatable and real-time odour test method. Development of a test rig has been proven to allow a processor to determine the feasibility to utilise aerobic water treatment technology at the future site (i.e. increased water throughput could require extra aerators if the pond size and loadings are increased). It is proposed that this method may also be adopted as a standard method for odour sampling from aerators in other wastewater treatment systems in meat processing across Australia.

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1 Background

A SE Qld red meat processor has a strategic business imperative to ramp up production and transition towards seven-day beef production. Currently odour emission rate from an emission source is measured by the odour concentration and an air flow rate. The Queensland EHP's Guideline: Odour Impact Assessment from Developments (EHP, 2013) (Odour Guideline) specifies odour sampling and analysis methodologies that are recommended for use in Queensland. The concentration of odour in an air sample is determined by olfactometry using AS4323.3:2001. The standard describes the equipment and method used to collect the sample and analyse for odour concentration.

The flow rate of an odorous air stream that is carried through vents and ductwork and emitted through a stack is relatively easy to measure. AS4323.3:2001 cross-references other Australian Standards that are relevant for the determination of air flow rate. In most circumstances, these standards are easy to implement provided there is appropriate access to sampling locations. The flow rate of odorous air from an aerial fugitive emission source (e.g. a pond) can be measured using AS4323.4:2009. This standard uses a clear plastic dome (40cm in diameter and 28cm in height; also known as a "flux hood") placed over part of the emitting surface. It is therefore not practical to adopt AS4323.4:2009 to measure emissions from the aerator, because the flux hood is too small and no seal can be maintained to ensure only emissions from the aeration zone are collected.

There are currently no approved standard testing procedures available for measuring or sampling odour emissions from waste water ponds with aerators used in meat processing. The proposed test rig is based on techniques incorporating aspects of both approved point source and area source sampling methodologies. By using this test method, it is proposed that the rig will provide the most accurate measurement of aerator emissions as it is a direct measurement technique of a single aerator. The method would then allow a processor to regularly test the odour from the aeration systems to maintain the odour inventory for the site.

2 Project Objectives

The overall objective of the project was to determine the odour emission rates from various parts of the WWTP at a SE Qld beef processor's facility. The current project proposed to develop and evaluate a prototype test rig concept for characterising odour at specified processing points to assist with the management of odour emissions from various point odour sources including aerobic ponds used in beef processing.

Specific deliverables included assessment and reporting of:

- the odour footprint of the site in its current format (i.e. baseline odour measure);
- the proportion of pond and site emissions that are due to the aerators;
- the feasibility to utilise aerobic water treatment technology at the future site (i.e. increased water throughput could require extra aerators if the pond size and loadings are increased).
- the sample collecting test rig and its suitability/ acceptability as standard test method for meat processing sites utilising aerobic ponds.

3 Methodology

The engineering drawings and specifications for the pre-production prototype test rig have been developed by a processor in consultation with an odour emissions provider. As there is no other methodology specified in the Odour Guideline, the processor proposed to develop a prototype test rig through an extensive literature review and in consultation with stack testers. The proposed methodology involves enclosing the entire source, inducing an air flow through a duct and measuring the odour emission rate as a point source emission rate in the duct. The airflow rate across the enclosed aerator should be maintained at 12 air changes per hour, which is the same number of air changes that occur in a flux hood.

A similar test rig design using enclosure methodology has been applied to determine the emission rates of odour from cooling moulds at a pilot foundry plant where highly accurate quantification of emission was required to design a ventilation stack. The design has not been tested in a commercial meat processing environment outside a controlled test room. This method was adopted as there was no other accurate way identified to directly sample the volume sources that were venting emissions in the building.

The following process was implemented:

Stage 1: Completion of site visit and documentation of sampling plan. A preliminary draft report on scoping study and odour emissions inventory submitted for approval

Stage 2: Initial benchmarking testing and characterisation of odour samples from the aerated waste water ponds using laboratory testing methods. Preliminary draft report submitted on odour analyses benchmarked against other companies / industries.

Stage 3: Build initial prototype odour test rig using specifications and engineering drawings in the processor's workshop. Submit draft report for approval.

Stage 4: Transfer and commission test rig from the processor's workshop to the aerator ponds using a Franna crane. Submit video of equipment and draft report for approval.

Photo 2: Crane lifting the pilot test rig in place over the aerobic ponds

Photo 3: Pilot test rig located in place over the aerobic ponds

Photo 4: Setting up exhaust extraction fans for collection of odours.

Photo 5: Pilot test rig setup over the aerobic ponds ready for odour collection.

Stage 5: Collecting data and validation of test rig on odour samples from a range of specified odour generating sites in beef processing against standard laboratory methods. Preliminary draft report submitted for approval.

Stage 6: Submit final report including:

- Benchmark odour data design
- Prototype test rig engineering drawings and specifications
- Validation data using test rig from specified sites including ponds
- Recommendations on development and implementation of a commercial test rig system
- Provider to also submit a final report for public release.

4 Odour Sampling Plan – Wastewater Treatment

4.1 Wastewater

The aim of this study is to determine the odour emission rates from various parts of the WWTP at a SE Qld beef processing facility.

There is no standard test methodology for the assessment of emissions from the onsite surface aerators. This sampling program will attempt to derive emission factors for the aerators based on the rate of water throughput of the aerator at the time of sampling and the following locations.

Table 1: Sample locations.

Sampling location	**Number of Samples**	**Importance of sample**
Initial Screen and Bin	1	High
Aeration Pond 1	3	High
Final Clarifier	1	Low
Sludge Press	1	Medium

4.1.1 Initial Screen and Bin (Source 1)

Sampling location: Enclose the entire structure, extract air and take an odour sample
Requirements:

- Enclosure and sample extraction point

Worst case conditions:

- Warm rendering water and lairage water entering the screen

Reasons for sampling:

- This is the first point of the wastewater treatment plant with raw odorous wastewater exposed to the environment. This is a potential source of significant odorous emissions
- The character of the odour observed here was of manure, which could contribute offsite odour impacts associated with of manure odour if plumes with similar odour character mix together[1]
- Screened odorous material is stored here

Sample conditions and time:

- Sample when warm rendering water and lairage water is being passed through the system

Standard Methodology and proposed methodology

The Initial screen and bin is a volume source of odour for which there is no standard sampling methodology because:

- Emissions from this source are not captured and vented
- This is not a source that can be sampled using the standard flux hood methodology applied to area sources of odour

As there is no standard methodology for sampling such a source the proposed methodology has been developed to produce an adequate representation of odorous emissions from this source.

4.1.2 Aeration Pond 1 (Source 2)

Sampling locations:

- From an enclosure around the aerators
- On an area of the exposed wastewater that does not have foaming
- On an area of the foamed material

Requirements:

- Enclosure of a single aerator with a hood containing inlet air ducts and a single outlet duct as per drawing *"pond aerator odour sampling hood indicative test rig layout rev130515.pdf"* to determine the emission rate from the onsite aerator when operational
- Enclosure of a single aerator with a hood containing inlet air ducts and a single outlet duct as per drawing *"pond aerator odour sampling hood indicative test rig layout rev130515.pdf"* to determine the emission rate from the onsite aerator when

[1] The impacts from odour plumes with different odour character (e.g. odour with rendering and manure character) are not additive when the plumes mix. When plumes with different odour character mix, the overall odour concentration could remain similar, drop or increase. Regulatory guidance in Queensland states that plumes with different odour character should be assessed in isolation. During site visits by Katestone engineers the odour perceived from sources such as the lairage and sources at the WWTP had a perceived manure odour. These sources are likely to produce plumes that when mixed are additive (i.e. the total impact is the sum of the odour concentration from each plume from the sources with similar odour character.)

non-operational – to determine the odour emission rate from the non-foamed surface area of the pond
- Enclosure of an area of the pond that contains a foam covering to determine the odour emission rate from the foamed area
- Odour emission sampling from each of these sources of odour

Worst case conditions:

- The odour emission rate from the pond is likely to fluctuate during the week with nutrient loading (falling at the weekend and rising to equilibrium once operations commence after the weekend shutdown). It is likely that equilibrium of nutrient loading would be reached by Wednesday with loading remaining steady until the weekend. The equilibrium nutrient loading is likely to result in relatively stable odour emission rates. The sample from the aeration pond should therefore be taken from Wednesday onwards when nutrient loading and odour emission rates are relatively stable.

Reason for sampling

- There was a strong manure odour detected when standing immediately downwind of this pond
- Due to the surface area exposed to the atmosphere it is appropriate to sample this source and quantify the emissions
- This source is the closest odour source to neighbouring properties

Sample conditions and time:

- Sample from Wednesday onwards

Standard Methodology and proposed methodology

The aerators in Aeration Pond 1 are volume sources of odour for which there is no standard sampling methodology because:

- Emissions from these sources are not captured and vented
- This is not an area sources that can be sampled using the standard flux hood methodology applied to area sources of odour as the water is splashed through the air to induce aeration

The proposed methodology of covering and sampling is therefore considered to produce the most appropriate and accurate representation of odorous emissions from this source.

The standard methodology for sampling the odours from the foam covered and non-foam covered areas of the pond would involve sampling using a flux hood. This may not be practical due to the depth of foam which would likely fill the flux hood and interfere with the airflow through the hood.

The proposed methodology would involve moving the aeration hood over:

- a foam covered area of the pond
- an area of the pond with no foam cover
- and measuring the odour emission rate.

To produce a comparable result to standard methodology the number of air changes from the induced airflow should be similar to that achieved by a flux hood (i.e. 12 air changes per hour).

The proposed methodology should provide a more representative odour emission rate when compared to the flux hood method as a substantially greater area is enclosed using this

method. The measured odour emission rate therefore provides an indication of the odour emission rate from a larger and therefore more representative area of Aeration Pond 1.

4.1.3 Final Clarifier (Source 3)

Sampling location: A flux hood sample would be taken from the surface of the clarifier
Requirements:

- Flux hood sample

Worst case conditions:

- It is likely that this source would have minimal variation in odour emission rate as water is constantly added from the second aeration pond. The sample is likely to be taken from Wednesday onwards

Reason for sampling:

- A distinct manure odour was detected in the immediate vicinity of the final clarifier

Sampling locations:

- From the surface of the clarifier

Sample conditions and time:
From Wednesday onwards once the WWTP has reached steady state
Standard Methodology
The methodology used to sample this source follows the standard methodology

4.1.4 Sludge Press (Source 4)

Sampling location: Enclose the entire structure, extract air and take an odour sample

Requirements:

- Enclosure and sample extraction point

Worst case conditions:

- Maximum through put of Sludge (Determine if the amount of sludge is a function of the day of the week – e.g. more sludge on a Friday, Less on a Monday)

Reason for sampling:

- This source is a potential source of odour as the sludge is concentrated from the wastewater and all passes through this single location

Sampling locations:

Outlet vent from the enclosed structure

Standard Methodology and proposed methodology

The sludge press is a volume source of odour for which there is no standard sampling methodology because:

- Emissions from this source are not captured and vented
- This is not a source that has area sources that can be sampled using the standard flux hood methodology applied to area sources of odour

As there is no standard methodology for sampling such a source the proposed methodology is considered to produce an adequate representation of odorous emissions from this source.

4.2 Test Rig Design

4.2.1 Overall design concept

The test rig for sampling is illustrated in “pond aerator odour sampling hood indicative test rig layout rev130515.pdf” (See Figure 1 & Photo 6).

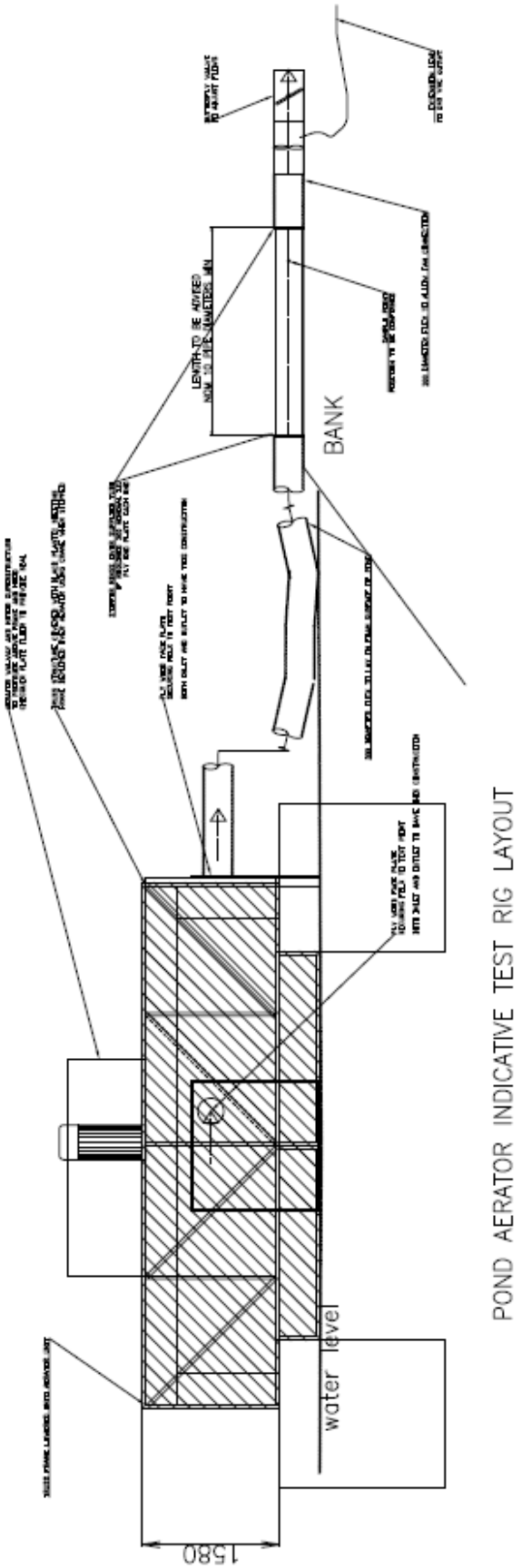


Figure 1: Drawings & specification (Overall design)

The requirements of an ideal sampling plane in accordance with the requirements of ASTM 4323.1 (1995) (Standards Association of Australia 1995, AS 4323.1–1995: Stationary source emission method 1 – selection of sampling positions) are as follows:

The sampling port should be in a straight section of pipe with the following consideration incorporated into the design:

- A minimum distance upstream from a bend, junction, connection or direction change of >2 Diameters (600 mm based on a 300mm duct)
- A minimum distance downstream from a bend, junction, connection or direction change of >6 Diameters (1,800 mm based on a 300mm duct)
- A minimum distance upstream from a louvre, butterfly damper(partially closed or closed) of >3 Diameters (900 mm based on a 300mm duct)
- A minimum distance downstream from a louvre, butterfly damper(partially closed or closed) of >6 Diameters (1,800 mm based on a 300mm duct)
- A minimum distance upstream from an Axial Fan of >3 Diameters (900 mm based on a 300mm duct)
- A minimum distance downstream from an Axial Fan of >8 Diameters (2,400 mm based on a 300mm duct)
- A minimum distance upstream from a Centrifugal Fan of >3 Diameters (900 mm based on a 300mm duct)
- A minimum distance downstream from a Centrifugal Fan of >6 Diameters (1,800 mm based on a 300mm duct)

If the sampling port is in a pipe that is 10 diameters (i.e. 3,000 mm then an Ideal location for the sampling port would be at 2,400 from the start of the pipe and 600mm from the butterfly fan and fan. This will ensure that the port is suitable for sampling as it is >6 diameters downwind of a junction and is >3 diameters upwind of the butterfly damper and fan.

The sampling port should be at least 2.5 inches in diameter.

Photos 6: Crane locating test rig in place over the aerobic ponds.

4.2.2 Test Rig Fan

Based on test rig dimensions in “stockyard odour sampling indicative test rig rev130515.pdf” and a height of 1,880 mm, the volume of the test rig is 147.5 m^3. The test requirement is for 12 Air Changes Per Hour (ACPH). The fan used to draw air across the aerator will require and air flowrate of 1,770 m^3/hr (147.5 m^3 x 12 ACPH)

The proposed fan has a design capacity of 3,600 m^3/hr at a static pressure of 345 pa. The capability of this fan appears sufficient for the testing purposes. The capacity of the fan will be tested in the workshop prior to the testing campaign on the pond (See Figure 2).

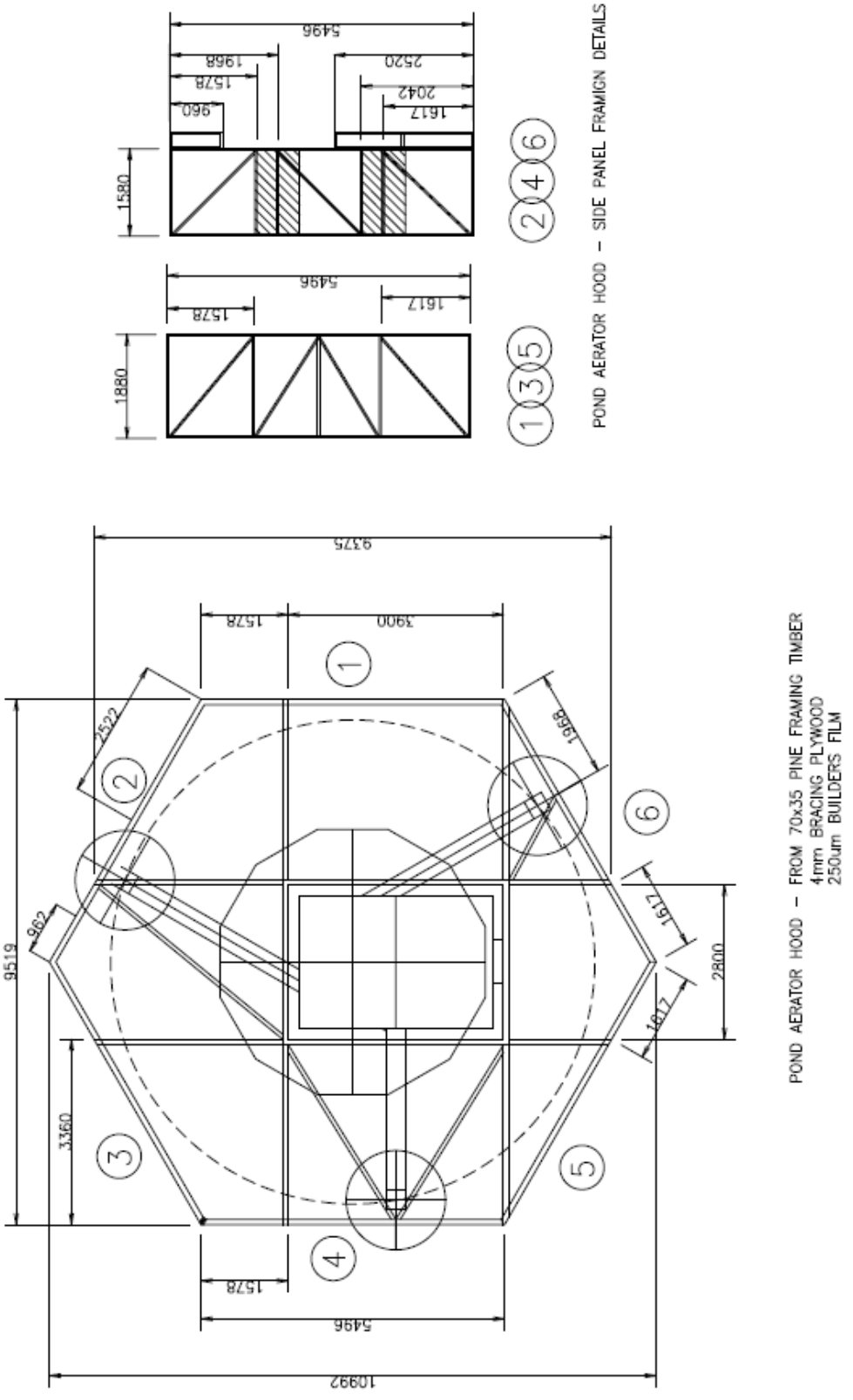


Figure 2: Drawings & specification (Pond Aerator Hood)

5 Results & Discussion

Katestone Environmental Pty Ltd (Katestone) was commissioned to derive an odour emissions inventory for a red meat processor in Queensland. This memorandum provides a summary of recent odour sampling of two aeration ponds that was conducted at the processing facility.

There are two aeration ponds at ponds at the Facility:

- A 6.5 mega-litre aeration pond with four surface aerators
- A 3.5 mega-litre aeration pond with two surface aerators.

Untreated wastewater from the lairage area (manure mixed with cleaning water) and rendering plant (stick water) is gravity drained from the Facility into the 6.5 mega-litre pond. The 6.5 mega-litre pond and the 3.5 mega-litre pond are linked by an underground channel that allows water to move freely between the ponds. Consequently, it is likely that the water in the 6.5 mega-litre pond contains more concentrated waste than the water in the 3.5 mega-litre. The 6.5 mega-litre pond was therefore sampled to provide a worst-case estimate of emissions.

The aerators consist of an electric motor and propeller suspended at the surface of the pond by large floats. The pond is aerated by the electric motor causing the propeller to rotate and disturb the surface creating a splash zone in the vicinity of the aerator. Surface aeration entrains air into the wastewater by agitation to increase the rate at which oxygen dissolves into the wastewater. Aeration also increases the rate at which odorous compounds in the wastewater volatilise. The aerators generate a foam that drifts and concentrates at the edge of the pond. As a consequence of the aerators, there are three odour emitting zones in the aerated ponds:

- Foam covered area
- Foam free area near aerator
- Disturbance zone.

Katestone staff conducted a number of site visits in December 2014 to determine the extent of odour sampling required to derive an emissions inventory for the facility. Katestone observed that the wastewater ponds, cattle trucks and lairage areas produced odour that can be readily identified as cattle manure in close proximity to these sources. According to the Queensland the Department of Environment and Heritage Protection's Guideline – Odour impact assessment from developments (Queensland Odour Guideline), odours of similar character are additive when determining downwind odour concentrations. Consequently, it is important that the emissions inventory is based on reliable measurements of each of these sources.

Odorous chemicals are released at the liquid-air interface at the surface of the ponds and at the liquid surface interface of the water droplets created in the splash zone of the aerators. The Queensland Odour Guideline provides the standard methodologies to sample area sources where there is little or no outward flow. According to the Queensland Odour Guideline the standard methodology for area source sampling and monitoring is the Flux Hood (Australian/New Zealand Standard AS/NZS 4323.4:2009 Stationary source emissions –Method 4: Area source sampling – Flux chamber technique). However, the Flux Hood is

not suitable for quantifying odour emissions from surface aerators because the splash zone is substantially larger than the Flux Hood. Equally the foam covered areas cannot be sampled using the Flux Hood because it is too heavy and would sink into the foam resulting in confounding results. Turbulence in the vicinity of the aerators is likely to hinder a flux hood measurement of the free water surface.

Katestone concluded that an alternative to the standard method was required to accurately measure the odour emission rate from the ponds.

A review of publically available literature indicated that there were no direct measurements of the odour emission rates associated with the surface aerators of wastewater treatment ponds.

Katestone devised an alternative method that involved enclosing entirely the surface aerator and splash zone. A sample would be collected by drawing air through the enclosure and into an outlet duct, from where the sample would be collected. Inlet air would be drawn from an odour free location. The air flowrate through the enclosure would also be measured in the outlet duct.

The enclosure was designed and constructed in August 2015. It was designed to rest on the large floats that keep the aerators buoyant while also enclosing the aerator down to the surface of the pond. The enclosure was hexagon-shaped with each side 5.2 m in length. The enclosure was 2 m high with a total surface area of 71 m2.

Odour sampling took place on 27 August 2015. The hood was lifted into place and suspended over the surface aerator using a crane. Odorous air was extracted using a 300 mm diameter duct attached to two fans. The fans were switched on and allowed to run for 15 minutes to ensure that a number of air changes had occurred within the hood and, therefore, a steady state conditions had been achieved. The first sample was collected with the surface aerator operating. After the sample was collected, the surface aerator was switched off and the ventilation fan was left running for a further 15 minutes after which a second sample was taken. The second sample being representative of the odour emission rate from the foam-free surface area of the pond.

The crane then lifted the hood and suspended it on an area of the pond covered by foam. The fan was switched on for 15 minutes to allow a number of air changes to occur and steady state conditions to be achieved. A sample was then collected.

The results of the odour measurements are presented in Table 2.

Table 2 Odour emission rates from the aeration pond at a meat processing facility.

Source	Measured odour concentration	Measured odour emission rate	Specific odour emission rate
	ou	ou.m³/s	ou.m³/m².s
Surface aerator	147	71.5	1.0
Foam-free area	51.5	25	0.36
Foam covered area	<16	<7.85	<0.11

The results of the odour sampling show that the odour emission rate from the splash zone was approximately three times greater than the foam-free surface area. The foam covered areas of the pond had very low odour emission rates. The odour concentration measured from the foam covered areas was below the detection limit for the olfactometer.

The total odour emission rates from the aerobic ponds are presented in Table 3. The odour emission rates are based on:

- A splash zone area of 71 m² for each aerator (same area as the hood used to cover the aerator when sampling)
- Four aerators operating on the 6.5 megalitre pond
- Two aerators operating on the 3.5 megalitre pond
- A total surface area of 2,270 m² for the 6.5 megalitre pond
- A total surface area of 1,570 m² for the 3.5 megalitre pond
- Areas outside the splash zone were assumed to have an emission rate associated with a foam- free area.

Table 3 Total odour emission rates from the aerobic ponds

Pond	Source	Area (m²)	Odour emission rate (ou/s)
6.5 mega litre pond	Aerators (4)	281	286
	Pond surface	1989	708
3.5 mega litre Pond	Aerators (2)	1570	143
	Pond surface	141	509
	Total OER		**1651**

There are limited data from previous measurements from ponds at the facility for comparison with the pond odour emission rates measured for this study. A 2002 review of odour emissions by Katestone provides some insight into previous measurements of the ponds located at the facility. The previous Katestone review provided a specific odour emissions rate for an aerobic pond of 1.2 OUE/m³/m²/s. This is higher than any of the measurements taken as part of the current measurement campaign.

6 Conclusions/Recommendations

6.1 Summary of Findings

- The use of the test rig in this application demonstrated the emission rate from additional aerators can be managed cost-effectively with real time test methods and capabilities without having to outsource capability and external test methods when production is ramped up.
- The results of the odour sampling show that the odour emission rate from the splash zone was approximately three times greater than the foam-free surface area. The foam covered areas of the pond had very low odour emission rates. The odour concentration measured from the foam covered areas was below the detection limit for the olfactometer.
- Overall the test rig proved to be an effective and cost-effective means of collecting and measuring odours.
- It is proposed that this method may also be adopted as a standard method for odour sampling from aerators in other wastewater treatment systems in meat processing across Australia.

6.2 Commercialising the test odour rig

The prototype test rig was proven to be technically and commercially feasible, and therefore it is proposed that a technology trial be undertaken at the plant in the future. A commercialiser of the test rig is required to be engaged in to the project after this prototype stage is proven to be viable.

Note the processor has developed prior art in the form of concept design drawings and specifications for the proposed pre-production prototype odour test rig including cooling moulds and ventilation stack. The processor requires an exclusivity period of 6 months from the conclusion of the project prior to release of the test rig device to the wider industry.

7 Key Messages

The following are the key messages:

- This project proposed to quantify odour emissions from odour sources including waste water ponds used in beef processing using a prototype test rig calibrated against standardised odour sampling test methods (i.e. tested off site in laboratories). The project also delivered capability with handover of longer term skills and capabilities to the processor and the wider industry.

- The project was dual purpose to build capability and develop technology. This project developed internal company skills and capabilities within the company to manage odour emissions using a simple, repeatable and real-time odour test method.

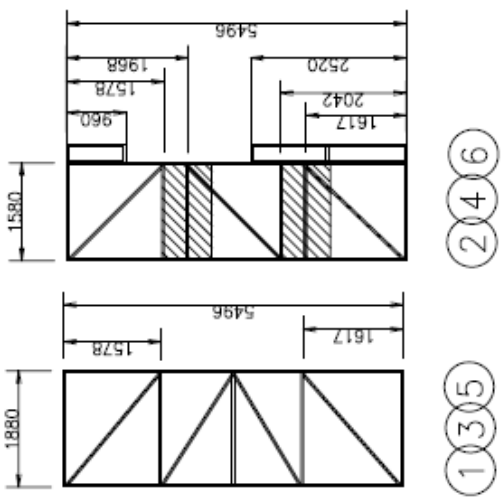
- The novel approach applied in this project to an odour measurement tool and capability made it eligible for R&D funding.

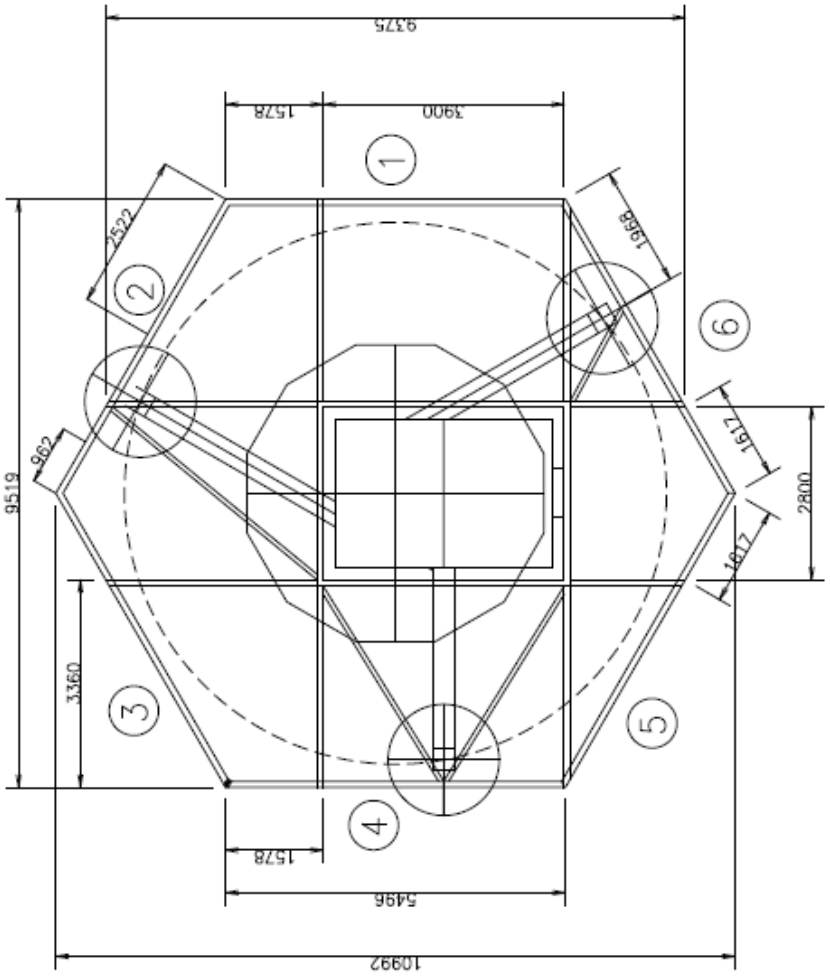
- Development of a test rig was to allow a processing company to determine the feasibility to utilise aerobic water treatment technology at the future site (i.e. increased water throughput could require extra aerators if the pond size and loadings are increased).

- This method is proposed to be adopted as a standard method for odour sampling from aerators in other waste water treatment systems in meat processing across Australia.

8 Appendix – Supporting Documents

8.1 Drawings & Specifications (Pond Aerator Hood)





8.2 Drawings & Specifications (Pond Aerator Indicative Test Rig Layout)